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MINERALS YEARBOOK

1957

Volume I of Three Volumes

METALS AND MINERALS (EXCEPT FUELS)

Prepared by the staff of the
BUREAU OF MINES
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UNITED STATES DEPARTMENT OF THE INTERIOR

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FOREWORD

MINERALS YEARBOOK, 1957, published in three volumes, provides a record of performance of the Nation's mineral industries during the year, with enough background information to interpret the year's developments.

Volume I includes chapters on metal and nonmetal mineral commodities, with the exception of the mineral fuels. Included also are a chapter reviewing these mineral industries, a statistical summary, and chapters on mining technology, metallurgical technology, and employment and injuries. An additional chapter in the 1957 volume I compares Bureau of Mines mineral-commodity production data for 1954 with those presented in the 1954 Census of Mineral Industries reports published by the United States Department of Commerce.

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

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

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

MARLING J. ANKENY, *Director.*

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

Alabama: Geological Survey of Alabama.
Alaska: Alaska Department of Mines.
Arkansas: Geological and Conservation Commission.
California: Division of Mines.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey.
Georgia: Geological Survey of Georgia.
Idaho: Bureau of Mines and Geology.
Illinois: Illinois State Geological Survey.
Indiana: Indiana Department of Conservation.
Iowa: Iowa Geological Survey.
Kansas: State Geological Survey of Kansas.
Kentucky: Kentucky Geological Survey.
Louisiana: Louisiana Geological Survey.
Maine: Geological Survey of Maine.
Maryland: Department of Geology, Mines, and Water Resources.
Michigan: Michigan Department of Conservation.
Mississippi: Mississippi Geological Survey.
Missouri: Division of Geological Survey and Water Resources.
Montana: Montana Bureau of Mines and Geology.
Nevada: Nevada Bureau of Mines.
New Hampshire: New Hampshire State Planning and Development Commission.
New Jersey: Bureau of Geology and Topography.
New York: New York State Science Service.
North Carolina: Geological Survey of North Carolina.
North Dakota: North Dakota Geological Survey.
Oklahoma: Oklahoma Geological Survey.
Oregon: State Department of Geology and Mineral Industries.
Pennsylvania: Bureau of Topographic and Geological Survey.
Puerto Rico: Mineralogy and Geology Section, Economic Development Administration.
South Carolina: Geological Survey of South Carolina.
South Dakota: State Geological Survey.
Tennessee: Tennessee Division of Geology.
Texas: Bureau of Economic Geology, The University of Texas.
Utah: Utah Geological and Mineralogical Survey.
Virginia: Division of Mineral Resources.
Washington: Division of Mines and Geology.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological Survey.
Wyoming: Geological Survey of Wyoming.

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

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

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

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

CHARLES W. MERRILL,
Chief, Division of Minerals.

CONTENTS

Review of the Mineral Industries[1]

(Metals and Nonmetals Except Fuels)

By William A. Vogely[2]

CONSUMPTION of nonfuel minerals dropped sharply in 1957; stocks increased substantially; production remained stable for the year as a whole, but dropped during the last quarter. This was the pattern of reaction of the nonfuel-minerals industry to the recession in general business activity that began at midyear.

Domestic production of metals and nonmetals (except fuels) increased slightly in 1957. Nonferrous-metal production, reacting to decreased consumption, dropped below 1956. Toward the end of 1957 the rate of production of all groups had declined.

The most significant aspect was the accumulation of large physical stocks at the end of 1957. Stability in production was achieved in the face of declining consumption only by accumulation of stocks. As the year closed, these stocks were a disturbing factor overhanging the mineral markets.

The value of nonfuel mineral production was less than in 1956 because of the declines in metal prices. Prices of cost items and the indexes of relative labor costs per dollar of recoverable metals for iron ore, lead-zinc ore, and copper-ore mining were higher than in 1956. Imports increased their share of the mineral markets.

The nondefense mineral programs supported domestic mining of asbestos, columbium-tantalum, Acid-grade fluorspar, and tungsten during 1957, and there was much policy discussion of the Administration's Long-Range Minerals Program. This program called for exploration assistance to all minerals, import tax assistance for lead and zinc, and special assistance to the domestic producers of beryl, columbium-tantalum, chromite, and asbestos. The proposals on lead and zinc led to an application for escape-clause relief under the Trade Agreements Act after the Congress took no action. The

[1] Some fuels are covered in this chapter but only where specifically indicated. In general, this occurs where mining-industry data were not available for both nonfuels and fuels components.
[2] Assistant chief economist.

Defense Mobilization activities in minerals continued approximately as in other years.

The world mineral markets reacted similarly to those in the United States during 1957. World metal-mining production was higher than in 1956 but dropped sharply in the last quarter of 1957. Freight rates were down to normal before the closing of the Suez Canal; world prices of minerals dropped slightly throughout the year.

NONDEFENSE MINERALS PROGRAM

Public Law 733.—Purchases under the Domestic Tungsten, Asbestos, Fluorspar, and Columbium-Tantalum Production and Purchase Act of 1956 were curtailed sharply during 1957. The Administration requested $30 million for this program, but the Congress appropriated only $6.7 million, with the express provision that none of the money be used for tungsten.[3] Purchases under this act to December 31, 1957, are presented in table 1.

TABLE 1.—Domestic Tungsten, Asbestos, Fluorspar, and Columbium-Tantalum Production and Purchase Act of 1956 [1]

Commodity	Total limitation	Interim limitation (Dec. 31, 1957) [2]	Quantity purchased to Dec. 31, 1957 [2]	Base price
Asbestos, chrysotile, nonferrous: [3]				
Crude Nos. 1 and 2 short tons	2,000	1,919	951	$1,500 900
Crude No. 3, when offered with No. 1 and/or No. 2 short tons	2,000	1,919	618	400
Columbium-tantalum bearing ores: [3] Contained combined pentoxides pounds	250,000	57,559	5,508	[4] 1.40–3.00
Fluorspar, Acid grade, 97 percent calcium fluoride, f. o. b. milling point short tons	250,000	126,647	46,732	53
Tungsten trioxide, f. o. b. milling point [5] do	1,250,000	293,584	283,463	55

[1] Public Law 733, 84th Cong., 2d sess.
[2] General Services Administration, Report of Purchases Under Domestic Purchase Regulation, Dec. 31, 1957: Federal Register, Feb. 18, 1958, p. 1062.
[3] Meeting same specifications and under regulations in effect on Jan. 1, 1956, Public Law 206, 83d Cong., 2d sess.
[4] Plus 100 percent bonus.
[5] A maximum of 5,000 short-ton units accepted from 1 producer in 1 month.

Long-Range Minerals Program.—The Secretary of the Interior presented the Administration's Long-Range Minerals Program to the Senate Interior and Insular Affairs Committee on June 4, 1957. Secretary Fred A. Seaton, in presenting this program, stated:

> The Administration believes that the Federal Government has a proper role to play in keeping [the mineral] industries healthy and strong. The Long-Range Minerals Program is designed to serve this purpose, within the scope of proper Federal activity and within the limits imposed by the Government's other responsibilities, both to the people of the United States and to the community of free nations.[4]

The Long-Range Minerals Program recommended three actions: First, accelerate Geological Survey, Bureau of Mines, and Bureau of Land Management activities which aid the development of all mineral resources; second, assist the lead and zinc industries to minimize

[3] Public Law 77, 85th Cong., 1st sess., July 1, 1957.
[4] Statement by Hon. Fred A. Seaton, Secretary of the Interior, before the Senate Interior and Insular Affairs Committee, June 4, 1957, p. 1.

injury as a result of imports by removing existing tariffs and substituting a sliding-scale import-excise tax; third, provide special encouragement to producers of beryl, columbium-tantalum, chromite, and asbestos.

Increases were recommended for research and development activities, including topographic- and geologic-mapping programs and continued research in methods of mineral discovery by the Federal Geological Survey; fundamental research on metallurgical processes (emphasis on developing and applying processes that produce high-purity metals); economic- and statistical-data collection and distribution by the Federal Bureau of Mines; revision of the mining laws to facilitate mineral development on the public domain under the Federal Bureau of Land Management; and continuing examination of mineral taxation by the Department of the Interior with the Treasury Department to assure that the fiscal incentives be maintained. In addition, a new program of financial assistance to private industry for exploration assistance was recommended. This program would provide loans for exploration purposes to applicants who cannot finance the exploration themselves and are unable to find private funds on reasonable terms. The loans would be repaid out of production, if any, or would be canceled if no minerals were discovered. Organic fuels were excluded from this program.

The import-excise tax recommended for lead and zinc would replace the present tariffs upon these minerals. The import-excise tax would be removed entirely when the price of lead exceeded 17 cents per pound and the price of zinc exceeded 14.5 cents per pound. The detailed recommendation is presented in tables 2 and 3.

The special production bonus recommended covered beryl, chromite, and columbium-tantalum. For beryl a bonus of $70.00 per

TABLE 2.—Import-excise tax recommendations for lead, Long-Range Minerals Program

Lead article	Current duty	Duty recommended by Tariff Commission	Import-excise taxes proposed when price is—[1]		
			16 cents, less than 17 cents	15 cents, less than 16 cents	Less than 15 cents
Par. 72:					
Lead pigments:					
Litharge .... cents per pound..	1¼	3⅜	1⅛	2¼	3⅜
Red lead .... do....	1⅞	3⅜	1⅛	2¼	3⅜
Orange mineral .... do....	2	3¾	1¼	2½	3¾
White lead .... do....	1 1/20	3 15/100	1 5/100	2 10/100	3 15/100
Suboxide of lead .... do....	3	4½	1½	3	4½
Lead pigments, not specially provided for percent of value..	20	30	10	20	30
Par. 391:					
Lead-bearing ores, flue dust, and mattes (lead content) .... cents per pound..	¾	1 8/10	½	1¼	2
Par. 392:					
Lead bullion or base bullion, lead pigs and bars, lead dross, reclaimed lead, scrap lead, type metal, antimonial lead, antimonial-scrap lead, and alloys or combinations of lead, not specially provided for (lead content) cents per pound..	1 1/16	2 55/100	1	2	3
Babbitt metal and solder (lead content) ... do....	1 1/16	2 55/100	1	2	3
Lead sheets, pipe, shot, glazier's lead, and lead wire .... cents per pound..	1 5/16	3 9/16	1 3/16	2⅜	3 9/16

[1] All import-excise taxes are suspended when price is 17 cents or above.

short ton (10 percent BeO) not to exceed 750 short tons per person or 100 tons for any 1 producer was suggested. The chromite bonus was set at $21.00 per long dry ton (48-percent basis) not to exceed 50,000 long dry tons per annum or 10,000 long dry tons from any 1 producer. The columbium-tantalum bonus at $2.35 per pound, not to exceed 25,000 pounds annually or 5,000 pounds for any 1 producer, was expected to stimulate production to at least 16,000 pounds per year, considerably above the current rate of production. The other 2 bonuses were designed to maintain competitive production at approximately 500 tons for beryl and 37,000 long dry tons for chromite.

TABLE 3.—Import-excise tax recommendations for zinc, Long-Range Minerals Program

(In cents per pound)

Article	Duty		Import-excise taxes proposed when price is—[1]		
	1957	Recommended by Tariff Commission	13½ cents, less than 14½ cents	12½ cents, less than 13½ cents	Less than 12½ cents
Par. 77:					
Zinc oxide and leaded zinc oxides containing not more than 25 percent of lead:					
In any form of dry powder	6/10	1 13/20	6/10	1 1/10	1 13/20
Ground in or mixed with oil or water	1	2¼	¾	1½	2¼
Lithopone, and other combinations or mixtures of zinc sulfide and barium sulfate:					
Containing by weight less than 30 percent of zinc sulfide	⅞	2¼	¾	1½	2¼
Containing by weight 30 percent or more of zinc sulfide	⅞ (+7½%)	2⅝ (+22½%)	⅞ (+7½%)	1¾ (+15%)	2⅝ (+22½%)
Par. 393:					
Zinc-bearing ores of all kinds, except pyrites containing not more than 3 percent of zinc (zinc content)	6/10	1 8/10	4/10	1 1/10	1 8/10
Par. 394:					
Zinc blocks, pigs, or slabs	7/10	2 1/10	½	1¼	2
Old and wornout zinc, fit only to be remanufactured, zinc dross, and zinc skimmings	¾	2¼	¾	1½	2¼
Zinc dust	7/10	2 1/10	7/10	1 4/10	2 1/10
Zinc sheets	1	3	1	2	3
Zinc sheets coated or plated with nickel or other metal (except gold, silver, or platinum), or solutions	1⅛	3⅜	1⅛	2¼	3⅜

[1] All import-excise taxes are suspended when price is 14½ cents or above.

The part of the Long-Range Minerals Program not dealing with lead and zinc was incorporated in Senate bill 2375 but was not reported out of committee by the end of 1957. The lead and zinc proposal was the subject of hearings before the House Committee on Ways and Means on August 1 and 2, 1957. As a result of these hearings, Jere Cooper, Chairman of the committee, wrote to the President on August 16, 1957, and stated (in part):[5]

It is my sincere conviction that you already have authority, previously delegated to you by the Congress in the trade agreements legislation, to afford relief to domestic industries from import competition in appropriate cases. The testimony of your representatives at the public hearings, in conjunction with the written recommendation of the Secretary of the Interior, indicates that the lead and zinc industries properly constitute such a case in the opinion of the administration. The testimony further shows that your present authority is adequate to afford the relief which you have recommended to the Congress.

[5] Congressional Record—Senate, Aug. 29, 1957, p. 15026.

The President replied to Representative Cooper on August 23, 1957, and stated (in part):[6]

> As I indicated in my press conference on August 21, my view with respect to maintaining the integrity of section 7 of the Trade Agreements Extension Act of 1951 is as one with yours and, I am sure, with that of all the members of the House Ways and Means Committee. H. R. 6894, as you know, is the sole exception proposed by this administration in over 4½ years. In view of this fact, I think you will agree that such exceptions are not proposed lightly.
>
> The special circumstances of this case that suggest the desirability of following the legislative route were set forth by administration witnesses before both your committee and the Senate Finance Committee.
>
> It is understood, of course, that the initiation before the Tariff Commission of an escape-clause proceeding by the industry is available in the last instance. It is my understanding that the industry will take such course if the Congress does not pass the requested legislation. In that event, I would request the Tariff Commission to expedite its consideration of the matter.

The Emergency Lead and Zinc Committee, established by the industries, filed an application for relief under the escape clause with the Tariff Commission on September 27, 1957. The application is discussed in detail in the Tariff section of this chapter.

DEFENSE MOBILIZATION[7]

Prepared by Gabrielle Sewall[8]

Defense Production Act.[9]—In 1957 programs under the Defense Production Act declined, and net changes in statistics were relatively small. Gross transactions certified as of December 31, 1957, for all programs at $8.3 billion were 11 percent less than at the end of 1956 because of cancellations and adjustments; gross transactions consummated increased slightly ($38 million) to $7.7 billion. The part covering metals and minerals programs amounted to $5.5 and $5.2 billion, respectively, and showed the same percentage changes from 1956 as the totals.[10]

The probable ultimate net cost of gross transactions certified for all programs also dropped from $1.0 billion to $960 million. Of this amount, $715 million covered metals and minerals programs, a 10-percent decline from 1956. The amount covering metals and minerals was distributed as follows: $4.8 billion for purchases, $35 million for exploration grants, $281 million for loans on facilities, and $17 million for research and development. Purchases of metals and minerals amounted to 71 percent of total purchases, compared with 67 percent in 1956.

Purchase Programs.—As a result of an increased supply of aluminum and a temporary lull in demand, primary producers offered aluminum for stockpiling to the Government under provisions of

[6] Work cited in footnote 5, p. 15027.
[7] This report on Defense Mobilization summarizes activity to Dec. 31, 1957. Hereafter only yearly event will be reported in this review.
[8] General economist, Office of Chief Economist.
[9] Executive Office of the President, Office of Defense Mobilization, Report on Borrowing Authority, Dec. 31, 1956, and Dec. 31, 1957.
Joint Committee on Defense Production Activities, Seventh Annual Report: House Rept. 1172, 85th Cong., 2d Sess., Jan. 16, 1958.
[10] The terms used to account for the activities under the Defense Production Act are unique, requiring definition for complete understanding. Terms used in this section are defined as follows: "Program" is a plan for an expansion of capacity or supply of a specific material. "Transactions" are the individual contracts or agreements entered into in carrying out a certified program. "Certificate" is an Office of Defense Mobilization notification that a program is essential and that transactions may be consummated up to specific limits. "Consummated" means executed contracts or agreements. "Probable ultimate net cost" is the estimated nonrecoverable cost to the Government of transactions under a certified program.

TABLE 4.—Costs of mineral programs under the Defense Production Act as of Dec. 31, 1957 [1]

(Million dollars)

Program	Gross transactions consummated		Probable ultimate net cost of transactions consummated	
	Amount	Percent	Amount	Percent
Aluminum	1,570	20.3	18	1.9
Nickel	807	10.4	123	13.0
Copper	795	10.3	20	2.1
Manganese	482	6.2	111	11.8
Tungsten	374	4.8	218	23.1
Tin	222	2.9	5	.5
Titanium	207	2.7	101	10.7
Cobalt	132	1.7	7	.8
Magnesium	129	1.7	18	1.9
Columbium-tantalum	98	1.3	53	5.6
Molybdenum	95	1.2	1	.1
Mica	55	.7	35	3.7
Steel	49	.6	----------	----------
Chrome	41	.5	22	2.3
Zinc	30	.4	7	.8
Bauxite	26	.3	(2)	(3)
Copper and cobalt	22	.3	----------	----------
Lead	21	.3	3	.3
Dolomite	20	.3	----------	----------
Fluorspar	16	.2	4	.4
Cryolite	16	.2	2	.2
Mercury	16	.2	2	.2
Lead-zinc	9	.1	9	1.0
Uranium	7	.1	7	.8
Lead-zinc-copper	4	.1	4	.4
Asbestos, chrysotile	2	(3)	1	.1
Graphite	1	(3)	1	.1
Rare earths	(2)	(3)	(2)	(3)
Total minerals and metals	5,246	67.8	[4] 771	81.8
Other materials, including fuels	2,388	30.9	70	7.4
Total administrative and interest expenses	102	1.3	102	10.8
Total	7,736	100.0	943	100.0

1 Executive Office of the President, Office of Defense Mobilization, Report on Borrowing Authority as of Dec. 31, 1957, pp. 10–11.
2 Less than $500,000.
3 Less than 0.05 percent.
4 Does not add to total owing to rounding.

GSA contracts covering output from the new facilities developed during the Korean emergency.

Military cutbacks in the aircraft program were responsible for releasing titanium for other uses.

Buying during the year continued under the Domestic Minerals Program Extension Act of 1953 (Public Law 206, 83d Cong.). The domestic manganese regulation (Butte-Philipsburg low-grade manganese) was amended in May 1957 to clarify and define acceptable mixtures of ore. The purchase programs for manganese at the Deming and Wendon Depots and for tungsten were completed, as the original objectives had been reached. In March an authorized extension of the mercury program through December 31, 1958, limited the quantity to 50,000 flasks—30,000 to be of United States origin and 20,000 to be of Mexican origin. Early in the year the industry made only nominal offerings, as the price of mercury was above that of the regulation but increased deliveries later in the year when the price of the metal had dropped to the $225 purchase price.

TABLE 5.—Commodities delivered under United States Government domestic purchase programs, 1956–57 [1]

Commodity	Quantity delivered as of December 31		Authorized total purchases
	1956	1957	
Asbestos, chrysotile, nonferrous (short tons):			
Crude No. 1 and No. 2	1,864	2,027	3,500
Crude No. 3 [2]	1,075	1,204	2,000
Beryl ore short tons	1,203	1,695	4,500
Chromium ores and concentrates [3] long tons	137,700	175,028	200,000
Columbium-tantalum ores and concentrates (combined contained pentoxides) [4] thousand pounds	15,601	15,586	15,250
Fluorspar, Acid-grade short tons	----------	46,732	250,000
Manganese ore (thousand long tons):			
Butte and Philipsburg Depots	3,262	5,296	6,000
Deming Depot	6,215	6,215	6,000
Wenden Depot	6,108	6,108	6,000
Domestic small producers (carload program)	10,538	16,718	28,000
Mercury (flasks, prime virgin):			
Domestic	5	2,967	155,000
Mexican	----------	15	95,000
Mica: Block, film, and hand-cobbed (hand-cobbed equivalent) short tons	10,124	12,915	25,000
Tungsten concentrates, (units WO_3) thousand short tons	3,267	3,280	4,250

[1] General Services Administration, Report of Purchases Under Domestic Purchase Regulations, as of Dec. 31, 1956, and Dec. 31, 1957, under section 4, Public Law 206, 83d Cong., and under Public Law 733, on delegation of authority by Department of the Interior.
[2] Crude No. 3 accepted under Public Law 206 on tie-in basis with 2 other grades, not figured into the quantity authorized.
[3] Purchased with stockpile funds for the national stockpile.
[4] Mostly foreign. Figures not published for domestic only. Reported delivered in 1956, 20,069 pounds was rejected in 1957.

The only purchase contract was negotiated with Cuban American Nickel Co. for constructing facilities to produce nickel and cobalt. Several other contracts for copper, fluorspar, molybdenum, and titanium were terminated as the stockpile position of these materials became more favorable.

Loan Program.—Total loans under the Defense Production Act [11] borrowing authority carried a gross-transactions value of $384 million at the end of 1957—an increase of $3 million over 1956 furnished by a project for steel. Thus, the gross transactions consummated for loans on metals and minerals were raised to $243 million from $240 million in 1956. The probable ultimate net cost of the loans is carried on the Government books at zero, since interest income was assumed to offset expenses. No new loans were certified in 1957.

Cumulative advances to contractors in connection with purchase contracts for metals and minerals, as of December 31, 1957, stood at $149.5 million—an 11-percent increase over the total at the end of 1956. Of this amount, the balance outstanding was $54 million, down 14 percent from 1956, as a result of repayments in cash and commodities. New advances were made in the nickel and titanium programs.[12]

Four loan guarantees were outstanding under which borrowers could obtain as much as $49.7 million from private sources but had actually drawn $37.7 million. The cumulative net earning of the Loan Guarantee Fund was $4.2 million.

[11] Work cited in footnote 9.
[12] General Services Administration, Defense Materials Service, Financial Report Defense Production Activities: Dec. 31, 1957.

Tax Amortization Program.—The minerals section of the accelerated tax-amortization program is presented in tables 6 and 7. The number of certificates of necessity in the mineral industries at the end of 1957 represented 2 percent of all certificates granted and 8 percent of the total cumulative cost of facilities.[13] Only 15 certificates were added during the year (out of a total of 263 for all industries), representing a value of new facilities certified of $109 million, as compared with 14 in 1956 that were valued at $49 million. The new certificates covered facilities as follows: 7 for uranium, 1 for nickel, 1 for beryllium, and 4 for titanium; 2 were reinstated for iron ore. The percentage of certified facilities reported in place as of December 31, 1957, was 88 for the metals and 99 for the nonmetallics. The several certificates that were dropped from the 1957 total in the table were withdrawn or expired in that year.

TABLE 6.—Certificates of necessity on facilities for producing metals and minerals on which construction was complete by Dec. 31, 1956 [1]

	Number of certificates	Reported value in place 1956 (thousand dollars)
Metal ores and materials:		
Antimony	1	194
Bauxite	[2] 7	[2] 30,021
Cadmium	2	276
Germanium	1	110
Magnesium	8	7,024
Manganese	9	19,135
Molybdenum	3	22,994
Platinum	1	28
Selenium	2	101
Silicon	2	3,306
Tungsten	17	5,960
Total metals	53	89,149
Nonmetal ores and materials:		
Arsenic	1	465
Barite	6	2,271
Borates	1	1,966
Nonmetal ores and materials—Continued		
Bromine	7	5,061
Diamond recovery	1	48
Diatomite	3	6,355
Fluorspar and fluorides	9	4,214
Garnet	1	299
Gypsum	1	158
Lithium	4	1,270
Mullite	1	47
Phosphate rock	6	11,360
Quartz crystals	5	632
Refractory clay	1	1,213
Salt	1	450
Sand	2	805
Soda ash	--------	16,200
Total nonmetals	51	52,814

[1] Unpublished records of Defense Materials Service, General Services Administration; Business and Defense Services Administration, U. S. Department of Commerce; Office of Defense Mobilization.
[2] Revised.

During 1957 expansion programs were severely curtailed. By May the tax-amortization program had been cut back substantially in line with the needs of the Department of Defense and the Atomic Energy Commission. In February the ODM closed the goals for Battery- and Chemical-grade manganese, selenium, and Chemical-grade chromite. In April the goal for mercury and in June the goals for nickel and substitutes for strategic mica (the last goals to remain open for mineral facilities) were closed. However, other forms of financial aids and incentives for these materials were still available.

Research and Development Program.—During the year further research on synthetic mica was encouraged through contracts to develop material suitable for use in electronics. Research also continued on titanium to develop standard samples of titanium sponge, metal, and alloys and to produce high-purity material by an electrorefining process.

[13] Executive Office of the President, Office of Defense Mobilization, Finance Division, Report on Tax Amortization, Jan. 8, 1958.

TABLE 7.—Certificates of necessity on facilities for the production of metals and minerals at end of year, 1954–57, and reported progress through Dec. 31, 1957 [1]

Commodity	Total number of certificates as of Dec. 31				Total reported value of facilities as certified as of Dec. 31 [2] (million dollars)				Reported value in place as of Dec. 31, 1957 [3] (million dollars)			
	1954	1955	1956	1957	1954	1955	1956	1957	Total	Completed	In progress	Percent reported in place, Dec. 31, 1957 [4]
Metallic ores and minerals:												
Alumina [5]	13	13	13	13	134.3	134.3	134.3	134.3	134.9	112.9	22.0	100
Aluminum	36	37	37	37	715.0	746.5	746.5	747.1	737.8	392.6	345.2	99
Beryllium	----	----	----	1	----	----	----	4.5	4.2	----	4.2	95
Columbium-tantalum	3	3	3	3	3.8	3.8	3.8	3.8	3.8	3.8	----	100
Copper	27	30	31	29	200.8	217.9	226.4	208.4	208.4	208.4	----	100
Iron, including taconite	140	144	146	146	1,246.2	1,253.2	1,260.0	1,273.0	1,034.9	349.8	685.1	81
Lead and zinc	48	49	49	49	57.4	62.6	62.6	73.1	61.4	41.0	20.4	84
Mercury	----	1	2	1	----	.3	1.1	.3	.3	.3	----	100
Nickel and cobalt	8	8	8	9	91.8	91.8	91.8	130.8	49.1	13.3	35.8	38
Rare earths	3	4	4	4	.9	4.3	4.3	4.2	4.1	.9	3.2	96
Titanium	11	14	18	22	105.0	119.9	[5] 117.2	130.7	128.9	103.0	25.9	99
Uranium	9	15	16	23	23.7	41.9	51.0	85.4	62.1	41.1	21.0	73
Zirconium	3	3	[5] 7	7	3.2	3.2	[5] 26.7	27.2	29.9	5.2	24.7	110
Other, with 100-percent value in place before 1957 [6]	53	53	53	53	89.1	89.1	89.1	89.1	89.1	89.1	----	100
Total metallic	354	374	387	397	2,671.3	2,768.7	2,814.7	2,912.1	2,549.1	1,361.5	1,187.6	88
Nonmetallic ores and materials:												
Cryolite	9	9	10	10	5.3	5.3	6.7	6.7	6.7	6.7	----	100
Lime, limestone, and dolomite	43	43	43	43	44.0	44.0	44.0	44.0	42.0	26.0	16.0	95
Mica	2	3	4	4	.5	1.5	1.8	1.8	1.7	1.5	.3	98
Refractory magnesia	10	10	10	9	19.7	19.7	19.7	14.6	14.6	14.6	----	100
Rutile and monazite	3	6	6	6	.7	2.4	2.4	2.4	2.4	2.4	----	100
Sulfur [7]	6	6	6	5	22.3	22.3	22.3	20.5	20.5	20.5	----	100
Other, with 100-percent value in place before 1957 [6]	51	51	51	51	52.8	52.8	52.8	52.8	52.8	52.8	----	100
Total nonmetallic	124	128	130	128	145.4	148.0	149.7	142.8	140.8	124.5	16.3	99
Total metallic and nonmetallic	478	502	517	525	2,816.7	2,916.8	2,964.4	3,054.9	2,689.9	1,486.0	1,203.8	88

[1] Source: Unpublished records of Defense Materials Service, General Services Administration, and Business and Defense Services Administration, U. S. Department of Commerce. Figures may not add exactly owing to rounding. For definition of "certificate of necessity" see text footnote.

[2] Value is amount certificated including all revisions of estimates indicated on latest Reports of Progress (Form BDSAF-1).

[3] Latest available BDSAF-1 report, which for most facilities covered the period through Dec. 31, 1957.

[4] Percentage based on amounts in thousand dollars.

[5] Revised.

[6] For detail of summary, see table 41.

[7] Mined only.

Defense Material System.—Table 8 shows the set-asides or allotments for "A" products for defense programs under the defense materials system under which the demand for certain materials in short supply was controlled. This program provided the nucleus of a system that could be rapidly expanded in an emergency. The allotments of "A" products represent purchase authority to prime contractors and producers of specially designed military equipment for the metals at the mill level. The set-asides for aluminum averaged about 15 percent of the primary metal availability. Because of the entry of 1 new producer and the changing structure of the industry since 1952, the base for them was set on shipments for 6 months in 1956 instead of the first quarter of 1952.

TABLE 8.—Allotments for "A" products [1]

(Thousand short tons)

Commodity	First quarter	Second quarter	Third quarter	Fourth quarter	Year
Aluminum:					
1956	60.0	65.9	62.5	64.5	252.9
1957	60.4	61.5	63.4	55.8	241.1
Change from 1956 percent	+.7	−6.7	+1.4	−13.5	−4.7
Copper and copper-base alloys:					
1956	30.0	27.3	26.0	25.4	108.7
1957	19.4	22.5	23.5	22.4	87.8
Change from 1956 percent	−35.3	−17.6	−9.6	−11.8	−19.2
Steel:					
1956	642.3	607.3	592.2	606.2	2,448.0
1957	552.6	561.6	589.2	546.6	2,250.0
Change from 1956 percent	−14.0	−7.5	−.5	−9.8	−8.1
Nickel alloys:					
1956				11.9	11.9
1957	4.8	4.9	4.8	4.0	18.5
Change from 1956 percent				−66.4	+55.5

[1] Office of Defense Mobilization various press releases.

National Strategic Stockpile Program.[14]—The stockpiling of strategic and critical materials was implemented in 1946 by the Strategic and Critical Materials Stockpiling Act (Public Law 520). Procurement proceeded slowly at first but gathered momentum in later years until, at the end of 1957, many objectives had been filled.

During 1957 stockpile policy was reappraised and a new policy adopted; this action limited procurement at the "procurement priority level" calculated to provide adequate materials for a 3-year emergency rather than the 5 years previously used as a standard in the minimum stockpile objective.[15] New procurement was to exceed 3 years in only a few instances, involving maintenance of the domestic-production

[14] Special Stockpile Advisory Committee, Stockpiling for Defense in the Nuclear Age: Jan. 2, 1958.
Executive Office of the President, Office of Defense Mobilization, Stockpile Report to the Congress: January–June 1957 and July–December 1957.
Executive Office of the President, Office of Defense Mobilization, Report on Borrowing Authority: Dec. 31, 1956, and Dec. 31, 1957.

[15] Determination of stockpile objectives by the previous standard was based on differing needs. A total national requirement consisted of requirements for an emergency in the categories: Military, atomic energy, industrial, essential civilian, and, in some cases, export. The Nation's ability to meet those needs was determined by measuring them against supplies that could be reasonably relied upon in wartime from domestic production and from accessible foreign sources. If the supply proved to be less than requirements, the indicated emergency deficit was termed the "minimum stockpile objective." Of this amount, the deficit that would exist over 3 years was identified as the "procurement prioity level," considered the predominant element in planning and procurement. The "long-term stockpile objective" provided an extra safety factor by discounting completely all foreign supplies excepting those accessible from neighboring countries. Additions to the long-term objectives were made only under certain favorable conditions, such as when the material could be acquired at favorable prices and when such procurement aided in maintaining the domestic mobilization base or could be arranged by the barter of surplus agricultural commodities abroad.

component of the mobilization base. In view of this reappraisal it is appropriate here to review the legislation under which materials are acquired for the stockpile.

Three major acts, which authorize national stockpiling, are the Strategic and Critical Materials Stockpiling Act of 1946 (Public Law 520, 79th Cong.), the Defense Production Act of 1950 (Public Law 774, 81st Cong.), and the Agricultural Trade Development and Assistance Act of 1954 (Public Law 540 and Public Law 480, 84th Cong.).

Fifty-six percent of the total acquisition for the stockpile in 1957 was from open-market purchases under the Stockpiling Act, compared with 80 percent in 1956. Any material acquired or transferred to the inventory under this act requires congressional approval before release, and no surplus quantity may be sold unless the whole inventory of the material is declared no longer needed for defense purposes.

Inventories under the Defense Production Act included about $880 million at the end of 1957, as shown in table 9. Metals and minerals purchased or contracted for under this act are obtained from new or expanded facilities, created to broaden the base of supply for an emergency. These materials may be transferred to the national stockpile, sold to industry, or diverted directly from their origin to meet scarcities in the economy. They are mainly under long-term contracts, which serve to guarantee a market for the mineral. Eighteen percent of stockpile acquisitions in 1957 came from Defense Production Act inventories.

The Commodity Credit Corporation was authorized by the Agricultural Trade Development and Assistance Act to barter strategic and other materials for surplus agricultural commodities. Under the act some of the strategic material, either bartered or acquired through the use of foreign currency, could be transferred directly to the national stockpile; the remainder could be placed in what is known as the Supplemental Stockpile that comprises strategic material over and above the minimum- and long-term objectives of the national stockpile. Provisions for release of this material are the same as those of the Strategic and Critical Materials Stockpiling Act.

The barter program for surplus agricultural commodities was suspended at the end of April 1957 to permit the United States Department of Agriculture to study safeguards against the substitution of barter transactions for dollar sales without a net gain in total exports of agricultural surpluses. In May a revised barter program permitted United States firms to participate in barter only if the transaction would mean a net increase in United States exports of the agricultural commodity involved. The agricultural commodities were to be designated in the barter contracts and to be exported to one or more designated friendly countries, with a guarantee against further transshipping. A further important restriction stipulated that all materials delivered under the program must be produced and processed abroad and the country of origin designated. Lead and zinc ores and concentrates that had been siphoned from the world market by barter arrangements for processing at United States smelters and refining plants were no longer admissable. Total acquisitions to the stockpile through barter amounted to 21 percent in 1957.

Additional accumulations of strategic materials have been acquired by the Government under specific provisions in other legislation. The Mutual Security Act of 1954 (Public Law 162) and the Federal Property and Administrative Services Act of 1949 (Public Law 152) provide for transfer of strategic materials to the national stockpile without reimbursement. During 1957 the estimated market value of surplus material transferred to the national stockpile from all Government agencies at no acquisition cost to the stockpile amounted to approximately $14.7 million—about 5 percent of total acquisitions.

In 1957 chrysotile asbestos, refractory bauxite, celestite, columbite, quartz crystal, and tungsten were added to the list of completed long-term objectives, bringing this total to 18; the minimum objectives for metallurgical chromite and Acid-grade fluorspar also were filled. Those metals and minerals for which the procurement priority had not been reached were amosite asbestos, Metallurgical-grade bauxite from Jamaica, Metallurgical-grade fluorspar, jewel bearings, magnesium, Chemical-grade manganese, mica, muscovite block and film, palladium, selenium, and silicon carbide. Titanium sponge was shifted from Group I, a list of commodities acquired through purchase or transfer, to Group II, acquired through transfer only; formal objectives are not established.

As of December 31, 1957, stockpile objectives representing 75 commodities were valued at $9.3 billion, at prevailing prices. The value of total objectives had declined 15 percent as a result of lower market prices of metals and minerals. About 26.3 million tons of materials, having a value of $5.7 billion, was actually on hand in 218 stockpile-storage sites at the end of 1957—an increase in physical volume of 7 percent over 1956. Of the $5.7 billion in inventory $3.0 billion was toward the procurement priority (97 percent filled), another $1.7 billion was toward the minimum objective (65 percent filled), and $1.0 billion was toward the long-term objective (28 percent filled), the last all associated with metals and minerals.

Deliveries to the strategic stockpile during 1957 amounted to $300 million and consisted principally of amosite asbestos, ferrochrome and ferrochrome silicon, metallurgical fluorspar, jewel bearings, lead, Battery-grade synthetic manganese dioxide, muscovite block-and-film mica, and zinc, all toward procurement priority levels, except lead, zinc, and Battery-grade synthetic manganese dioxide, which were purchased under the domestic incentive program as an aid in maintaining the respective mobilization bases. Materials on order amounted to $140 million at the end of 1957—$210 million less than was on order a year before.

There remained in 1957 industrial shortages of only two major materials being stockpiled—molybdenum and nickel. Deferral of shipments to the Government and release to industry of 3 million pounds during the first half of the year eased a temporary shortage of molybdenum. The continuing shortage of nickel necessitated diversion to industry of all nickel scheduled for delivery to the Government in 1957. In the first 3 quarters, over 85 million pounds was sold to industry, but by the fourth quarter demand had slackened and much of that quarter's production was not claimed.

TABLE 9.—Inventory of minerals acquired under the Defense Production Act, as of Dec. 31, 1957 [1]

(Thousands)

Commodity	As of Dec. 31, 1957		Net change in physical quantity during 1957
	Quantity	Cost [2]	
Aluminum metal ... short tons	304	$154,096	+304
Asbestos, chrysotile ... do	2	2,103	------
Bauxite, metallurgical, Jamaica ... long dry tons	421	5,585	+229
Beryl ore ... short dry tons	1	543	(3)
Bismuth ... pounds	23	52	------
Chromite, metallurgical ... long dry tons	503	20,539	+102
Cobalt and cobalt-nickel alloy ... pounds	2,992	6,855	+2,804
Columbium-tantalum:			
Pentoxides ... do	12,691	54,289	+375
Potassium tantalum fluoride ... do	86	664	------
Malayan tin slag ... do	3,197	1,497	------
Copper ... short tons	25	13,594	+2
Cryolite ... short dry tons	39	10,760	(3)
Fluorspar, acid ... do	19	1,394	−188
Graphite, crystalline ... do	1	178	------
Lead ... short tons	2	782	+1
Manganese, metallurgical:			
Contained ... long tons	37,904	67,216	+15,241
Recoverable ... do	18,304	31,634	+2,718
Manganese, electrolytic ... do	5	2,951	------
Manganese, synthetic dioxide ... long dry tons	1	767	(3)
Mercury ... flasks	3	671	+3
Mica, foreign and domestic:			
Graded ... pounds	1,609	10,224	+61
Ungraded ... do	163	10	−227
Nickel ... do	29,839	22,333	+19,667
Palladium ... troy ounces	8	177	------
Rare-earths residue ... pounds	1,700	------	+1,700
Tin ... long tons	1	1,038	------
Titanium ... short tons	20	144,849	+11
Tungsten ... pounds W	79,897	325,414	−342
Zinc ... short tons	------	------	−3
Total cost of metals and minerals		880,215	

[1] Executive Office of the President, Office of Defense Mobilization, Report on Borrowing Authority: Dec. 31, 1956, and Dec. 31, 1957.
[2] Cost represents acquisition cost plus direct charges (duty, bank charges, ocean freight, transportation to first storage point, beneficiation costs, and accounting adjustments) but excludes storage, administrative expenses, and interest charges.
[3] Less than 500.

Defense Minerals Exploration Administration.[16]—Government encouragement, in the form of financial participation, of exploration for new sources of strategic and critical materials continued during 1957, with the issue of 40 certifications of discovery or development by DMEA, compared with 56 in 1956. Certifications on projects in 13 States were made for copper, lead, manganese, mercury, mica, tungsten, uranium, and zinc. In all, 173 exploration contracts were in force December 31, 1957. With respect to these, the Government contractual share amounted to $11.1 million (60 percent) out of total estimated costs of $18.7 million at the end of the year. Comparable amounts, for 1956, were $12.9 and $21.5 million, with the percentage unchanged. The potential ore reserves on all 316 certified projects were estimated to have a net recoverable value of $465 million at the prevailing market prices. Total royalties paid to the Government to the end of the year on all projects amounted to $2.2 million. The

[16] Defense Minerals Exploration Administration, Report for 4th Quarter, 1957, and monthly reports. 1957.

net value of the minerals produced, on which royalties had been received, was approximately $45 million.

October 22, 1957, the level of Government participation for exploration was reduced to 50 percent on 25 of the 34 materials eligible for exploration assistance, since they presented no major supply problems. Nine still eligible for 75 percent were antimony, beryl, cobalt, manganese, strategic mica, nickel, rutile-brookite, selenium, and block steatite talc.[17]

Office of Minerals Mobilization.[18]—Comprehensive mobilization base evaluations for metals and minerals were completed during 1957 with the assistance of the Bureau of Mines and the Geological Survey, for aluminum, cadmium, celestite, cobalt, copper, industrial diamonds, dolomite, emery, lead, magnesite, Battery- and Chemical-grade manganese, molybdenum, quartz crystals, platinum metals, rutile and ilmenite, selenium, tin, titanium metals, vanadium, zinc, and zirconium. Recommendations dealing exclusively with expansion-goal programs for mica and nickel were made to ODM during the year.

Export Control.[19]—Export controls as administered by the U. S. Department of Commerce are basically of two types—"short supply" and "security." All commercial exports from the United States and its Territories and possessions, except to Canada, are prohibited unless the Department of Commerce has either issued a "validated license" or established a "general license" permitting such shipments. A validated license is a formal document issued to an exporter upon application for a specific transaction. A general license is a broad authorization issued to an exporter, which permits exportation of some commodities under specified conditions without requiring the filing of an application by the exporter. Commodities under control by the Department of Commerce comprise the Positive List of Controlled Commodities.

As some of the scarce metals and minerals became more plentiful in 1957, export-control restrictions were eased considerably, particularly with respect to aluminum metal and scrap and copper ores, metal, and scrap. At the end of the year the only mineral commodities subject to quantitative export controls were nickel, certain types of nickel scrap, and industrial-diamond bort.

In February, because of an unusually heavy volume of export applications, export licensing of iron and steel scrap to Japan, the United Kingdom, and the European Coal and Steel Community was suspended to protect domestic supplies of this material. In May an interim policy, which restricted export of No. 1 and No. 2 Heavy-Melting grades of iron and steel scrap for these destinations to the

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[17] Joint Committee on Defense Production, 7th Annual Report on Activities: Jan. 16, 1958, pp. 65–66.

[18] U. S. Department of the Interior, Office of Minerals Mobilization, Quarterly Report to the Joint Committee: January–March, April–June, July–September, October–December, 1957.

[19] Secretary of Commerce, Export Control, 42d Quarterly Report to the President, the Senate, and House of Representatives: Feb. 1, 1958.

tonnages shipped in 1956, was adopted. In June an agreement was made with these countries whereby they would voluntarily limit their total imports of Heavy-Melting grades of scrap from the United States to approximately 13 percent above that imported in each category in 1956, and open-end export quota to all the Free World was reestablished.

DOMESTIC PRODUCTION

Value of Mineral Production.—The value of nonfuel mineral production in the United States decreased in 1957 compared with 1956, the first drop since 1954 and only the third since the end of World War II. The major contributor to the 10-percent-value decrease in metals was from declines in prices—production was up only slightly. The value of nonmetals decreased slightly, while that of fuels rose 9 percent.

Volume of Mineral Production.—The Bureau of Mines index of the physical volume of mineral production in the United States rose 0.1 point in 1957. The metals index rose 1.6 points, supplied primarily by a rise in ferrous metals of 5.7 points, since nonferrous metals declined as a group. The nonmetals group rose 2.9 points, bolstered by the rise of 9.0 points in construction materials. The Federal Reserve Board indexes correlate fairly closely with the Bureau of Mines index; metal mining increased 2 points and nonmetal mining 1 point.

The monthly Federal Reserve Board indexes, seasonally adjusted, show that the impact of the recession began for metal mining in September 1957 and had not been felt in stone and earth minerals by the end of the year. This dating of the downturn in metals is not firm, because the index was severely affected in July and August 1956 by the steel strike. The 1957 index itself turned downward in August but was higher than the year before until September.

TABLE 10.—Value of mineral production in continental United States, 1948–52 (average) and 1953–57, by mineral group

(Million dollars)

Mineral group	1948–52 (average)	1953 [1]	1954 [1]	1955 [1]	1956 [1]	1957 [1]	Change in 1957 from 1956 (percent)
Metals and nonmetals except fuels:							
Nonmetals	1,835	2,250	[2] 2,630	[2] 2,972	[2] 3,284	[2] 3,277	
Metals	1,392	1,811	1,518	2,055	2,358	2,129	−10
Total	3,227	4,161	4,148	5,027	5,639	5,406	−4
Mineral fuels	9,101	10,257	9,919	10,780	11,741	12,720	+8
Grand total	12,328	14,418	14,067	15,807	17,383	18,126	+4

[1] Includes Alaska and Hawaii.
[2] The total has been adjusted to eliminate duplicating the value of clays and stone.

TABLE 11.—Indexes of the physical volume of mineral production in the United States, 1948–57, by groups and subgroups [1]

(1947–49=100)

Year	All minerals	Metals						Nonmetals				Fuels
		Total	Ferrous	Nonferrous				Total	Construction	Chemical	Other	
				Total	Base	Monetary	Other					
1948	105.9	104.4	108.6	101.4	101.7	100.6	99.0	103.4	103.3	103.0	106.8	106.5
1949	92.1	94.1	91.2	96.1	95.7	97.2	98.9	101.0	102.8	98.2	93.5	90.7
1950	102.6	108.8	106.1	110.7	109.0	117.4	113.9	116.1	117.9	112.9	110.0	100.1
1951	112.6	117.2	126.6	110.6	110.0	100.8	149.7	127.3	128.3	123.9	130.0	110.1
1952	110.9	112.7	109.5	114.9	109.4	97.4	251.8	132.1	134.6	127.7	124.2	107.8
1953	112.6	119.1	133.3	109.2	103.0	98.3	236.7	135.2	137.5	133.6	118.5	108.8
1954	107.9	97.6	95.5	99.0	93.2	93.6	205.2	146.4	152.4	140.9	107.8	104.0
1955	119.0	115.0	122.8	109.5	106.8	95.3	194.0	161.0	170.0	146.4	[2]127.5	113.8
1956 [2]	125.8	117.2	116.5	117.6	116.2	94.9	207.0	172.4	179.5	163.4	135.9	120.5
1957	125.9	118.8	122.2	116.4	113.7	93.0	229.5	175.3	188.5	154.3	125.4	120.1

[1] For description of index see Minerals Yearbook 1956, vol. I, Review of the Mineral Industries chapter, pp. 2–5.
[2] Revised figures.

TABLE 12.—Indexes of physical volume of metal and mineral mining, production of metals, production of nonmetallic products, and industrial production, 1950–57 [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
1950	111	117	111	118	112
1951	121	131	116	134	120
1952	115	115	121	131	124
1953	119	138	136	138	134
1954	106	108	136	137	125
1955	120	144	[3] 145	155	139
1956	127	142	[3] 152	164	143
1957	129	140	151	160	143

[1] Federal Reserve Bulletin, April 1958, pp. 478–481. 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.
[3] Revised figure.

NET SUPPLY

Net Supply.—The net supply [20] of minerals and metals in 1957 showed a mixed pattern when compared with 1956. The net supply of the ferrous group varied more widely than in 1956; chromite increased by 48 percent; and tungsten decreased by 49 percent. The other metallic ores group showed similar disparity, but the nonmetallic-minerals group was generally more stable. Of the 32 com-

[20] Sum of primary shipments, secondary production, and imports, minus exports.

modities shown in table 14, 9 declined over 5 percent, 13 changed less than 5 percent, and 10 increased over 5 percent. The net supply analysis indicates that 1957 was a year of indecision for minerals, as the general business recession was making itself felt during the latter part of the year.

TABLE 13.—Monthly indexes of production, metal mining, and stone and earth minerals, 1956–57, seasonally adjusted [1]

(1947–49 average=100)

Month	Metal mining			Stone and earth minerals		
	1956	1957	Change from 1956 (percent)	1956	1957	Change from 1956 (percent)
January	117	120	2.6	138	142	2.9
February	116	122	5.2	138	142	2.9
March	117	121	3.4	138	143	3.6
April	129	121	−6.2	141	140	−.7
May	118	114	−3.4	140	142	1.4
June	113	121	7.1	143	142	−.7
July	60	122	103.3	142	143	.7
August	103	121	17.5	140	146	4.3
September	123	115	−6.5	143	144	.7
October	132	107	−18.9	141	143	1.4
November	128	100	−21.9	142	140	−1.4
December	127	110	−13.4	141	141	----------
Annual average	114	116	1.8	141	142	.7

[1] Federal Reserve Bulletin, various issues; 1957 data subject to revision.

Sources of Supply.—Mineral imports continued to increase in importance as a source of supply during 1957. Iron, copper, lead, zinc, aluminum, tungsten, titanium concentrates, and fluorspar were important minerals from domestic production considerations, where imports supplied a larger part of the market in 1957 (12 other imports also increased); mercury (and 11 other categories) either showed the same or decreased import contribution to supply. When the 5-year period (1953–57) is analyzed for the above mentioned major commodities, imports increased persistently as a source of supply in iron, aluminum, and fluorspar; decreased in copper and tungsten; and no significant change in lead, zinc, and titanium concentrates (comparable data are not available for mercury).

Sources of Imports.—Canada and Mexico increased their share of the import market, while most other regions lost some part of the market. The U. S. S. R. Bloc, already unimportant as a source of supply, dropped still further. This analysis is of significance in that it indicates the magnitude of the supply problem in time of war—the East and South Pacific region supplies normally move through the Panama Canal.

TABLE 14.—Net supply of principal minerals in the United States and components of gross supply, 1956–57 [1]

(Thousand short tons, unless otherwise stated)

Commodity	Net supply 1956	Net supply 1957	Net supply: Change from 1956 (percent)	Primary shipments [2] 1956	Primary shipments [2] 1957	Secondary production [3] 1956	Secondary production [3] 1957	Imports [4] 1956	Imports [4] 1957	Exports as a percent of gross supply 1956	Exports as a percent of gross supply 1957
Ferrous ores, scrap, and metals:											
Iron (equivalent)[5]	[6] 118,654	118,053	−1	49	52	[6 7] 32	[6] 28	[6 8] 19	[8] 20	3	4
Manganese (content)	[6] 1,227	1,664	+36	19	14			[8] 81	[8] 86	1	1
Chromite (Cr_2O_3 content)	710	1,051	+48	12	6			88	94		
Cobalt (content) ... thousand pounds	19,629	21,937	+12	19	19	[10] 2	[10] 2	79	79	(9)	(9)
Molybdenum (content) ... do	38,543	32,943	−15	100	97				[8] 3	33	44
Nickel (content)	159	160	+1	5	8	5	4	90	87	(9)	
Tungsten ore and concentrate (W content) ... short tons	[6] 17,815	9,137	−49	[6] 39	26			[6 8] 61	[8] 74	[6] 1	4
Other metallic ores, scrap, and metals:											
Copper (content)	[6] 1,947	1,753	−10	[6] 51	51	[6] 22	20	[6 8] 27	[8] 28	10	16
Lead (content)	1,252	1,282	+2	28	26	35	34	[8] 37	[8] 41	(9)	(9)
Zinc (recoverable content)	1,299	1,295	(9)	41	40	6	6	[8] 53	[8] 54	1	1
Aluminum (equivalent)[11]	1,914	2,117	+11	[12] 19	[12] 14	4	3	[13] 77	[13] 83	3	2
Tin (content) ... thousand long tons	96	70	−27			18	21	[8] 82	[8] 79	(6) (9)	2
Antimony (recoverable content)	[6] 36	37	+3	5	5	[6] 59	54	[6 8 14] 36	[8 14] 40	(9)	(9)
Cadmium (content)[15] ... short tons	5,534	5,724	+3	24	38			[8] 76	[8] 62	[6] 10	6
Magnesium (content)	71	86	+22	[16] 93	[16] 93	7	6	(9)	1	5	1
Mercury ... 76-pound flasks	[6] 78,931	79,435	+1	[6 16] 29	[16] 39	[6] 7	7	[6 8] 63	[8] 54	[6] 4	6
Platinum-group metals ... thousand troy ounces	1,119	753	−33	2	2	[17] 9	[17] 11	89	87	4	5
Titanium concentrates:											
Ilmenite and slag (TiO_2 content)	[6] 620	707	+14	62	58			38	42		
Rutile (TiO_2 content)	57	90	+58	20	11			80	89		
Nonmetals:											
Asbestos	[6] 728	723	−1	6	6			94	94	(9) (18)	(9) (18)
Barite, crude	1,883	1,986	+5	69	58			31	42		
Boron minerals and compounds, finished products (gross weight)[19]	312	371	+19	100	99			(9)	1	44	37
Bromine and bromine in compounds ... million pounds	193	181	−6	99	100			1	(9)	3	5
Clays	[6] 50,550	45,388	−10	100	100			(9)	(9)	1	1
Fluorspar, finished	815	879	+8	40	35			[8] 60	[8] 65	(9)	(9)
Gypsum, crude	[6] 14,291	13,481	−6	[20] 70	[20] 68			30	32		
Mica (except scrap) ... thousand pounds	12,829	12,931	+1	7	5			93	95	4	7
Phosphate rock (P_2O_5 content) ... thousand long tons	3,524	3,577	+2	99	99			1	1	21	22
Potash (K_2O equivalent)	2,058	2,058	+1	92	92			8	8	10	10
Salt (common)	24,248	24,117	−1	99	97			1	3	1	2
Sulfur, all forms (content)[21] ... thousand long tons	5,735	5,556	−3	95	91			5	9	23	22
Talc and allied minerals	716	672	−6	97	97			3	3	6	6

[1] Net supply is the sum of primary shipments, secondary production, and imports, minus exports. Gross supply is the total before the subtraction of exports.

[2] Primary shipments are mine shipments or mine sales (including consumption by producers) plus byproduct output. Shipments more nearly represent quantities marketed by the domestic industry and as such are more comparable to imports. Use of shipments data rather than production data also permits uniform treatment among more commodities.

[3] From old scrap only.

[4] Imports for consumption, except where otherwise indicated; scrap is excluded where possible both in imports and exports but included are all other sources of minerals through the refined or roughly comparable stage, except where the commodity description indicates an earlier stage.

[5] Iron ore reduced to an estimated pig-iron equivalent; reported weights used for all other items of supply.

[6] Revised figure.

[7] Receipts of purchased scrap.

[8] General imports; corresponding exports are of both domestic and foreign merchandise.

[9] Less than 0.5 percent.

[10] Consumption of purchased scrap.

[11] Includes 85 percent of bauxite mine production (rather than shipments) and imports, and 92 percent of alumina imports, both converted to estimated aluminum equivalent (3.93 long tons bauxite to 1 short ton aluminum) in 1956; 83 and 92 percent in 1957 (3.862 conversion factor). These percentages are based on estimated proportions used in producing metal. To avoid a duplicate adjustment for nonmetallic use, exports of bauxite to Canada were excluded from exports.

[12] Mine production of bauxite.

[13] Includes ingot equivalent (weight times 0.9) of imports of scrap, which are largely scrap pig. Some duplication occurs because of small quantity of loose scrap imported, which is also reflected in secondary production. See also footnote 11.

[14] Includes recovery in antimonial lead from foreign silver and lead ores.

[15] Primary shipments are estimated as a percentage of total primary production of metal, decreasing with increasing imports of lead and zinc, while imports are represented by the sum of the remaining percentage of such production plus imports of metal. In 1957 the ratio was 44: 56, but cannot be disclosed for 1956. Primary compounds not made from metal, data for which cannot be disclosed, are excluded for both years. Secondary includes recovery from both old and new scrap. Secondary data cannot be disclosed and are included with primary.

[16] Primary production of metal.

[17] Recovery from both old and new scrap.

[18] Exports of foreign merchandise (reexports) are included.

[19] Reported in terms of finished products; not comparable with earlier years.

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

[21] For pyrites, includes sulfur content (48 percent) of production.

TABLE 15.—Percentage distribution of imports of principal minerals consumed in the United States in 1956–57, by country group of origin [1]

Commodity	Canada and Mexico		East and South Pacific [2]		Other Western Hemisphere		Other Free World		U. S. S. R. bloc [3]	
	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957
Ferrous ores, scrap, and metals:										
Iron (equivalent) [4]	46	36	11	15	35	43	8	6	------	------
Manganese (content)	6	9	1	2	19	32	74	58	------	------
Chromite (Cr_2O_3 content)	(5)	------	3	------	2	5	95	96	------	------
Cobalt (content)	9	13	------	------	------	------	91	87	------	------
Nickel (content)	79	78	------	(5)	11	16	10	6	------	------
Tungsten ore and concentrate (W content)	11	13	34	38	20	27	34	22	------	------
Other metallic ores, scrap, and metals:										
Copper (content)	29	27	51	50	3	3	16	20	------	------
Lead (content)	30	31	48	44	2	4	20	22	------	------
Zinc (recoverable content)	66	64	18	21	2	2	14	14	------	------
Aluminum (equivalent) [6]	13	12	(5)	(5)	85	88	1	(5)	------	(5)
Tin (content)	(5)	(5)	11	(5)	------	------	89	100	------	------
Antimony (recoverable amount) [7]	36	57	17	15	------	(5)	47	28	------	------
Cadmium (content) [8]	52	82	1	2	------	------	47	17	------	------
Mercury	25	13	1	1	------	(5)	75	87	------	------
Platinum-group metals	28	17	(5)	1	3	1	65	81	4	1
Titanium concentrates: Rutile, ilmenite and slag (TiO_2 content)	48	40	12	16	------	------	40	45	------	------
Nonmetals:										
Asbestos	92	92	(5)	1	(5)	(5)	8	7	(5)	------
Barite, crude	76	62	5	15	3	4	16	19	------	------
Fluorspar, finished	72	65	------	------	------	------	28	35	------	------
Gypsum, crude	95	95	------	------	4	5	(5)	(5)	------	------
Mica (except scrap)	(5)	(5)	------	------	18	14	81	86	------	------
Potash (K_2O equivalent)	(5)	(5)	6	7	------	26	76	51	18	16
Sulfur (content)	100	100	------	------	------	------	(5)	(5)	------	------

[1] Data are based upon imports for consumption and are classified like net supply shown in table 14.
[2] West coast of South America (Salvador, Chile, Bolivia, Peru, and Ecuador), New Zealand, New Caledonia, and Australia.
[3] U. S. S. R., Bulgaria, East Germany, Albania, Czechoslovakia, Hungary, Estonia, Latvia, Lithuania, Poland, Rumania, China, and North Korea.
[4] Includes iron ore, pig iron, and scrap.
[5] Less than 0.5 percent.
[6] See footnotes 11 and 13, table 14.
[7] Excludes antimony from foreign silver and lead ores.
[8] Metal and flue dust only.

CONSUMPTION

Patterns.—The sharp decline in consumption reflects the depth of the recession in 1957 more accurately than the production data. Only 2 minerals showed consumption increases of greater than 5 percent (boron up 19 percent and rutile up 13 percent), while consumption of 15 minerals dropped by 5 percent or more during the year. Consumption of minerals going into the steel complex and the aluminum industry held virtually steady in 1957 compared with 1956, but molybdenum was a major exception, dropping 11 percent. Increased consumption of rutile resulted from the continuing shift from ilmenite and slag to this raw material. These two minerals taken together declined in consumption.

Sales and Orders.—Seasonally adjusted sales of the primary-metal-manufacturing industry dropped almost steadily throughout 1957, and the total for the year was 2 percent below 1956. Adjusted sales of stone, clay, and glass dropped sharply during the last 5 months of 1957, and the total for the year was 6 percent below 1956. The

December 1957 volume was 16 percent lower than December 1956 in the primary metal industry, and 12 percent lower in the stone, clay, and glass industry.

New orders (seasonally adjusted) were much lower for the primary metal industry for the entire year (down 12 percent) and also fell at an accelerated rate in the last quarter of 1957. The volume of new orders in December 1957 was 36 percent below that in December 1956.

TABLE 16.—Reported consumption of principal metals and minerals in the United States, 1956–57

(Thousand short tons, unless otherwise stated)

Commodity	1956	1957	Change from 1956 (percent)
Antimony, primary [1] ... short tons	14,962	11,931	−20
Barite, crude	[2] 2,035	1,671	−18
Bauxite ... dried equivalent thousand long tons	7,751	7,633	−2
Chromite ... gross weight	1,847	1,760	−5
Cobalt ... thousand pounds	9,562	9,157	−4
Copper, refined	1,521	1,348	−11
Fluorspar, finished	621	645	+4
Iron ore ... gross weight thousand long tons	125,170	130,602	+4
Lead	1,210	1,108	−8
Magnesium, primary ... short tons	53,610	43,811	−18
Manganese ore ... gross weight	2,264	2,361	+4
Mercury ... 76-pound flasks	54,143	52,889	−2
Mica splittings ... thousand pounds	8,662	8,037	−7
Molybdenum, primary products (shipments to domestic destinations) Mo content ... do	39,082	34,662	−11
Nickel, exclusive of scrap ... short tons	127,578	122,466	−4
Platinum-group metals (sales to consumers) ... thousand troy ounces	[2] 859	746	−13
Tin ... long tons	90,324	82,507	−9
Titanium concentrates:			
Ilmenite and slag ... estimated TiO_2 content	579	517	−11
Rutile ... do	46	52	+13
Tungsten concentrate ... short tons, W content	4,531	4,272	−6
Zinc, slab	1,009	936	−7

[1] Includes antimony content of antimonial lead produced from foreign and domestic ores. In previous years this class of material was reported separately.
[2] Revised figure.

TABLE 17.—Apparent consumption of metals and minerals in the United States, 1956–57 [1]

(Thousand short tons, unless otherwise stated)

Commodity	1956	1957	Change from 1956 (percent)
Aluminum, primary	1,782	1,778	----------
Asbestos, all grades [2]	[3] 728	723	−1
Boron minerals and compounds ... gross weight	[3] [4] 324	[4] 383	+18
Bromine and bromine in compounds ... million pounds	191	181	−5
Cadmium, primary [2] ... Cd content thousand pounds	[3] 12,701	10,999	−13
Clays	[3] 50,550	45,387	−10
Gypsum, crude	[3] 14,663	13,529	−8
Phosphate rock ... P_2O_5 content[5] thousand long tons	3,576	3,626	+1
Potash K_2O equivalent	2,058	2,084	+1
Salt, common	24,248	24,117	−1
Sulfur (all forms) ... S content thousand long tons	[3] 5,744	5,563	−3
Talc and allied minerals [2]	[3] 716	672	−6

[1] Covers commodities on which reported consumption is not collected.
[2] Adjustments are not made for national stockpile acquisitions, if any.
[3] Revised figures.
[4] Reported in terms of finished products. Not comparable with prior years.
[5] Estimated at 31 percent.

TABLE 18.—Sales, primary metal industry and stone, clay, and glass industry, and new orders, primary metal industry, 1954–57 [1]

(Million dollars)

Year	Primary metal		Stone, clay, and glass	Year	Primary metal		Stone, clay, and glass
	Sales	New orders	Sales		Sales	New orders	Sales
1954	20,106	18,721	7,215	1957 [2]—Continued			
1955	26,468	29,542	8,677	May	2,263	2,136	747
1956	28,339	29,028	8,982	June	2,289	2,306	741
1957	27,852	25,500	8,484	July	2,447	2,241	736
1957: [2]				August	2,362	2,078	708
January	2,594	2,345	751	September	2,182	2,202	668
February	2,453	2,403	766	October	2,224	2,081	650
March	2,389	2,330	747	November	2,156	1,686	659
April	2,357	2,197	707	December	2,073	1,512	654

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 38, February 1958, May 1958, and previous issues.
[2] Seasonally adjusted data, therefore will not add to 1957 total.

STOCKS

Physical Stocks.—Mineral stocks in the hands of manufacturers, consumers, and dealers increased sharply during 1957. These major stock accumulations account for the general stability of production in spite of sharply decreased consumption. Table 19 details the stock movements, and the large increases in aluminum, copper, iron ore, lead, and zinc are especially noticeable. The existence of such large stocks at year end in these major commodities was a definitely depressing factor in the short-term outlook for the mineral industries.

Mine Stocks.—Mine stocks, available only for those minerals shown in table 20, also increased markedly during 1957. Tungsten stocks continued their sharp rise but did not quite reach the 266-percent increase shown in 1956. The large increase in iron-ore stocks (20 percent) indicates that the increase shown in physical stocks discussed in the preceding paragraph probably carried over to mine stocks for those minerals for which data are not available.

Stocks in Bonded Warehouses.—Most changes in stocks in customs bonded warehouses were opposed to other stock movements. Stocks of lead, zinc, and aluminum decreased, but stocks of copper increased. The zinc decrease was especially large.

Value of Inventories.—The seasonally adjusted value of inventories for all primary-metal manufacturing (including several industries that are not ordinarily considered part of mineral manufacturing) increased during 1957; December 1957 was 7 percent above December 1956. Inventory value in stone, clay, and glass products also increased throughout the year and stood 8 percent above December 1956 at the end of 1957. These data reinforce the finding that 1957 was a year of very substantial stock accumulation in the mineral industries.

TABLE 19.—Selected physical stocks of mineral commodities of mineral manufacturers, consumers, and dealers in the United States at end of year, 1954–57 [1]

Commodity and type of stock	1954	1955	1956	1957 Quantity	1957 Change from 1956 (percent)
Aluminum:					
Primary, at reduction plants.............short tons..	21,100	15,020	102,496	171,141	+67
Purchased aluminum scrap, consumers (gross weight) short tons..	18,462	19,457	24,426	25,163	+3
Arsenic, producers' stocks..........thousand short tons..	12.5	11.6	[2] 4.8	2.5	−48
Bauxite, at consumers (dried equivalent) thousand long tons..	2,286	2,248	2,016	2,779	+38
Bismuth, consumers' and dealers' stocks thousand pounds..	252.8	234.3	[2] 229.0	348.4	+52
Cadmium, metal and compounds, producers, distributors, and consumers (Cd content)..thousand pounds..	6,294	5,139	[2] 5,052	5,322	+5
Cement, at mills...............million 376-pound barrels..	16.6	17.5	[2] 22.5	28.6	+27
Chromite, at consumers' plants:					
Metallurgical.................thousand short tons..	804	628	640	849	+33
Refractory..................................do....	257	313	431	610	+42
Chemical....................................do....	206	168	155	160	+3
Total.......................................do....	1,268	1,110	1,227	1,619	+32
Copper:					
At primary smelting and refining plants (Cu content):					
Refined.................thousand short tons..	25	34	78	109	+40
Blister and material in process.............do....	189	201	261	274	+5
In fabricators' hands, refined, including in process and primary fabricated shapes (Cu content) thousand short tons..	361	390	437	430	−2
Purchased copper scrap, consumers (gross weight) thousand short tons..	108	152	150	121	−19
Ferrous scrap and pig iron, at consumers' plants:					
Total scrap.................thousand short tons..	7,349	7,210	7,416	8,949	+21
Pig iron....................................do....	2,536	2,289	2,355	3,817	+62
Total.......................................do....	9,885	9,499	9,771	12,766	+31
Fluorspar:					
At consumers' plants........................do....	143.8	140.6	[2] 189.6	227.0	+20
Importers...................................do....	26.1	54.0	53.9	70.6	+31
Iron ore:					
At consumers' plants...........thousand long tons..	43,139	44,358	47,292	54,182	+15
On Lake Erie docks..........................do....	6,591	6,820	[2] 4,277	5,200	+22
Total.......................................do....	49,730	51,178	[2] 51,569	59,382	+15
Lead (Pb content):					
At smelters and refineries:					
Refined pig lead...........thousand short tons..	77.9	21.2	29.4	79.7	+171
Antimonial lead.............................do....	14.8	9.9	11.7	11.9	+2
In base bullion, including in process at and in transit to refineries......thousand short tons..	47.1	47.9	40.2	37.0	−8
In ore, matte, and in process at smelters...do....	62.1	71.8	77.9	79.4	+2
Total.......................................do....	201.9	150.8	159.3	207.9	+31
Consumers' stocks:					
Refined..	82.0	73.5	73.7	75.8	+3
Antimonial...	17.6	23.1	40.2	38.0	−5
In unmelted white-metal scrap, percentage metals, copper-base scrap, and drosses, residues, etc.[3]......................................	25.0	20.9	10.1	8.7	−14
Total..	124.6	117.5	124.0	122.4	−1
Manganese ore and ferromanganese, at plants, including bonded warehouses (gross weight):					
Ore.........................thousand short tons..	1,579	1,362	[2] 1,274	1,559	+22
Ferromanganese (excludes producers' stocks)..do....	175	152	155	168	+8
Mercury, in hands of consumers and dealers thousand 76-pound flasks..	23.3	9.1	21.1	17.0	−19
Molybdenum primary products, producers' stocks (Mo content)........................thousand pounds..	3,430	3,156	2,812	5,789	+106

See footnotes at end of table.

TABLE 19.—Selected physical stocks of mineral commodities of mineral manufacturers, consumers, and dealers in the United States at end of year, 1954–57—Con.

Commodity and type of stock	1954	1955	1956	1957 Quantity	1957 Change from 1956 (percent)
Nickel, consumers' plants:					
Metal [4] (Ni content)....short tons..	8,628	7,017	9,838	21,130	+115
In other forms, exclusive of scrap [5] (Ni content) short tons..	2,146	2,262	3,044	4,203	+38
Total [4] (Ni content)....do....	10,774	9,279	12,882	25,333	+97
Purchased nickel scrap (gross weight)....	1,627	1,404	3,142	2,113	−33
Platinum-group metals, all forms, held by refiners, importers, and dealers: [5]					
Platinum....thousand troy ounces..	243.0	304.5	353.8	307.0	−13
Palladium....do....	115.3	153.1	163.7	154.0	−6
Iridium, osmium, rhodium, and ruthenium...do....	43.5	45.5	47.0	46.2	−2
Total....do....	401.8	503.1	564.5	507.2	−10
Tin, consumers' plants:					
Pig tin, virgin, (includes in transit in United States, at other warehouses, and held by jobbers) long tons..	14,702	18,470	18,725	22,096	+18
In process (tin content)....do....	11,164	11,552	12,156	11,904	−2
Purchased tin scrap (gross weight)....do....	547	915	[2] 584	654	+12
Titanium concentrate, consumers and distributors (estimated TiO_2 content)....thousand short tons..	369	345	[2] 385	545	+42
Tungsten concentrate, consumers and dealers (W content)....thousand pounds..	3,913	3,502	2,980	4,103	+38
Zinc:					
Slab:					
At primary smelters and secondary distilling plants thousand short tons..	120.5	39.3	[2] 68.6	166.7	+143
At consumers' plants....do....	103.7	123.5	105.0	86.0	−18
Purchased zinc scrap, at consumers' plants (gross weight)....thousand short tons..	34.6	34.1	41.2	29.0	−30

[1] Stocks in the National Strategic Stockpile or Reconstruction Finance Corporation stocks of tin or Government-held nonstrategic stockpiles of bauxite are not included. Figures do not add to totals owing to rounding.
[2] Revised figure.
[3] In 1956 and 1957 unmelted white-metal scrap, drosses, residues, etc., included in secondary smelter stocks of scrap.
[4] Includes quantities in transit to consumers' plants.
[5] Revised on new basis. Not comparable with figures published in previous years.

TABLE 20.—Stocks of minerals at mines or in hands of primary producers, 1956–57

Commodity and unit	1956	1957	Change from 1956 (percent)
Antimony ore and concentrate....short tons, Sb content..	[1] 242	88	−64
Bauxite:			
Crude....thousand long tons..	1,133	748	−34
Processed (dried, calcined, and activated)....do....	6	6	....
Fluorspar, finished....short tons..	[1] 19,180	17,445	−9
Gypsum, crude....thousand short tons..	2,265	2,313	+2
Iron ore....thousand long tons..	5,465	6,536	+20
Mercury....76-pound flasks..	1,210	3,642	+201
Molybdenum concentrate [2]....thousand pounds, Mo content..	2,920	7,093	+143
Phosphate rock....thousand long tons, P_2O_5 content..	[1] 1,358	1,150	−15
Potassium salts....thousand short tons, gross weight..	[1] 739	939	+27
Sulfur:			
Frasch....thousand long tons..	3,935	4,423	+12
Recovered....do....	[1] 119	157	+32
Titanium concentrates (estimated TiO_2 content):			
Ilmenite....short tons..	29,736	18,062	−39
Rutile....do....	24	78	+225
Tungsten concentrate, W content....do....	739	2,084	+182

[1] Revised figure.
[2] Includes stocks of concentrate at plants making molybdenum products.

TABLE 21.—Estimated changes in stocks of selected minerals in custom bonded warehouses, Jan. 1, 1957–Dec. 31, 1957 [1]

(Short tons, unless otherwise stated)

Commodity	Estimated stock change	
	Component	Class
Aluminum		−1,239
Bauxite, crude	−1,232	
Metal and alloys in crude form	−7	
Antimony		−363
Regulus or metal, and oxide	−363	
Barite, crude		+88,597
Cadmium (content) pounds		+154,876
Cadmium do	+4,850	
Cadmium flue dust do	+150,026	
Clay		+117,228
China clay or kaolin	+117,228	
Copper (content)		+42,950
Copper ore and concentrate	+42,715	
Regulus, black, coarse	+836	
Refined ingots, plates, bars	−601	
Fluorspar, finished		−84,665
Acid grade	−131,618	
Metallurgical grade	+46,953	
Lead (content)		−28,107
Ores, flue dust, matte, base bullion	−34,369	
Pigs and bars	+6,862	
Manganese (content)		+476,143
Manganese ore, Battery grade	+37,041	
Manganese ore, Metallurgical grade	+489,379	
Ferromanganese and manganese-silicon	−50,277	
Mercury 76-pound flasks		+1,793
Mica, except scrap pounds		+3,574,734
Manufactured do	+3,385,448	
Reexports of foreign merchandise, both types do	−189,286	
Molybdenum do		+1,236,916
Nickel		+2,139
Nickel alloy and metal, including scrap	+2,139	
Talc and allied minerals long tons		−22
Tungsten ore and concentrate (W content)		−2,901
Zinc (content)		−156,316
Zinc bearing ores	−156,109	
Blocks, pigs, or slabs	−207	

[1] Estimated by the subtraction of "imports for consumption" and "reexports of foreign merchandise" from "general imports." All data from U. S. Department of Commerce. Minerals are those included in net-supply table, which enter bonded warehouses and changed during 1957.

TABLE 22.—Seasonally adjusted book value of inventory, primary metal industry and stone, clay, and glass, December 1954–56 and monthly 1957 [1]

(Million dollars)

Year and month	Primary metal	Stone, clay, and glass	Year and month	Primary metal	Stone, clay, and glass
1954: December	3,138	917	1957: May	4,192	1,240
1955: December	3,420	1,013	June	4,207	1,254
1956: December	3,975	1,171	July	4,245	1,239
1957: December	4,269	1,270	August	4,326	1,210
January	3,962	1,156	September	4,344	1,251
February	4,071	1,170	October	4,356	1,273
March	4,102	1,174	November	4,279	1,274
April	4,114	1,209			

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 38, February 1958 and May 1958, and earlier issues.

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LABOR AND PRODUCTIVITY

Employment.—Total employment held up relatively well in the mineral industries during 1957, in line with the stability in production. Employment in the copper and lead and zinc industries, however, dropped persistently during 1957; the average for 1957 was 500 and 700 employees lower, respectively, than in 1956. These declines were more than offset by the increase of 2,800 employees in the iron-ore industry. Employment in the smelting and refining of nonferrous metals remained virtually stable compared with 1956, but in blast furnaces, steel works and rolling mills it rose substantially. The increase in the iron-ore and steel industries employment as compared with 1956 were affected to some degree by the strikes during the summer of 1956, but the 1957 levels were also higher than 1955 when there was no strike. The major changes in employment for 1957 over 1956 follow:

	Percent
All industries	+1
Mining (including fuels)	+3
Metals and minerals (except fuels)	+1
Metal mining	+1
Nonmetallic mining and quarrying	+1
Fuels	+4
Mineral manufacturing [1]	+1

[1] Based upon categories listed under "Mineral Manufacturing" in table 23.

Employment in the lead- and zinc-mining industries decreased beginning in May; in copper mining it began to decline in August. Total metal-mining employment turned downward in August, but employment in the nonmetallic-mining and quarrying industry did not fall until September, after its usual seasonal upturn during the summer months.

Total Wages and Salaries.—Wage and salary income rose 3 percent over 1956 but did not match the 12-percent increase in 1956. All categories of mining shared the lower rate of increase, and the primary metal industries also felt the impact of the business recession.

Hours and Earnings.—Average weekly hours of production workers dropped below 1956 to match 1954—42.4. However, total weekly earnings rose as a result of continued increases in hourly earnings. Both the copper and the lead and zinc industries declined in hourly earnings as well as in weekly hours.

The declines in mining were not found in the nonferrous smelting and refining industries. Although the drop in weekly hours was general throughout the mineral-manufacturing industries, both weekly and hourly earnings increased over 1956. The rates of increase, especially in the primary smelting and refining of copper and lead and zinc, were substantially less than those for 1956 over 1955. As in employment, these data on hours and earnings show the relatively large decreases in the nonferrous-metal industries during the 1957 recession.

Labor-Turnover Rates.—The 1957 total accession rate and layoff rate reflect the weakness in the nonferrous mineral industries. The copper- and lead-zinc-mining layoff rate increased sharply over 1956

TABLE 23.—Total employment in the mineral industries (nonfuel) in the continental United States, 1954–57, by industry [1]

(In thousands)

Year and month	Mining					
	Total	Non-metallic mining and quarrying	Metal			
			Total [2]	Iron	Copper	Lead and zinc
1954	204.4	105.1	99.3	35.2	27.9	16.4
1955	208.0	107.0	101.0	33.7	29.2	16.6
1956	[3] 224.5	[3] 116.2	[3] 108.3	[3] 34.6	[3] 33.3	[3] 17.4
1957:						
January	222.0	111.8	110.2	35.1	33.6	18.3
February	220.2	110.0	110.2	34.9	33.7	18.3
March	222.0	111.8	110.2	34.8	33.9	18.3
April	226.1	115.3	110.8	36.1	33.5	18.2
May	230.1	118.2	111.9	38.2	33.0	17.4
June	231.1	118.7	112.4	38.9	33.4	17.5
July	232.6	119.2	113.4	39.3	33.4	16.8
August	233.5	121.3	112.2	40.1	32.8	15.9
September	231.3	121.2	110.1	39.6	32.0	15.4
October	225.8	120.1	105.7	38.1	30.3	14.9
November	223.2	118.7	104.5	36.9	30.3	14.7
December	220.1	116.1	104.0	35.9	30.3	15.3
Year (average)	226.5	116.8	109.7	37.4	32.5	16.7

Year and month	Mineral manufacturing				
	Fertilizers	Cement, hydraulic	Blast furnaces, steel works, and rolling mills	Smelting and refining of nonferrous metals	
				Primary	Secondary
1954	36.8	41.4	580.8	62.3	12.4
1955	36.9	42.6	635.3	63.8	12.7
1956	[3] 36.0	43.4	[3] 630.6	[3] 67.5	[3] 14.3
1957:					
January	34.4	42.4	661.8	70.3	14.5
February	36.7	42.3	662.2	68.5	14.5
March	42.0	42.4	659.5	68.9	14.4
April	44.9	42.2	654.6	68.9	14.4
May	42.5	42.6	651.5	67.9	14.4
June	33.5	41.5	652.1	67.9	14.1
July	30.5	29.7	648.9	67.1	14.1
August	31.0	41.6	648.4	66.9	13.9
September	33.3	43.1	641.7	66.0	14.1
October	33.9	42.5	629.7	64.6	14.1
November	32.6	42.5	616.4	64.6	13.9
December	32.4	42.1	599.3	64.3	13.8
Year (average)	35.6	41.2	643.7	67.2	14.2

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

TABLE 24.—Wages and salaries in the mineral industries in the United States, 1956–57

(Million dollars)

Industry	1956 [1]	1957 [2]	Industry	1956 [1]	1957 [2]
Mining	4,088	4,230	Mining—Continued		
Nonfuel mining	1,127	1,163	Fuel mining	2,961	3,067
Metal mining	588	608	Manufacturing	77,629	80,000
Nonmetallic mining and quarrying	539	555	Primary metal industries	7,200	7,370

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 37, No. 7, July 1957, p. 16.
[2] Estimated by author from data on employment, hours, and earnings. No longer published as part of the National Income Issue of the Survey of Current Business.

TABLE 25.—Average hours and gross earnings of production and related workers in the mineral industries (nonfuel) in continental United States, 1954–57, by industries [1]

Year	Mining								
	Total [2]			Metal					
				Total [3]			Iron		
	Weekly—		Hourly earnings	Weekly—		Hourly earnings	Weekly—		Hourly earnings
	Earnings	Hours		Earnings	Hours		Earnings	Hours	
1954	$80.85	42.4	$1.91	$84.46	40.8	$2.07	$82.03	37.8	$2.17
1955	86.54	43.4	2.00	92.42	42.2	2.19	92.46	40.2	2.30
1956	[4] 91.03	[4] 43.4	2.10	[4] 96.83	[4] 42.1	2.30	[4] 96.71	[4] 39.8	2.43
1957	93.10	42.4	2.20	98.98	40.9	2.42	104.01	39.7	2.62

Year	Metal—Continued						Nonmetallic mining and quarrying		
	Copper			Lead and zinc					
1954	$87.13	42.5	$2.05	$76.92	40.7	$1.89	$77.44	44.0	$1.76
1955	95.70	44.1	2.17	83.82	41.7	2.01	80.99	44.5	1.82
1956	[4] 100.28	[4] 43.6	[4] 2.30	[4] 89.24	[4] 41.7	[4] 2.14	85.63	44.6	1.92
1957	98.23	41.1	2.39	89.19	41.1	2.17	87.60	43.8	2.00

Year	Mineral manufacturing								
	Fertilizer			Cement, hydraulic			Blast furnaces, steel works, and rolling mills [5]		
1954	$61.48	42.4	$1.45	$75.71	41.6	$1.82	$83.38	37.9	$2.20
1955	63.75	42.5	1.50	78.85	41.5	1.90	95.99	40.5	2.37
1956	[4] 67.68	[4] 42.3	[4] 1.60	[4] 83.84	[4] 41.3	2.03	[4] 102.06	40.5	[4] 2.52
1957	71.66	42.4	1.69	87.91	40.7	2.16	104.40	39.1	2.67

Year	*Electrometallurgical products*			*Other*			Primary smelting and refining of nonferrous metals [5]		
1954	$80.20	40.3	$1.99	$83.16	37.8	$2.20	$80.00	40.2	$1.99
1955	87.14	41.3	2.11	96.39	40.5	2.38	84.45	40.6	2.08
1956	[4] 88.44	[4] 40.2	2.20	102.47	40.5	2.53	91.46	41.2	2.22
1957	93.43	40.1	2.33	104.79	39.1	2.68	95.41	40.6	2.35

Year	*Primary smelling and refining of copper, lead, and zinc*			*Primary refining of aluminum*			Secondary smelting and refining of nonferrous metals		
1954	$76.80	40.0	$1.92	$84.84	40.4	$2.10	$74.80	41.1	$1.82
1955	81.61	40.6	2.01	88.88	40.4	2.20	82.03	42.5	1.93
1956	[4] 89.02	41.6	[4] 2.12	95.34	40.4	2.36	[4] 85.04	[4] 42.1	[4] 2.02
1957	90.13	40.6	2.22	103.68	40.5	2.56	87.53	40.9	2.14

[1] U. S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review: Vol. 81, No. 3, March 1958, table C–1, p. 327ff and earlier issues.
[2] Weighted average of data for metal mining and nonmetallic mining and quarrying, computed by author of chapter, using figures for production workers as weights.
[3] Includes other metal mining, not shown separately.
[4] Revised figure.
[5] Italicized titles that follow are components of this industry.

while the accessions rate dropped substantially. Iron-ore mining was a relatively strong factor but did show a lower accession rate and a slightly higher layoff rate as compared with 1956. For total metal mining the decrease in the accession rate and the increase in the layoff rate were much greater than those shown for total manufacturing.

Productivity.—Productivity increased slightly in the copper-ore industry but decreased in the iron-ore industries. The rise was striking in recoverable metal per man-hour in the copper-ore industry,

TABLE 26.—Monthly labor-turnover rates in the mineral industries, 1956 average, and 1957 by months [1]

(Per 100 employees)

Turnover rate	All manufacturing	Hydraulic cement products	Blast furnaces, steel works, and rolling mills	Primary smelting and refining of nonferrous metals: copper, lead, zinc	Metal mining			
					Total metal mining	Iron mining	Copper mining	Lead and zinc mining
Total accession rate:								
1956 average	3.4	1.9	1.7	2.2	3.8	1.9	4.1	3.0
1957:								
January	3.2	1.4	1.6	1.7	3.2	1.0	4.1	2.1
February	2.8	1.2	1.3	1.4	2.4	.6	2.9	1.5
March	2.8	1.6	1.2	1.2	2.5	1.0	2.4	1.7
April	2.8	1.5	1.3	1.9	2.9	1.2	2.6	2.4
May	3.0	2.3	1.4	2.3	2.8	.6	2.5	2.3
June	3.9	3.1	2.5	2.7	4.1	1.6	2.8	5.2
July	3.2	2.3	1.5	1.4	2.2	.8	2.4	1.5
August	3.2	3.0	1.3	1.4	2.4	.8	2.3	1.0
September	3.3	1.8	1.1	2.1	2.1	.7	1.5	1.2
October	2.9	1.4	1.1	1.3	2.2	.6	2.5	1.4
November	2.2	.9	.7	1.1	1.3	.4	1.9	1.0
December	1.6	.3	.8	1.3	1.1	.3	1.2	2.6
1957 average	2.9	1.7	1.3	1.7	2.4	.8	2.4	2.0
Total separation rate:								
1956 average	3.5	1.9	1.5	2.1	3.6	1.7	4.1	2.9
1957:								
January	3.3	2.1	1.2	1.7	3.1	.8	3.8	2.4
February	3.0	1.5	1.3	1.7	2.7	1.3	3.1	1.6
March	3.3	1.1	1.7	1.8	3.7	.9	4.6	2.6
April	3.3	1.4	2.1	1.7	4.6	1.0	4.5	5.3
May	3.4	1.6	1.8	2.4	4.1	1.2	5.2	3.5
June	3.0	2.3	1.5	2.3	3.2	.8	4.0	2.9
July	3.2	1.7	2.1	2.4	2.7	.6	4.0	4.1
August	4.0	2.4	1.9	2.7	4.4	.7	4.6	7.8
September	4.4	3.1	3.2	3.9	4.2	1.8	6.6	3.8
October	4.0	1.4	3.0	2.0	4.2	2.9	6.6	2.8
November	4.0	2.0	3.7	1.4	2.3	1.2	3.6	1.8
December	3.6	4.8	3.5	2.2	3.9	5.8	3.2	3.9
1957 average	3.5	2.1	2.3	2.2	3.6	1.6	4.5	3.5
Layoff rate:								
1956 average	1.5	.4	.3	.2	.4	.7	.1	.6
1957:								
January	1.5	1.1	.2	.2	.2	.7	.1	.5
February	1.4	.7	.4	.2	.4	.8	.1	.5
March	1.4	(2)	.7	.4	.4	.3	.2	.5
April	1.5	.5	1.1	.1	.9	.2	.1	2.6
May	1.5	.5	.8	.3	.4	.5	.2	.7
June	1.1	1.0	.5	.6	.3	.3	.1	.7
July	1.4	.4	1.2	1.1	.5	(2)	.3	2.3
August	1.6	.3	.8	1.1	1.7	(2)	1.4	5.6
September	1.8	.6	1.4	1.5	1.2	.4	3.0	1.1
October	2.3	.3	2.2	.7	2.2	2.3	3.7	1.5
November	2.7	1.1	3.0	.5	.7	.8	1.1	.6
December	2.6	4.1	3.0	1.3	2.5	5.4	1.1	2.0
1957 average	1.7	.9	1.3	.7	1.0	1.0	1.0	2.0

[1] U. S. Department of Labor Bureau of Labor Statistics Monthly Labor Review: various monthly issues, table B-2.
[2] Less than 0.05.

well above the previous high in 1955, but the index per production worker did not rise.

The computed index of production per man-hour for lead and zinc showed a slight rise in productivity, 104 in 1957, compared with 102 in 1956.[21]

TABLE 27.—Labor-productivity indexes for copper- and iron-ore mining, 1948–52 (average) and 1953–57 [1]

(1947-49=100)

Year	Copper		Iron	
	Crude ore mined per—		Crude ore mined per—	
	Production worker	Man-hour	Production worker	Man-hour
1948-52 (average)	113.2	111.3	111.0	107.5
1953	119.9	115.5	122.6	116.9
1954	114.4	118.8	[2] 99.3	[2] 106.1
1955	134.2	134.3	132.7	133.4
1956	135.4	137.2	[2] 133.1	[2] 135.3
1957	[3] 138.1	[3] 149.0	[3] 131.4	[3] 134.4
	Recoverable metal [4] per—		Recoverable metal [4] per—	
	Production worker	Man-hour	Production worker	Man-hour
1948-52 (average)	111.1	109.3	107.3	104.0
1953	112.2	108.2	114.2	108.9
1954	104.0	108.1	87.4	93.4
1955	121.8	122.0	118.2	118.9
1956	116.1	117.6	[2] 109.6	[2] 111.4
1957	118.0	127.3	107.0	109.5

[1] U. S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review: February 1956, vol. 79, No. 2, and later reports.
[2] Revised figure.
[3] Preliminary.
[4] Figures refer to usable ore rather than recoverable metal. For iron ore, usable ore is that product with the desired iron content (by selective mining, mixture of ores, washing, jigging, concentrating, sintering, etc.).

PRICES AND COSTS

Prices.—The price indexes for the mineral categories listed in table 28 showed the spotty nature of the mineral markets during 1957. The nonferrous metals and iron- and steel-scrap indexes both dropped 12 percent for the year; the January to December fall in iron and steel scrap reached 44 percent. The 1957 experience contrasted strongly with 1956, when all indexes increased substantially.

Costs.—Indexes of cost items rose during the year, except for lumber, indicating that the spread between price and cost for many minerals, especially the nonferrous group, narrowed during 1957.

Relative Labor Costs.—The index of labor cost per pound increased for iron-ore mining, dropped for copper-ore mining, and remained stable for lead-zinc-ore mining. However, owing to the softening in price for the nonferrous group, the index of labor costs per dollar of recoverable metal increased for each industry, increasing 22 points in copper-ore mining, 16 points in lead-zinc-ore mining, and 3 points in

[21] Index computed by author of chapter. See Review of the Mineral Industries, Minerals Yearbook, 1956, pp. 19-20, for description of index.

iron-ore mining. The lead-zinc-ore mining index was at its highest point since 1949, and the copper-ore-mining index equaled that for 1953–54.

TABLE 28.—Price relatives for selected metals and mineral commodities, January and December 1956, and annual averages, 1956 and 1957 [1]

(1947–49=100)

Commodity	1957		Change from January (percent)	Annual average		Change from 1956 (percent)
	January	December		1956	1957	
Iron ore	172.9	182.4	+5	173.0	181.7	+5
Iron and steel scrap	149.2	83.6	−44	132.4	116.9	−12
Iron and steel	164.3	166.5	+1	154.7	166.2	+7
Nonferrous metals	148.7	130.6	−12	156.1	137.4	−12
Clay products	150.6	155.1	+3	148.0	154.0	+4
Gypsum products	127.1	127.1	0	127.1	127.1	----------
Concrete ingredients	134.6	136.9	+2	130.6	136.0	+4
Building lime, insulation material and asbestos cement shingles	124.3	131.1	+5	123.4	128.0	+4
Fertilizer materials	105.9	107.8	+2	108.4	106.8	−1
All commodities (minerals and all other)	116.9	118.5	+1	114.3	117.6	+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.

TABLE 29.—Price relatives for selected cost items in nonfuel mineral production, January and December 1956, and annual averages, 1956 and 1957 [1]

(1947–49=100)

Commodity	1957		Change from January (percent)	Annual average		Change from 1956 (percent)
	January	December		1956	1957	
Coal	124.1	122.9	−1	114.4	124.4	+9
Coke	159.1	161.9	+2	149.7	161.7	+8
Gas	119.9	120.7	+1	114.3	116.1	+2
Petroleum products	124.9	123.5	−1	118.2	127.0	+7
Industrial chemicals	123.5	123.9	(2)	121.4	123.5	+2
Lumber	122.6	116.4	−5	127.2	119.7	−6
Explosives	133.8	139.5	+4	130.5	136.7	+5
Construction machinery and equipment	156.2	165.3	+6	148.6	160.0	+8

[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.

Index of Mining Expenses.—The following index represents the changes in major expense items, 1950–57 (1947–49=100) and uses weights derived from the 1954 Census of Mineral Industries and data in tables 29 and 30. The index does not represent changes in total costs of mining as it excludes capital cost and contract work. It does, however, gage the impact of labor cost and productivity and changes in prices of items used by the mining industry. The Index of Mining Expenses for the 8-year period (1947–49=100) is:

1950	96.2	1954	127.6
1951	105.6	1955	119.7
1952	113.1	1956	128.2
1953	120.1	1957	132.9

TABLE 30.—Indexes of relative labor costs, copper-, lead-zinc-, and iron-ore mining, 1949–57

(1949=100)

Year	Index of labor costs per pound of recoverable metal [1]			Index of value of recoverable metal per man-hour [2]			Index of labor costs per dollar of recoverable metal [3]		
	Copper	Lead-zinc	Iron ore	Copper	Lead-zinc	Iron ore	Copper	Lead-zinc	Iron ore
1949	100	100	100	100	100	100	100	100	100
1950	91	93	96	128	109	114	83	94	90
1951	97	112	100	146	130	132	77	87	88
1952	108	124	115	146	116	130	86	105	95
1953	122	122	129	160	89	150	82	137	97
1954	126	120	153	166	89	130	82	135	113
1955	118	124	128	235	102	168	61	125	93
1956	129	133	141	254	106	172	60	128	95
1957	125	133	153	193	96	180	82	144	98

[1] Index computed by author from data in tables 25 and 27.
[2] Index computed by author from data in table 27, multiplied by price of electrolytic copper, average lead and zinc, and iron ore, and rebased.
[3] Index computed by author using the above index of value and data in table 25.

INCOME

National Income Originated.—Metal mining declined sharply in national income originated in 1957 as compared with 1956. This decrease contrasted strongly with the increases in 1955 and 1956 and illustrates again the wide cyclical swings characteristic of the metal-mining industry. Nonmetals also decreased, but only by about one-third as much. Although the national income originated in mining, except fuels, was still above the 1954 figure, the share of the total dropped below that in 1954.

TABLE 31.—National income originated in the mineral industries in the United States, 1955–57 [1]

(Million dollars)

Industry	Income			
	1955 [2]	1956 [2]	1957	Change from 1956 (percent)
All industries	330,206	349,356	363,951	+4
Metal mining	990	1,095	847	−23
Nonmetallic mining and quarrying	763	844	781	−7
Total mining except fuels	1,753	1,939	1,628	−16
Total mining including fuels	5,609	6,265	6,191	−1
Primary metal industries	10,176	11,105	11,229	+1
Stone, clay, and glass products	3,792	4,031	3,957	−2
(Percent)				
All industries	100	100	100	
Metal mining	.30	.31	.23	
Nonmetallic mining and quarrying	.23	.24	.21	
Total mining except fuels	.53	.56	.45	
Total mining including fuels	1.69	1.79	1.70	
Primary metal industries	3.08	3.18	3.09	
Stone, clay, and glass products	1.15	1.15	1.09	

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business, July 1958, p. 9, T. 6. In arriving at national income, depletion charges are not deducted. This affects the data for the mining industries.
[2] Revised figures.

Business Failures.—The number of mining failures increased sharply in 1957 as compared with 1956, and the current liabilities of those firms that failed increased. The experience in mining approximated that in all industrial and commercial industries.

TABLE 32.—Industrial and commercial failures and liabilities, 1955–57 [1]

Industry	1955	1956	1957
Mining: [2]			
Number of failures	55	42	75
Current liabilities (thousand dollars)	5,156	8,193	11,588
Manufacturing:			
Number of failures	2,147	[3] 2,243	2,336
Current liabilities (thousand dollars)	151,789	183,037	185,253
All industrial and commercial industries:			
Number of failures	10,969	12,686	13,739
Current liabilities (thousand dollars)	449,380	562,697	615,293

[1] Dun & Bradstreet, Inc., Monthly Business Failures: New York, N. Y., Jan. 23, 1958, p. 2.
[2] Including fuels.
[3] Revised figure.

INVESTMENT

New Plant and Equipment.—The expenditure for new plant and equipment by fuel- and nonfuel-mining firms was almost the same as in 1956. Unlike 1956, however, the expenditure rate turned sharply downward in the last quarter of 1957, reflecting the dropoff in demand resulting from the recession. Manufacturing firms as a whole spent over $1 billion more in 1957 for new plants and equipment than in 1956; this contrasted with the $3.5 billion increase between 1955 and 1956. The expenditure of firms manufacturing stone, clay, and glass products declined.

Issues of Mining Securities.—The mining industry (including fuels) was the source of only 2.2 percent of all new corporate securities offered in 1957, as compared with 4.2 percent in 1956, 4.1 percent in 1955, and 5.7 percent in 1954. Quite significant was the continued shift away from common stocks in the mining industries—a drop to 27 percent from 34 percent in 1956 and 50 percent in 1955. The total gross proceeds from securities offered in 1957 was $166 million lower than in

TABLE 33.—Expenditures on new plant and equipment by firms in mining and selected mineral manufacturing industries, 1955–57 [1]

(Million dollars)

Industry	1955	1956	1957	1957			
				January-March	April-June	July-September	October-December
Mining [2]	957	1,241	1,243	300	327	314	302
Manufacturing	11,439	14,954	15,959	3,505	4,183	4,010	4,261
Primary iron and steel	863	1,268	1,722	327	437	452	506
Primary nonferrous metals	214	412	814	147	217	223	227
Stone, clay, and glass products	498	686	572	135	156	139	142
Chemicals and allied products	1,016	1,455	1,724	353	435	440	496
Petroleum and coal products	2,798	3,135	3,453	728	892	894	939

[1] Office of Business Economies, U. S. Department of Commerce, Survey of Current Business: Vol. 38, No. 3, March 1958, p. 12.
[2] Including fuels.

1956 for the mining group, a 36-percent drop, compared with the 16-percent increase in the manufacturing group. In this area the mining industry was affected relatively strongly by the general business recession.

TABLE 34.—Estimated gross proceeds of new corporate securities offered for cash in the United States in 1957 [1]

Type of security	Total corporate		Manufacturing		Mining [2]	
	Million dollars	Percent	Million dollars	Percent	Million dollars	Percent
Bonds	9,957	77	2,858	68	204	71
Preferred stock	411	3	94	2	6	2
Common stock	2,516	20	1,282	30	79	27
Total	12,884	100	4,234	100	289	100

[1] U. S. Securities and Exchange Commission, Statistical Bulletin: Vol. 17, No. 5, May 1958, p. 10. Substantially all new issues of securities offered for cash sale in the United States in amounts over $100,000 and with terms to maturity of more than 1 year are covered in these data.
[2] Including fuels.

Prices of Mining Securities.—The mining-company common-stock annual average price index for 1957 dropped somewhat more than the composite index or the manufacturing index. Even so, the mining index was well above that in 1955. When compared with the 1956 average, the 1957 averages were down 4.2 percent for mining, 3.7 percent for manufacturing, and 3.9 percent for the composite.

TABLE 35.—Indexes of common-stock annual average prices, 1953–57 [1]

(1939=100)

Year	Composite [2]	Manufacturing	Mining [3]
1953	193.3	220.1	240.5
1954	229.8	271.3	267.0
1955	304.6	374.4	312.9
1956	345.0	438.6	357.5
1957	331.4	422.1	342.4

[1] Council of Economic Advisers, Economic Indicators (prepared for the Joint Committee on the Economic Report): June 1958, p. 30. These indexes are yearly averages of the weekly closing price indexes of common stock on the New York Stock Exchange, published currently in the U. S. Securities and Exchange Commission Monthly Statistical Bulletin.
[2] Covers, in addition to mining and manufacturing, transportation, utilities, and trade, finance, and service.
[3] Including fuels.

Foreign Investment.—The book value of United States (net) direct private investment in mining and smelting in foreign countries increased $235 million during 1957. The largest increase ($56 million) occurred in Canada, with Peru ($38 million) and Mexico ($25 million) the next in importance. Net capital movements contributed over 75 percent of the increase in book value, as compared to 50 percent in 1956 and 36 percent in 1955. Undistributed earnings of subsidiaries were lower than in 1956 (down 31 percent), net capital movements were higher (up 86 percent), and the total was higher (up 29 percent). The increase in investment in mining and smelting was considerably greater than the 10 percent rise for all industries.

TABLE 36.—Direct private investments of the United States in foreign mining and smelting industries, 1957 [1]

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

Country	Mining and smelting: Book value, beginning of year [2]	Mining and smelting: Net capital movements	Mining and smelting: Undistributed earnings of subsidiaries	Mining and smelting: Book value end of year	All industries: Book value, beginning of year [2]	All industries: Net capital movements	All industries: Undistributed earnings of subsidiaries	All industries: Book value end of year [2]
Canada	940	39	17	996	7,460	584	274	8,332
Latin American republics:								
Chile	434	25	−2	457	676	24	2	702
Mexico	166	15	10	191	690	61	36	787
Peru	221	37	1	258	343	47	10	400
Total [3]	1,096	130	12	1,238	7,459	1,104	251	8,805
Western European countries	45	1	7	50	3,520	254	236	3,993
Western European dependencies	121	5	6	132	805	66	34	906
Union of South Africa	84	2	6	92	288	−15	31	305
All other countries	113	1	12	126	2,645	79	191	2,911
Total, all areas	2,399	177	61	2,634	22,177	2,072	1,017	25,252

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 38, No. 9, September 1958. Figures may not add to totals owing to rounding. All figures are preliminary except as footnoted.
[2] Final figures.
[3] Includes countries not shown above.

TRANSPORTATION

Statistical transportation data for 1957 were not available when this chapter was prepared. There is no reason to believe that the patterns shown in the 1956 Review chapter were substantially changed.

TABLE 37.—Indexes of average freight rates on carload traffic, 1955–56, and average revenue per ton, originated or terminated, 1954–56, in the United States

Item	Indexes [1] (1950=100): 1955	Indexes [1] (1950=100): 1956	Average revenue per ton [2] (dollars): 1954	Average revenue per ton [2] (dollars): 1955	Average revenue per ton [2] (dollars): 1956
Products of mines	107	110	2.82	2.78	2.96
Iron ore	110	115	1.83	1.84	2.07
Clay and bentonite	114	119	6.09	6.35	6.58
Sand, industrial	108	113	2.88	2.82	3.05
Gravel and sand, n. o. s.	109	110	1.22	1.25	1.29
Stone and rock, broken, ground and crushed	108	111	1.53	1.52	1.57
Fluxing stone and raw dolomite	113	117	1.52	1.50	1.58
Salt	108	109	6.32	6.24	6.37
Phosphate rock	105	108	2.99	2.56	2.32
Mineral manufactures and miscellaneous	108	112	10.92	10.54	10.68
Fertilizers, n. o. s.	111	112	5.81	6.07	7.62
Iron, pig	114	117	3.83	4.20	4.49
Cement: Natural and portland	104	102	4.51	4.26	4.14
Lime, n. o. s.	111	116	5.73	5.62	5.73
Scrap iron and scrap steel	108	113	3.75	3.62	3.97
Furnace slag	105	109	1.73	1.71	1.88
Nonmineral categories:					
Products of agriculture	109	112	8.58	8.38	8.48
Animals and products	112	116	21.87	21.78	22.34
Products of forests	113	117	7.85	7.83	7.58
Forwarder traffic	112	115	38.74	38.57	40.67
All commodities	108	112	6.48	6.23	6.32

[1] U. S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Index of Average Freight Rates on Railroad Carload Traffic 1948–56: Statement R1-1, 1948–56, March 1958. Indexes are based on the Commission's 1-percent waybill sample.
[2] U. S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Freight Commodity Statistics, Class 1 Steam (sic) Railways in the United States: Statement 55100, 1954; 56100, 1955; and 57100, 1956, Table 5.

Construction on the St. Lawrence Seaway continued, and its partial completion will alter mineral-transportation routes. Mineral commodities (except fuels) most likely to be directly affected are iron ore and other minerals associated with steel manufacture.

Freight Rates.—The 1957 indexes are not yet available. Freight rates increased across the board in 1956 compared with 1955. Cement is the only category in table 36 to decline. The index for all products of mines rose 3 percent; iron ore and sand and gravel increased 5 percent. Ocean freight rates are discussed in the World Review section.

FOREIGN TRADE

Value.—The total value of nonfuel minerals and metals imported in 1957 rose slightly over the 1956 total, but the value of exports declined. The entire increase in import value was furnished by the

TABLE 38.—Value of minerals and mineral products imported and exported by the United States, 1955–57, by commodity groups and commodities,[1] (thousand dollars)

[U. S. Department of Commerce]

SITC number	Group and commodity	Imports for consumption [2]			Exports of domestic merchandise [3]		
		1955	1956 [4]	1957	1955	1956 [4]	1957
	CRUDE METALLIC MINERALS [5]						
281-01	Iron ore and concentrates	177,345	250,855	285,062	36,993	48,805	49,227
282-01	Iron and steel scrap	7,051	11,331	10,168	177,526	300,620	217,938
	Ores of nonferrous base metals and concentrates:						
283-07	Manganese	71,835	66,975	99,828	612	664	724
283-11	Tungsten	56,155	58,011	34,525	65	225	227
283-06	Tin	36,773	9,423	118			
283-01	Copper	77,868	65,213	70,238	7,326	11,648	9,964
283-08	Chromium	37,854	49,349	55,661	76	99	53
283-05	Zinc	39,556	53,110	89,075		162	1
283-03	Bauxite (aluminum ore) and concentrates	36,629	44,414	60,951	528	834	4,847
283-04	Lead	38,272	51,666	61,617	5	340	257
[6] 283-19	Columbium	19,852	8,387	3,038	10	9	44
283-02	Nickel	3,264	4,638	5,300		556	
[6] 283-19	Titanium:						
	Ilmenite	7,031	9,198	10,317	194	312	278
	Rutile	1,984	7,148	11,843			
[6] 283-19	Cobalt	5,759	3,737	1,320			
[6] 283-19	Molybdenum	142		55	15,783	21,296	32,428
[6] 283-19	Other	11,016	12,767	11,516	1,887	202	683
	Nonferrous metal scrap:						
284-01	Aluminum	16,364	10,770	5,396	6,501	8,127	6,435
	Old and scrap copper	9,058	3,463	3,039	20,560	20,056	28,414
	Old brass and bronze and clippings	5,145	3,003	2,393	[7] 24,507	[7] 29,814	[7] 32,968
	Other, not elsewhere included	6,916	9,839	4,932	7,030	5,946	5,852
285-02	Platinum-group metals	15,801	15,606	11,240			
	Total crude metallic minerals	681,670	748,903	837,632	299,603	449,715	390,340
	METALS (UNWROUGHT) [5] [8]						
681-01	Pig iron and sponge iron	15,849	19,108	14,525	2,056	15,250	57,158
681-02	Ferroalloys:						
	Ferromanganese	12,022	28,500	60,232	643	682	1,869
	Ferrochromium	8,012	11,403	14,460	2,267	2,891	2,419
	Other	3,394	3,861	4,512	3,325	4,836	3,639
682-01	Copper	335,721	383,965	276,554	152,384	191,452	212,515
687-01	Tin	141,787	145,835	130,739	504	821	1,526
684-01	Aluminum	74,695	100,137	107,339	2,773	19,109	14,051
683-01	Nickel (including scrap)	149,522	153,888	156,786			
686-01	Zinc	46,638	65,034	63,947	4,203	2,540	2,618

See footnotes at end of table.

TABLE 38.—Value of minerals and mineral products imported and exported by the United States, 1955–57, by commodity groups and commodities,[1] (thousand dollars)—Continued

SITC number	Group and commodity	Imports for consumption [2]			Exports of domestic merchandise [3]		
		1955	1956 [4]	1957	1955	1956 [4]	1957
	METALS (UNWROUGHT)—con.						
685-01	Lead	74,753	81,111	89,993	154	1,300	1,345
689-01	Cobalt	38,585	32,910	32,559	(9)	(9)	(9)
689-01	Mercury	5,149	11,010	9,333	155	284	484
689-01	Other nonferrous base metals	13,575	17,073	32,643	11,028	12,349	9,479
671-02	Platinum-group metals, including unworked and partly worked	32,361	42,149	24,492	2,724	3,927	2,804
	Total metals	952,063	1,095,984	1,018,114	182,216	255,441	309,907
	Total metals and metallic minerals	1,633,733	1,844,887	1,855,746	481,819	705,156	700,247
	CRUDE NONMETALLIC MINERALS (EXCEPT FUELS)						
	Diamonds:						
[6] 672-01	Gems, rough or uncut	76,735	75,796	77,142	785	675	424
[6] 272-07	Industrial	66,051	73,989	50,870	16	98	544
	Total	142,786	149,785	128,012	801	773	968
272-12	Asbestos, crude, washed or ground	60,958	61,472	60,140	236	338	340
271-02	Sodium nitrate	21,699	16,337	17,107	553	210	182
272-13	Mica, unmanufactured (including scrap)	10,862	11,232	10,910	35	92	46
[6] 272-14	Fluorspar	8,540	11,225	16,031	65	31	81
272-11	Stone for industrial uses, except dimension	7,106	9,051	8,882	738	711	763
272-06	Sulfur	612	5,274	12,232	51,068	50,081	44,966
271-03	Phosphates, natural, ground or unground	2,703	2,626	3,090	20,302	25,704	28,189
272-04	Clay	2,941	2,971	2,938	10,891	12,593	13,528
(10)	Other nonmetallic minerals (except fuels)	20,473	23,971	30,884	22,011	24,930	26,590
	Total crude nonmetallic minerals (except fuels)	278,680	293,944	290,226	106,700	115,463	115,653
	Grand total, minerals and metals (except fuels)	1,912,413	2,138,831	2,145,972	588,519	820,619	815,900

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

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

[2] 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.

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

[4] Revised figures.

[5] Excludes gold and silver.

[6] Part of the SITC category indicated is covered, the remainder is elsewhere in the major grouping.

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

[8] Includes alloys.

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

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

crude-metallic-minerals group; the other two groups declined. The greatest decline in value of imports occurred in copper, iron ore, manganese, zinc, bauxite, and ferromanganese all increased substantially. The ratio of value of exports to value of imports remained stable at 38 percent. For the first time in recent years this ratio did not increase.

The decline in export value largely resulted from the $82-million decrease in iron and steel-scrap exports. Exports of metals (unwrought) and crude nonmetallic minerals both increased in value over 1956 in 1957.

Tariffs.—Proposed changes in the lead and zinc tariff in the Administration's Long-Range Minerals Program and a subsequent application for relief under the escape clause of the Trade Agreements Act were the most important tariff developments for the mineral industries during 1957. After President Eisenhower and the Chairman of the Joint Committee on Ways and Means had exchanged correspondence, the Emergency Lead-Zinc Committee applied to the Tariff Commission for escape-clause relief on September 27, 1957. This application included lead and zinc products, but the Commission limited the case to unmanufactured lead and zinc. Hearings were held on November 12–26, 1957. The Tariff Commission had not reported its findings by the end of the year.

Senate Resolution 195, 85th Congress, 1st session, August 28, 1957, called upon the Tariff Commission to investigate tungsten ores and concentrates under section 336, Tariff Act of 1930. This section provides that the Tariff Commission, upon a finding of the difference in costs of production between a foreign and domestic article, shall report its findings to the President and shall specify such increases or decreases in duty as will equalize the difference. The duty change cannot exceed 50 percent of the rate fixed by statute. Pursuant to the Senate resolution, the Tariff Commission instituted an investigation on August 30, 1957, but no action had been taken by the end of 1957.

A treaty establishing the European Economic Community was signed on March 25, 1957, by representatives of Belgium, France, West Germany, Italy, Luxembourg, and the Netherlands. The terms of this treaty will become fully effective after 15 years, when all internal tariff barriers among the 6 countries will be removed. Such a large free-trade area is certain to have repercussions on United States export markets and import sources.

WORLD REVIEW

World Production.—The United Nations Index of World Mining Production (including fuels) rose slightly from 116 in 1956 to 119 (1953 equals 100). The change is the same as shown by the United States mining industry, but the index for all member countries of the Organization for European Economic Cooperation rose somewhat more, from 108 in 1956 to 112 in 1957. The metal mining index of the United Nations for the world increased from 114 in 1956 to 121, but the index dropped sharply for the last quarter of 1957.

World Prices.—Prices of metal ores fell slightly but steadily throughout the year. This decrease in part reflected the major reduction in ocean freight rates as the effects of the closing of Suez were overcome. Both the total minerals and primary commodities index rose at times during 1957, but on the average, they fell consistently over the year as a whole.

Ocean Freight Rates.—Ocean freight-rate indexes fell sharply during 1957 (at least 50 percent) from the high rates occasioned by the Suez crisis. By the end of 1957 the indexes were almost down to those in 1953.

TABLE 39.—Index of world metal-mining industrial production, 1953–57 [1]

(1953=100)

Year	Free World	North America [2]	Latin America [3]	Asia: East and Southeast [4]	Europe [5]
1953	100	100	100	100	100
1954	97	86	99	106	99
1955	108	102	112	112	112
1956	114	106	114	119	121
1957	121	110	----------	117	131
First quarter	110	92	117	110	126
Second quarter	125	121	129	114	133
Third quarter	128	128	133	121	129
Fourth quarter [6]	121	100	----------	122	135

[1] United Nations, Monthly Bulletin of Statistics: Vol. 12, No. 5, May 1958, pp. x–xiv.
[2] Canada and the United States.
[3] Central and South America and the Caribbean Islands.
[4] Burma, Cambodia, Ceylon, Federation of Malaya, and Colony of Singapore, Hong Kong, India, Indonesia, Japan, South Korea, Laos, Pakistan, Philippines, China (Taiwan), Thailand, and South Viet-Nam.
[5] Excludes Albania, Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Rumania, and U. S. S. R.
[6] Provisional.

TABLE 40.—Index numbers of production in mining and quarrying, and production in basic metal industries in selected OEEC countries, 1951–57 [1]

(1953=100)

Year	All member countries	Austria	Belgium-Luxembourg [2]	France	Germany, West	Greece	Italy	Netherlands	Norway	Sweden	Turkey	United Kingdom
MINING AND QUARRYING												
1951	[3] 94	88	99	[3] 96	91	41	75	100	77	89	77	99
1952	[3] 99	93	101	[3] 104	97	58	88	100	88	99	83	100
1953	100	100	100	100	100	100	100	100	100	100	100	100
1954	101	109	[3] 96	[3] 103	104	123	[3] 110	100	100	91	88	101
1955	105	116	100	[3] 110	110	132	[3] 123	101	108	[3] 104	97	99
1956	[3] 108	120	100	[3] 113	115	150	[3] 139	103	121	[3] 114	107	100
1957	112	127	99	120	119	195	156	106	122	119	([4])	100
BASIC METAL INDUSTRIES												
1951	[3] 98	81	114	107	94	74	91	83	92	90	------	100
1952	[3] 104	91	111	112	105	90	101	81	97	102	------	103
1953	100	100	100	100	100	100	100	100	100	100	------	100
1954	[3] 113	119	108	114	116	103	[3] 119	117	104	110	------	108
1955	131	140	125	133	141	98	[3] 148	133	124	[3] 125	------	117
1956	[3] 139	151	135	140	150	102	[3] 162	131	160	[3] 138	------	[3] 118
1957	145	175	131	153	154	120	182	135	169	144	------	120

[1] Organization for European Economic Cooperation, General Statistics: No. 3, May 1958, pp. 10, 14.
[2] Weighted average, computed by authors, using Organisation for European Economic Cooperation weights.
[3] Revised figure.
[4] Data not available.

TABLE 41.—World trade price and freight-rate indexes, 1953–56, and quarterly 1957 [1]

(1953=100)

Year	Price indexes			Trip charter freight rate indexes [2]		
	Primary commodities	Total minerals	Metal ores	General cargo	Ore	Fertilizers
1953	100	100	100	100	100	100
1954	104	99	95	111	110	106
1955	101	102	104	165	144	141
1956	102	110	112	203	174	159
1957	104	115	110	145	138	131
First quarter	107	120	114	209	196	156
Second quarter	105	115	112	155	139	(3)
Third quarter	103	112	108	116	117	(3)
Fourth quarter	100	111	104	101	102	(3)

[1] United Nations, Monthly Bulletin of Statistics, March 1958, special tables A and D.
[2] United Kingdom indexes based upon weighted average of quotations by all flags on routes important to United Kingdom tramp fleet.
[3] Data not available.

Review of Metallurgical Technology

By Earl T. Hayes [1]

METALLURGICAL PROGRESS during the year was highlighted by the following events:

1. Half of the world's uranium needs will be produced by solvent-extraction processes when current plant-expansion programs are completed.
2. The United States now has achieved a production rate of 35 million tons of blast-furnace sinter a year.
3. The world's largest oxygen converters for use in steel production showed many advantages in installation costs, operation, and flexibility.
4. Columbium metal with a hardness of Brinell 60 was produced in the United States by melting in high vacuum in an electron-gun-bombardment furnace.

Thirty-three papers from all countries were presented in the International Mineral Dressing Congress in Stockholm in September 1957; this undoubtedly constituted the best review of modern mineral-dressing technology today. Crushing and grinding at Outokumpu, Finland, using ore pebbles as the grinding mediums, was described by Tanner and Heikkinen. It was necessary to decrease the pulp density, increase the pebble charge and keep the circulating load as high as possible to obtain maximum grinding efficiency. The same principle has been revived at Canadian nickel and uranium mines and some South African gold mines to establish savings in their milling departments. Although not all ores are adaptable as grinding mediums it is clear that at many mills costs could be lowered by adoption of similar processes.

Another paper announcing the results of grinding at supercritical speeds in rod and ball mills destroyed many illusions about critical ball-mill speeds. When operating at 240 percent instead of the customary 80 to 85 percent of critical speed, the mill was found to be highly efficient and produced a semiattrition grind by slippage of the balls in the body of the mill. Svensson and Murkes described an empirical relationship between work input and particle size distribution before and after grinding. A large number of experiments were carried out in laboratory ball mills to establish a relationship between work input and particle size and the effect of various factors on grinding. The theories of Rittinger, Kick, and Bond did not conform fully with the experimental results, and a new empirical formula was proposed to agree with the experimental results.

The use of cyclones for dewatering and subsizing operations continued unabated, and two papers at the Stockholm conference discussed the influence of orifices on the washing characteristics of the hydrocyclone and the evolution and newer applications of this versatile piece of equipment. From a modest beginning after World War II, the cyclone had developed in 1957 to the point where it was the

[1] Acting chief metallurgist.

primary method of classification for virtually all new installations, as witness the Reserve Mining Co. concentrator, which uses 96 such units to classify ball-mill discharge of approximately 36,000 tons of iron ore per day.

As in other fields of metallurgy, the Russians have shown great efficiency in developing their basic knowledge of flotation, and four good papers were presented at Stockholm. These covered the separation of bulk sulfide concentrates by flotation, absorption of diethyldithiophosphate and butyl xanthate by sulfides, selective flotation of nonsulfide minerals, and some of the general problems concerning theory and practice of selective flotation in the U. S. S. R. This last paper pointed out that sodium sulfide, while commonly employed as a sulfidizer, has rather limited use in selective flotation in countries outside of the U. S. S. R. One example cited was production of a clean molybdenite concentrate from a bulk float product.

Frank McQuiston presented a general survey of practice employed at plants at Canada, Mexico, Peru, Africa, and the United States for flotation of complex copper-lead-zinc ores and traced a pattern that applies to these ores.

Since uranium in 1957 became second to gold in the world, in terms of mineral production, it was only natural that uranium recovery should receive considerable attention. One of the most interesting discussions was that on applications of solvent extraction in processing uranium ores by Clemmer of the Federal Bureau of Mines. This paper reviewed laboratory and pilot-plant research at Salt Lake City, Utah, for the Atomic Energy Commission and application of solvent-extraction procedures for processing uranium ores; and it also described the selectivity and handling characteristics of various organic extractants. Proof of establishment of the solvent-extraction process can be seen in the fact that, when contemplated expansion plans are completed in 1958, almost half of the uranium recovered will be obtained by such methods.

In the field of iron-ore beneficiation, the tonnage of material treated by the iron-ore industries outshadowed all other products of the country combined. For the first time in history, the tonnage of beneficiated ore from the Mesabi area was higher than direct-shipping ores and the day seemed close when most of the ore from the entire iron range would be beneficiated in one form or the other before shipment.

A considerable increase in the capacity of a blast furnace is obtained by using the richer sintered concentrates in place of the domestic direct-shipping ores that are now available. With the tremendous investment required to build new blast-furnace installations it is easier, at least for the present, to beneficiate the blast-furnace feed and obtain production requirements. Ore has been beneficiated in increasing quantities by rather simple means of washing and screening, but beneficiation plants involving grinding, dense-medium separation, flotation, magnetic concentration, pelletizing, and sintering represent the modern tools that technology brought to bear on this portion of the steel industry. Consolidation of fine material resulting from ore-dressing operations is a continuing operational problem.

Plants continue to grow in size, and 2 under construstion at the close of 1957 will have a capacity of over 4½ million tons of sinter a year. Most of the sintering machines being installed were larger than heretofore. Some were 96 inches wide, although 2 were 144 inches. Capacity has risen rapidly to over 35 million tons of blast-furnace sinter capacity per year, with a probability that it will rise to 60 million tons by 1960.

Another means of increasing blast-furnace and steel making capacity is the increased use of oxygen. Enrichment of the blast by 4 percent oxygen in 1 plant was found to increase iron output almost 20 percent. The same company was considering installing a second 500 ton-a-day oxygen plant. Close control of water vapor is known to improve blast-furnace operation. Some of the larger companies were considering installing such control. The Bureau of Mines scheduled studies of the effects of water-vapor control at its experimental blast furnace at Bruceton, Pa.

The world's largest oxygen converters installed by Jones & Laughlin and put into production the latter part of the year promised great economies in steelmaking. Although the converter takes a much smaller charge than the open hearth, a heat of iron can be conditioned in 30 to 40 minutes rather than in several hours. The oxygen converter offers better quality control and greater flexibility than the Bessemer process and cheaper steel than that produced in the open hearth. Jones & Laughlin obtained an annual increase in capacity of 750,000 tons for $11 million; similar capacity in an open hearth would have cost as much as twice that amount. The open hearth has been used for some production of steel by induction of oxygen, and 1 company using approximately 100-ton heats was able to produce a heat every 3.4 hours, using the oxygen conversion principle. The steel- and metal-working business used over 75 percent of the Nation's oxygen production.

As in late years, many millions of dollars were spent on the development of alternate reduction procedures. One of these, the R-N process, probably received the most attention. In this process iron-ore concentrate and process coal fines are charged into the kiln and heated in an oxidizing flame. There is excellent reduction of the ore with the large excess of carbon present. The kiln discharge is quenched, and crushed, the uncombined carbon is returned to the circuit, and the metallic iron is separated from the slag and briquetted for direct use in the open hearth.

One of the most interesting metallurgical papers of recent years was that of Stanley Morgan of Imperial Smelting Corp., Avonmouth, England, describing two blast furnaces for producing 70 tons of zinc per day. This has been the dream of zinc-smelting people for over 30 years, and until Morgan's announcement all attempts had been unsuccessful. It is not difficult to reduce zinc in a blast furnace. The problem has been to prevent the metal from reoxidizing in the blast-furnace atmosphere before the reduced metal could be collected.

The same problem was solved in the case of carbothermic magnesium by Hansgirg in the early 1940's. There the reaction MgO—C to give Mg—CO proceeded nicely at temperatures of 2,100° to 2,200° C., but the reaction reversed near 1,800° C., and below that temperature the metal was converted to the oxide by contact with CO. Hansgirg solved this problem by quenching the reaction products in a hydrocarbon.

As noted in earlier metallurgical reviews, Morgan's group on zinc has learned to control the amount of CO and CO_2 in the furnace atmosphere and to quench the reaction products in a stream of molten lead before the zinc can be reoxidized. In operation, a hard-burned sinter is heated to about 1,200° C. and produces gases containing 5 to 6 percent zinc and controlled amounts of CO, CO_2, PbO and PbS. Zinc recovery is almost 90 percent. The method offers possibilities of lowering zinc-smelting costs and treating smelter dumps, some of which have slags containing as much as 25 percent zinc.

Something new was added to chemical metallurgy when a firm in Newburg, N. Y., announced that it was successfully handling 10 tons a day of arsenical cobalt ores. The heart of the process is autoclave leaching at 120 p. s. i. and 240° F. in a 10-percent caustic solution to remove arsenic and sulfur. Following this treatment, the residue could be treated by conventional methods to recover both base and rare metals.

The search for high-temperature materials was newly emphasized during the year owing to the demands of the rocket and missile people for action. Through the years a concept has developed that a high-temperature material must be able to withstand a certain load application for a given number of hours and at a given temperature. Modern high-temperature alloys are so rated for performance. Of late years, the extremely short term ability of a material to withstand high temperatures has become another rating factor. Out of this we find that some plastics are satisfactory for use even in applications where their expected life is only a matter of seconds or 1 or 2 minutes at most.

Corning Glass Co. announced a new ceramic material that is melted and formed like glass but is crystalline and almost 10 times as strong as plateglass. This material holds great promise not only for short-term, high-temperature applications but for moderate-temperature chemical-processing equipment.

Testing of columbium-base alloys for elevated-temperature mechanical properties and oxidation resistance continued through the year. It was reliably reported that alloys approaching the 1,650° F. working temperature appeared possible, but no announcement has been made on these at the year's end. Interest in the columbium metal continued to be high; but, as noted in the previous review, development of a columbium-base-alloy industry will depend entirely upon the results of alloy tests now in progress.

The greatest single contribution to improving the quality of tantalum and columbium metal in many years was the electron-gun-bombardment furnace developed industrially by Temescal Metallurgical Corp. of Richmond, Calif. Furnaces capable of melting 3-inch-diameter ingots of columbium metal in a vacuum of 2 x 10^{-5} mm. Hg were used successfully through the latter part of the year on a custom basis for melting columbium metal produced by several companies in the United States. When melting in high vacuum, the furnace has the advantage in being able to draw off the more volatile tantalum or columbium oxides from the parent metal. Columbium metal with a Brinell hardness of 60 was produced in 100-pound and larger lots. The electron-gun furnace probably will be used to melt all tantalum and columbium metal in future. The metallurgical technology of columbium-ore beneficiation might be revised, since large deposits of 3- to 5-percent columbium oxide ore have been found in Brazil.

In the field of pure metals, the Bureau of Mines at Boulder City, Nev., reported excellent progress on refining metals by fused-salt electrolysis. Vanadium with a Brinell hardness of less than 40, titanium with a BHN of 60, and chromium crystals that were cold ductile were produced by this electrolysis refinement. At least one industrial producer of titanium appeared close to solving the mechanical problems associated with producing electrolytic titanium by such methods, but the sharp decrease in demand for titanium removed some of the incentive for introducing the new method. The Kroll patent on the basic reduction of titanium chloride with magnesium expired in August 1957.

The problem of purity that is paramount in the production of semiconductors appeared to have been largely solved for germanium, where about 1 foreign atom in 10^8 can be tolerated. On the same basis, the reliability of silicon semiconductors is disturbed by impurities of the order of 1 in 10^{12} atoms. This means that there is still room for considerable improvement, since the 2 large manufacturers of the past year announced that their best purity was about 1 part in 6 billion, or 6×10^9. Silicon is intrinsically harder to purify than germanium. This has led to development of new techniques for continuing and carrying out the refining operation, such as the Bell Laboratory new automatic floating refining process, which required no containers.

During the year General Electric scientists announced Borazon, a cubic boron nitride, with a hardness rivaling the diamond but able to withstand temperatures up to 3,500°F.—twice that of the diamond. This material is made under pressures of about 1 million pounds per square inch at temperatures of 3,000°F., using techniques similar to that developed for producing synthetic diamonds.

The importance of metallurgical technology in the U. S. S. R. was the announcement that the Soviets were graduating seven times as many metallurgists as we are today and regarded metallurgy as the No. 1 physical science. An interesting sideline is that the number of women who graduate in metallurgy is twice our total output.

This was a memorable year for deemphasizing the metal titanium, for reasons that were more economic than technologic. For over 10 years titanium has been studied extensively, from production processes to the development of superalloys. In fact, there was little in metallurgical history to compare with the phenomenal expenditure of money and talent and production of technical papers. Because over 98 percent of the metal was used for defense purposes, the reduction in orders for the J–57 jet engine late in 1956, which used 55 percent of all titanium, affected the entire industry. Although the price of titanium sponge had decreased steadily through the years, there was no corresponding drop in the price of mill products. Materials like the high-strength precipitation hardening stainless steels are proving to be formidable competitors to titanium. Work on cheaper reduction processes and better scrap-utilization methods is continuing, and it is anticipated that a healthy and sizable titanium industry will emerge in the future.

Review of Mining Technology

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

THIS CHAPTER reviews the highlights of development in mining technology during 1957 and presents a special report on the theory of breaking rock with explosives.

Probably the most outstanding development in mining technology during the period has been the increased mining research in foreign countries. Their concern with research in more publicized fields has not caused them to neglect mining. In reading numerous reports from foreign countries, including the U. S. S. R., it is apparent that many scientists and engineers are engaged in mining research. The problems most mentioned concern control of subsidence over mine openings and new and improved means of fragmentation. The approach to the solution of these problems through application of scientific principles is most significant.

EXPLORATION

An interesting operations research study to determine what could be expected from systematic prospecting of about 400,000 square miles in the Algerian Sahara Desert was reported in 1957.[4] An estimate of the probable expenditures for development and of probable profits from the discovered ore deposits also was included in the study.

An initial approach to the problem was made by relating the accumulated prospecting data already proved on exploitable deposits in well-developed areas of other countries to the unprospected Algerian Sahara. An exploitable deposit in the Algerian Sahara was defined as one that would have an annual output value between 330 million ($1 million) and 330 billion francs ($1 billion). The lower limit marked the least value deposit that could be exploited in an area such as the Algerian Sahara, and the upper limit marked the greatest value that could be reasonably anticipated.

Based on the statistical data accumulated from the distribution of deposits in other countries, it was assumed for the Sahara study that (1) the number of expected deposits would occur according to Poisson's distribution; (2) the value of the different deposits actually occurring would have a lognormal distribution; and (3) the normal law for dimensionless parameters, such as standard deviation, would apply.

[1] Chief mining engineer.
[2] Assistant chief mining engineer.
[3] Mining engineer, Bureau of Mines.
[4] Allais, M., Method of Appraising Economic Prospects of Mining Exploration Over Large Territories: Management Sci., vol. 3, No. 4, July 1957, pp. 285–347.

It was determined that the cost of complete prospecting of the 400,000-square-mile area would range from $36 to $54 million, and the expected number of exploitable deposits would be between 4 and 50. The mean total value of the exploitable deposits was expected to be about $510 million. Because of the remote location of the Algerian Sahara and the difficulty of transportation and communications, it was estimated that $300 million would be required for transportation and dwelling. Added to the cost of prospecting, this would result in an initial outlay of about $354 million. Because of the excessively high first cost, the probability of net gain would be 0.35, or about 1 chance out of 3 that exploitation of the area would be profitable.

Minneapolis, Minn., and Denver, Colo., were selected as the locations of permanent Bureau of Mines drill-core storage facilities.[5] Stored drill core includes that from Bureau of Mines mineral-exploration projects, other Government agencies, State agencies, private companies, and individuals. Decision of whether to accept the drill core offered for storage rests with the Bureau of Mines. A total of about 700,000 feet of drill core was stored. The core is available for inspection by anyone having a legitimate interest in the mineral deposits represented by the core.

Development of a downhole television unit was reported in 1957.[6] The unit is a television transmitting tube 13.5 millimeters in diameter. Suitably encased for lowering into a drill hole, the tube transmits, by closed-circuit television, a continuous picture of the rock formations penetrated by the hole. The total diameter of the encased unit, including a compass and level, is 62 millimeters (about 2.44 inches). The maximum operating depth at present is 300 meters, but an increase to about 800 meters by the addition of amplifiers was expected.

Research engineers in the Mining Research Laboratory at the Central Test Station in Limburg, Treebeek, Netherlands, perfected a seismic method of exploration for coal, whereby both reflection and refraction waves can be used for determining the horizon of coal beds.[7]

Development of a retractable rock bit by the Carter Oil Co. was reported at the 12th Annual Petroleum Mechanical Engineers' Conference, September 22–25, 1957, at Tulsa, Okla. The bit enters the hole by wireline in collapsed condition. At the bottom of the casing a special drill collar on the casing holds the bit in place. The bit is turned by the drill casing.[8]

DRILLING

In an attempt to overcome the limitations inherent in either the percussive action or rotary action commonly employed in pneumatic rock drills, a combined rotary-percussive-action drill has been developed. The first production models of this type of drill were developed in Germany.[9] Early tests indicated drilling speeds 2 to 7 times greater for percussion-rotary over straight percussion drilling in harder rocks where maximum thrust could be applied. There is a definite relationship in percussion drilling between applied thrust,

[5] Hill, James E., Storage and Cataloging of Drill Core by the Bureau of Mines: Bureau of Mines Inf. Circ. 7777, 1957, 24 pp.
[6] Anderson, Omer, Downhole Television Unit Is Developed in Germany: Drilling, vol. 19, No. 1, November 1957, p. 93.
[7] Obert, Leonard, Mining Research in Europe: Bureau of Mines unpub. rept., Aug. 27, 1957, 73 pp.
[8] Oil and Gas Journal, Retractable Bit Unveiled: Vol. 55, No. 39, September 1957, pp. 50–51.
[9] Inett, E. W., A Survey of Rotary-Percussive Drilling: Mine and Quarry Eng. (London), vol. 23, Nos. 1, 2, and 3, January, February, and March 1957, pp. 2–7, 62–68, 106–110.

penetration rate, and operating air pressure. At any given air pressure insufficient thrust will result in low drilling efficiency and excessive thrust will stall the drill. A comparable relationship exists between torque, applied thrust, and penetration rate in rotary drilling, but conditions inducing stalling are different in that cuttings are produced at such a rate that clogging occurs and contributes to eventual stalling.

Bits designed for use with rotary-percussive drills have the clearance space of rotary bits and the impact strength of percussive bits; the drilling action tends to overcome the limitations of the individual actions when high thrust is applied for a high rate of penetration.

A report was published on research on the process of fragmentation by rotary drilling.[10] The research was simplified by testing the cutting action through straight-line motion with no confining side walls. Experimentation disclosed that, under these conditions, the action in rotary cutting consisted of producing fine particles and in sequence a solid chip, approximately equal to the volume of fine particles; the solid chip is formed when the bit face and rock surface are at some critical angle.

The sequence of fragmentation of fine particles and, in turn, a solid chip was thought to be an effect of the method of drilling and was not the effect of the shape of the bit or the type of rock being drilled. Tests further revealed that, regardless of speed, the solid chips broke in similar shapes as long as the thrust remained the same. The similarity in shapes was constant through tests of different types of rock when the thrust was kept constant.

After extensive comparative drilling tests, the Chino Mines Division, Kennecott Copper Corp., ordered two large rotary drills to replace churn drills for blasthole drilling at the Chino mine in Santa Rita, N. Mex.[11] An electric rotary drill capable of drilling a 12-inch hole was purchased in May 1955 and tested in the pit for about 1½ years. It drilled 95,701 feet, at a rate of 167.4 feet per shift, in various types of ground. During the same period the rate of churn drilling was 51.56 feet per shift. The electric rotary rig was equipped with a 1,200-cubic-feet-per-minute air compressor for blowing the cuttings out of the hole. Compressed-air pressure was 60 pounds per square inch, and the air velocity was 2,600 feet per minute.

Drilling represents 25 percent of the total cost of mining taconite at the Pilotac mine, owned and operated by the Oliver Iron Mining Division, United States Steel Corp., Virginia, Minn.[12] Since 1952, field drilling trials in taconite have been made with the churn drill, interchangeable percussive and rotary drill, rotary drill, down-the-hole drill, and jet piercer. Field test data indicate that there is no universal drill for drilling taconite, as the variation in physical characteristics of the taconites will require several types of drills rather than one all-purpose type. A systematic study of churn drilling indicated that a change in bit design and length of stroke was necessary

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[10] Goodrich, Ross H., High-Pressure Rotary Drilling: Bull. Missouri Sch. Mines and Metallurgy, Tech. Ser., No. 94, 1957, pp. 25–45.

[11] McNaughton, D. D., Recent Developments in Rock Drilling at Chino Mines: Min. Eng., vol. 9, No. 5, May 1957, pp. 542–543.

[12] Rubow, Irvin H., Drilling Taconites: Pres. at Metal Mining and Industrial Minerals Convention Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 8 pp.

for drilling taconite. A change in the clearance angle from 15° to 5° and a 40-inch length of stroke resulted in a penetration rate of 4.98 feet per hour and 11.5 feet per bit. Drilling rates of 10 to 30 feet per hour and bit life of 250 to 850 feet were achieved with the rotary drill. The jet piercer was found to be the most satisfactory drill in taconite that is massive and extremely hard and spalls readily. Drilling rates of 35 feet per hour were common in this type of taconite.

EXPLOSIVES FRAGMENTATION

An approximate method of computing the important detonating properties and performance parameters of blasting explosives was discussed at mining-research symposiums in 1956 and 1957.[13] The computing method may be employed for most commercial blasting explosives, which are a combination of carbon, hydrogen, nitrogen, and oxygen, the mixture balanced so that there is enough oxygen to oxidize the carbon and hydrogen to carbon dioxide and steam. The computing method is not adequate for highly underoxidized explosives; however, these explosives are rarely used in commercial blasting.

Theoretical calculations are suitable for determining the gaseous products of explosion, explosion temperatures, heats of reaction, explosion pressures, and specific heats of the explosive ingredients.[14] The computed explosion temperature and pressure represent an average result of the explosion; thus, only the upper limit of the explosion temperature can be computed. The computation is based on the following assumptions; (1) The explosion occurs at constant volume; (2) all of the explosive reacts; (3) heat losses are neglected; (4) motion of gases is neglected; (5) spectroscopic thermodynamic data are used; (6) the gaseous products of detonation obey Abel's gas law; and (7) the products of detonation are calculated by assuming thermodynamic equilibrium at the explosion temperature. Computations are not only useful for determining the important performance parameters of blasting explosives but also as an aid to interpreting and checking experimental results.

Special Report on Review of Blasting Research in the Bureau of Mines

By Wilbur I. Duvall [15]

The Bureau of Mines has been interested in blasting problems for many years, and various units within the Bureau have contributed to this field of study. However, it was not until 1947 that a concentrated effort was made to study some of the fundamental physical processes involved in breaking rock with explosives. At that time the Bureau of Mines undertook, on a contract basis from the United States Army Corps of Engineers, development of a gage for measuring the dynamic strain produced in rock by detonation of an explosive charge in a drill hole.

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[13] Brown, F. W., Determination of Basic Performance Properties of Blasting Explosives: Quart. Colorado Sch. Mines, Symposium on Rock Mechanics, vol. 51, No. 3, July 1956, pp. 171–188. Simplified Methods for Computing Performance Parameters of Explosives: Bull., Sch. Mines and Metallurgy, Rolla, Mo., Tech. Ser., 94, 1957, pp. 123–137.

[14] Brown, F. W., Theoretical Calculations for Explosives. I. Explosion Temperatures and Gaseous Products and The Effects of Changes in Carbonaceous Material: Bureau of Mines Tech. Paper 632, 1941, 21 pp.

[15] Supervising physicist, Applied Physics Laboratory, Bureau of Mines, College Park, Md.

The Applied Physics Laboratory, College Park, Md., was successful in developing a suitable strain gage[16] and has continued a blasting-research program ever since.

Instrumentation for a blasting-research program was a prime consideration at first, and considerable effort was devoted to developing gages and recording equipment for measuring the transient phenomena related to blasting.[17] The Bureau of Mines strain gage, which can be cemented into a diamond drill hole in rock, proved the most satisfactory transducer for detecting the transient wave motion generated by detonation of explosives in rock.[18] The output of these gages is recorded on high-speed oscilloscope drum cameras housed in the Bureau of Mines mobile laboratory.[19] A high-speed camera is used for recording the various phenomena that take place as the rock is broken by a blast.

Theoretical and experimental investigations were conducted on the generation and propagation of strains in rock.[20] These studies showed that the size and shape of the strain pulse obtained was approximately what would be expected for a perfect elastic medium. Differences between theoretical and experimental results were noted. These differences indicated that the rock was an absorbing medium, which caused the strain pulse to decay rapidly in amplitude and to spread out as it propagated. More important, the strain-gage records showed that detonation of an explosive charge in a drill hole produced a simple compressive strain pulse in the surrounding rock. The length of this pulse was of the order of magnitude of the burdens used in blasting. These facts suggested that reflection of strain waves by free surfaces might be important in explaining rock breakage by explosions.

The crater test was selected for study to determine if reflection phenomena played an important role in rock breakage by explosives. Extensive experimental investigation on crater formation was conducted for a number of years. Experimental evidences obtained from these investigations have been shown to support the reflection theory of rock breakage.[21] Other investigators have published data demonstrating also that rock is broken by reflected stress waves.[22]

According to the reflection theory of rock breakage, the rock is pulled apart, not pushed apart. Detonation of the explosive charge creates a high gas pressure in the drill hole in a few microseconds. Reaction of this high pressure on the walls of the drill hole generates a compressive stress pulse in the surrounding rock. This compressive stress pulse travels outward from the drill hole in all directions. Near the drill hole the amplitude of the compressive stress pulse is sufficient to cause crushing of the rock; however, as the compressive stress pulse travels outward, its amplitude decreases

[16] Obert, Leonard, and Duvall, Wilbur I., A Gage and Recording Equipment for Measuring Dynamic Strain in Rock: Bureau of Mines Rept. of Investigations 4581, 1949, 12 pp.

[17] Blair, B. E., and Duvall, W. I., Evaluation of Gages for Measuring Displacement, Velocity, and Acceleration of Seismic Pulses: Bureau of Mines Rept. of Investigations 5073, 1954, 21 pp.

[18] Work cited in footnote 16.

[19] Atchison, T. C., Duvall, W. I., and Obert, Leonard, Mobile Laboratory for Recording Blasting and Other Transient Phenomena: Bureau of Mines Rept. of Investigations 5197, 1956, 22 pp.

[20] Obert, Leonard, and Duvall, Wilbur I., Generation and Propagation of Strain Waves in Rock: Bureau of Mines Rept. of Investigations 4683, 1950, 19 pp.

Duvall, Wilbur I., and Atchison, T. C., Vibrations Associated With a Spherical Cavity in an Elastic Medium: Bureau of Mines Rept. of Investigations 4692, 1950, 9 pp.

Duvall, Wilbur I., Strain-Wave Shapes in Rock: Geophysics, vol. 18 No. 2, April 1953, pp. 310-323.

[21] Duvall, Wilbur I., and Atchison, T. C., Rock Breakage by Explosives: Bureau of Mines Rept. of Investigations 5356, 1957, 52 pp.

[22] Hino, Kumao, Fragmentation of Rock Through Blasting: Jour. Ind. Explosives Soc., Japan, vol. 17, No. 1, 1956, 11 pp.

rapidly until no further crushing of rock is possible. The compressive stress pulse continues to travel outward until it is reflected by a free surface. Upon reflection, the compressive stress pulse becomes a tensile stress pulse. As the strength of rock in tension is less than in compression by a factor of 50 or more, the reflected tensile stress pulse can break the rock in tension, progressing from the free surface back toward the shot point.

The reflection theory of rock breakage will not solve all blasting problems today or tomorrow. Too little information is available on the details of this theory to apply it directly to all blasting problems. The importance of the reflection theory of rock breakage is that it provides a guide to the important variables in blasting problems. For example, the ratio of compressive to tensile strength of the rock must be large if reflection-type breakage is to occur. This ratio may be used as a blastibility coefficient.[23] Then rocks having a large blastibility coefficient should be easier to break with explosives than those with a small one, all other variables being constant. However, just how important this variable is has not been established. Thus, determination of the importance of this blastibility coefficient is an existing problem for study.

The crushing strength of the rock determines the amplitude of the compressive stress pulse generated in the rock around the charge hole. This compressive stress pulse must be propagated to a free surface before a reflection can occur. Amplitude of the compressive stress pulse arriving at the free surface, therefore, is a function of the propagation characteristics of the rock and the compressive strength of the rock. Thus, the propagation characteristics of rock for explosion-generated stress pulses have to be studied to determine their importance in blasting problems.

Thermodynamic properties of explosives would be expected to control the amount of stress applied to the walls of a blasthole. Therefore, another field for study and research is determination of those properties of explosives that are important in controlling the amplitude of the stress wave generated in the rock surrounding the charge hole.

The above three examples illustrate the need for additional blasting research to attain better understanding of the physical processes involved in breaking rock with explosives.

MECHANICAL FRAGMENTATION

According to the National Coal Board Technical Mission, hydraulic mining of coal has passed the experimental stage in the Soviet Union, and 69 installations are in the planning stage.[24] An experiment with hydraulic methods in an operating Soviet mine resulted in an output of 12–15 tons per man shift, which was 4 to 5 times the output with conventional methods. The procedure in a mine developed to carry out the experimental work was first to loosen the coal by long-hole pulsed infusion. Loosened coal was then removed from the face by high-pressure water jets directed against the face by a monitor.

[23] Work cited in footnote 22.
[24] National Coal Board (London), The Coal Industry of the U. S. S. R., Part I: Rept. by Tech. Mission, 1957, pp. 52–57.

Fragmented coal was carried by water down steel flumes laid on the floor to a screen and crusher, which reduced all the coal to minus 2.36 inches in size. The crushed coal and water mixture was transferred from the crusher by gravity flow to a 350-cubic-foot sump. Low-pressure primary pumps transferred the water and coal to the main pump at the drift bottom, where they were pumped 765 yards to a preparation plant. Hydraulic transportation of coal was the only form used in the experimental mine. Materials and supplies were brought in by a monorail suspended from the roof.

All coal seams in the Soviet Union are classified for hardness by a standard test and assigned a hardness factor (Protodiakonov index F). This hardness factor is utilized to establish the minimum monitor nozzle pressure required to remove the coal without prior pulsed-infusion shot firing. In the experimental mine where the hydraulic method was undergoing extensive tests, a nozzle pressure of 880 to 1,000 pounds per square inch was needed to break the coal. Experiments were made with nozzle pressures of 3,000 pounds per square inch in conjunction with water-pulsed infusion, in an attempt to develop a hydraulic mining system for rock.

Basically, hydraulic mining is not new in the United States or its Territories. It has been used for many years in placer mining for gold. Nozzle pressures for placer mining above 260 pounds per square inch are unusual. Probably the most well-known uses of hydraulicking, other than placer, are the Florida phosphate field; mining silica sand at Ottawa, Ill.; tunnel construction at Minneapolis and St. Paul, Minn.; and mining gilsonite at Bonanza, Utah. In the Florida phosphate field, hydraulicking is employed to break up phosphate rock dug by a dragline and transport the broken rock to a concentrator.[25] For this operation, pressure at the nozzle varies from a low of 80 pounds per square inch to a high of 130 pounds per square inch.

At Ottawa, Ill., silica sand is drilled and blasted, disintegrated by hydraulicking, and transported out of the underground workings by pump. The nozzle pressure used for disintegrating the blasted sand is 150 to 200 pounds per square inch.[26] In tunnel construction at Minneapolis and St. Paul, Minn., St. Peter sandstone was cut from the face with jets and transported from the tunnel by pumps.[27] The nozzle pressure for breaking the sandstone at the face was maintained at 300 pounds per square inch. At Bonanza, Utah, the American Gilsonite Co. mines 700 tons of gilsonite per day by hydraulic methods.[28] Nozzle pressure is maintained at 2,000 pounds per square inch. Nozzles are mounted on booms attached to cars. Water directed at the surface of the gilsonite enters tiny fissures and breaks the material away from the face.

It is readily seen that only one of the hydraulic methods of mining that have been or are being used in the United States employs the high nozzle pressures used in the Soviet Union. Highest on record in

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

[26] Bryant, A. D., Hydraulic Methods for Underground Mining of Silica Sand: Min. Eng., vol. 5, No. 3, March 1953, pp. 282–283.

[27] Lewis, Walter E., Hydraulic Tunneling in St. Peter Sandstone at Minneapolis, Minn.: Bureau of Mines Inf. Circ. 7571, 1950, 12 pp.

[28] Engineering and Mining Journal, 72-Mile Pipeline Moves Gilsonite Ore: Vol. 158, No. 9, September 1957, pp. 106–108.

Argall, George O., New Jet Mining Method Stopes Gilsonite for Gasoline: Min. World, vol. 19, No. 10, September 1957, pp. 68–69.

the United States, in use for mining, is about 2,000 pounds per square inch, which is about twice the pressure used by the Russians for what is apparently medium-hardness coal.

Methods of transporting water to the nozzles, types of nozzles, bracing to withstand the high pressures, and monitor anchorage were not discussed in describing the Soviet hydraulic method, but it could be assumed that these problems are important and would be exacting in their requirements. These problems appear to have been solved satisfactorily by the American Gilsonite Co. in its mine at Bonanza, Utah, to furnish 2,000 pounds per square inch of nozzle pressure at the ore face; in all probability, the mechanical problems associated with even higher pressures could be solved. Higher pressures have already been obtained by the indirect hydraulic methods of water-pulsed infusion.

Water infusion of solid coal, static or pulsed, has become an accepted, standard method of dust suppression in Great Britain. In mid-1956 it was applied to 27 percent of the total length of coal face requiring dust suppression.[29] Static water infusion is used in longwall and room-and-pillar mining in coal seams 1½ to 8 feet thick. Water is forced under 100 to 1,200 pounds per square inch pressure into 1¾- to 2⅛-inch-diameter holes. The position and direction of the holes are determined by the thickness of the seam and formation of cleavages and fractures in the coal. In addition to controlling dust, the amount of explosives required for breaking the coal is often reduced; this feature, discovered in using static water infusion, led to development of a combined blasting-water-infusion technique for coal breaking. The combined method of fragmentation is termed water-pulsed infusion.

In pulsed infusion the holes bored in the coal are for both water infusion and the explosive. The process involves charging the borehole with explosive and then pumping water into the surrounding mass by an infusion tube inserted into the same borehole. While the water is being applied to the coal under pressure, the charge is detonated. The resulting high-pressure impulse is transmitted by the water into the cleavage planes and fractures and breaks the coal.[30] Special explosives are required for the pulsed-infusion method. Basic requirements of the explosive are that it be waterproof and capable of complete detonation under pressures up to 800 pounds per square inch. Electric detonators capable of withstanding the high pressures and detonating the explosive are of the submarine type used in seismic exploration.

The Scientific Department of the National Coal Board, Great Britain, completed a laboratory study of water infusion as a preliminary investigation to pulsed-infusion experiments.[31] Water was applied under known pressure to 1 face of a coal sample (4-inch cube) and flows to the opposite face measured. Factors that affect the flow of water through coal were determined by the study. It was found that the flow increased disproportionately with pressure but also decreased with time, independent of the pressure. It was deduced

[29] Boyle, William, How Britain Controls Dust: Coal Age, vol. 62, No. 2, February 1957, pp. 86–91.
[30] Haslam, R., Davidson, S. H., and Hancock, J., Development of a Combined Blasting/Water Infusion Technique for Coal Breaking: Trans. Inst. Min. Eng. (London), vol. 114, session 1954–55, pp. 87–103.
[31] Fish, B. G., and Turski, A. B., A Laboratory Study of Water Infusion: Nat. Coal Board (London), Mining Research Establishment, Rep. 2044, September 1956, 10 pp.

that the first factor was due to elastic deformation expansion of the water passages; the second factor was due to an inward swelling of the coal over a period of time, which closed the water passages.

The Bureau of Mines conducted water-infusion tests in its Experimental Coal Mine at Bruceton, Pa., to determine whether water infusion would reduce the concentration of airborne dust during mining.[32] Coal in the Experimental Mine is characterized by pronounced, nearly vertical face and butt cleats, which permit free flow of water from the infusion holes. Although good flow of water into the coal was obtained, the tests indicated that water infusion of the Pittsburgh coal seam in the Experimental Mine did not reduce the amount of fine dust produced during mining operations to the extent reported elsewhere. The experimental work was confined solely to the effect of water infusion on concentration of airborne dust, and the reduction in charge weight of explosives needed for blasting was not investigated.

A study was made to determine the augering practice, type of equipment used, and production rates of eight mines in Pennsylvania, West Virginia, and Ohio, employing coal augers to mine bituminous coal near outcrops.[33] Auger mining has been in use since 1947; and, as a coal-recovery method supplementary to strip mining, it has grown rapidly. About 6 million tons of bituminous coal was produced by auger mining in 1955. At the 8 mines studied the production of raw coal per man employed ranged from 22 to 46 tons. The average production of raw coal per shift ranged from 65 to 503 tons. The study revealed that auger mining is used to best advantage in recovering coal between abandoned underground mines and adjacent strip mines and in areas where mining by other methods is not feasible.

A rotary-drilling machine had completed boring seven 6-foot-diameter shafts in Virginia and West Virginia by April 1957.[34] Greatest depth of the seven was the No. 6 shaft at the Bunker mine No. 2, Trotter Coal Co., Core, W. Va., which was drilled to 465 feet. The machine has been patterned after rotary drills employed for drilling blastholes. The enormous amount of cuttings and high thrusts required on the bits necessitated designing the machine tq core rather than cutting all of the bottom of the hole. A 4-inch-wide kerf is cut by 6 cutters mounted on bit bearings of the tricone type and bolted at equal intervals on the cutting end of the core barrel. A total thrust of 100,000 pounds can be applied to the bits. The complete machine, including rotary-drive motors and a cutting-head assembly, is suspended in the shaft by wire rope. Operators occupy a platform immediately above the drive motors. High thrusts are obtained by anchoring the unit to the shaft walls by a horizontal jack at the top of the unit and advancing the core barrel independently, through a thrust mechanism below the jack. Based on past performance of the boring machine, drilling shafts with 8-foot diameters may be possible.

Boring devices similar in cutting action to the type of borer described above have been in use in Germany for driving inclined and vertical raise openings up to 5 feet in diameter. One of the devices

[32] Nagy, John, Hartmann, Irving, and Mitchell, Donald, Experiments on Water Infusion in the Experimental Coal Mine: Bureau of Mines Rept. of Investigations 5353, 1957, 12 pp.
[33] Haley, Wilbur A., and Dowd, James J., The Use of Augers in Surface Mining of Bituminous Coal: Bureau of Mines Rept. of Investigations 5325, 1957, 22 pp.
[34] Zeni, Victor, and Williamson, Thomas N., Sinking Large-Diameter Mine Shafts by Rotary Drilling: Min. Eng., vol. 9, No. 4, April 1957, pp. 455–459.

in use produced core, whereas, two other types cut the entire hole and produced no core.[35]

The School of Mines, King's College, Durham, England, in association with the Durham Division of the National Coal Board, has conducted research on the plowability or planability of coal seams since 1955. Apparatus employed in testing for the plowability index is a hydraulic cylinder actuated through a hydropneumatic accumulator by a double-acting, high-pressure hand pump.[36] Attached to the cylinder is a steel wedge to which various cutting blades may be fastened. A total thrust of about 19,000 pounds can be developed by the test apparatus. Pressure fluctuations and cutting-blade penetration are recorded automatically on a chart during a test. For underground testing of a seam, the apparatus is mounted on a screw-jack prop installed at the face to be tested.

General conclusions on tests at various coal mines in the Durham district in England were that the apparatus was satisfactory for testing the plowability of the coal and also for selecting the best design of plow for a particular seam.[37] To establish a "plowability index" for coal seams in Durham, data previously obtained in actual testing were summarized into the frequency distribution form, and the number of readings in each range of grouping calculated as percentages of the total number taken.[38] The cumulative percentage values were plotted against the cutting force (pounds), forming a distribution curve. These charts allowed direct reading of the cutting force in pounds required in any percentage of tests. With enough tests of any particular seam, the distribution curve indicated the cutting characteristic of the seam under a given set of conditions, such as depth of cut and blade angle. The curve, plotted at the same scale as previous data, can be compared against the curve of plowable coal seams, and the total amount of the seam plowable at the same cutting force can be read directly.

A laboratory experiment by the British National Coal Board mining-research establishment on the practicability of bursting coal from the face by a steel cone forced through a hole parallel to the face was described in 1957.[39] The experiment was made on laboratory specimens ranging from 6 to 15 inches in height and width and from 15 to 36 inches in length. During the bursting process a simulated roof load was maintained on the specimens. Surfaces of the experimental bursting cones were machine-finished, and the cone angle was 10°. Initial experiments consisted of pulling the cone through the hole by wire rope, but later experiments included adding a percussive action to the back of the cone. With the percussive action it was possible to break larger burdens without undue stress on the haulage rope. Current experimental work indicates that the cone-bursting method may be applicable to solid soft coals or to coals with a pronounced cleat. Percussive action added to the haulage force of the

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[35] Engineering and Mining Journal, German Boring Units Speed Raising: Vol. 158, No. 10, October 1957, pp. 100–102.

[36] Binns, P. D., and Potts, E. L. J., The Ploughability of Coal Seams: Colliery Eng. (London), vol. 32, May 1955, pp. 201–204.

[37] Binns, P. D., and Potts, E. L. J., The Ploughability of Coal Seams: Colliery Eng. (London), vol. 32, June and July 1955, pp. 241–246, 289–293.

[38] Potts, E. L. J., and Binns, P. D., The Establishment of a Ploughability Index for Seams in Durham: Trans. Inst. Min. Eng. (London), vol. 116, Part 2, November 1956, pp. 98–107.

[39] Fish, B. G., and Stevens, M. J., Studies in Coal Bursting, Using Cone Wedge: Colliery Eng. (London) vol. 34, May and June 1957, pp. 188–190, 240–244.

wire rope resulted in a marked reduction in the amount of haulage force required. If the method has a practical application, percussive action probably will have to be added to the haulage force.

MATERIALS HANDLING: LOADING, TRANSPORTATION, HOISTING

Loading continued to be one of the major problems in handling materials. At most mining operations loading machines were the most critical pieces of equipment in the materials-handling circuit.

In a search for a better loader, the Eagle-Picher Co., operating in the Tri-State and Upper Mississippi lead-zinc districts, has tentatively settled on rubber-tired end loaders for use in its mines under particular conditions.[40] For the majority of loading conditions, they appear to be the best.

Field tests in the Tri-State district with a 2-cubic-yard-capacity, rubber-tired end loader resulted in obtaining an average of 595 tons per shift at a total operating cost of $0.090 per ton. Operating labor was $0.038, fuel $0.005, and tires $0.033; other repairs and repair labor were $0.014 per ton.

A 2-cubic-yard-capacity, rubber-tired end loader was also tested 10 months in a mine in Wisconsin and, with an average of 450 tons per shift, the operating cost was $0.151. Operating labor was $0.039, fuel and lubrication $0.010, tires $0.055, and other repairs, supplies, and repair labor $0.047 per ton. Adjustment of this cost to include complete overhaul ($0.034 per ton) and amortization ($0.05) results in an overall loading cost of $0.235 per ton loaded.

Montevecchio mines in Sardinia, Province of Cagliari, have developed a special machine for handling ore. It is comprised of an overshot-type shovel loader mounted on a rubber-tired dump wagon.[41] The machine is designed to load, haul, and dump and has been developed in two sizes. The smaller had a 3½-cubic-foot bucket, body capacity of 26 cubic feet, turning radius of 4 feet 10 inches, and a traveling speed of 4 feet per second. The larger had an 8½-cubic-foot bucket, a body capacity of 58 cubic feet, and a speed of 3 feet per second. Both the large and small machines can pull a 12-percent grade fully loaded.

At the Jackpile uranium mine 48 miles west of Albuquerque, N. Mex., The Anaconda Co. employed a mobile, diesel-electric plant to power its open pit loading equipment.[42] The mobile power plant is mounted in a 32-foot 8-inch-long, 11-foot 10¾-inch-high trailer. An 8-cylinder, 2-cycle diesel engine furnished the mechanical power for operating the alternating-current generator at 720 revolutions per minute. The resulting electrical energy was sufficient to power an electric shovel with a 5-cubic-yard dipper. The mobile plant will be used in place of constructing a stationary power unit.

Shaft-mucking techniques have undergone several changes in the period 1948–57. Probably the latest change was introduction of

[40] Dale, C. O., Discussion of Underground Loaders: Pres. at 1957 Metal Mining and Industrial Minerals Convention, Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 7 pp.

[41] Mine and Quarry Engineering (London), Ore Handling at Montevecchio: Vol. 23, No. 3, 1957, pp. 99–101.

[42] Engineering and Mining Journal, Mobile Unit Supplies Shovel Power: Vol. 158, No. 3, March 1957, p. 75.

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crawler-mounted loaders running directly onto the muckpile and loading by overshot action into the shaft bucket.[43] In the Intermountain Chemical Co. Westvaco mine shaft near Green River, Wyo., the crawler-mounted loader, under optimum conditions, loaded 15 to 18 cubic yards of solid per hour. The shaft was 20 feet in unfinished diameter, and enough maneuvering room for the crawler was available. Loading in a shaft less than 14 feet in diameter was considered hazardous.

Bucket-wheel excavators, employed in combination with belt-conveyor haulage, were in use throughout the world.[44] Machines built in the United States were used in the Northern Illinois coalfield to strip overburden too high to be reached by 30- to 40-cubic-yard shovels. In Germany bucket-wheel excavators were used to remove overburden 600 feet or more thick. For these operations, haulage has been largely by rail but was being changed to belt conveyors. Extensive use of the large machines in Germany since World War II has resulted in improved designs of excavators with a capacity up to 10,000 cubic yards per hour. Conveyor belts to support this high production are run at high speeds with troughing idlers at 30°.

The belt conveyor has become one of the major methods for transporting materials. Technologic advances in belt fabric, machinery design, and construction have been rapid.[45] In about 1945 a 36-inch belt conveyor 500 feet long, with 150- or 200-horsepower drive, was about the maximum size of conveying unit. Belts in 1957 had widths greater than 72 inches and carrying capacities of 3,000 to 6,000 tons per hour, often requiring over 2,500 horsepower for drive. Belt speeds of 600 to 800 feet per minute were common, and overland conveyors followed the contour of the ground without being broken into sections. A major factor in the technologic advance of belt conveyors has been the improvements in strength and other properties of fibers used in manufacturing high-tension fabric belts.[46]

Tensions, which at one time could only be handled by belts having steel, cable-strength members, can be handled easily by fabric belts constructed of synthetic fibers. Fabric belts of rayon or nylon can withstand tensions of 1,400 to 1,800 pounds per inch of belt w dth. The new synthetic fiber materials not only have added tensile strength to the belt but have improved the properties of troughing, bending, and absorption of shock and impact under high tension. Where the tension range from 2,000 to 3,000 pounds per inch of belt width, steel cable belts were still used, especially in belt widths above 30 inches.

The design and use of belt conveyors in the underground coal-mining industry have been undergoing changes since 1950. Continuous miners that mine coal from a solid face have pointed up the need for a transportation system that can handle the continuous flow of coal to accompany the mining operations. Application of belt-conveyor transportation systems to continuous mining operations has resulted in designs that make conveyors exceptionally versatile for

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[43] Berry, T. M., Shaft Loading, Clamshell vs. Crawler-Mounted Loader: Min. Eng., vol. 8, No. 12, December 1956, pp. 1196–1198.

[44] Wamsley, W. H., German Bucket-Wheel Excavators and Belt Conveyors: Min. Eng., vol. 8, No. 12, December 1956, pp. 1179–1180.

[45] Vander Laan, Martin, Current Trends in Heavy Conveyor Belts: Pres. at Metal Mining and Industrial Minerals Convention, Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 3 pp.

[46] Arguedas, Arthur, Current Trends in Heavy Conveyor Belts: Pres. at Metal Mining and Industrial Minerals Convention, Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 6 pp.

continuous mining operations. Essentially, the belt conveyor has succeeded in providing continuous haulage for continuous mining.

Belt-conveyor systems being constructed work directly with continuous mining machines. Conveyors of this class are extensible and mobile train units. Extensible conveyors can be extended while in the process of transporting material.

Mobile train units are flexible conveyor assemblies designed specifically to support continuous mining machines. They are a train of portable belt conveyors, mounted on rubber tires permanently connected.[47]

In addition to requiring flexible units at the mining face, the continuous miner also requires a main-line-conveyor transportation system that can be installed and extended quickly and cheaply. New designs of conveyors to meet these needs are rope or cable belt conveyors. In Europe, in a common type of design, the load is borne by twin steel rope upon which the belt is carried by means of a steel strap across the underside of the belt. Shoes on each end of the strap bear on the ropes. The ropes take the drive, the belt acting only as a carrier. Advantages of the design are listed as follows: (1) First cost is lower than that of comparable conventional conveyor installations; (2) belt-edge wear is eliminated; (3) maintenance is low; (4) driving power is provided at less cost than in conventional conveyor systems; and (5) the system can be all one unit, as the necessity of operating in tandem is eliminated because there is no tension on the belt.

In line with the design of a conveyor in which the sole function of the belt is to carry the load, steel conveyors have been developed in Europe employing chains as a means of furnishing the stress transmission. The steel conveyors, rather than running on idlers, are equipped with wheels that run on tracks or angle irons.

Rope belt conveyors are of different design in the United States; however, the essential purpose—a conveyor system that can be installed quickly and cheaply—is the same as in Europe. In American design the belt conveyor is suspended on two parallel, stationary wire ropes.[48] Idlers are fastened to the ropes, and the belt furnishes the drive and also acts as the carrier. Ropes are supported at 20-foot intervals by 3-piece pipestands, which, in addition to giving support, also withstand the horizontal forces that tend to squeeze the ropes together. A feature of the system is that, under load, the rope flexes with the load, and the position of the idlers changes with the load pattern.

International Minerals & Chemical Corp. installed a rope-suspended belt conveyor at its potash mine near Carlsbad, N. Mex., to replace excessive shuttle-car haulage that had extended to distances of 1,500 feet.[49] The initial flight of 540 feet was installed on rope spans 160 feet in length anchored in the roof. Idlers were placed on 4-foot centers. Further extensions of the belt were installed on ropes anchored in the floor instead of the roof. The rope belt conveyor proved to be flexible, high-capacity equipment. Only about 6 hours

[47] Stevenson, J. W., Jeffery Molveyor Supporting Continuous Type Mining Machines: Proc. Illinois Min. Inst., Ann. Meeting, Springfield, Ill., Oct. 26, 1956, pp. 66–69.

[48] Ohlen, Louis S., Rope Belt Conveyors: Proc. Illinois Min. Inst., Ann. Meeting, Springfield, Ill., Oct. 26, 1956, pp. 58–65.

[49] Skinner, E. C., Operating Experience With Steel-Supported Conveyors: Pres. at Metal Mining and Industrial Minerals Convention, Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 4 pp.

was required for extending the belt length, and the installation permitted a reduction from 5 shuttle cars to 3.

Pneumatic packing machines, which are employed for pneumatic packing or stowing in coal-mine workings, have focused attention on pneumatic transportation or conveying of solids through pipes. The Scientific Department of the National Coal Board conducted a theoretical study on pneumatic transportation that will have as its final objective the study of pneumatically conveying sticky, irregularly shaped particles used in pneumatic packing in the coal industry.[50] Study was confined to the movement of dry, spherical particles through straight, level pipes. By using such materials, the range and number of variables involved in the study were limited. Two equations were obtained from the experimental study, giving the pressure gradient and velocity of a fully accelerated particle along the pipe when conveying nonadhesive, spherical particles. The equations were checked by testing application under smaller diameter pipe and smaller diameter particles and found to be true even under the widening range of these variables.

Central Test Station, State Mines in Limburg, Treebeek, Netherlands, employed a functional-type analog computer to determine mathematically the cause of vibrations in hoist cables and skips during high-speed hoisting and to assist in establishing corrective measures for solution of the vibration problems.[51]

Experimental and practical studies on the electromagnetic method of testing wire ropes were discussed at a meeting of electrical engineers in South Africa.[52] The method consists of introducing a magnetizing force into the rope and in turn measuring the magnetic flux in the rope, the flux in the rope being proportional to the magnetizing force, the magnetic permeability of the steel, and the area of the steel in the rope. Testing may be conducted while the rope is in motion, the rope speed during a test depending upon the response of the recorder and detector circuit. Usual speed is about 200 feet per minute.

Results of the testing are recorded on a chart in the form of traces. Charts are interpreted according to variations of the trace. Variations may be caused by eddy currents, corrosion, or changes in magnetic permeability. Eddy currents and magnetic permeability are not indications of rope deterioration. Indication of corrosion in the rope probably is the most important information on the rope given by the charts. Corrosion may be hidden and cannot be detected by surface examination; often appreciable reduction in strength results from the corrosion. Proportionality of the magnetic flux to the area of the steel in the rope permitted establishment of a relationship between breaking load and magnitude of the magnetic flux; this relationship may be used to determine the amount of strength deterioration that has occurred, either by corrosion or excessive wear. Undoubtedly the method will have great value in testing wire ropes.

Closed-circuit television was employed at No. 17 coal mine, Pana, Ill., allowing the hoist operator to observe dumping of the loaded

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[50] Hitchcock, J. A., and Jones, C., The Pneumatic Conveying of Spheres Through Straight Pipes: Nat. Coal Board (London), Mining Research Establishment Rept. 2053, December 1956, 12 pp.

[51] Work cited in footnote 7.

[52] Semmelink, A., Electromagnetic Testing of Winding Ropes: Trans. South African Inst. E ec. Eng., vol. 47, part 7, July 1956, pp. 206–233.

skip into the raw-coal hopper.[53] By the closed-circuit viewing system, the operator can easily see if large chunks of coal are wedged in the skip and if the skip door closed properly after dumping.

GROUND SUPPORT AND CONTROL

Developing instruments to measure the magnitude and direction of stresses induced by construction of underground openings continues to be a major problem in ground-control studies. A survey of European mining-research establishments by the Bureau of Mines indicated that they place great emphasis on basic research and are making noteworthy progress in solving the problem of developing instruments for rock-stress measurement.[54]

A primary objective of the Strata-Control Research Laboratory at King's College, University of Durham, England, was to develop instrumentation for research in ground-control problems. The final objective was development of instruments that will measure the magnitude and direction of acting stresses in the solid ahead of the mining face, at the face, and in the packing area behind the face. Stress-measuring devices developed for measuring support loads include a prop- and roof-bolt-load cell and stressmeter.[55] In the prop-load cell, load on the cell is related to measurement of an "out-of-balance" current produced by changes in the resistance of three electrical resistance strain gages fixed to the inner wall of the cell. The cell and associated measuring equipment record changes in the load taking place on the prop. With constant or selective switch reading of 20 to 40 load cells attached to props, the effect and extent of influence of operations at the face can be determined either on individual props or on all props included in the load survey.

The stressmeter is a device developed for insertion in a borehole to measure the stresses present in the solid ahead of the mining face. Two designs of the stressmeter were in use—one for coal, the other for hard rock. The hard-rock stressmeter has been designed to enter a 1-inch-diameter borehole. The method of measuring acting stresses is essentially the same as in the prop-load cell. Use of the stressmeter indicates that loads are constantly being redistributed as mining progresses. In 1 test the stressmeter was installed in a coal mine at a depth of 1,350 feet—20 feet ahead of the mining face. As coal cutting proceeded, stress rose from about 450 to a maximum of 850 pounds per square inch. In the course of filling, when there was no active mining in progress, the load pressure was changing, either increasing or decreasing.

Research was also conducted at King's College on determination of strata pressures by measurement of sonic velocities over a constant length path.[56] This research was based on the almost invariable increase in sonic velocity as stress increases, unless the rock is undergoing failure. Measurement of velocity along paths from selected

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[53] Coal Age, Closed-Circuit Television: Vol. 62, No. 10, October 1957, pp. 90–91.
[54] Work cited in footnote 7.
[55] Potts, Edward L. J., Underground Instrumentation: Quart. Colorado Sch. Mines, vol. 52, No. 3, July 1957, pp. 135–182.
Banister, Donald, The Measurement and Analysis of Support Loads Underground: Quart. Colorado Sch. of Mines, vol. 51, No. 3, July 1956, pp. 37–61.
[56] Potts, E. L. J., A Scientific Approach to Strata Control: Trans. Inst. Min. Eng. (London), vol. 116, part 2, November 1956, pp. 113–129.

positions in an area indicates the relative stress distribution; however, because of the high velocity of sonic waves in rock, measurement of the length of paths and velocities must be done with extreme accuracy. This method of stress measurement was in the experimental stage.

An outstanding example of basic research in Europe was development of a stress-measuring device by Prof. Nils Hast of Stockholm, Sweden. The device measures magnitude and principal direction of stress on or near the surface of underground openings and at depths up to 50 feet or more in solid rock; it can establish the stresses that were residual in the rock and those induced by mining.

At the Klausthal Mining Academy, Klausthal, Germany, the physical properties of rocks were investigated. A study of the effects of plasticity of rocks related to time was included. Stopes, pillar supports, shafts, and shaft pillars have been designed in nonmetal mines from criteria developed as a result of physical properties of rock studies.

Rock-mechanics research related to the control of subsidence was undergoing intensive study by the Technical Service Laboratory, Association of French Iron Mines, Briey, France. Studies were concerned primarily with control of ground subsidence as pillars are removed in retreating. The basic problem has been to control subsidence so that pillars next to the caved area do not fail prematurely, resulting in loss of pillar ore. Experimental work has demonstrated that there is an optimum rate of retreat. If pillars are removed too rapidly, incomplete subsidence transfers excessive loads upon pillars adjoining the caving area, causing them to fail. If pillars are removed too slowly, adjoining pillars undergo plastic deformation that causes them to spall and ultimately fail. Horizontal rock bolts have been employed for reinforcing the pillars.

The University of Durham, King's College, England, designed and supervised construction of a mine workers' community, including houses, water systems, sewerage, gas, and road systems over an area that was to be mined and caved. They were designed to eliminate failure during the subsidence produced by removing the coal lying beneath the area. A complete record of subsidence in the community was maintained, and all subsidence measurements were correlated with the progress of underground mining.

A problem of shifting ground in shafts in the State Mines at Limburg, Treebeek, Netherlands, was solved by a new method for lining shafts. Shafts are sunk to approximately 3,000 feet in depth. During sinking the shaft diameter is mined with an overbreak of about 2 feet. Precast, steel-reinforced concrete lining sections are placed in the opening, leaving the overbreak area clear. The overbreak area is then filled with a material of asphaltic composition, which allows considerable rock movement without disturbing the shaft lining.

Ground-control problems in the Kolar goldfield, Mysore, India, were greater than elsewhere.[57] The Champion Reef mine was 10,030 feet deep and was the deepest in the world. At this depth rock temperature is 150° F. Two surface air conditioners were used to cool the mine to 86° F. at the bottom of the shaft and 125° F. at the end of drifts on the lowest level. Another cooling plant will be installed

[57] Tufty, Barbara, World's Deepest Mine: Science News Letter, vol. 72, No. 10, September 1957, pp. 154–155.

at 8,000 feet to assist the surface plant in cooling the air. The country rock is hornblende schist, which, though strong, is exhibiting evidences of natural plasticity in some of the deepest openings. Some walls move as much as 6 inches into the excavation within 24 hours after opening.

As would be expected under such enormous pressures, rock bursts are common. To minimize their effect, granite blocks (8 or 12 inches in size) are quarried on the surface and transported underground for fill in the stopes. They are packed by hand to form a continuous, rigid wall. Over 5,000 tons of blocks is packed into the mine excavations each month. Underground openings that must be kept open are encircled with steel rails every 3½ feet. Areas between the rails are rock-bolted. The Champion Reef mine is expected to reach 11,500 feet in depth using these methods. To exceed this depth, new ground-control methods will have to be devised.

Applied Physics Laboratory, Bureau of Mines, College Park, Md., continued its roof-span studies in 1957. Field tests were conducted at a limestone mine by instrumenting a selected 10- by 100-foot area and widening in successive increments to an open room 40 by 100 feet.[58] Measurements were made of separations in the roof strata and deflection of the roof through successive widening periods. The 40- by 100-foot dimension and the roof horizon of the room were determined by investigation of the physical features of the rock, the physical properties of samples of rock from the roof, and calculations from the theory of loaded beams. After each widening of the span the roof sagged abruptly; and, in the periods between widenings, the roof sagged slowly for about 4 months and then stopped. Cessation of sagging indicated that the roof was not being affected by time deterioration. The lowest 6-inch layer of the roof separated, but the layer did not fail. It was removed after standing for about 4 months, when the roof was at maximum dimension. The method of roof-span design employed in the test is applicable to any spanned opening in which the rock is bedded horizontally in thin layers; however, a safety-factor allowance must be made for rock defects, such as joints and variations in physical properties that would tend to weaken the rock structurally.

Information from Bureau of Mines coal-mine inspectors' reports during the calendar year 1956 indicated that 424 bituminous-coal mines in the United States employed rock bolts for ground control.[59] An average of 2.64 million bolts was installed per month, which is a decrease of 0.36 million from 1955. Ninety-one percent of the 424 bituminous-coal mines used rock bolts equipped with expansion shells for anchorage, 3 percent used slotted-type bolt anchorage, and 6 percent used both types of anchorage. Data are not available on the number of bolts installed in metal and nonmetal mines.

The third report on anchorage tests of mine rock bolts was published in 1957 by the Bureau of Mines.[60] Thirty tests were made to measure the anchorage in a sandstone and shale roof with 5 makes of expan-

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[58] Merrill, R. H., Roof-Span Studies in Limestone: Bureau of Mines Rept. of Investigations 5348, 1957, 38 pp.

[59] Thomas, Edward, Summary of Coal-Mine Inspectors' Reports on Roof Bolting for Calendar Year 1956: Bureau of Mines unpub. rept., January 1957, 2 pp.

[60] Barry, A. J., Panek, L. A., and McCormick, John A., Anchorage Testing of Mine-Roof Bolts, Part 3. Expansion-Type, ⅝-Inch Bolts: Bureau of Mines Rept. of Investigations 5310, 1957, 8 pp.

sion-type shells and 2 types of mild-steel and high-strength ⅝-inch bolts. Anchorage obtained in the sandstone or shale was such that the yield load of both bolt types was exceeded before excessive slip occurred. A method of evaluating the anchorage effectiveness of the ⅝-inch expansion-type bolts was presented in graph form by plotting the relationship between bolt load and bolt displacement.

Self-advancing, hydraulic-powered roof supports have been developed in Britain.[61] Greatest use of the supports is realized in fully mechanized mining. Support units are made in two types: One type has 2 props and a twin-section top beam, and the other has 3 props and a triple-section beam. When the support advances, it advances as a unit, including the beam and props. The props in each unit are set to yield independently at 21 tons. A cantilever section of the beam supporting the portion of roof over the mining machinery can be preset at loads up to 9 tons.

An experimental test in the use of yielding steel supports (props) in combination with backfilling was conducted in an anthracite mine at Plymouth, Luzerne County, Pa., under a cooperative agreement between an operating company and the Bureau of Mines.[62] The test was made in an attempt to recover the maximum amount of coal from the pillars. Previous efforts to recover the coal with conventional timbering resulted in badly fractured roof, loss of some coal, and a major part of the working time being consumed in installing the timbers. Becorit yielding-type metal props were used in the experiment. For conventional use in longwall mining in Europe, this type of prop is in use only a few days, whereas in this experiment the props were in service and under continuous load for 90 days. In the first test some of the props collapsed because of load shedding, but the difficulty was overcome by substituting a newly developed lock assembly to replace the original lock assembly on the props. The props were placed with a setting load of 10 tons, which dropped to 7 tons when the setting device was removed. At about 10-millimeter yield the props assumed carrying loads ranging from 30 to 50 tons.

The first of a series of reports concerning research on strengthening mine roof by pressure injection of cementing material into fractures and bedding planes was published by the Bureau of Mines.[63] The aims of tests made in operating coal mines were development of suitable injection equipment, and determining the pressure required for injecting fluids into the roof strata. Initial tests that attempted injection of water at a pressure of 125 pounds per square inch were unsuccessful. Final equipment, developed and designed for mounting on a mobile, 3-wheeled cart, consisted of a high-pressure gear pump, electric motor, and auxiliary equipment capable of producing any desired pressure up to 1,200 pounds per square inch. Experiments in which oil was injected into the roof disclosed that higher pressures must be used at the face than are necessary a distance back from the face; and, when a flow could not be obtained at the face, it was possible to obtain a flow after the face had been advanced one or more

[61] Mining Journal (London), Powered Roof Supports in Mines: Vol. 248, No. 6358, June 28, 1957, p. 818.

[62] Hartley, John C., Cooner, Sr., John D., and Brennan, Robert J., Anthracite Mechanical-Mining Investigations. Use of Yielding Steel Supports (Props) in Combination With Backfilling for Mining Thick, Flat Beds: Bureau of Mines Rept. of Investigations 5290, 1956, 29 pp.

[63] Maize, Earl R., and Wallace, Joseph J., Cementation of Bituminous-Coal-Mine Roof Strata. Part I—Determining Penetrability of Mine Roof by Injecting Oil and Water: Bureau of Mines Rept. of Investigations 5304, 1956, 11 pp.

cuts. Relationship of the required pressure and position of the face were attributed to roof sag after mining. Research was to be continued and directed toward developing a cementing material capable of being injected into the roof rock and bonding the fractures.

A water barrier surrounding a deep foundation excavation in New York City was constructed by chemical injection and solidification.[64] The chemicals were injected through 60-foot-long injection pipes placed in cased drill holes. Sodium silicate solution, followed by a calcium chloride solution, were the chemical mixtures used to solidify the rock. Casing was pulled, and successive injections were made as the injection pipe was removed from the hole in 1-foot stages. The average height of column solidified was 18 feet. Injection pressures ranged from 150 to 600 pounds per square inch.

A progress report on a study of the physical features of the San Manuel (Ariz.) mineral deposit affecting and related to block caving was published.[65] The study indicates that the physical features affecting block caving are essentially those that pertain to rock strength and include structure, rock types, alteration, mineralization, oxidation, and ground water. Detailed mapping of the fracture pattern and graphing of their density of occurrence, according to their strike and dip, indicated zones of weakness trending in the direction of strike. The study, which was essentially an experiment in correlating the physical feature data with action of block caving, will be continued.

Fundamental data available for determining slope stability in open-pit mines were reviewed.[66] Physical property studies of the material in open-pit walls indicate that the extreme limits defining the physical condition of the material are as follows: (1) The condition of a solid, (2) condition of a liquid, and (3) condition of an aggregate of unbonded dry and loose, but individually solid, particles. In the solid condition resistance is offered to both tension and shear. In the condition of an aggregate of unbonded dry and loose solid particles, no resistance is offered in tension, but resistance is offered to shear through friction of individual particles. In the liquid condition no resistance is offered to either shear or tension. Normally, the materials comprising open-pit slopes are in a physical condition that is somewhat of an average of all three extreme limits.

DRAINAGE

A revision of American Recommended Practice for drainage of coal mines (M6) was published by the Bureau of Mines.[67] The publication lists (1) standard practice for using gathering and permanent pumps; (2) piping for pumps; (3) methods of operation of pumps, storage of water, natural drainage, and unwatering abandoned workings; (4) the composition of mine waters, their action on mine drainage equipment, and alloys that are acid-resisting; and (5) methods for reducing electrolysis in pipelines. The newly recommended standards

[64] Construction Methods and Equipment, Chemically Made Rock Seals Foundation Pit: Vol. 39, No. 9, September 1957, pp. 94–97.

[65] Wilson, E. D., Geologic Factors Related to Block Caving at San Manuel Copper Mine, Pinal County, Ariz., Progress Report, April 1954–March 1956: Bureau of Mines Rept. of Investigations 5336, 1957, 78 pp.

[66] Vine, W. A., Slope Stability in Open-Pit Mines: Pres. at the Metal Mining and Industrial Minerals Convention, Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 5 pp.

[67] Bureau of Mines, American Standard Recommended Practice for Drainage of Coal Mines (M6.1–55, UDC 622.5) Bull. 570, 1957, 18 pp.

were formulated according to the procedure of the American Standards Association.

VENTILATION

A tube fabricated from Polyethylene film, 4-mil (0.004-inch) thickness, was employed for delivering air under low pressure and velocity to underground workings in the No. 1 mine of Minerva Oil Co., Fluorspar Division, Hardin County, Ill.[68] The plastic material was obtained in 100-foot rolls, 16 feet in width and fabricated into a tube 54 inches in diameter at the mine. Cost of the completed tube was $0.96 per foot, and installation cost was $0.38 per foot. The longitudinal seam fastened with staples and 3-inch acetate fiber tape, gave some trouble during 5 months of use, but it was thought that no serious difficulty would be experienced in developing an improved method of fastening the seams.

HEALTH AND SAFETY

Carbon dioxide gas and carbon dioxide as dry ice were used to control and extinguish an underground fire in the Penokee mine, Ironwood, Mich., operated by the North Range Mining Co., Negaunee, Mich.[69] The fire area was a 300-foot, double-compartment, cribbed raise between the 29th and 31st levels of the mine. Carbon dioxide gas was introduced from the surface into the fire area through the main compressed-air line and 6 blocks of dry ice weighing about 50 pounds each were dumped into the raise from the top. Apparently sublimation was immediate when the dry ice encountered the high temperatures of the fire. When the smoke cleared and reentry to the area was possible, a ton of dry ice was dumped down the raise, while gas was continuously introduced into the area through the main air line. Through the combined introduction of gas and dry ice, the fire was under control and extinguished in less than 24 hours.

A survey of State laws and regulations affecting the use of internal-combustion engines underground was published in 1957.[70] The Bureau of Mines has conducted investigations on the safe use of diesel engines underground since 1937. Abstracts of laws, regulations, and comments of State officials covering 36 States were published. Some States ban internal-combustion engines but exempt diesel engines, subject to special regulations. The report recommends that manufacturers of diesel equipment consult State authorities before selling such equipment for underground use in States where laws are not specific.

Research on the cause and control of coal-dust explosions was reviewed.[71] The Experimental Coal Mine of the Bureau of Mines has served as a laboratory for operational research for determining the explosibility of coal dust and mine gas, factors that govern the propagation of mine explosions, and the effect of preventive measures

[68] Daly, J. J., Plastic Ducts for Mine Ventilation: Pres. at Metal Mining and Industrial Minerals Convention, Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 3 pp.
[69] Haller, F. J., Fighting a Fire With CO_2: Pres. at Metal Mining and Industrial Minerals Convention, Am. Min. Cong., Salt Lake City, Utah, Sept. 9–11, 1957; press release, 5 pp.
[70] Holtz, J. C., Gleim, E. J., State Regulations Pertaining to the Use of Internal-Combustion Engines Underground: Bureau of Mines Inf. Circ. 7789, 1957, 24 pp.
[71] Hartmann, Irving, Studies on the Development and Control of Coal-Dust Explosions in Mines, Bureau of Mines Inf. Circ. 7785, 1957, 27 pp.

to stop or eliminate explosions. About 2,500 explosion tests have been made in the Experimental Mine, but many of them are no longer applicable to current conditions. Highly mechanized operations, which are common in coal mines today, have increased the production of fine coal dust and raised problems of applying rock dust to within 40 feet of all active faces.

MINING METHODS AND PERFORMANCE

Publication by the Bureau of Mines of a series of information circulars reporting mining methods, performance, and costs was continued during 1957. During the year 13 circulars were published,[72] making a total of 19 circulars published in this series since reactivation of the program in 1955.

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[72] Trengove, R. L., and Johnson, A. C., Sampling Deep-Ore Deposits by Rotary Drilling and Methods of Surveying and Controlling the Direction of Drill Holes: Bureau of Mines Inf. Circ. 7768, 1956, 15 pp.
Clark, S. S., Mining Methods and Costs at the Westside Mine of the Eagle-Picher Co., Cherokee County, Kans.: Bureau of Mines Inf. Circ. 7774, 1957, 20 pp.
Cole, W. A., Mining and Milling Methods and Costs, Tri-State Zinc, Inc., Jo Daviess County, Ill.: Bureau of Mines Inf. Circ. 7780, 1957, 19 pp.
Lane, M. E., Mining Methods and Costs at the Hayden Creek Mine of St. Joseph Lead Co., St. Francois County, Mo.: Bureau of Mines Inf. Circ. 7781, 1957, 33 pp.
Olds, E. B., and Parsons, E. W., Methods and Costs of Deepening the Crescent Shaft, Bunker Hill & Sullivan Mining & Concentrating Co., Kellogg, Shoshone County, Idaho: Bureau of Mines Inf. Circ. 7783, 1957, 11 pp.
Storms, W. R., and Bowman, A. B., Mining Methods and Practices at the Mineral Hill Copper Mine, Banner Mining Co., Pima County, Ariz.: Bureau of Mines Inf. Circ. 7786, 1957, 25 pp.
Hardwick, W. R., and Sierakoski, G., Mining Methods and Practices at the Johnson Camp Copper & Zinc Co., Cochise County, Ariz.: Bureau of Mines Inf. Circ. 7788, 1957, 27 pp.
Evans, T. B., and Eilertsen, N. A., Mining Methods and Costs at the Sunbright Limestone Mine, Foote Mineral Co., Sunbright, Va.: Bureau of Mines Inf. Circ. 7793, 1957, 44 pp.
Lickes, M. R., Mining, Processing, and Costs, Idaho Almaden Mercury Mine, Washington County, Idaho: Bureau of Mines Inf. Circ. 7800, 1957, 33 pp.
Dare, W. L., Mining Methods and Costs, Continental Uranium, Inc., Continental No. 1 Mine, San Juan County, Utah: Bureau of Mines Inf. Circ. 7801, 1957, 20 pp.
Dare, W. L., and Delicate, D. T., Mining Methods and Costs—La Sal Mining and Development Co., La Sal Uranium Mine, San Juan County, Utah: Bureau of Mines Inf. Circ. 7803, 1957, 48 pp.
Pettit, R. F., Jr., Calhoun, W. A., and Reynolds, B. M., Mining Methods and Costs, Ozark Ore Co., Iron Mountain Iron-Ore Mine, St. Francois County, Mo.: Bureau of Mines Inf. Circ. 7807, 1957, 46 pp.
Dare, W. L., Mining Methods and Costs, Calyx Nos. 3 and 8 Uranium Mines, Temple Mountain District, Emery County, Utah: Bureau of Mines Inf. Circ. 7811, 1957, 36 pp.

Statistical Summary of Mineral Production

By Kathleen J. D'Amico [1]

THIS SUMMARY is identical to that in volume III of this series on mineral production in the United States (including Alaska and Hawaii), its island possessions, the Canal Zone, and the Commonwealth of Puerto Rico and on the principal minerals imported into and exported from the United States. For further details on production see the several commodity and area chapters. A summary table comparing world and United States mineral production also is included.

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

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. The quantities of gold, silver, copper, lead, zinc, and tin are recorded on a mine basis—that is, as the recoverable content of ore sold or treated; the values assigned to these quantities, however, are based on the average selling price of refined metal, not the mine value. Mercury is measured in the form of recovered metal and valued at the average New York price for metal.

Data for clays and limestone, 1954–57, include output used in making cement and lime. Mineral-production totals have been adjusted to eliminate duplicating these values.

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

[1] Publications editor.

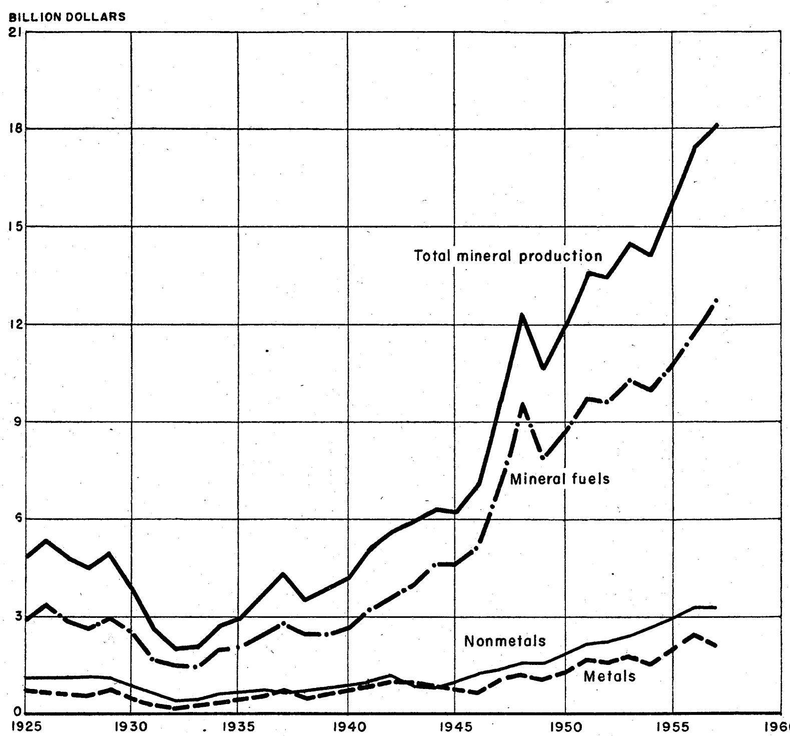

FIGURE 1.—Value of mineral production in the United States, 1925–57.

TABLE 1.—Value of mineral production in continental United States, 1925–57, by mineral groups [1]

(Millions)

Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total	Year	Mineral fuels	Nonmetals (except fuels)	Metals	Total
1925	$2,910	$1,187	$715	$4,812	1942	$3,568	$1,056	$999	$5,623
1926	3,371	1,219	721	5,311	1943	4,028	916	987	5,931
1927	2,875	1,201	622	4,698	1944	4,574	836	900	6,310
1928	2,666	1,163	655	4,484	1945	4,569	888	774	6,231
1929	2,940	1,166	802	4,908	1946	5,090	1,243	729	7,062
1930	2,500	973	507	3,980	1947	7,188	1,338	1,084	9,610
1931	1,620	671	287	2,578	1948	9,502	1,552	1,219	12,273
1932	1,460	412	128	2,000	1949	7,920	1,559	1,101	10,058
1933	1,413	432	205	2,050	1950	8,689	1,822	1,351	11,862
1934	1,947	520	277	2,744	1951	9,779	2,079	1,671	13,529
1935	2,013	564	365	2,942	1952	9,616	2,163	1,617	13,396
1936	2,405	685	516	3,606	1953 [2]	10,257	2,350	1,811	14,418
1937	2,798	711	756	4,265	1954 [2]	9,919	[3] 2,630	1,518	14,067
1938	2,436	622	460	3,518	1955 [2]	10,780	[3] 2,972	2,055	15,807
1939	2,423	754	631	3,808	1956 [2]	11,741	[3] 3,284	2,358	17,383
1940	2,662	784	752	4,198	1957 [2]	12,720	[3] 3,277	2,129	18,126
1941	3,228	989	890	5,107					

[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 for such products.
[2] Includes Alaska and Hawaii.
[3] The total has been adjusted to eliminate duplicating the value of clays and stone.

TABLE 2.—Mineral production [1] in the United States,[2] 1954–57

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
MINERAL FUELS								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone	1,337,822	$3,686	1,427,207	$4,111	1,458,533	$4,114	1,168,507	$3,221
Gilsonite	75,943	2,724	82,822	3,117	89,003	3,822	206,041	4,259
Carbon dioxide, natural (estimated) ... thousand cubic feet	638,900	211	702,417	234	713,030	235	704,276	139
Coal:								
Bituminous and lignite [3] ... thousand short tons	391,706	1,769,620	464,633	2,092,383	500,874	2,412,004	492,704	2,504,406
Pennsylvania anthracite ... do	29,083	247,870	26,205	206,097	28,900	236,785	25,338	227,754
Helium ... thousand cubic feet	189,873	3,202	235,868	3,881	266,937	4,413	310,365	5,112
Natural gas ... million cubic feet	8,742,546	882,501	9,405,351	978,357	10,081,923	1,083,812	[4] 10,604,130	[4] 1,212,408
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	5,385,282	402,418	5,844,904	423,775	5,807,100	431,958	5,734,307	415,791
LP-gases ... do	5,204,304	178,994	5,972,698	195,231	6,487,413	265,185	6,655,282	263,665
Peat	244,163	2,258	273,669	2,283	[5] 272,972	[5] 2,320	316,217	3,458
Petroleum (crude) ... thousand 42-gallon barrels	2,314,988	6,424,930	2,484,428	6,870,380	2,617,283	[5] 7,296,760	[4] 2,616,778	[4] 8,079,504
Total mineral fuels		9,919,000		10,780,000		[5] 11,741,000		12,720,000
NONMETALS (EXCEPT FUELS)								
Abrasive stone:[6]								
Grindstones and pulpstones	2,218	164	2,799	196	(7)	(7)	1,505	132
Millstones	(8)	(7)	(8)	(7)	(8)	$4	(8)	5
Pebbles (grinding)	3,070	99	2,130	68	2,330	71	2,902	86
Tube-mill liners (natural)	933	59	(7)	(7)	1,061	74	1,440	108
Asbestos	47,621	4,698	44,568	4,487	41,312	4,742	43,653	4,917
Barite	883,283	8,508	1,108,103	10,809	1,299,888	13,498	1,152,882	11,756
Boron monerals	790,449	26,714	924,496	33,816	[5] 568,087	[5] 35,722	597,857	40,817
Bromine ... thousand pounds	187,399	41,313	184,454	39,856	196,730	47,434	191,971	48,038
Cement ... thousand 376-pound barrels	274,703	763,413	306,128	884,381	321,295	989,233	299,189	961,499
Clays ... thousand short tons	42,367	123,165	48,106	139,540	[9] 50,182	[9] 157,361	[9] 45,078	[9] 150,721
Emery	9,758	132	10,735	151	12,153	174	11,893	184
Epsom salts from epsomite	(7)	(7)	100	5	(7)	(7)	(7)	(7)
Feldspar ... long tons	411,018	3,490	465,378	3,801	[5] 693,276	[5] 6,014	611,801	5,439
Fluorspar	245,628	12,333	279,540	12,590	329,719	14,257	328,872	15,777
Garnet (abrasive)	14,183	971	11,835	1,191	9,812	1,073	9,776	1,080
Gem stones (estimated)	(8)	613	(8)	818	(8)	925	(8)	882
Gypsum ... thousand short tons	8,996	27,384	10,684	33,938	10,316	34,099	9,195	29,871
Iron oxide pigment materials (crude)	16,259	129	16,190	157	15,362	156	18,366	193

See footnotes at end of table.

TABLE 2.—Mineral production [1] in the United States,[2] 1954–57—Continued

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
NONMETALS (EXCEPT FUELS)—continued								
Lime .... thousand short tons	8,621	$101,525	10,470	$126,890	10,567	$135,532	10,266	$135,143
Magnesite	284,015	1,391	486,088	2,713	686,569	2,502	678,489	3,258
Magnesium compounds from sea water and brines (except for metals) .... MgO equivalent	113,774	9,469	155,779	12,704	169,019	13,668	184,499	16,235
Marl:								
Calcareous (except for cement)	206,257	152	183,044	128	285,653	215	(10)	(10)
Greensand	2,838	199	5,704	218	(7)	(7)	(7)	(7)
Mica:								
Scrap	81,073	1,734	95,432	2,058	86,309	1,850	[11] 92,438	[11] 2,110
Sheet .... pounds	668,788	2,393	642,113	3,370	887,871	[5] 2,757	690,052	2,492
Perlite	219,703	1,762	286,157	2,282	310,800	2,550	301,605	2,562
Phosphate rock .... thousand long tons	13,821	86,669	12,265	75,379	15,747	97,922	13,976	87,689
Potassium salts [12] .... K_2O equivalent	1,948,721	72,950	2,066,706	78,602	2,171,584	82,107	2,266,481	84,612
Pumice .... thousand short tons	1,647	2,974	1,804	3,369	1,482	[5] 4,749	1,827	4,628
Pyrites .... thousand long tons	909	7,159	1,007	8,391	1,070	9,743	1,067	9,087
Salt (common) .... thousand short tons	20,660	105,487	22,693	123,276	24,206	136,139	23,844	147,291
Sand and gravel .... do	556,160	503,293	591,683	535,510	[5] 631,495	[5] 602,412	630,697	597,372
Slate .... do	761	12,961	760	12,914	645	11,666	632	11,029
Sodium carbonate (natural)	527,282	13,536	613,594	15,001	652,891	17,400	652,717	17,792
Sodium sulfate (natural)	249,701	3,890	284,549	5,381	[5] 332,990	[5] 6,437	331,382	6,542
Stone [13] .... thousand short tons	409,196	609,445	467,272	702,142	[5] 504,031	[5] 763,313	531,488	812,193
Strontium minerals (crude) .... long tons	12	(14)	177	4	4,040	77	(7)	(7)
Sulfur:								
Frasch-process mines .... thousand long tons	5,328	142,014	5,839	163,156	5,676	150,356	5,035	122,915
Other mines .... long tons	185,085	(7)	199,899	(7)	185,532	(7)	(7)	(7)
Sulfur, recovered elemental .... do	399,950	11,209	458,021	12,585	503,314	14,241	472,686	12,962
Talc, pyrophyllite, and soapstone	618,994	3,493	725,708	4,517	739,039	4,859	684,453	4,796
Titanium-iron concentrate (non-titanium use)	(7)	(7)	1,350	7	----------	----------	----------	----------
Tripoli	41,625	1,459	49,662	213	45,009	203	50,717	195
Vermiculite	195,538	2,538	204,040	2,702	192,628	2,543	183,987	2,603
Value of items that cannot be disclosed: Aplite, brucite, calcium-magnesium chloride, certain clays, diatomite, graphite, iodine, kyanite, lithium minerals, nitrogen compounds (1957), olivine, staurolite (1957), sharpening stones, wollastonite, and values indicated by footnote 7	----------	22,580	----------	30,805	----------	40,778	----------	38,813
Total nonmetallic minerals [15]	----------	[5] 2,630,000	----------	[5] 2,972,000	----------	[5] 3,284,000	----------	3,277,000

METALS								
Antimony ore and concentrate........antimony content..	766	([16])	633	([16])	590	([16])	710	([16])
Bauxite........long tons, dried equivalent..	1,994,896	16,403	1,788,341	14,543	1,743,344	13,973	1,416,172	12,154
Beryllium concentrate........gross weight..	669	304	500	268	460	237	521	276
Chromite........do....	163,365	7,164	153,253	6,644	[17] 207,662	[17] 8,715	166,157	7,816
Cobalt (content of concentrate)........thousand pounds..	2,219	([16])	2,439	([16])	3,657	([16])	4,123	([16])
Columbium-tantalum concentrates........do....	32,829	57	12,954	22	216,606	([16])	370,483	([16])
Copper (recoverable content of ores, etc.)........	835,472	492,929	998,570	744,933	[11] 1,104,156	[11] 938,532	[11] 1,086,859	[11] 654,289
Gold (recoverable content of ores, etc.)........troy ounces..	1,837,310	64,306	1,880,142	65,805	[11] 1,827,159	[11] 63,950	1,793,597	62,776
Iron ore, usable (excluding byproduct iron sinter) thousand long tons, gross weight..	76,126	525,818	105,237	748,602	96,944	[11] 750,354	104,157	865,703
Lead (recoverable content of ores, etc.)........	325,419	89,165	338,025	100,731	352,826	110,787	338,216	96,730
Manganese ore (35 percent or more Mn)........gross weight..	206,128	15,176	287,254	21,651	344,735	26,990	366,334	29,363
Manganiferous ore (5 to 35 percent Mn)........do....	558,332	3,079	911,636	5,128	680,651	3,984	865,127	([16])
Manganiferous residuum........do....	214,931	([16])	213,370	([16])	130,129	([16])	([16])	([16])
Mercury........76-pound flasks..	18,543	4,903	18,955	5,504	24,177	6,284	[11] 34,625	[11] 8,552
Molybdenum (content of concentrate)........thousand pounds..	64,021	64,070	64,709	66,919	57,126	[5] 63,901	57,143	67,605
Nickel (content of ore and concentrate)........	14	([16])	4,411	([16])	7,392	([16])	12,901	([16])
Rare-earth metals concentrates........	([16])	([16])	([16])	([16])	([16])	([16])	2,907	649
Silver (recoverable content of ores, etc.)....thousand troy ounces..	36,941	33,434	37,198	33,666	[11] 38,722	[11] 35,044	38,165	34,541
Titanium concentrate:								
Ilmenite........gross weight..	531,895	7,375	573,192	10,268	735,388	14,199	782,975	17,362
Rutile........do....	7,305	870	9,182	1,122	12,065	1,749	10,644	1,544
Tungsten ore and concentrate........60-percent WO_3 basis..	13,691	51,433	16,412	60,841	14,737	51,201	5,520	8,186
Uranium ore........	([18])	([18])	([18])	([18])	[5] 3,003,590	[5] 70,601	3,682,543	78,454
Vanadium........thousand pounds..	6,052	([16])	6,572	([16])	7,735	([16])	7,383	([16])
Zinc (recoverable content of ores, etc.)........	473,471	102,180	514,671	126,609	542,340	148,503	531,735	123,235
Zirconium concentrate........	17,959	820	28,913	1,426	([16])	([16])	([16])	([16])
Value of items that cannot be disclosed: Magnesium chloride for magnesium metal, platinum-group metals (crude), tin (1954–55), and values indicated by footnote 16........	....	38,880	....	40,596	....	[5] 48,704	....	59,558
Total metals........	....	1,518,000	....	2,055,000	....	[5] 2,358,000	....	2,129,000
Grand total mineral production........	....	[5] 14,067,000	....	[5] 15,807,000	....	[5] 17,383,000	....	18,126,000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes Alaska and Hawaii.
[3] Includes small quantity of anthracite mined in States other than Pennsylvania.
[4] Preliminary figure.
[5] Revised figure.
[6] Excludes sharpening stones, value for which is included with "Nonmetal items that cannot be disclosed."
[7] Figure withheld to avoid disclosing individual company confidential data; value included with "Nonmetal items that cannot be disclosed."
[8] Weight not recorded.
[9] Excludes certain clays; value included with "Nonmetal items that cannot be disclosed."
[10] Beginning with 1957 calcareous marl included with stone.
[11] Final figure. Supersedes preliminary figure given in commodity chapter.
[12] Marketable production. Supersedes figures for "Sold or used" as reported previously.
[13] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table.
[14] Less than $1,000.
[15] The total has been adjusted to eliminate duplicating value of clays and stone.
[16] Figure withheld to avoid disclosing individual company confidential data; value included with "Metal items that cannot be disclosed."
[17] Includes 45,710 short tons of concentrate produced in 1955 and 1956 from low-grade ore and concentrate stockpiled near Coquille, Oreg., during World War II.
[18] Data not available.

TABLE 3.—Minerals produced in the United States,[1] by States, and principal producing States in 1957

State	Antimony	Aplite	Asbestos	Asphalt	Barite	Bauxite	Beryllium	Boron	Bromine	Brucite	Calcium magnesium chloride	Carbon dioxide	Cement	Chromite	Clays	Coal
Alabama				3		2							√		√	√
Alaska	3													4		√
Arizona			2				√						√		√	√
Arkansas					1	1			4				√		√	√
California			3		√			1	3		2		2	2	4	√
Colorado							2					2	√		√	√
Connecticut							4								√	
Delaware															√	
Florida													√		√	
Georgia					3	3	√						√		√	√
Hawaii															√	
Idaho	1				√		√						√		√	
Illinois													√		√	4
Indiana													√		√	√
Iowa													√		√	√
Kansas													√		√	√
Kentucky				√									√		√	3
Louisiana													√		√	
Maine							√						√		√	
Maryland							√						√		√	√
Massachusetts															√	
Michigan									2		1		4		√	
Minnesota													√		√	
Mississippi													√		√	
Missouri				√	2								√		√	√
Montana					√								√	1	√	√
Nebraska													√		√	
Nevada	2				4					1					√	
New Hampshire							√								√	
New Jersey															√	
New Mexico					√		3					1			√	√
New York													√		√	
North Carolina			4				√								√	
North Dakota															√	√
Ohio													√		1	√
Oklahoma				4									√		√	√
Oregon												√	√	3	√	
Pennsylvania													1		2	2
Rhode Island																
South Carolina					√								√		√	
South Dakota							1						√		√	√
Tennessee					√								√		√	√
Texas				1					1				3		3	
Utah				2								3	√		√	√
Vermont			1												√	
Virginia		1											√		√	√
Washington					√							4	√		√	√
West Virginia									√		3		√		√	1
Wisconsin													√		√	
Wyoming							√						√		√	√

[1] Includes Alaska and Hawaii.

TABLE 3.—Minerals produced in the United States,[1] by States, and principal producing States in 1957—Continued

State	Cobalt	Columbium-tantalum	Copper	Diatomite	Emery	Epsomite	Feldspar	Fluorspar	Garnet	Gem stones	Gold	Graphite	Gypsum	Helium	Iodine
Alabama															
Alaska			√							√	3				
Arizona		2	1				√	√		√	√		√		
Arkansas										√			√		
California			√	1			2	√		3	4		2		1
Colorado		√	√				3	3		√	√		√		
Connecticut							√			√					
Delaware															
Florida										√					
Georgia							√			√					
Hawaii															
Idaho	1	1	√						2	√	√		√		
Illinois								1		√					
Indiana													√		
Iowa										√			3		
Kansas													√	3	
Kentucky								4							
Louisiana													√		
Maine							√			√					
Maryland										√					
Massachusetts															
Michigan			√							√			1		
Minnesota										√					
Mississippi															
Missouri	2		√							√					
Montana			3					2		√	√		√		
Nebraska										√					
Nevada			4	2				√		4	√		√		
New Hampshire							√			√					
New Jersey										√					
New Mexico		4	√							√	√			2	
New York					1				1	√			√		
North Carolina			√				1			√	√				
North Dakota										√					
Ohio													√		
Oklahoma													√		
Oregon			√	3						1	√				
Pennsylvania	3		√							√	√				
Rhode Island												2			
South Carolina															
South Dakota		3					4			√	1		√		
Tennessee			√					√			√				
Texas							√			2		1	4	1	
Utah			2					√		√	2		√		
Vermont			√								√				
Virginia							√			√			√		
Washington			√	4		1				√	√		√		
West Virginia															
Wisconsin										√					
Wyoming			√				√			√	√		√		

[1] Includes Alaska and Hawaii.

TABLE 3.—Minerals produced in the United States,[1] by States, and principal producing States in 1957—Continued

State	Iron ore	Iron oxide pigments	Kyanite	Lead	Lime	Mangesite	Magnesium chloride	Magnesium compounds	Manganese	Mercury	Mica	Molybdenum	Natural gas	Natural-gas liquids	Nickel
Alabama	3				√						3		√		
Alaska				√	√					3					
Arizona				√	√				2	√	√	3	√		
Arkansas	√				√				√				√	√	
California	√			√	√			1	√	1	√	4	√	2	
Colorado	√	√		4	√				√		√	1	√	√	
Connecticut					√						√				
Delaware															
Florida					√								√		
Georgia	√	2							√		2				
Hawaii					√										
Idaho	√			2						√	√				3
Illinois				√	√								√	√	
Indiana													√		
Iowa					√										
Kansas				√									√	√	
Kentucky				√									√	√	
Louisiana					√								2	3	
Maine					√						√				
Maryland					√								√		
Massachusetts					√										
Michigan	2	1			√			2					√	√	
Minnesota	1	√			√				√						
Mississippi	√												√	√	
Missouri	√			1	2				√						2
Montana	√			√	√				3		√		√	√	
Nebraska													√	√	
Nevada	√			√	√	2			1	2		√			
New Hampshire											√				
New Jersey	√				√			3							
New Mexico	√			√	√			√	4		√	√	3	√	
New York	√	3		√	√								√		
North Carolina				√							1				
North Dakota													√	√	
Ohio					1								√	√	
Oklahoma				√	√				√				4	4	
Oregon	√	√		√	√					4					1
Pennsylvania	√	√			3						√		√	√	
Rhode Island															
South Carolina			2								4				
South Dakota	√				√						√				
Tennessee	√				√				√		√		√		
Texas	√				4		1	4		√			1	1	
Utah	4			3	√				√			2	√	√	
Vermont					√										
Virginia		4	1	√	√				√		√		√		
Washington	√			√		1				√					
West Virginia					√				√				√	√	
Wisconsin	√			√	√										
Wyoming	√												√	√	

[1] Includes Alaska and Hawaii.

TABLE 3.—Minerals produced in the United States,[1] by States, and principal producing States in 1957—Continued

State	Olivine	Peat	Perlite	Petroleum	Phosphate rock	Platinum-group metals	Potassium salts	Pumice	Pyrites	Rare-earth metals	Salt	Sand and gravel	Silver	Slate	Sodium carbonate
Alabama				√							√	√			
Alaska						1						√	√		
Arizona			4					2	√			√	4		
Arkansas				√								√		√	
California		4	√	2		2	2	1	3	√	√	1	√	√	2
Colorado		√	2	√				√	4	2	√	√	√		
Connecticut		√										√			
Delaware												√			
Florida		3		√	1					3		√			
Georgia		√										√		1	
Hawaii								4			√	√			
Idaho		√			3			√		4		√	1		
Illinois		√		√								4			
Indiana		√		√								√			
Iowa		√										√			
Kansas				√				√			√	√			
Kentucky				√								√	√		
Louisiana				3							4	√			
Maine		√										√		√	
Maryland							√					√			
Massachusetts		√										√			
Michigan		1		√			4				1	2	√		
Minnesota		√										√			
Mississippi				√								√			
Missouri				√								√	√		
Montana				√	4				√			√	3		
Nebraska				√				√				√			
Nevada			3	√				√			√	√	√		
New Hampshire		√										√			
New Jersey		√										√			
New Mexico			1	√			1	3			√	√	√		
New York		√		√							3	√	√	4	
North Carolina	1											√	√	√	
North Dakota				√				√				√			
Ohio		√		√							√	3			
Oklahoma				4				√			√	√			
Oregon								√				√	√		
Pennsylvania		√		√					√			√	√	2	
Rhode Island												√			
South Carolina										1		√			
South Dakota				√								√	√		
Tennessee				√	2				1			√	√		
Texas				1				√			2	√			
Utah			√	√	√		3	√			√	√	2		
Vermont									√			√	√	3	
Virginia				√					2		√	√	√	√	
Washington	2	2		√				√				√	√		
West Virginia				√							√	√			
Wisconsin		√										√			
Wyoming				√	√			√		√		√	√		1

[1] Includes Alaska and Hawaii.

TABLE 3.—Minerals produced in the United States,[1] by States, and principal producing States in 1957—Continued

State	Sodium sulfate	Stone	Strontium	Sulfur	Talc, pyrophyllite, and soapstone	Titanium	Tripoli	Tungsten	Uranium	Vanadium	Vermiculite	Wollastonite	Zinc	Zirconium
Alabama		√			√									
Alaska		√							√					
Arizona		√						√	4	3			√	
Arkansas		√		4	√									
California	1	2	2	1	2			2	√			2	√	
Colorado		√						√	3	1			√	
Connecticut		√												
Delaware		√												
Florida		√				2								1
Georgia		√			4									
Hawaii		√												
Idaho		√				4		√	√				3	
Illinois		√		√			1						√	
Indiana		√		√										
Iowa		√												
Kansas		√											√	
Kentucky		√											√	
Louisiana		√		√										
Maine		√												
Maryland		√			√									
Massachusetts		√												
Michigan		4		√										
Minnesota		√		√										
Mississippi		√												
Missouri		√											√	
Montana		√		√	√			4	√	√	1		4	
Nebraska		√												
Nevada		√		√	√			3	√				√	
New Hampshire		√												
New Jersey		√		√									√	
New Mexico		√		√					1	4			√	
New York		√			1	1						1	1	
North Carolina		√			3			1					√	
North Dakota		√		√										
Ohio		3												
Oklahoma		√		√			2						√	
Oregon		√						√	√					
Pennsylvania		1		√	√		3							
Rhode Island		√												
South Carolina		√				√					2			2
South Dakota		√							√					
Tennessee		√											2	
Texas	2	√		2	√				√					
Utah		√							2	2			√	
Vermont		√			√									
Virginia		√			√	3							√	
Washington		√	1		√			√	√				√	
West Virginia		√		√										
Wisconsin		√											√	
Wyoming	3	√		3					√	√				

[1] Includes Alaska and Hawaii.

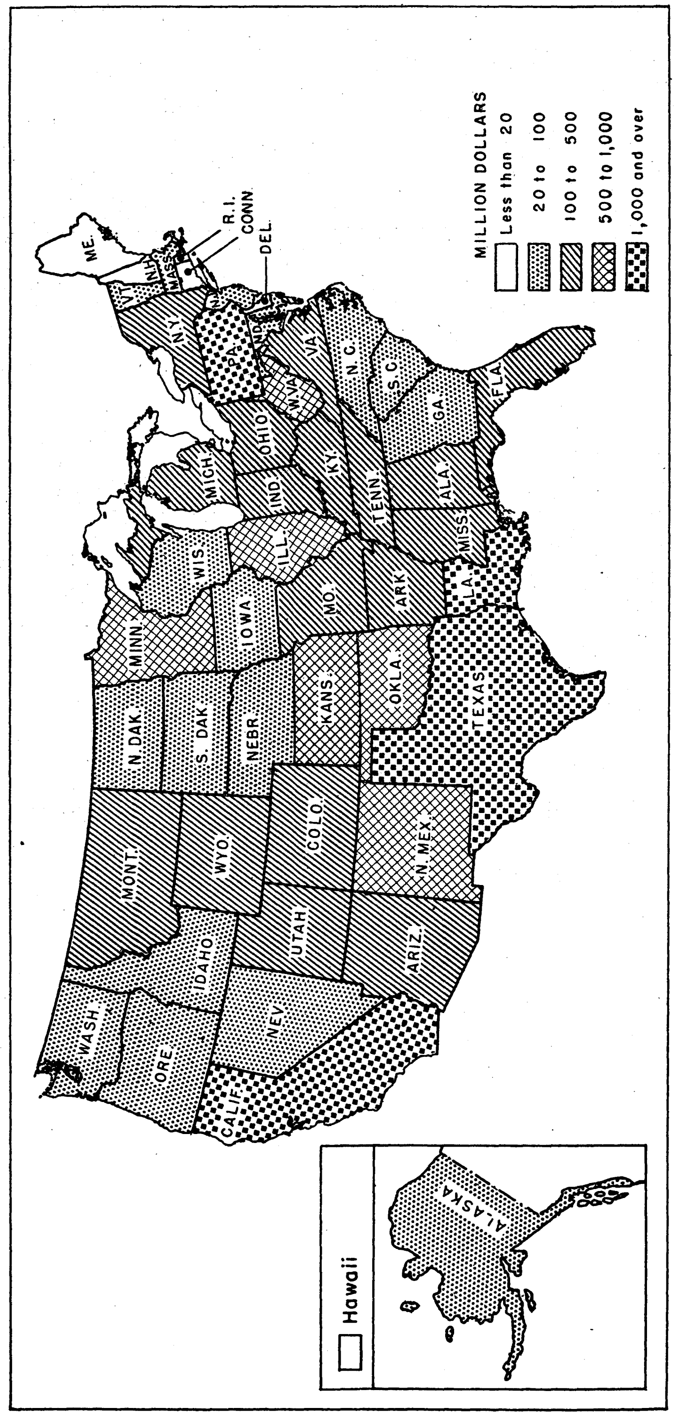

FIGURE 2.—Value of mineral production in the United States (including Alaska and Hawaii), 1957, by States.

TABLE 4.—Value of mineral production in the United States,[1] 1954–57, by States, in thousand dollars, and principal minerals produced in 1957

State	1954	1955	1956	1957			
				Value	Rank	Percent of U. S. total	Principal minerals in order of value
Alabama	154,639	186,453	189,186	209,422	20	1.16	Coal, iron ore, cement, stone.
Alaska	24,408	25,412	23,408	28,792	41	.16	Sand and gravel, gold, coal, stone.
Arizona	254,479	378,277	484,959	372,644	14	2.06	Copper, sand and gravel, cement, zinc.
Arkansas	131,745	132,822	135,210	140,939	25	.78	Petroleum, bauxite, stone, sand and gravel.
California	1,429,539	1,456,682	1,551,413	1,650,855	2	9.11	Petroleum, cement, natural gas, natural-gas liquids.
Colorado	255,852	286,219	321,914	340,638	17	1.88	Petroleum, molybdenum, coal, uranium ore.
Connecticut	9,581	10,428	11,737	16,055	45	.09	Stone, sand and gravel, lime, clays.
Delaware	947	1,658	1,232	1,042	50	(1)	Sand and gravel, stone, clays.
Florida	106,510	108,957	140,490	136,026	26	.75	Phosphate rock, stone, cement, titanium concentrate.
Georgia	55,828	60,417	67,912	69,799	31	.38	Clays, stone, cement, barite.
Hawaii	3,596	3,592	6,972	5,930	47	.03	Stone, sand and gravel, pumice, lime.
Idaho	69,689	68,513	75,150	73,464	30	.40	Lead, silver, zinc, phosphate rock.
Illinois	473,077	533,062	572,321	579,584	8	3.20	Petroleum, coal, stone, sand and gravel.
Indiana	165,369	183,479	196,753	198,942	21	1.10	Coal, cement, petroleum, stone.
Iowa	58,798	63,555	66,529	68,985	32	.38	Cement, stone, sand and gravel, coal.
Kansas	449,587	470,830	493,770	505,084	10	2.79	Petroleum, natural gas, cement, stone.
Kentucky	327,503	391,068	443,168	450,354	11	2.48	Coal, petroleum, natural gas, stone.
Louisiana	998,057	1,156,637	1,288,331	1,524,928	3	8.41	Petroleum, natural gas, natural-gas liquids, sulfur.
Maine	10,716	12,991	12,728	12,711	46	.07	Cement, stone, sand and gravel, slate.
Maryland	30,741	35,488	40,534	39,607	39	.22	Stone, sand and gravel, cement, coal.
Massachusetts	18,851	22,109	25,085	24,789	42	.14	Stone, sand and gravel, lime, clays.
Michigan	279,935	363,778	394,556	404,377	12	2.23	Iron ore, cement, salt, copper.
Minnesota	351,474	501,151	501,027	584,501	7	3.22	Iron ore, sand and gravel, stone, cement.
Mississippi	110,563	122,620	133,098	149,305	24	.82	Petroleum, natural gas, sand and gravel, cement.
Missouri	131,280	151,626	163,693	152,879	23	.84	Lead, cement, stone, lime.
Montana	126,412	166,993	213,781	191,728	22	1.06	Petroleum, copper, zinc, sand and gravel.
Nebraska	42,393	54,237	71,311	83,290	29	.46	Petroleum, cement, sand and gravel, stone.
Nevada	89,138	113,220	126,681	86,023	28	.47	Copper, manganese ore, iron ore, sand and gravel.
New Hampshire	2,112	2,605	3,436	3,331	48	.02	Sand and gravel, mica, feldspar, stone.
New Jersey	47,044	57,495	64,279	64,937	34	.36	Stone, sand and gravel, iron ore, magnesium compounds.
New Mexico	374,690	438,692	515,009	553,034	9	3.05	Petroleum, potassium salts, natural gas, copper.
New York	192,738	216,907	237,016	244,349	18	1.35	Cement, iron ore, stone, salt.
North Carolina	41,651	41,210	40,873	37,570	40	.21	Stone, sand and gravel, mica, feldspar.
North Dakota	22,223	44,123	53,555	57,796	36	.32	Petroleum, coal, sand and gravel, natural-gas liquids.
Ohio	293,659	340,457	375,488	385,858	13	2.13	Coal, stone, cement, lime.

Oklahoma	650, 205	711, 089	757, 120	803, 937	6	4. 44	Petroleum, natural gas, natural-gas liquids, coal.
Oregon	32, 268	31, 736	34, 021	42, 480	37	. 23	Sand and gravel, stone, cement, nickel.
Pennsylvania	925, 545	969, 910	1, 088, 867	1, 082, 093	4	5. 97	Coal, cement, stone, petroleum.
Rhode Island	1, 461	1, 834	1, 627	1, 369	49	. 01	Sand and gravel, stone, graphite.
South Carolina	17, 744	20, 197	21, 342	22, 168	43	. 12	Cement, stone, clays, sand and gravel.
South Dakota	37, 874	40, 526	42, 281	39, 990	38	. 22	Gold, sand and gravel, stone, cement.
Tennessee	105, 686	119, 316	137, 846	128, 738	27	. 71	Coal, stone, cement, zinc.
Texas	3, 730, 705	3, 993, 310	4, 245, 123	4, 497, 264	1	24. 81	Petroleum, natural gas, natural-gas liquids, sulfur.
Utah	255, 550	332, 002	399, 759	356, 213	15	1. 97	Copper, coal, iron ore, uranium.
Vermont	20, 483	23, 884	23, 131	21, 893	44	. 12	Stone, asbestos, slate, copper.
Virginia	129, 603	172, 541	208, 806	224, 531	19	1. 24	Coal, stone, cement, sand and gravel.
Washington	53, 300	67, 334	61, 723	58, 690	35	. 32	Sand and gravel, cement, stone, zinc.
West Virginia	636, 311	755, 512	935, 074	982, 719	5	5. 42	Coal, natural gas, stone, cement.
Wisconsin	54, 286	65, 813	65, 860	68, 644	33	. 38	Stone, sand and gravel, iron ore, cement.
Wyoming	281, 306	297, 752	317, 594	345, 604	16	1. 91	Petroleum, clays, sodium carbonate, natural gas.
Total	14, 067, 000	15, 807, 000	17, 381, 000	18, 126, 000	--------	100. 00	Petroleum, coal, natural gas, cement.

[1]Less than 1 percent.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
ALABAMA								
Cement [3] ....thousand 376-pound barrels..	11, 122	$28, 583	13, 721	$38, 350	14. 065	$41, 840	13, 000	$40, 279
Clays........thousand short tons..	1, 331	2, 258	(4)	(4)	[5] 1, 594	[5] 2, 147	[5] 1, 316	[5] 1, 504
Coal........do....	10, 283	67, 338	13, 088	79. 337	12, 663	79, 322	13. 260	86, 114
Iron ore (usable)........thousand long tons, gross weight..	5, 913	33, 327	6, 814	44. 657	5, 633	34, 824	6, 223	40. 518
Lime........thousand short tons..	422	4, 488	462	5, 186	466	5, 089	554	6, 271
Mica (sheet)........	(4)	(4)	(4)	(4)	1, 122	7	(4)	(4)
Natural gas........million cubic feet..	87	5	282	20	42	3	[6] 50	[6] 4
Petroleum (crude)........thousand 42-gallon barrels..	1, 584	3, 690	1, 411	2. 910	3, 069	7, 335	(4)	(4)
Sand and gravel........thousand short tons..	3, 966	3, 451	3, 680	3, 524	4, 999	4, 621	5, 065	4, 883
Stone........do....	7, 394	11, 609	8, 269	11, 867	[7] 12, 343	[7] 14, 702	[7] 9, 519	[7] 11, 972
Talc........	....	....	1, 500	8	2, 200	5	1, 600	3
Value of items that cannot be disclosed: Native asphalt, bauxite, pozzolan cement (1954–56), slag cement (1957), clays (kaolin, 1956–57), scrap mica, salt, stone (dimension limestone and marble, shell, 1957), and values indicated by footnote [4]........	....	4, 856	....	4, 325	....	4, 083	....	23, 225
Total Alabama [8]........	....	154, 639	....	186, 453	....	189, 186	....	209, 422
ALASKA								
Antimony ore and concentrate........antimony content..	....	....	....	....	28	(4)	17	(4)
Chromite........gross weight..	2, 953	208	7, 082	625	7, 193	711	4, 207	431
Clays........thousand short tons..	(4)	(4)	1	4	....	....	....	....
Coal........do....	667	6, 442	640	5, 759	727	6, 374	842	7, 296
Copper (recoverable content of ores, etc.)........	4	2	1	1	....	....	(9)	(10)
Gold (recoverable content of ores, etc.)........troy ounces..	248, 511	8, 698	249, 294	8, 725	209, 296	7, 325	215, 467	7, 541
Lead (recoverable content of ores, etc.)........	....	....	1	(10)	1	(10)	9	3
Mercury........76-pound flasks..	1, 046	277	(4)	(4)	3, 280	853	5, 461	1, 349
Sand and gravel........thousand short tons..	6, 640	6, 302	9, 793	8, 242	5, 955	5, 880	6, 096	8, 799
Silver (recoverable content of ores, etc.)........thousand troy ounces..	34	31	34	31	28	26	29	26
Stone........thousand short tons..	284	466	266	290	195	595	528	1, 953
Tin (content of concentrate)........long tons..	199	410	86	183	....	....	....	....
Value of items that cannot be disclosed: Gem stones (1954, 1956–57), platinum-group metals, uranium ore (1957), and values indicated by footnote 4........	....	1, 572	....	1, 552	....	1, 644	....	1, 394
Total Alaska........	....	24. 408	....	25. 412	....	23, 408	....	28, 792
ARIZONA								
Beryllium concentrate........gross weight..	(4)	(4)	(4)	(4)	6	3	5	2
Clays........thousand short tons..	254	814	254	869	[5] 112	[5] 168	[5] 118	[5] 177
Columbium-tantalum concentrate........pounds..	....	....	(4)	(4)	....	....	2, 435	7

Coal .... thousand short tons	11	68	9	59	10	66	9	62
Copper (recoverable content of ores, etc.)	377,927	222,977	454,105	338,762	505,908	430,022	515,854	310,544
Gem stones	(11)	(4)	(11)	97	(11)	104	(11)	75
Gold (recoverable content of ores, etc.) .... troy ounces	114,809	4,018	127,616	4,467	146,110	5,114	152,449	5,336
Gypsum .... thousand short tons	(4)	(4)	(4)	(4)	96	366	(4)	(4)
Lead (recoverable content of ores, etc.)	8,385	2,297	9,817	2,925	11,999	3,768	12,441	3,558
Lime .... thousand short tons	89	1,131	112	1,438	127	1,756	138	2,127
Manganese ore (35 percent or more Mn) .... gross weight	------	------	1,444	(4)	42,088	3,468	79,505	6,626
Mercury .... 76-pound flasks	163	43	477	138	(4)	(4)	28	7
Mica (scrap)	1,682	18	1,353	9	------	------	1,650	17
Molybdenum (content of concentrate) .... thousand pounds	1,538	1,525	1,497	1,511	2,392	2,670	2,385	3,071
Natural gas .... million cubic feet	------	------	(4)	(4)	21	3	[6] 22	[6] 3
Perlite	1,296	7	10,568	84	15,928	108	15,646	114
Pumice .... thousand short tons	81	126	92	373	115	366	397	640
Sand and gravel .... do	3,764	3,067	7,755	6,519	7,932	6,167	10,287	9,222
Silver (recoverable content of ores, etc.) .... thousand troy ounces	4,299	3,891	4,634	4,194	5,179	4,687	5,279	4,778
Stone .... thousand short tons	1,205	1,914	1,601	2,329	1,623	2,474	2,101	2,982
Tungsten concentrate .... 60-percent WO_3 basis	132	457	181	676	186	637	5	9
Uranium ore	------	------	------	------	274,505	5,408	286,037	6,277
Zinc (recoverable content of ores, etc.)	21,461	4,636	22,684	5,580	25,580	7,009	33,905	7,866
Value of items that cannot be disclosed: Asbestos, barite (1954–55), cement, clays (bentonite, 1955–56), diatomite (1954–55), feldspar, fluorspar (1954–1957), nitrogen compounds (1957), pyrites (1957), rare-earth metals concentrates (1955), vanadium, vermiculite (1954), and values indicated by footnote 4	------	8,172	------	9,201	------	[12] 11,701	------	10,441
Total Arizona [8]	------	254,479	------	378,277	------	[12] 484,959	------	372,644

ARKANSAS

Abrasive stones (whetstones)	(4)	(4)	(4)	(4)	35	11	------	------
Barite	370,621	3,489	462,986	3,755	486,254	4,256	477,327	3,494
Bauxite .... long tons, dried equivalent	1,949,368	15,994	1,721,243	14,026	1,668,432	13,307	1,356,898	11,600
Clays .... thousand short tons	617	2,556	739	2,376	719	1,636	617	1,586
Coal .... do	477	3,589	578	4,319	590	4,601	508	3,976
Gem stones	------	------	(11)	4	(11)	25	(11)	(4)
Iron ore (usable) .... thousand long tons, gross weight	(9)	(4)	------	------	(4)	(4)	7	35
Manganese ore (35 percent or more Mn) .... gross weight	13,728	1,021	23,744	1,727	29,485	2,066	23,261	1,726
Natural gas .... million cubic feet	33,471	1,841	32,123	1,799	30,162	1,810	[6] 36,200	[6] 2,500
Natural-gas liquids:								
Natural gasoline and cycle products .... thousand gallons	50,778	3,234	47,483	3,239	41,529	2,541	39,869	2,313
LP-gases .... do	58,506	2,521	57,088	2,169	56,146	2,293	54,034	2,097
Petroleum (crude) .... thousand 42-gallon barrels	29,130	79,520	28,369	76,880	29,355	78,965	[6] 30,597	[6] 89,343
Sand and gravel .... thousand short tons	6,612	6,567	9,003	7,663	10,200	8,730	8,599	6,949
Slate .... do	42	379	(4)	(4)	(4)	(4)	(4)	(4)
Stone .... do	4,604	5,930	6,176	8,026	6,325	8,113	7,278	8,378
Value of items that cannot be disclosed: Abrasive stones (oilstones), bromine (1957), cement, gypsum, lime, soapstone, recovered elemental sulfur, and values indicated by footnote 4	------	5,742	------	7,616	------	8,182		8,014
Total Arkansas [8]	------	131,745	------	132,822	------	135,210	------	140,939

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

CALIFORNIA

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Boron minerals	790,449	$26,714	924,496	$33,817	[12] 568,087	[12] $35,722	597,857	$40,817
Cement ... thousand 376-pound barrels	32,762	98,251	35,087	103,804	39,290	120,511	[13] 37,731	[13] 117,852
Chromite ... gross weight	30,661	2,285	22,105	1,834	27,082	2,192	34,901	2,789
Clays ... thousand short tons	2,723	4,477	2,860	5,027	2,982	6,137	2,729	5,764
Coal (lignite) ... do	(4)	(4)	8	77	12	120	(4)	(4)
Copper (recoverable content of ores, etc.)	362	214	613	457	859	730	945	569
Feldspar ... long tons	(4)	(4)	(4)	(4)	241,160	1,265	181,613	1,086
Gem stones	(11)	(4)	(11)	(4)	(11)	90	(11)	100
Gold (recoverable content of ores, etc.) ... troy ounces	237,886	8,326	251,737	8,811	193,816	6,784	170,885	5,981
Gypsum ... thousand short tons	1,162	2,804	1,308	3,274	1,399	3,402	1,268	2,995
Iron ore (usable) ... thousand long tons, gross weight	1,270	(4)	1,777	(4)	2,414	(4)	(4)	(4)
Lead (recoverable content of ores, etc.)	2,671	732	8,265	2,463	9,296	2,919	3,458	989
Lime ... thousand short tons	212	3,388	268	4,373	302	5,078	325	5,408
Magnesium compounds from sea water and bitterns (partly estimated) MgO equivalent	40,969	2,716	58,042	3,833	66,007	4,532	74,558	5,315
Manganese ore (35 percent or more Mn) ... gross weight	831	45	3,136	271	6,595	595	9,009	802
Mercury ... 76-pound flasks	11,262	2,978	9,875	2,867	9,017	2,344	[19] 16,511	[19] 4,078
Natural gas ... million cubic feet	507,289	104,502	538,178	119,476	504,458	113,503	[6] 502,572	[6] 114,416
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	923,160	89,293	929,649	89,003	876,902	84,615	843,378	81,355
LP-gases ... do	396,186	22,262	360,902	19,379	410,232	21,332	390,743	20,421
Peat	(4)	(4)	(4)	(4)	18,918	215	35,916	424
Perlite	14,811	103	15,653	125	15,119	135	15,109	113
Petroleum (crude) ... thousand 42-gallon barrels	355,865	907,460	354,812	887,030	350,754	918,975	[6] 339,646	[6] 1,035,920
Pumice ... thousand short tons	567	652	797	1,099	634	2,334	459	1,510
Salt (common) ... do	1,186	6,126	1,315	6,751	1,444	7,606	1,330	8,721
Sand and gravel ... do	70,525	68,139	64,879	66,820	[12] 86,447	[12] 96,526	79,024	87,030
Silver (recoverable content of ores, etc.) ... thousand troy ounces	310	280	954	864	938	849	522	473
Stone ... thousand short tons	23,304	37,541	24,708	37,164	32,583	46,109	41,351	53,591
Strontium minerals	12	(10)	177	4	(4)	(4)	(4)	(10)
Sulfur ore ... long tons	185,085	(4)	199,599	(4)	(4)	(4)	(4)	(4)
Recovered elemental sulfur	(4)	(4)	(4)	(4)	(4)	(4)	80,906	2,709
Talc, pyrophyllite and soapstone	133,474	1,211	166,551	1,553	153,710	1,419	133,915	1,526
Tungsten concentrate ... 60-percent WO_3 basis	3,512	13,209	4,383	16,201	3,719	13,449	1,750	2,735
Zinc (recoverable content of ores, etc.)	1,415	306	6,836	1,682	8,049	2,205	2,969	689
Value of items that cannot be disclosed: Asbestos, barite, bromine, calcium-magnesium chloride, carbon dioxide, masonry cement (1956–57), clay (kaolin 1957), diatomite, fluorspar (1957), abrasive garnet (1954–56),								

Iodine, lithium minerals (1954), magnesite (1954-56), mica, molybdenum, platinum-group metals (crude), potassium salts, pyrites, rare-earth metals concentrates, slate, sodium carbonate and sulfate, titanium iron concentrate (nontitanium use, 1954-55), uranium ore (1956-57), and values indicated by footnote 4	------------	[12] 43, 650	------------	[12] 55, 858	------------	[12] 68, 030	------------	62, 188
Total California [8]	------------	[12] 1, 429, 539	------------	[12] 1, 456, 682	------------	[12] 1, 551, 413	------------	1, 650, 855

COLORADO

Beryllium concentrate ... gross weight	60	27	46	23	179	94	182	91
Clays ... thousand short tons	855	1, 003	464	1, 118	523	1, 215	403	978
Coal ... do	2, 900	16, 079	3, 568	20, 100	3, 502	19, 832	3, 594	21, 831
Columbium-tantalum concentrate ... pounds	4, 967	10	4, 325	7	52	(10)	103	(10)
Copper (recoverable content of ores, etc.)	4, 523	2, 669	4, 323	3, 225	4, 228	3, 594	5, 115	3, 079
Feldspar ... long tons	(4)	(4)	46, 114	314	47, 014	327	43, 818	307
Fluorspar	59, 197	3, 197	(4)	(4)	(4)	(4)	(4)	(4)
Gem stones	(11)	(4)	(11)	48	(11)	30	(11)	35
Gold (recoverable content of ores, etc.) ... troy ounces	96, 146	3, 365	88, 577	3, 100	97, 668	3, 418	87, 928	3, 078
Gypsum ... thousand short tons	65	253	77	329	88	353	(4)	(4)
Iron ore (usable) ... thousand long tons, gross weight	6	(4)	4	(4)	(4)	(4)	(4)	(4)
Lead (recoverable content of ores, etc.)	17, 823	4, 883	15, 805	4, 710	19, 856	6, 235	21, 003	6, 007
Lime ... thousand short tons	------------	------------	------------	------------	------------	------------	2	45
Manganese ore (35 percent or more Mn) ... gross weight	------------	------------	------------	------------	------------	------------	175	14
Mica: Scrap	(4)	(4)	699	13	517	7	312	6
Sheet ... pounds	------------	------------	------------	------------	8	(10)	14	(10)
Molybdenum ... thousand pounds	42, 545	(4)	45, 837	(4)	(4)	(4)	(4)	(4)
Natural gas ... million cubic feet	45, 705	3, 976	49, 152	4, 866	54, 205	5, 312	[6] 119, 500	[6] 12, 000
Peat	9, 028	(4)	------------	------------	------------	------------	3, 559	(4)
Petroleum (crude) ... thousand 42-gallon barrels	46, 206	127, 990	52, 653	144, 800	58, 516	162, 674	[6] 54, 867	[6] 165, 698
Pumice ... thousand short tons	(4)	(4)	71	163	50	109	25	53
Pyrites ... thousand long tons	(4)	(4)	(4)	(4)	(4)	(4)	62	(4)
Rare-earth metals concentrates	------------	------------	(4)	(4)	16	23	577	20
Salt ... thousand short tons	------------	------------	4	17	4	18	(4)	(4)
Sand and gravel ... do	13, 552	9, 027	12, 912	8, 915	15, 152	11, 082	16, 400	13, 994
Silver (recoverable content of ores, etc.) ... thousand troy ounces	3, 417	3, 093	2, 772	2, 509	2, 285	2, 068	2, 788	2, 523
Stone ... thousand short sons	1, 804	2, 112	2, 149	3, 508	2, 250	5, 217	2, 438	4, 168
Tungsten concentrate ... 60-percent WO_3 basis	927	3, 421	1, 152	4, 079	873	3, 010	45	55
Uranium ore	------------	------------	------------	------------	[12] 496, 517	[12] 12, 410	740, 055	15, 605
Vanadium ... thousand pounds	4, 528	(4)	4, 595	(4)	5, 582	(4)	6, 264	(4)
Zinc (recoverable content of ores, etc.)	35, 150	7, 592	35, 350	8, 696	40, 246	11, 027	47, 000	10, 904
Value of items that cannot be disclosed: Carbon dioxide, cement, iron-oxide pigments (1957), lithium minerals (1954), natural-gas liquids, perlite, tin (1954-55), vermiculite (1954), and values indicated by footnote 4	------------	67, 874	------------	76, 969	------------	[12] 75, 632	------------	81, 918
Total Colorado [8]	------------	255, 852	------------	286, 219	------------	[12] 321, 914	------------	340, 638

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

CONNECTICUT

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Beryllium concentrate ... gross weight	13	8	5	3	(4)	(4)	(4)	(4)
Clays ... thousand short tons	289	285	325	315	338	390	308	409
Feldspar ... long tons	9,280	60	(4)	(4)	(4)	(4)	(4)	(4)
Lime ... thousand short tons	(4)	(4)	35	503	40	609	30	503
Mica (sheet and scrap)	(4)	(4)	3	13	[14] 310	[14] 2	(4)	(4)
Peat	5,856	24	(4)	(4)	[12] 3,190	[12] 13	2,004	11
Sand and gravel ... thousand short tons	4,846	4,315	4,345	4,080	4,369	4,101	4,777	5,042
Stone ... do	2,829	4,269	3,642	5,451	[7] 4,428	[7] 6,590	6,199	10,040
Value of items that cannot be disclosed: Columbium-tantalum concentrate (1954–55), gem stones (1957), stone (crushed granite and dimension limestone 1955, dimension limestone, 1956) and values indicated by footnote 4	----------	725	----------	123	----------	124	----------	119
Total Connecticut [8]	----------	9,581	----------	10,428	----------	[12] 11,737	----------	16,055

DELAWARE

Mineral	1954 Short tons	1954 Value	1955 Short tons	1955 Value	1956 Short tons	1956 Value	1957 Short tons	1957 Value
Sand and gravel ... thousand short tons	972	752	2,297	1,407	1,160	967	974	860
Stone ... do	(4)	(4)	79	228	83	232	(4)	(4)
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4	----------	195	----------	23	----------	33	----------	182
Total Delaware	----------	947	----------	1,658	----------	1,232	----------	1,042

FLORIDA

Mineral	1954 Short tons	1954 Value	1955 Short tons	1955 Value	1956 Short tons	1956 Value	1957 Short tons	1957 Value
Clays ... thousand short tons	372	$3,337	413	$4,816	432	$5,826	422	$6,067
Lime ... do	(4)	(4)	(4)	(4)	40	490	(4)	(4)
Natural gas ... million cubic feet	35	3	36	4	35	3	[6] 40	[6] 3
Peat	37,449	168	61,098	232	58,496	203	37,844	195
Petroleum (crude) ... thousand 42-gallon barrels	548	(4)	495	(4)	(4)	(4)	(4)	(4)
Phosphate rock ... thousand long tons	10.437	64,500	8,747	53,640	11,822	74,290	10,191	64,789
Sand and gravel ... thousand short tons	3,469	2.661	5,066	4,349	5,815	5,034	6,753	6,148
Stone ... do	[7] 14,225	[7] 16,832	[7] 17,028	[7] 22,966	18,779	25,183	21,786	30,467

Titanium concentrate:								
Ilmenite ---- gross weight	157,157	2,412	(4)	(4)	(4)	(4)	(4)	(4)
Rutile ---- do	7,305	869	9,182	1,122	(4)	(4)	(4)	(4)
Zirconium concentrate	17,959	820	28,913	1,425	43,794	2,160	56,802	1,976
Value of items that cannot be disclosed: Cement, abrasive garnet (1954–56), gem stones (1956), rare-earth metals concentrates (1956–57), staurolite (1957), stone (dimension limestone, (1954–55)), and values indicated by footnote 4	----	15,956	----	22,787	----	28,452	----	28,718
Total Florida [8]	----	106,510	----	108,957	----	140,490	----	136,026
GEORGIA								
Clays ---- thousand short tons	2,711	24,107	2,953	26,145	3,047	29,501	2,707	30,120
Coal ---- do	8	41	12	62	8	42	13	63
Iron ore (usable) ---- thousand long tons, gross weight	222	872	257	994	357	1,609	443	2,109
Iron oxide pigments	(4)	(4)	6,139	36	(4)	(4)	(4)	(4)
Manganiferous ore (5 to 35 percent Mn) ---- gross weight	----	----	(4)	(4)	(4)	(4)	2,203	(4)
Mica (sheet) ---- pounds	(4)	(4)	(4)	(4)	20,149	150	16,933	158
Peat	5,150	61	(4)	(4)	6,225	48	4,690	45
Sand and gravel ---- thousand short tons	2,703	2,466	2,988	2,199	2,426	2,183	2,127	2,096
Stone ---- do	8,058	21,384	[7] 7,488	[7] 14,250	[7] 9,196	[7] 20,714	[7] 9,065	[7] 15,833
Talc and soapstone	50,536	177	53,828	118	57,916	122	49,372	106
Value of items that cannot be disclosed: Asbestos (1954), barite, bauxite (1955–57), beryllium concentrate, cement, feldspar, gem stones (1955–57), lime (1954), manganese ore, scrap mica, slate, stone (dimension and crushed marble and crushed sandstone, 1955: crushed marble and crushed sandstone, 1956; dimension and crushed marble and crushed sandstone, 1957), and minerals indicated by footnote 4	----	7,481	----	17,495	----	14,558	----	20,081
Total Georgia [8]	----	55,828	----	60,417	----	67,912	----	69,799
HAWAII								
Clays ---- thousand short tons	(4)	(4)	(4)	(4)	2	2	2	3
Lime ---- do	8	251	6	202	10	306	8	271
Pumice ---- do	(4)	(4)	130	76	59	92	266	493
Salt ---- do	(4)	(4)	(4)	(4)	(9)	18	(9)	15
Sand and gravel ---- do	119	319	165	426	193	503	286	538
Stone ---- do	1,485	2,993	1,414	2,884	3,494	6,076	2,585	4,632
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 4	----	59	----	22	----	----	----	----
Total Hawaii [15]	----	3,596	----	3,592	----	6,972	----	5,930

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

IDAHO

Mineral	1954		1955		1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
Antimony ore and concentrate......antimony content..	764	(4)	633	(4)	549	(4)	664	(4)
Beryllium concentrate......gross weight..	(4)	(4)					1	(10)
Clays......thousand short tons..	(4)	(4)	35	$30	[5] 23	[5] $13	[5] 23	[5] $16
Cobalt (content of concentrate)......thousand pounds..	1,702	(4)	1,691	(4)	2,385	(4)	2,618	(4)
Columbium-tantalum concentrate......do....			(4)	(4)	215,900	(4)	364,768	(4)
Copper (recoverable content of ores, etc.)......	4,828	$2,848	5,618	4,191	6,656	5,658	7,912	4,763
Gem stones......	(11)	(4)	(11)	(4)	(11)	(4)	(11)	5
Gold (recoverable content of ores, etc.)......troy ounces..	13,245	463	10,572	370	[12] 9,210	[12] 322	12,301	431
Iron ore (usable)......thousand long tons..					1	(4)	(4)	(4)
Lead (recoverable content of ores, etc.)......	60,302	18,989	64,163	19,121	64,321	20,197	71,637	20,488
Mercury......76-pound flasks..	609	161	1,107	321	3,394	882	2,260	558
Nickel (content of ore and concentrate)......	13	(4)	33	(4)	49	(4)	37	55
Peat......	500	(4)	(4)	(4)			(4)	(4)
Phosphate rock......thousand long tons..	1,093	5,687	1,330	6,038	1,438	6,539	1,307	5,684
Pumice......thousand short tons..	(4)	(4)	(4)	(4)	102	206	100	168
Rare-earth metals concentrates......			(4)	(4)	303	(4)	366	(4)
Sand and gravel......thousand short tons..	6,718	4,569	8,652	3,934	7,874	5,661	6,601	5,236
Silver (recoverable content of ores, etc.)......thousand troy ounces..	15,867	14,361	13,831	12,518	13,472	12,193	15,067	13,637
Stone......thousand short tons..	2,329	3,013	1,525	1,866	1,791	2,752	1.542	2,759
Titanium concentrate......gross weight..			1,330	7	48,619	261	28,397	(4)
Tungsten concentrate......60-percent WO_3 basis..	471	(4)	642	(4)	582	(4)	35	(4)
Zinc (recoverable content of ores, etc.)......	61,528	13,290	53,314	13,115	49,561	13,580	57,831	13,417
Value of items that cannot be disclosed: Barite, cement, fire clay (1956–57), abrasive garnet, fluorspar (1955), scrap mica (1954), sheet mica (1954–55, 1957), stone (crushed limestone 1955), uranium ore (1957), vanadium (1954), and values indicated by footnote 4......		[15] 6,308		[15] 7,002		[15] 6,885		[15] 6,247
Total Idaho......		69,689		68,513		[12] 75,150		73,464

ILLINOIS

Mineral	1954		1955		1956		1957	
Cement......thousand 376-pound barrels..	9,109	23,148	9,397	25,032	9,301	27,264	8,575	26,356
Clays......thousand short tons..	2,027	3,482	2,339	3,979	2,258	4,005	1,917	5,155
Coal......do....	41,971	160,213	45,932	167,938	48,102	184,678	46,993	187,908
Fluorspar......	107,830	5,989	166,337	7,838	178,254	8,470	169,939	8,827
Gem stones......							(11)	2
Lead (recoverable content of ores, etc.)......	3,232	886	4,544	1,354	3,832	1,203	2,970	849

Lime ... thousand short tons	532	7,421	644	9,416	(4)	(4)	(4)	(4)
Natural gas ... million cubic feet	9,475	1,345	8,033	1,036	6,177	933	[6] 8,500	[6] 1,000
Peat	(4)	(4)	(4)	(4)	14,451	158	11,480	106
Petroleum (crude) ... thousand 42-gallon barrels	66,798	199,060	81,423	236,940	82,346	241,274	[6] 78,278	[6] 244,227
Sand and gravel ... thousand short tons	24,443	26,164	26,362	28,139	31,239	33,254	30,151	32,572
Silver (recoverable content of ores, etc.) ... thousand troy ounces	1	1	3	3	2	1	------	------
Stone ... thousand short tons	26,407	31,134	28,866	35,621	31,855	40,859	31,861	41,835
Zinc (recoverable content of ores, etc.)	14,427	3,116	21,700	5,338	24,039	6,587	22,185	5,147
Value of items that cannot be disclosed: Iron oxide pigments (1954), natural-gas liquids, recovered elemental sulfur, tripoli, and values indicated by footnote 4	------	13,061	------	12,666	------	26,048	------	27,925
Total Illinois [8]	------	473,077	------	533,062	------	572,321	------	579,584
INDIANA								
Abrasive stones	(4)	(4)	(4)	(4)	3	5	4	8
Clays ... thousand short tons	1,946	2,991	1,729	2,938	2,051	3,457	1,475	2,569
Coal ... do	13,400	48,913	16,149	58,000	17,089	64,061	15,841	62,055
Lime ... do	(4)	(4)	(4)	(4)	(9)	1	------	------
Marl, calcareous (except for cement)	28,536	19	17,080	10	99,561	66	(16)	(16)
Natural gas ... million cubic feet	735	44	1,226	152	791	96	[6] 600	[6] 80
Peat	(4)	(4)	(4)	(4)	11,383	79	13,805	130
Petroleum (crude) ... thousand 42-gallon barrels	11,204	33,160	10,988	31,980	11,513	33,733	[6] 12,859	[6] 40,249
Sand and gravel ... thousand short tons	14,405	11,879	17,082	14,306	[19] 18,302	[19] 15,432	16,750	14,206
Stone ... do	11,182	27,460	14,124	34,680	14,700	31,575	14,460	33,094
Value of items that cannot be disclosed: Cement, gypsum (1955-57), recovered elemental sulfur, and values indicated by footnote 4	------	42,448	------	43,888	------	50,598	------	48,716
Total Indiana [8]	------	165,369	------	183,479	------	[12] 196,753	------	198,942
IOWA								
Cement ... thousand 376-pound barrels	9,859	27,044	10,430	29,539	10,760	32,823	10,823	34,881
Clays ... thousand short tons	883	921	(4)	(4)	[5] 852	[5] 1,078	[5] 752	[5] 944
Coal ... do	1,197	4,503	1,258	4,402	1,358	4,732	1,312	4,543
Gypsum ... do	1,107	3,036	1,337	4,177	1,177	3,919	1,123	3,773
Lead (recoverable content of ores, etc.)	4	1	------	------	------	------	------	------
Peat	(4)	(4)	(4)	(4)	27,375	(4)	(4)	(4)
Sand and gravel ... thousand short tons	12,200	9,276	11,771	8,345	12,895	9,525	12,042	8,927
Stone ... do	13,240	16,388	15,705	18,555	14,035	17,256	15,214	18,768
Value of items that cannot be disclosed: Nonmetals and minerals indicated by footnote 4	------	251	------	1,252	------	467	------	614
Total Iowa [8]	------	58,798	------	63,555	------	66,529	------	68,985

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

KANSAS

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Cement [17] ... thousand 376-pound barrels	9,076	$23,874	9,454	$25,854	10,598	$30,696	8,178	$24,814
Clays ... thousand short tons	(4)	(4)	[5] 768	[5] 873	977	1,169	909	1,240
Coal ... do	1,372	5,603	742	3,166	884	3,856	749	3,331
Helium ... thousand cubic feet	37,530	593	42,750	663	45,035	698	36,743	570
Lead (recoverable content of ores, etc.)	4,033	1,105	5,498	1,638	7,635	2,398	4,257	1,217
Natural gas ... million cubic feet	412,369	43,711	471,041	52,286	526,091	59,448	[6] 580,700	[6] 66,200
Natural-gas liquids:								
Natural gasoline ... thousand gallons	(4)	(4)	118,599	6,318	105,482	5,928	119,247	6,569
LP-gases ... do	(4)	(4)	92,596	2,643	90,287	3,843	103,494	4,042
Petroleum (crude) ... thousand 42-gallon barrels	119,317	335,280	121,669	340,670	124,204	346,529	[6] 121,705	[6] 366,332
Pumice ... thousand short tons	23	93	2	60	(4)	(4)	(4)	(4)
Salt (common) ... do	877	7,779	911	8,432	1,004	9,167	1,018	10,353
Sand and gravel ... do	10,422	7,194	10,665	6,910	12,515	8,022	9,345	6,175
Stone ... do	10,377	12,942	12,483	15,946	13,434	15,703	[7] 10,412	[7] 11,926
Zinc (recoverable content of ores, etc.)	19,110	4,128	27,611	6,792	28,665	7,854	15,859	3,679
Value of items that cannot be disclosed: Natural cement, fire clay (1955), gypsum, stone (dimension and crushed sandstone, 1957), and values indicated by footnote 4		9,721		1,616		1,465		1,191
Total Kansas [8]		449,587		470,830		493,770		505,084

KENTUCKY

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Clays ... thousand short tons	571	2,995	876	4,416	905	4,079	894	3,915
Coal ... do	56,964	236,737	69,020	288,665	74,555	331,358	74,667	338,109
Fluorspar	35,831	1,510	8,899	308	14,865	608	20,626	979
Lead (recoverable content of ores, etc.)	80	22			228	72	411	118
Natural gas ... million cubic feet	72,713	16,579	73,214	17,352	73,687	17,022	[6] 77,300	[6] 18,100
Natural-gas liquids:								
Natural gasoline ... thousand gallons	28,224	1,552	34,991	2,492	35,275	2,414	34,956	1,935
LP-gases ... do	189,966	5,066	189,247	6,451	248,992	8,709	176,033	7,403
Petroleum (crude) ... thousand 42-gallon barrels	13,791	40,270	15,518	44,850	17,628	51,297	16,879	52,831
Sand and gravel ... thousand short tons	4,730	4,402	4,899	5,298	5,684	5,974	4,482	4,556
Stone ... do	10,130	13,286	11,934	15,579	11,553	15,324	12,718	16,714
Zinc (recoverable content of ores, etc.)	458	99			417	114	837	194
Value of items that cannot be disclosed: Native asphalt, cement, iron ore (1956), silver (1956–57)		5,626		6,446		7,079		6,211
Total Kentucky [8]		327,503		391,068		443,168		450,354

LOUISIANA

Clays [5] ... thousand short tons	714	941	651	659	785	785	642	642
Gypsum ... do	(4)	(4)	335	587	276	598	(4)	(4)
Natural gas ... million cubic feet	1,399,222	124,531	1,680,032	189,844	1,886,302	215,038	[6] 1,943,900	[6] 262,400
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	665,070	54,330	782,328	59,158	773,949	62,394	775,009	63,956
LP-gases ... do	292,226	11,620	291,138	10,323	305,222	14,727	335,142	14,888
Petroleum (crude) ... thousand 42-gallon barrels	246,558	722,370	271,010	793,280	299,421	877,951	[6] 323,199	[6] 1,072,101
Salt (common) ... thousand short tons	3,089	11,101	3,563	15,407	3,704	17,695	3,461	18,944
Sand and gravel ... do	7,910	9,687	8,574	10,942	[12] 15,074	[12] 18,640	12,579	14,730
Stone ... do	2,044	3,127	3,253	4,961	4,405	6,674	4,383	7,152
Sulfur (Frasch-process) ... thousand long tons	1,854	49,222	2,072	58,028	2,239	59,330	2,156	52,690
Value of items that cannot be disclosed: Cement, bentonite, lime, recovered elemental sulfur, and values indicated by footnote 4	...	13,334	...	15,309	...	16,563	...	19,110
Total Louisiana [15]	...	998,057	...	1,156,637	...	[12] 1,288,331	...	1,524,928

MAINE

Beryllium concentrate ... gross weight	(4)	(4)	22	13	12	7	4	2
Cement ... thousand 376-pound barrels	1,973	5,425	2,349	6,875	(4)	(4)	(4)	(4)
Clays ... thousand short tons	27	27	33	33	26	23	30	28
Feldspar ... long tons	(4)	(4)	26,282	189	22,219	144	14,330	92
Gem stones	(11)	(4)	(11)	5	(11)	1	(11)	1
Lime ... thousand short tons	(4)	(4)	(4)	(4)	12	179	(4)	(4)
Mica: Scrap	(4)	(4)	71	2	114	3	6	(10)
Sheet ... pounds	10,320	37	21,121	129	19,913	146	25,453	202
Peat	(4)	(4)	(4)	(4)	(4)	(4)	3,770	175
Sand and gravel ... thousand short tons	7,461	2,538	7,529	2,855	7,196	3,085	8,037	3,099
Stone ... do	1,024	2,356	1,192	2,542	[12] 947	[12] 2,787	889	3,076
Value of items that cannot be disclosed: Columbium-tantalum concentrate (1954–56), slate, and values indicated by footnote 4	...	865	...	857	...	6,912	...	6,617
Total Maine [15]	...	10,716	...	12,991	...	[12] 12,728	...	12,711

MARYLAND

Clays ... thousand short tons	627	1,166	698	1,2	[5] 636	[5] 1,046	[5] 631	[5] 963
Coal ... do	422	1,879	512	2,002	669	2,685	748	3,082
Lime ... do	67	685	74	669	53	581	(4)	(4)
Natural gas ... million cubic feet	1,394	282	3,116	626	4,619	1,169	[6] 4,300	[6] 1,200
Sand and gravel ... thousand short tons	10,098	12,171	9,695	12,211	10,147	12,395	8,679	11,594
Stone ... do	5,065	8,266	[7] 5,343	[7] 8,800	6,229	13,305	6,140	13,392
Value of items that cannot be disclosed: Beryllium concentrate (1954–57), cement, ball clay (1956–57), gem stones (1956–57), greensand marl, mica (1954, 1957), potassium salts, slate (1954–55), stone (oystershell 1955), talc and soapstone, and values indicated by footnote 4	...	[12] 7,287	...	[12] 11,025	...	[12] 10,729	...	10,664
Total Maryland [9]	...	30,741	...	[12] 35,488	...	40,534	...	39,607

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

MASSACHUSETTS

Mineral	1954		1955		1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
Clays……thousand short tons	129	$121	125	$142	128	$213	78	$97
Lime……do	128	1,709	135	1,957	134	2,093	137	2,233
Peat	(4)	(4)	(4)	(4)	300	(4)	600	(4)
Sand and gravel……thousand short tons	9,640	8,366	9,581	8,926	10,189	9,520	9,900	9,691
Stone……do	2,942	9,040	4,128	11,381	5,442	13,753	4,877	13,165
Value of items that cannot be disclosed: Mineral fuels and nonmetals	----	12	----	6	----	3	----	6
Total Massachusetts [15]	----	18,851	----	22,109	----	25,085	----	24,789

MICHIGAN

Mineral	1954		1955		1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
Cement……thousand 376-pound barrels	16,712	45,692	19,738	58,048	21,880	67,798	22,045	71,606
Clays……thousand short tons	1,871	1,919	1,938	2,019	2,110	2,401	1,842	1,982
Copper (recoverable content of ores, etc.)	23,593	13,920	50,066	37,349	61,526	52,297	58,400	35,157
Gypsum……thousand short tons	1,693	5,036	1,762	5,661	1,716	5,861	1,386	4,823
Iron ore (usable)……thousand long tons, gross weight	9,709	70,004	14,144	104,258	12,536	98,111	13,123	111,484
Magnesium compounds from well brines (partly estimated) MgO equivalent	37,038	4,104	46,336	5,064	(4)	(4)	(4)	(4)
Manganiferous ore (5 to 35 percent Mn)……gross weight	15,361	(4)	----	----	----	----	123,547	(4)
Marl, calcareous (except for cement)	106,668	38	119,313	57	157,246	95	(16)	(16)
Natural gas……million cubic feet	6,962	1,239	8,300	955	10,911	1,451	[6] 9,900	[6] 1,300
Peat	(4)	(4)	(4)	(4)	31,111	475	80,271	1,406
Petroleum (crude)……thousand 42-gallon barrels	12,028	35,600	11,266	32,900	10,740	30,824	[6] 10,169	[6] 31,117
Salt (common)……thousand short tons	5,064	29,397	4,975	31,668	5,548	35,644	5,225	41,073
Sand and gravel……do	32,041	25,516	37,214	29,491	42,150	35,146	41,838	35,144
Silver (recoverable content of ores, etc.)……thousand troy ounces	----	----	478	433	380	344	430	389
Stone……thousand short tons	27,758	21,904	33,636	28,909	33,999	31,010	34,495	34,176
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, gem stones (1955–57), lime, magnesium chloride for metal (1954–55), natural-gas liquids, potassium salts, and values indicated by footnote 4	----	[13] 29,267	----	[13] 31,841	----	[13] 38,737	----	40,441
Total Michigan [8]	----	[13] 279,935	----	[13] 363,778	----	[13] 394,556	----	404,377

MINNESOTA

Mineral	1954		1955		1956		1957	
Clays……thousand short tons	(4)	(4)	(4)	(4)	[5] 80	[5] 91	[5] 97	[5] 113
Iron ore (usable)……thousand long tons, gross weight	48,613	319,633	69,419	465,170	62,637	461,904	67,656	541,474

Manganiferous ore (5 to 35 percent Mn)....do....	504,057	(4)	864,628	(4)	633,919	(4)	692,295	(4)
Marl, calcareous (except for cement)....	(4)	(4)	(4)	(4)	875	(4)	(18)	(18)
Peat....	(4)	(4)	(4)	(4)	(4)	(4)	1,300	(4)
Sand and gravel....thousand short tons..	23,849	16,319	25,896	17,429	28,197	18,254	28,493	19,385
Stone[7]....do....	2,629	7,485	3,005	7,043	3,084	7,552	2,968	8,175
Value of items that cannot be disclosed: Abrasive stones, cement, fire clay (1956-57), gem stones (1955-57), lime, manganese ore (1955-57), stone (crushed sandstone, 1954-57, calcareous marl 1957), recovered elemental sulfur (1957), and values indicated by footnote 4....	....	8,204	....	11,739	....	13,443	....	15,571
Total Minnesota[15]....	....	351,474	....	501,151	....	501,027	....	584,501

MISSISSIPPI

Clays....thousand short tons..	559	3,103	701	3,913	613	3,590	616	3,635
Iron ore....thousand long tons..	....	....	....	....	(18)	(10)	(18)	1
Natural gas....million cubic feet..	140,448	11,657	163,167	15,664	185,137	18,143	[6] 182,411	[6] 21,047
Natural-gas liquids:								
Natural gasoline and cycle products....thousand gallons..	27,804	1,944	22,382	1,573	24,829	1,751	25,152	1,469
LP-gases....do....	15,288	528	12,242	396	10,698	580	10,044	472
Petroleum (crude)....thousand 42-gallon barrels	34,240	85,600	37,741	92,840	40,824	100,019	[6] 39,202	[6] 114,078
Sand and gravel....thousand short tons..	5,442	4,287	5,625	4,603	5,315	4,701	5,172	4,344
Stone....do....	181	181	573	573	656	656	[7] 60	[7] 54
Value of items that cannot be disclosed: Certain metals and nonmetals....	....	3,353	....	3,590	....	4,174	....	4,694
Total Mississippi[15]....	....	110,563	....	122,620	....	133,098	....	149,305

MISSOURI

Barite....	312,791	3,047	363,692	4,004	381,642	4,462	317,350	3,938
Cement....thousand 376-pound barrels..	11,379	31,425	[13] 12,255	[13] 34,912	[13] 12,012	[13] 36,888	[13] 10,794	[13] 34,307
Clays....thousand short tons..	1,927	5,859	2,402	6,902	2,658	8,016	2,648	7,648
Coal....do....	2,514	10,028	3,232	12,772	3,283	13,223	2,976	12,691
Copper (recoverable content of ores, etc.)....	1,925	1,136	1,722	1,285	1,890	1,606	[19] 1,604	[19] 966
Iron ore (usable)....thousand long tons, gross wetghi..	173	(4)	261	(4)	365	(4)	530	(4)
Lead (recoverable content of ores, etc.)....	125,250	34,319	125,412	37,373	123,783	38,868	126,345	36,135
Lime....thousand short tons..	1,126	11,165	1,465	14,408	1,482	15,814	1,393	16,475
Natural gas....million cubic feet..	16	(4)	15	3	12	2	....	....
Petroleum (crude)....thousand 42-gallon barrels..	(4)	(4)	72	190	65	176	(4)	(4)
Sand and gravel....thousand short tons..	9,891	10,204	9,984	9,981	9,585	10,117	8,480	8,942
Silver (recoverable content of ores, etc.)....thousand troy ounces..	353	320	269	243	295	267	184	166
Stone....thousand short tons..	18,672	24,752	[7] 22,369	[7] 29,580	24,578	33,577	22,098	29,836
Zinc (recoverable content of ores, etc.)....	5,210	1,125	4,476	1,101	4,380	1,200	2,951	685
Value of items that cannot be disclosed: Native asphalt, masonry cement (1955-57), cobalt (1955-57), gem stones (1957), iron oxide pigment materials (1955-56), manganese ore (1954, 1957), nickel (content of ore, 1955-57), stone (dimension marble 1955), tripoli (1954), and values indicated by footnote 4....	....	2,908	....	4,833	....	5,897	....	7,385
Total Missouri[6]....	....	131,280	....	151,626	....	163,693	....	152,879

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

MONTANA

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Chromite ...gross weight..	123,096	$4,133	118,703	$3,719	118,780	$3,807	119,149	$3,921
Clays ...thousand short tons..	(4)	(4)	(4)	(4)	[5] 33	[5] 31	[5] 32	[5] 24
Coal: Bituminous and lignite ...do....	1,491	4,157	1,247	3,782	846	3,468	413	2,160
Copper (recoverable content of ores, etc.)	59,349	35,016	81,542	60,830	98,426	81,962	91,512	55,090
Fluorspar	15,102	(4)	25,223	(4)	59,775	(4)	64,339	(4)
Gem stones	(11)	(4)	(11)	(4)	(11)	35	(11)	35
Gold (recoverable content of ores, etc.) ...troy ounces..	23,660	828	28,123	984	38,121	1,334	32,766	1,147
Iron ore (usable) ...thousand long tons, gross weight..	6	(4)	7	(4)	12	(4)	36	(4)
Lead (recoverable content of ores, etc.)	14,820	4,061	17,028	5,075	18,642	5,853	13,300	3,804
Manganese ore (35 percent or more Mn) ...gross weight..	58,661	(4)	106,026	(4)	80,552	(4)	68,298	(4)
Manganiferous ore (5 to 35 percent Mn) ...do....	5,266	(4)	6,341	(4)	4,752	(4)	4,547	(4)
Mica, sheet ...pounds..	(4)	(4)	------	------	56	1	13	(10)
Natural gas ...million cubic feet..	30,252	2,057	28,255	1,724	25,847	1,758	[6] 30,200	[6] 2,200
Petroleum (crude) ...thousand 42-gallon barrels..	14,195	31,230	15,654	35,380	21,760	56,141	[6] 27,215	[6] 73,481
Phosphate rock ...thousand long tons..	(4)	(4)	(4)	(4)	558	3,957	534	3,825
Pumice	175	1	(4)	(4)	(4)	(10)	------	------
Sand and gravel ...thousand short tons..	13,341	7,460	13,772	6,615	10,024	7,174	11,108	8,150
Silver (recoverable content of ores, etc.) ...thousand troy ounces..	5,178	4,686	6,080	5,503	7,386	6,685	5,558	5,030
Stone ...thousand short tons..	1,320	1,385	1,274	1,200	1,247	1,816	2,567	3,654
Talc	(4)	(4)	(4)	(4)	22,197	210	(4)	(4)
Tungsten ore and concentrate ...60-percent WO_3 basis..	678	(4)	1,211	(4)	1,230	(4)	661	(4)
Zinc (recoverable content of ores, etc.)	60,952	13,166	68,588	16,873	70,520	19,322	50,520	11,721
Value of items that cannot be disclosed: Barite, cement, clay (bentonite, 1956; bentonite and fire clay, 1957), gypsum, lime, natural-gas liquids, pyrites, recovered elemental sulfur (1956–57), vanadium (1957), vermiculite, uranium ore (1956–57), and values indicated by footnote 4	------	18,519	------	25,637	------	[12] 21,133	------	18,222
Total Montana [11]	------	126,412	------	166,993	------	[12] 213,781	------	191,728

NEBRASKA

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Clays ...thousand short tons..	164	164	151	151	153	154	134	135
Gem stones	------	------	(11)	2	(11)	3	(11)	2
Natural gas ...million cubic feet..	6,801	796	12,515	2,553	13,541	2,844	[6] 12,500	[6] 2,700
Petroleum (crude) ...thousand 42-gallon barrels..	7,783	21,400	11,203	30,810	16,204	45,209	[6] 19,586	[6] 58,368
Sand and gravel ...thousand short tons..	8,548	6,992	8,405	6,193	10,350	7,404	7,944	5,889
Stone ...do....	2,660	3,512	3,081	4,177	3,063	4,142	3,065	3,749

Value of items that cannot be disclosed: Cement, natural-gas liquids, and pumice		10,637		11,144		[12] 12,771		13,670
Total Nebraska [8]		42,393		54,237		[12] 71,311		83,290
NEVADA								
Antimony ore and concentrate ... antimony content	4	(4)			13	(4)	29	9
Barite	83,833	517	113,694	709	178,440	1,067	109,663	721
Clays ... thousand short tons	5	9	6	13	14	32	12	20
Copper (recoverable content of ores, etc.)	70,217	41,428	78,925	58,878	[19] 80,824	[19] 68,700	77,750	46,806
Gem stones	(11)	(4)	(11)	(4)	(11)	50	(11)	100
Gold (recoverable content of ores, etc.) ... troy ounces	79,067	2,767	72,913	2,552	[19] 68,040	[19] 2,381	76,752	2,686
Gypsum ... thousand short tons	654	2,217	837	2,836	790	2,701	674	(4)
Iron ore (usable) ... thousand long tons, gross weight	351	2,025	325	1,667	917	[19] 5,021	904	5,341
Lead (recoverable content of ores, etc.)	3,041	833	3,291	981	6,384	2,004	5,979	1,710
Manganese ore (35 percent or more Mn) ... gross weight	(4)	(4)	101,469	(4)	121,482	(4)	129,046	(4)
Manganiferous ore (5 to 35 percent Mn) ... do	12,870	165						
Mercury ... 76-pound flasks	4,974	1,315	5,750	1,669	5,859	1,523	6,313	1,559
Petroleum ... thousand 42-gallon barrels	33	40	64	110	64	111	[6] 44	[6] 76
Pumice ... thousand short tons	(4)	(4)	(4)	(4)	12	34	(4)	(4)
Sand and gravel ... do	3,531	2,957	3,580	3,762	4,687	4,569	5,233	5,190
Silver (recoverable content of ores, etc.) ... thousand troy ounces	560	507	845	765	[19] 994	[19] 899	959	868
Stone ... thousand short tons	1,833	2,011	1,612	2,609	1,401	2,281	925	1,585
Talc and soapstone	5,866	54	10,732	[17] 79	10,540	98	7,467	57
Tungsten concentrate ... 60-percent WO_3 basis	5,331	20,048	6,155	22,751	5,400	19,263	1,196	1,676
Zinc (recoverable content of ores, etc.)	1,035	224	2,670	657	7,488	2,052	5,292	1,228
Value of items that cannot be disclosed: Brucite (1954, 1956–57), diatomite, fluorspar, lime, magnesite, calcareous marl (1954–56), molybdenum, perlite, salt, sulfur ore (1955–57), uranium (1956–57), and values indicated by footnote 4		12,435		13,752		[12] 14,446		16,756
Total Nevada [15]		89,138		113,220		[12] 126,681		86,023
NEW HAMPSHIRE								
Beryllium concentrate ... gross weight	12	7	20	12	(4)	(4)	4	2
Clays ... thousand short tons	36	36	35	35	36	47	37	51
Columbium-tantalum concentrate ... pounds	255	(10)	(4)	(4)				
Gem stones			(11)	5	(11)	1	(11)	(10)
Mica:								
Sheet ... pounds	42,466	234	(4)	(4)	50,873	178	53,554	460
Scrap	325	12	(4)	(4)	305	10	522	17
Peat	(4)	(4)	(4)	(4)	320	(4)	85	(4)
Sand and gravel ... thousand short tons	2,241	1,095	2,432	1,593	3,862	1,822	4,505	1,970
Stone ... do	72	473	(4)	(4)	(4)	(4)	(4)	(4)
Value of items that cannot be disclosed: Abrasive stones, feldspar, and values indicated by footnote 4		255		960		1,378		831
Total New Hampshire		2,112		2,605		3,436		3,331

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

NEW JERSEY

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Clays ... thousand short tons	578	$1,246	644	$1,562	651	$2,214	[5] 593	[5] $1,872
Iron ore (usable) ... thousand long tons, gross weight	476	6,622	760	13,633	912	16,842	877	16,668
Manganiferous residuum ... gross weight	214,931	(4)	213,370	(4)	130,129	(4)	(4)	(4)
Marl (greensand)	2,101	185	(4)	(4)	(4)	(4)	(4)	(4)
Sand and gravel ... thousand short tons	10,005	14,705	11,153	16,425	11,194	18,239	10,323	17,619
Stone ... do	5,772	12,110	[7] 8,358	[7] 17,528	9,012	20,825	8,792	21,222
Sulfur, recovered elemental ... long tons	(4)	(4)	7,404	244	8,972	291	(4)	(4)
Zinc (recoverable content of ores, etc.) [20]	37,416	7,992	11,643	2,864	4,667	1,260	12,530	2,857
Value of items that cannot be disclosed: Ball clay (1956–57), gem stones (1955–57), lime, magnesium compounds, peat, stone (crushed marble, 1955), and values indicated by footnote 4. Excludes limestone used in manufacturing lime	------	4,184	------	5,239	------	4,608	------	4,699
Total New Jersey	------	47,044	------	57,495	------	64,279	------	64,937

NEW MEXICO

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Barite	(4)	(4)	(4)	(4)	4,059	81	4,441	98
Beryllium concentrate ... gross weight	117	44	106	56	31	(4)	29	15
Clays ... thousand short tons	48	83	45	109	40	95	33	83
Coal ... do	123	727	202	1,236	158	923	137	829
Columbium-tantalum concentrate ... pounds	2,093	4	76	(10)	95	(10)	866	1
Copper (recoverable content of ores, etc.)	60,558	35,729	66,417	49,547	74,345	63,193	67,472	40,618
Fluorspar	8,876	(4)	(4)	(4)	------	------	------	------
Gem stones	(11)	(4)	(11)	25	(11)	30	(11)	30
Gold (recoverable content of ores, etc.) ... troy ounces	3,539	124	1,917	67	3,275	115	3,212	112
Gypsum	887	3	------	------	------	------	------	------
Helium ... thousand cubic feet	41,755	735	53,721	946	76,072	1,350	69,336	1,189
Iron ore (usable) ... thousand long tons, gross weight	3	(4)	9	(4)	(4)	(4)	(18)	1
Lead (recoverable content of ores, etc.)	887	243	3,296	982	6,042	1,897	5,294	1,514
Lime ... thousand short tons	------	------	------	------	31	373	24	290
Manganese ore (35 percent or more Mn) ... gross weight	------	------	1,390	(4)	22,011	1,834	25,459	2,114
Manganiferous ore (5 to 35 percent Mn) ... do	20,546	82	40,320	(4)	38,782	(4)	42,535	152
Mica:								
Scrap	------	------	84	3	767	22	1,347	47
Sheet ... pounds	2,054	14	9,431	65	6,247	53	2,134	16
Natural gas ... million cubic feet	449,346	35,049	540,664	48,119	626,340	55,118	[6] 735,100	[6] 69,800

Natural-gas liquids:								
Natural gasoline and cycle products ---- thousand gallons	224, 112	11, 744	261, 023	15, 425	306, 595	16, 560	309, 010	19, 941
LP-gases ---- do	225, 994	5, 704	278, 403	6, 767	308, 218	11, 065	375, 930	13, 046
Perlite	111, 040	886	147, 805	1, 091	167, 705	1, 271	187, 259	1, 568
Petroleum (crude) ---- thousand 42-gallon barrels	74, 820.	205, 760	82, 958	227, 310	87, 893	241, 706	[6] 94, 759	[6] 283, 128
Potassium salts [21] ---- K_2O equivalent	1, 763, 378	65, 538	1, 898, 770	71, 839	1, 996, 693	75, 122	2, 080, 475	77, 197
Pumice ---- thousand short tons	364	1, 060	394	780	292	667	321	756
Salt (common) ---- do	51	333	50	597	58	501	53	429
Sand and gravel ---- do	6, 519	8, 340	4, 556	6, 005	6, 054	5, 776	7, 991	7, 803
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	109	99	251	227	393	356	309	280
Stone ---- thousand short tons	772	714	1, 573	1, 547	1, 268	1, 272	1, 348	1, 618
Tungsten ore and concentrate ---- 60-percent WO_3 basis	(22)	1	1	3	(22)	2	----	----
Uranium ore	----	----	----	----	1, 105, 183	24, 086	1, 175, 742	20, 538
Zinc (recoverable content of ores, etc.)	6	1	15. 277	3, 758	35, 010	9, 593	32, 680	7, 582
Value of items that cannot be disclosed: Carbon dioxide, diatomite (1954-55), molybdenum, magnesium compounds (1954, 1956-57), rare-earth metals concentrates (1956), recovered elemental sulfur, vanadium, and values indicated by footnote 4	----	1, 673	----	2, 188	----	2, 039	----	2, 317
Total New Mexico	----	[12] 474, 690	----	[12] 438, 692	----	[12 15] 515, 009	----	[15] 553, 034

NEW YORK

Cement [17] ---- thousand 376-pound barrels	14, 497	38, 861	17, 942	52, 150	(4)	(4)	(4)	(4)
Clays ---- thousand short tons	1, 199	1, 494	1, 394	1, 676	1, 235	1, 508	1, 002	1, 270
Emery	9, 758	132	10, 735	151	12, 153	174	11, 893	184
Gem stones	----	----	(11)	(8)	(11)	2	(11)	5
Gypsum ---- thousand short tons	1, 134	4, 005	1, 249	4, 404	1, 140	4, 817	864	3, 749
Iron ore (usable) ---- thousand long tons, gross weight	2, 803	31, 707	3, 202	38, 019	3, 188	41, 094	3, 329	44, 567
Lead (recoverable content of ores, etc.)	1, 187	325	1, 037	309	1, 608	505	1, 667	477
Lime ---- thousand short tons	(4)	(4)	83	1, 366	87	1, 030	(4)	(4)
Natural gas ---- million cubic feet	2, 598	847	3, 637	1, 073	4, 098	1, 160	[6] 3, 300	[6] 1, 050
Peat	(4)	(4)	(4)	(4)	2, 900	23	(4)	(4)
Petroleum (crude) ---- thousand 42-gallon barrels	3, 257	11, 140	2, 904	10, 310	2, 748	12, 091	[6] 2, 677	[6] 12, 662
Salt (common) ---- thousand short tons	3, 413	22, 754	3, 780	25, 214	3, 873	27, 545	3, 691	28, 002
Sand and gravel ---- do	30, 082	29, 756	25, 562	25, 542	27, 815	28, 722	25, 640	26, 480
Silver (recoverable content of ores, etc.) ---- thousand troy ounces	35	31	66	60	84	76	64	58
Slate ---- thousand short tons	115	1, 742	91	1. 345	64	944	59	961
Stone ---- do	19, 410	31, 426	22, 812	37. 919	22, 805	36, 135	24, 265	43, 276
Zinc (recoverable content of ores, etc.)	53, 199	11, 491	53, 016	13, 042	59, 111	16, 196	64, 659	15, 001
Value of items that cannot be disclosed: Abrasive stone (1954), beryllium concentrate (1954), natural cement (1954-55), abrasive garnet, iron oxide pigments (1955-57), calcareous marl (1954), recovered elemental sulfur (1954), talc, titanium concentrate, wollastonite, and values indicated by footnote 4	----	9, 883	----	8, 773	----	68, 969	----	70, 699
Total New York [8]	----	192, 738	----	216, 907	----	237, 016	----	244, 349

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

NORTH CAROLINA

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Abrasive stones	587	$12	[23] 227	$12	[23] 454	$16	(11)	[24] $5
Beryllium concentrate ... gross weight	(4)	(4)	(4)	(4)	3	2	1	1
Clays ... thousand short tons	1,873	2,520	2,375	1,792	2,663	2,027	[5] 2,392	[5] 1,407
Feldspar ... long tons	230,744	2,221	242,724	2,185	255,637	3,192	233,439	2,728
Gem stones			(11)	(8)	(11)	1	(11)	(10)
Gold (recoverable content of ores, etc.) ... troy ounces	214	8	190	7	882	31	1,373	48
Lead (recoverable content of ores, etc.)	4	1	2	1	10	3	9	3
Mica:								
Scrap	61,049	1,457	60,887	1,377	47,125	1,065	53,452	1,173
Sheet ... pounds	479,221	1,787	553,444	2,745	770,903	2,135	577,607	1,575
Sand and gravel ... thousand short tons	7,441	5,508	7,786	5,911	7,581	6,264	6,829	5,724
Silver (recoverable content of ores, etc.) ... thousand troy ounces	(25)	(10)	(25)	(10)	1	1	12	11
Stone ... thousand short tons	10,134	15,625	10,903	16,533	[7] 8,352	[7] 11,472	[7] 9,455	[7] 12,839
Talc and pyrophyllite	112,704	389	125,206	572	125,487	529	120,905	558
Tungsten concentrate ... 60-percent WO_3 basis	2,538	(4)	2,609	(4)	2,732	(4)	1,828	(4)
Zinc							2	(10)
Value of items that cannot be disclosed: Abrasive stone (millstones, 1954; grinding pebbles and tube-mill liners, 1957), asbestos (1954–55, 1957), clay (bentonite, 1957), copper, lithium minerals, olivine, slate (1957), stone (crushed and dimension granite, crushed limestone, crushed miscellaneous, and dimension sandstone, 1956); dimension granite, crushed basalt, dimension and crushed marble, crushed limestone, and crushed sandstone (1957), vermiculite (1954–55), and values indicated by footnote 4		12,123		10,075		[12] 14,135		11,498
Total North Carolina		41,651		41,210		[12] 40,873		37,570

NORTH DAKOTA

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Clays ... thousand short tons	(4)	(4)	(4)	(4)	[5] 52	[5] 71	[5] 55	[5] 67
Coal (lignite) ... do	(4)	(4)	3,102	7,261	2,815	6,578	2,561	5,947
Natural gas ... million cubic feet	1,093	69	5,256	405	11,725	950	[6] 12,400	[6] 1,100
Petroleum (crude) ... thousand 42-gallon barrels	6,025	12,890	11,143	32,200	13,495	39,136	[6] 13,642	[6] 42,699
Pumice ... thousand short tons			4	10	5	5	2	2
Sand and gravel ... do	7,105	2,219	11,169	2,638	5,946	4,259	7,048	4,967
Stone ... do	1	4	77	80	83	87	29	52
Sulfur, recovered elemental ... long tons					1,735	46	10,314	264

Value of items that cannot be disclosed: Certain minerals and values indicated by footnote 4		7,041		1,529		2,423		2,698
Total North Dakota		22,223		44,123		53,555		57,796
OHIO								
Abrasive stones, grindstones and pulpstones	(4)	(4)	(4)	(4)	(4)	(4)	1,505	$132
Cement ... thousand 376-pound barrels	13,077	$35,929	14,914	$42,966	16,065	$49,794	16,238	52,184
Clays ... thousand short tons	5,051	11,137	6,297	15,677	6,703	17,675	6,136	16,073
Coal ... do	32,469	117,520	37,870	133,814	38,934	148,650	36,862	146,134
Lime ... do	2,549	31,444	3,039	39,394	2,995	40,805	2,763	38,383
Natural gas ... million cubic feet	28,824	6,111	33,756	7,595	25,368	6,088	[6] 29,300	[6] 7,200
Peat	29,540	357	22,484	249	15,509	174	5,478	102
Petroleum (crude) ... thousand 42-gallon barrels	3,880	10,710	4,353	12,580	4,785	15,025	[6] 5,478	[6] 17,694
Salt (common) ... thousand short tons	2,749	12,359	2,905	14,769	2,972	15,923	2,825	16,936
Sand and gravel ... do	25,827	27,873	27,906	31,995	30,200	36,146	30,596	37,503
Stone ... do	32,627	47,802	33,273	49,841	[7] 33,418	[7] 50,947	[7] 37,451	[7] 61,847
Value of items that cannot be disclosed: Calcium-magnesium chloride (1954–56), gypsum, natural gasoline, stone (crushed sandstone, 1956; dimension limestone and calcareous marl, 1957), recovered elemental sulfur (1954–56), and values indicated by footnote 4		2,084		2,865		5,394		2,452
Total Ohio [8]		293,659		340,457		375,488		385,858
OKLAHOMA								
Clays ... thousand short tons	452	1,283	[5] 724	[5] 727	[5] 705	[5] 701	[5] 641	[5] 642
Coal ... do	1,915	11,265	2,164	12,668	2,007	12,341	2,195	14,165
Lead (recoverable content of ores, etc.)	14,204	3,892	14,126	4,209	12,350	3,878	7,183	2,054
Natural gas ... million cubic feet	616,355	43,145	614,976	45,508	678,603	54,288	[6] 635,000	[6] 63,300
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	478,590	24,332	504,692	28,770	489,963	26,543	460,644	25,329
LP-gases ... do	453,810	13,506	512,320	14,297	579,101	23,427	587,140	21,824
Petroleum (crude) ... thousand 42-gallon barrels	185,851	518,520	202,817	563,830	215,862	600,096	[6] 215,111	[6] 651,786
Pumice ... thousand short tons	(4)	(4)			(9)	3	(4)	(4)
Salt (common) ... do	(4)	(4)	(4)	(4)	10	90	7	63
Sand and gravel ... do	5,424	4,265	6,294	4,786	5,947	4,842	4,960	4,507
Stone ... do	9,239	9,147	10,933	12,295	10,547	12,417	12,016	14,064
Tripoli	(4)	(4)	(4)	(4)	(4)	(4)	22,236	67
Zinc (recoverable content of ores, etc.)	43,171	9,325	41,543	10,220	27,515	7,539	14,951	3,469
Value of items that cannot be disclosed: Native asphalt, clay (bentonite, 1955–57), cement, gypsum, lime, manganese ore (1957), stone (dimension limestone 1954), recovered elemental sulfur, uranium ore (1956), and values indicated by footnote 4		12,584		15,525		[12] 12,969		14,586
Total Oklahoma [8]		650,205		711,089		[12] 757,120		803,937

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

OREGON

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Chromium ... gross weight	6,655	$538	5,341	$463	[26] 54,577	[26] $2,001	240	$675
Clays ... thousand short tons	(4)	(4)	251	276	257	278	7,900	266
Copper (recoverable content of ores, etc.)	5	3	4	3	7	6	23	14
Gem stones	(11)	(4)	(11)	(4)	(11)	250	(11)	200
Gold (recoverable content of ores, etc.) ... troy ounces	6,520	228	1,708	60	2,738	96	3,381	118
Iron ore (usable) ... thousand long tons	----	----	2	(4)	1	(4)	(18)	(4)
Lead (recoverable content of ores, etc.)	5	1	3	1	5	2	5	1
Mercury ... 76-pound flasks	489	129	1,056	307	1,893	492	3,993	986
Nickel (content of ore and concentrate)	1,993	(4)	4,181	(4)	6,866	(4)	12,276	(4)
Pumice ... thousand short tons	68	178	(4)	(4)	(4)	(4)	123	294
Sand and gravel ... do	13,157	14,150	11,954	11,832	11,637	11,647	12,843	13,481
Silver (recoverable content of ores, etc.) ... thousand troy ounces	14	13	9	8	14	12	16	14
Stone ... thousand short tons	5,872	8,618	7,742	9,418	6,098	7,890	10,311	11,405
Value of items that cannot be disclosed: Carbon dioxide, cement, diatomite, iron oxide pigments (1954, 1956–57), lime (1957), sodium carbonate (1956), tungsten concentrate, uranium ore (1956–57), and values indicated by footnote 4	----	9,634	----	10,500	----	[12] 12,689	----	15,954
Total Oregon [8]	----	32,268	----	31,736	----	[12] 34,021	----	42,480

PENNSYLVANIA

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Cement ... thousand 376-pound barrels	43,068	117,912	48,090	141,969	51,964	162,387	44,680	148,130
Clays ... thousand short tons	3,524	10,244	4,020	12,413	[5] 4,413	[5] 23,782	4,074	22,012
Coal:								
Anthracite ... do	29,083	247,870	26,205	206,097	28,900	236,785	25,338	227,754
Bituminous ... do	72,010	378,659	85,713	440,452	90,287	479,437	85,365	492,539
Cobalt (content of concentrate) ... thousand pounds	517	(4)	479	(4)	533	(4)	599	(4)
Gold (recoverable content of ores, etc.) ... troy ounces	1,317	46	1,610	56	(4)	(4)	(4)	(4)
Iron ore (usable) ... thousand long tons, gross weight	708	(4)	838	(4)	(4)	(4)	(4)	(4)
Iron oxide pigments (crude)	----	----	519	7	600	7	998	9
Lime ... thousand short tons	1,082	13,206	1,424	17,632	1,443	18,282	1,298	18,406
Natural gas ... million cubic feet	145,934	43,634	99,172	29,652	104,508	33,652	[6] 107,300	[6] 35,400
Natural-gas liquids:								
Natural-gasoline ... thousand gallons	4,830	320	4,305	281	4,081	251	3,106	192
LP-gases ... do	1,008	89	995	90	1,127	99	1,211	106
Peat	15,621	141	23,277	220	20,498	213	26,086	236

Petroleum (crude)..........**thousand 42-gallon barrels**..	9,107	31,150	8,531	30,200	8,230	35,718	[6] 8,179	[6] 38,687
Pyrophyllite (sericite schist)..........	1,898	9	(4)	(4)	(4)	(4)	(4)	(4)
Sand and gravel..........thousand short tons..	14,218	20,596	13,313	20,512	14,047	21,321	12,406	19,570
Silver (recoverable content of ores, etc.)..........thousand troy ounces..	8	8	10	9	(4)	(4)	(4)	(4)
Slate..........thousand short tons..	194	4,419	186	4,421	154	4,194	139	4,005
Stone..........do....	40,522	61,193	44,438	[17] 68,918	[7] 44,913	[7] 73,831	43,258	73,090
Sulfur, recovered elemental..........long tons..	(4)	(4)	7,738	263	11,350	386	(4)	(4)
Tripoli..........	(4)	(4)	1,090	6	1,030	7	(4)	(4)
Value of items that cannot be disclosed: Clays (kaolin 1956), copper, gem stones (1955–57), mica, pyrites, stone (dimension basalt 1956, shell 1956), and values indicated by footnote 4..........	....	12,549	....	15,819	....	16,202	....	16,911
Total Pennsylvania [8]..........	....	925,545	....	969,910	....	1,088,867	....	1,082,133

RHODE ISLAND

Sand and gravel..........thousand short tons..	1,013	980	1,941	1,498	1,308	1,263	1,058	1,060
Stone..........do....	(4)	(4)	(4)	(4)	42	221	[7] 4	[7] 14
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4..........	....	481	....	336	....	143	....	295
Total Rhode Island..........	....	1,461	....	1,834	....	1,627	....	1,369

SOUTH CAROLINA

Clays..........thousand short tons..	1,136	4,702	1,086	5,463	1,087	5,450	937	5,161
Mica (sheet)..........pounds..	(4)	(4)	(4)	(4)	5,400	14	2,278	12
Sand and gravel..........thousand short tons..	2,814	2,550	3,127	2,677	3,229	2,926	2,647	2,571
Stone..........do....	2,862	4,233	3,455	4,921	3,304	4,285	[7] 3,413	[7] 4,581
Value of items that cannot be disclosed: Barite, cement, kyanite, scrap mica, rare-earth metals concentrates (1956–57), staurolite (1957), stone (dimension granite, 1953–54; dimension granite and crushed limestone, 1956–57; calcareous marl, 1957), titanium (1956–57), vermiculite, zirconium concentrate (1957), and values indicated by footnote 4..........	....	6,374	....	7,400	....	9,277	....	10,491
Total South Carolina [15]..........	....	17,744	....	20,197	....	21,342	....	22,168

SOUTH DAKOTA

Beryllium concentrate..........gross weight..	337	140	294	157	195	95	268	145
Clays..........**thousand short** tons..	(4)	(4)	(4)	(4)	[5] 201	[5] 201	[5] 176	[5] 176
Coal (lignite)..........do....	(4)	(4)	26	90	25	90	21	79
Columbium-tantalum concentrate..........pounds..	25,447	43	5,638	10	237	(10)	2,311	6
Feldspar..........long tons..	(4)	(4)	42,164	267	45,226	289	41,316	267
Gem stones..........	(11)	5	(11)	7	(11)	10	(11)	15

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

SOUTA DAKOTA—Continued

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Gold (recoverable content of ores, etc.) ... troy ounces	541,445	$18,951	529,865	$18,545	568,523	$19,898	568,130	$19,885
Gypsum ... thousand short tons	9	11	13	16	16	63	13	53
Iron ore (usable) ... thousand long tons, gross weight	2	(4)	2	(4)	22	100	(18)	(4)
Mica:								
Scrap	1,510	27	1,322	27	1,268	31	1,626	43
Sheet ... pounds	16,299	65	4,854	21	12,494	[12] 67	9,093	46
Natural gas ... million cubic feet	7	(4)	------	------	------	------	------	------
Sand and gravel ... thousand short tons	14,819	7,840	13,538	10,097	12,539	8,423	14,758	8,001
Silver (recoverable content of ores, etc.) ... thousand troy ounces	151	137	154	140	136	123	135	122
Stone ... thousand short tons	1,615	4,929	2,262	5,680	2,200	5,725	1,718	5,068
Tungsten ore and concentrate ... 60-percent WO_3 basis	(20)	1	------	------	------	------	------	------
Uranium ore	------	------	------	------	35,302	475	69,800	760
Value of items that cannot be disclosed: Cement, clays (bentonite, 1956–57), lime, lithium minerals (1954), petroleum, vanadium (1954), and values indicated by footnote 4	------	6,121	------	6,115	------	7,547	------	6,084
Total South Dakota [8]	------	37,874	------	40,526	------	[12] 42,281	------	39,990

TENNESSEE

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Cement ... thousand 376-pound barrels	7,569	19,734	8,812	23,673	8,755	25,435	7,415	22,806
Clays ... thousand short tons	1,015	3,781	1,208	4,170	1,379	4,888	1,154	4,228
Coal ... do	6,429	25,477	7,053	28,747	8,848	35,609	7,955	31,147
Copper (recoverable content of ores, etc.)	9,087	5,362	9,911	7,394	10,449	8,882	9,790	5,894
Gold (recoverable content of ores, etc.) ... troy ounces	218	8	221	8	189	7	172	6
Lead (recoverable content of ores, etc.)	------	------	------	------	5	1	------	------
Lime ... thousand short tons	80	968	103	1,102	125	1,436	94	1,134
Manganese ore (35 percent or more Mn) ... gross weight	11,823	920	15,895	1,280	17,821	1,417	12,938	1,007
Natural gas ... million cubic feet	89	10	39	5	45	6	[6] 35	[6] 5
Phosphate rock ... thousand long tons	1,633	11,743	1,466	10,526	1,685	11,643	1,812	12,514
Sand and gravel ... thousand short tons	5,155	6,141	5,137	5,814	5,629	6,480	5,617	6,641
Silver (recoverable content of ores, etc.) ... thousand troy ounces	61	55	67	60	65	59	54	49
Stone ... thousand short tons	14,040	22,046	14,381	22,276	[7] 15,556	[7] 23,796	[7] 15,354	[7] 24,155
Zinc (recoverable content of ores, etc.)	30,326	6,550	40,216	9,893	46,023	12,610	58,063	13,470
Value of items that cannot be disclosed: Barite, fluorspar (1956–57), iron ore, manganiferous ore (1954), scrap mica (1956–57), petroleum, pyrites, stone (crushed sandstone, 1956; crushed granite and crushed sandstone, 1957), and minerals indicated by footnote 4	------	5,480	------	6,994	------	8,772	------	8,029
Total Tennessee [8]	------	105,686	------	119,316	------	137,846	------	128,738

TEXAS

Cement ... thousand 376-pound barrels	21,928	56,674	24,856	67,549	25,966	75,695	22,144	68,541
Clays ... thousand short tons	2,401	7,002	[5] 3,097	[5] 5,100	[5] 3,146	[5] 4,765	[5] 2,992	[5] 4,934
Copper (recoverable content of ores, etc.)	------	------	1	1	------	------	------	------
Gem stones	([11])	100	([11])	115	([11])	115	([11])	100
Gypsum ... thousand short tons	1,218	3,773	1,349	4,220	1,157	3,623	1,043	3,343
Helium ... thousand cubic feet	110,588	1,874	139,397	2,272	145,830	2,364	204,286	3,353
Iron ore (usable) ... thousand long tons, gross weight	915	([4])	875	([4])	([4])	([4])	([4])	([4])
Lime ... thousand short tons	547	5,422	585	5,549	592	6,938	796	7,489
Natural gas ... million cubic feet	4,551,232	386,855	4,730,798	378,464	4,999,889	434,990	[6] 5,256,600	[6] 478,400
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	2,732,100	200,559	2,987,808	206,506	2,964,609	216,378	2,944,381	201,423
LP-gases ... do	2,983,962	95,913	3,450,430	110,414	3,731,047	144,745	3,831,664	147,618
Petroleum (crude) ... thousand 42-gallon barrels	974,275	2,768,490	1,053,297	2,989,330	1,107,808	[12] 3,131,225	[6] 1,083,812	[6] 3,369,371
Salt (common) ... thousand short tons	2,864	9,310	3,583	12,867	3,963	14,370	4,612	17,104
Sand and gravel ... do	26,316	24,841	31,518	28,480	29,336	27,213	23,685	23,427
Sodium sulfate	([4])	([4])	46,718	1,099	([4])	([4])	([4])	([4])
Stone ... thousand short tons	[6] 25,840	[6] 29,344	27,321	33,544	32,773	36,350	30,660	35,358
Sulfur (Frasch-process) ... thousand long tons	3,474	92,792	3,767	105,128	3,437	91,026	2,879	70,226
Sulfur, recovered elemental ... long tons	107,232	2,889	114,989	3,144	140,164	3,865	163,571	4,022
Talc and soapstone	19,362	128	35,064	213	41,332	244	47,780	199
Value of items that cannot be disclosed: Abrasive stones, native asphalt, bromine, clay, (fuller's earth 1955-57), coal (lignite), feldspar (1957), graphite, magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1955-57), peat (1954), pumice, silver (1954-55), stone (dimension sandstone, 1954), uranium ore (1956-57), and values indicated by footnote 4	------	52,527	------	50,069	------	[12] 62,354	------	71,510
Total Texas [6]	------	3,730,705	------	3,993,310	------	[12] 4,245,123	------	4,497,264

UTAH

Asphalt and related bitumens, native: Gilsonite	75,943	2,724	82,822	3,117	([4])	([4])	206,041	4,259
Clays ... thousand short tons	([4])	([4])	([4])	([4])	[5] 227	[5] 492	[5] 164	[5] 473
Coal ... do	5,008	29,761	6,296	40,005	6,522	34,436	6,858	40,263
Copper (recoverable content of ores, etc.)	211,835	124,983	232,949	173,780	250,604	213,013	237,857	143,190
Fluorspar	4,403	82	7,328	151	10,581	265	11,087	387
Gem stones	------	------	([11])	6	([11])	10	([11])	12
Gold (recoverable content of ores, etc.) ... troy ounces	403,401	14,119	441,206	15,442	416,031	14,561	378,438	13,245
Iron ore (usable) ... thousand long tons, gross weight	3,041	19,277	3,847	24,688	4,002	27,508	4,156	30,383
Lead (recoverable content of ores, etc.)	44,972	12,322	50,452	15,035	49,555	15,560	44,471	12,719
Lime ... thousand short tons	30	432	39	583	55	830	53	821
Manganese ore (35 percent or more Mn) ... gross weight	25	([4])	------	------	------	------	142	12
Manganiferous ore (5 to 35 percent Mn) ... do	97	([4])	------	------	------	------		
Natural gas ... million cubic feet	16,024	2,259	17,163	2,386	17,268	2,435	[6] 19,000	[6] 2,700
Perlite	([4])	([4])	([4])	([4])	2,271	9	([4])	([4])
Petroleum (crude) ... thousand 42-gallon barrels	1,905	4,480	2,227	5,140	2,466	5,302	[6] 4,093	[6] 9,291
Phosphate rock ... thousand long tons	([4])	([4])	([4])	([4])	125	772	114	756
Pumice ... thousand short tons	4	4	2	20	45	330	36	148
Salt (common) ... do	167	1,020	196	1,339	184	1,471	221	2,013
Sand and gravel ... do	5,328	3,592	5,158	3,309	5,836	4,476	26,958	15,485

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

UTAH—Continued

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousands)	1955 Short tons (unless otherwise stated)	1955 Value (thousands)	1956 Short tons (unless otherwise stated)	1956 Value (thousands)	1957 Short tons (unless otherwise stated)	1957 Value (thousands)
Silver (recoverable content of ores, etc.) ... thousand troy ounces	6,179	$5,593	6,251	$5,657	6,572	$5,948	6,199	$5,610
Stone ... thousand short tons	1,127	1,546	1,926	2,650	2,322	3,298	7,854	8,540
Tungsten ore and concentrate ... 60-percent WO_3 basis	84	309	65	225	11	41	----------	----------
Uranium ore	----------	----------	----------	----------	[12] 926,273	[12] 25,214	1,075,759	29,774
Vanadium ... thousand pounds	576	(4)	996	(4)	1,099	(4)	1,017	(4)
Zinc (recoverable content of ores, etc.)	34,031	7,351	43,556	10,715	42,374	11,610	40,846	9,476
Value of items that cannot be disclosed: Carbon dioixde, cement, clay (kaolin, 1956–57), gypsum, molybdenum, natural gasoline, potassium salts, and values indicated by footnote 4	----------	[12] 26,258	----------	[12] 28,806	----------	[12] 33,352	----------	27,651
Total Utah [15]	----------	[12] 255,550	----------	[12] 332,002	----------	[12] 399,759	----------	356,213

VERMONT

Mineral	1954 Short tons	1954 Value	1955 Short tons	1955 Value	1956 Short tons	1956 Value	1957 Short tons	1957 Value
Clays ... thousand short tons	(4)	(4)	14	14	(4)	(4)	(4)	(4)
Copper (recoverable content of ores, etc.)	4,352	2,568	4,305	3,212	3,403	2,893	3,405	2,050
Gold (recoverable content of ores, etc.) ... troy ounces	185	6	181	6	(4)	(4)	(4)	(4)
Pyrites ... thousand long tons	21	(4)	22	(4)	23	107	10	56
Sand and gravel ... thousand short tons	1,482	1,111	1,763	1,169	1,910	905	2,216	1,051
Silver (recoverable content of ores, etc.) ... thousand troy ounces	49	44	50	46	(4)	(4)	37	33
Slate ... thousand short tons	(4)	(4)	(4)	(4)	162	3,722	(4)	3,269
Stone ... do	437	8,178	582	11,061	621	11,622	557	11,404
Talc	66,195	199	(4)	(4)	(4)	(4)	(4)	(4)
Value of items that cannot be disclosed: Asbestos, gem stones (1955), lime, and values indicated by footnote 4	----------	8,401	----------	8,400	----------	3,915	----------	4,060
Total Vermont [15]	----------	20,483	----------	23,884	----------	23,131	----------	21,893

VIRGINIA

Mineral	1954 Short tons	1954 Value	1955 Short tons	1955 Value	1956 Short tons	1956 Value	1957 Short tons	1957 Value
Beryllium concentrate ... gross weight	(4)	(10)	(4)	(10)	1	(10)	----------	----------
Clays ... thousand short tons	705	723	936	874	1,000	1,033	893	986
Coal ... do	16,387	72,901	23,508	108,174	28,063	138,127	29,506	153,959
Lead (recoverable content of ores, etc.)	4,320	1,184	2,997	893	3,035	953	3,143	899
Lime ... thousand short tons	445	4,611	494	5,049	512	5,926	510	6,029

Manganese ore (35 percent or more Mn)....gross weight..	22,678	1,781	32,654	2,779	20,231	1,902	12,655	1,058
Marl, calcareous (except for cement)....	33,174	21	(4)	(4)	10,522	12	(10)	(10)
Mica, sheet....pounds..	(4)	(4)	(4)	(4)	396	6	529	6
Natural gas....million cubic feet..	1,401	380	968	259	2,926	810	[6] 2,500	[6] 700
Petroleum (crude)....thousand 42-gallon barrels..	7	(4)	4	(4)	(4)	(4)	(4)	(4)
Sand and gravel....thousand short tons..	7,115	8,658	6,461	8,076	7,783	9,240	6,298	8,854
Silver (recoverable content of ores, etc.)....thousand troy ounces..	2	2	2	2	2	2	(4)	(4)
Slate....thousand short tons..	17	469	32	820	32	1,035	(4)	1,003
Stone....do....	10,894	18,138	11,966	19,870	14,082	23,076	14,244	21,158
Zinc (recoverable content of ores, etc.)....	16,738	3,615	18,329	4,509	19,196	5,181	23,080	5,277
Value of items that cannot be disclosed: Aplite, cement, feldspar, gem stones (1955–56), gypsum, iron ore (1954), iron oxide pigments, kyanite, manganiferous ore (1956), mica (scrap 1954–55), pyrites, salt, stone (dimension miscellaneous dimension sandstone and calcareous marl 1957), talc and soapstone, titanium concentrate, and values indicated by footnote 4..	....	19,403	....	24,046	....	24,931	....	28,154
Total Virginia [8]....	....	129,603	....	172,541	....	208,806	....	224,531

WASHINGTON

Abrasive stone: Pebbles (grinding)....	(4)	(4)	(4)	(4)	25	(10)	25	(10)
Barite....	(4)	(4)	25	(10)	....	....	(4)	(4)
Chromite....gross weight..	....	....	22	2	30	3	....	....
Clays....thousand short tons..	261	318	365	412	320	440	298	488
Coal....do....	619	4,478	610	4,263	473	3,432	360	2,761
Copper (recoverable content of ores, etc.)....	3,636	2,145	3,958	2,953	2,926	2,487	1,700	1,023
Epsomite....	(4)	(4)	100	5	(4)	(4)	(4)	(4)
Gem stones....	(11)	(4)	(11)	(4)	(11)	75	(11)	75
Gold (recoverable content of ores, etc.)....troy ounces..	66,740	2,336	74,360	2,602	70,669	2,473	(4)	(4)
Gypsum....thousand short tons..	(4)	(4)	4	14	(4)	(4)	6	(4)
Iron ore....thousand long tons..	....	....	2	(4)	2	(4)	4	(4)
Lead (recoverable content of ores, etc.)....	9,938	2,723	10,340	3,081	11,657	3,660	12,734	3,642
Peat....	43,134	153	37,640	113	37,043	129	39,364	153
Pumice....thousand short tons..	(4)	(4)	(4)	(4)	5	15	(4)	(4)
Sand and gravel....do....	16,045	13,595	21,645	19,351	16,842	15,037	19,924	16,775
Silver (recoverable content of ores, etc.)....thousand troy ounces..	314	284	436	395	448	406	(4)	(4)
Stone....thousand short tons..	5,367	9,527	6,593	10,580	8,057	11,660	8,454	10,600
Talc and soapstone....	(4)	(4)	(4)	(4)	(4)	(4)	4,065	24
Tungsten concentrate....60-percent WO_3 basis..	18	66	12	46	2	(4)	(9)	(4)
Zinc (recoverable content of ores, etc.)....	22,304	4,818	29,536	7,266	25,609	7,017	24,000	5,568
Value of items that cannot be disclosed: Carbon dioxide, cement, diatomite, lime, magnesite, mercury (1957), olivine, petroleum (1957), strontium minerals (1956–57), uranium ore (1956–57), and values indicated by footnote 4....	....	16,924	....	19,765	....	[12] 17,736	....	18,950
Total Washington [8]....	....	53,300	....	67,334	....	[12] 61,723	....	58,690

See footnotes at end of table.

TABLE 5.—Mineral production [1] in the United States,[2] 1954–57, by States—Continued

WEST VIRGINIA

Mineral	1954		1955		1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
Clays ... thousand short tons	587	$1,451	707	$2,563	770	$2,449	708	$2,691
Coal ... do	115,996	541,370	139,168	653,388	155,890	824,043	156,842	875,587
Marl, calcareous	(4)	(4)	(4)	(4)	1,685	1	(16)	(16)
Natural gas ... million cubic feet	191,601	45,601	212,403	49,915	204,717	48,518	[6] 204,900	[6] 49,200
Natural-gas liquids:								
Natural gasoline ... thousand gallons	41,076	2,593	35,756	2,352	35,728	2,594	30,435	2,185
LP-gases ... do	142,884	5,035	286,871	6,376	240,989	12,031	235,881	6,543
Petroleum (crude) ... thousand 42-gallon barrels	2,902	8,500	2,320	7,080	2,179	8,411	[6] 2,215	[6] 9,436
Salt (common) ... thousand short tons	472	2,886	638	3,477	681	3,453	648	2,642
Sand and gravel ... do	4,074	8,351	5,171	9,779	5,110	10,711	5,354	9,893
Stone ... do	7,315	11,743	5,899	9,714	6,579	10,765	6,989	11,934
Value of items that cannot be disclosed: Abrasive stone, (1955), bromine, calcium-magnesium chloride, cement, lime, manganese ore (1957), recovered elemental sulfur, and values indicated by footnote 4		10,504		12,930		14,590		14,984
Total West Virginia [8]		636,311		755,512		935,074		982,719

WISCONSIN

Mineral	1954		1955		1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
Abrasive stones: Pebbles (grinding)	(4)	(4)	(4)	(4)	1,093	31	1,790	43
Clays ... thousand short tons	180	174	165	166	163	172	131	136
Iron ore (usable) ... thousand long tons, gross weight	1,429	(4)	1,886	(4)	1,488	(4)	1,576	(4)
Lead (recoverable content of ores, etc.)	1,261	346	1,948	581	2,582	811	1,900	543
Lime ... thousand short tons	115	1,558	135	1,768	(4)	(4)	(4)	(4)
Marl, calcareous (except for cement)	19,607	10	14,087	7	11,074	6	(16)	(16)
Peat	(4)	(4)					400	(4)
Sand and gravel ... thousand short tons	23,979	17,396	27,978	19,958	27,715	19,097	29,394	18,694
Stone ... do	8,289	16,188	12,180	18,843	11,126	20,402	12,434	22,455
Zinc (recoverable content of ores, etc.)	15,534	3,355	18,326	4,508	23,890	6,546	21,575	5,006
Value of items that cannot be disclosed: Abrasive stone (tube-mill liners, 1954–56), cement, gem stones (1957), stone (crushed basalt, 1955), and values indicated by footnote 4		15,840		20,528		19,451		22,590
Total Wisconsin [8]		54,286		65,813		65,860		68,644

WYOMING

Beryllium concentrate......gross weight..					(4)	(4)	5	$3
Clays......thousand short tons..	944	9,534	10,036	10,924	[12] 1,086	[12] 11,864	[5] 1,069	[5] 11,973
Coal......do....	2,831	11,541	2,927	11,845	2,553	9,920	2,117	7,777
Copper (recoverable content of ores, etc.)......	1	1			3	3	4	2
Feldspar......long tons..					1,201	8	(4)	(4)
Gem stones......	(11)	(4)	(11)	57	(11)	75	(11)	55
Gold (recoverable content of ores, etc.)......troy ounces..	407	14	52	2	762	27	573	20
Gypsum......thousand short tons..	7	30	22	89	11	46	(4)	(4)
Iron ore (usable)......thousand long tons, gross weight..	458	(4)	749	(4)	650	(4)	736	(4)
Natural gas......million cubic feet..	71,068	5,970	77,819	6,615	84,398	7,258	[6] 90,000	[6] 8,400
Natural-gas liquids:								
Natural gasoline......thousand gallons..	47,082	3,137	40,290	2,775	48,859	3,160	47,709	2,866
LP-gases......do....	46,084	2,128	46,106	1,961	49,838	2,337	57,805	2,566
Petroleum (crude)......thousand 42-gallon barrels..	93,533	229,160	99,483	239,750	104,830	255,785	[6] 106,616	[6] 283,599
Phosphate rock......thousand long tons..	(4)	(4)	55	345	119	721	18	121
Pumice......thousand short tons..	(4)	(4)	(4)	(4)	46	38	49	41
Rare-earth metals concentrates......							2	5
Sand and gravel......thousand short tons..	4,164	2,682	3,952	3,978	3,904	2,935	2,425	1,905
Sodium carbonate (natural)......	(4)	(4)	(4)	(4)	337,851	8,345	(4)	(4)
Stone......thousand short tons..	1,616	1,665	1,303	2,034	1,333	2,076	1,291	2,266
Sulfur, recovered elemental......long tons..	113,101	2,978	120,697	3,206	121,161	3,214	107,366	2,767
Tungsten ore and concentrate .60-percent WO_3 basis......					2	7		
Uranium ore......					[12] 156,509	[12] 2,765	274,699	4,669
Value of items that cannot be disclosed: Cement, fire clay (1957), silver, sodium sulfate, vanadium, and values indicated by footnote 4......		12,827		14,983		7,824		17,527
Total Wyoming [8]......		281,306		297,752		[13] 317,594		345,604

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes Alaska and Hawaii.
[3] Excludes pozzolan cement and slag, value for which is included with "Items that cannot be disclosed."
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Excludes certain clays, value for which is included with "Items that cannot be disclosed."
[6] Preliminary figure.
[7] Excludes certain stone, value included with "Items that cannot be disclosed."
[8] Total adjusted to eliminate duplication in the value of clays and stone.
[9] Less than 1,000 short tons.
[10] Less than $1,000.
[11] Weight not recorded.
[12] Revised figure.
[13] Excludes masonry cement, value for which is included with "Items that cannot be disclosed."
[14] Sheet mica only.
[15] Total has been adjusted to eliminate duplication in the value of raw materials used in the manufacture of cement and/or lime.
[16] Beginning with 1957 calcareous marl included with stone.
[17] Excludes natural cement, value for which is included with "Items that cannot be disclosed."
[18] Less than 1,000 long tons.
[19] Final figure. Supersedes preliminary figure given in commodity chapter.
[20] Recoverable zinc valued at the yearly average price of Prime Western slab zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of ore at mine.
[21] Marketable production. Supersedes figures for "sold or used" as previously reported.
[22] Less than 1 ton.
[23] Grinding pebbles and tube-mill liners, weight of millstones not recorded.
[24] Millstones only.
[25] Less than 1,000 troy ounces.
[26] Includes 45,710 short tons of concentrate produced in 1955 and 1956 from low-grade ore and concentrate stockpiled near Coquille, Oregon during World War II.

TABLE 6.—Mineral production [1] in the Canal Zone and islands administered by the United States,[2] 1954–57

Mineral	1954		1955		1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
American Samoa:								
Sand and gravel ... thousand short tons	2	$1	1	$1	---	---	---	---
Stone ... do	58	15	9	4	2	$6	34	$37
Total American Samoa	---	16	---	5	---	6	---	37
Canal Zone:								
Sand and gravel ... thousand short tons	---	---	36	47	40	48	---	---
Stone (crushed) ... do	187	245	169	240	177	230	59	99
Total Canal Zone	---	245	---	287	---	278	---	99
Canton: Stone (crushed) ... thousand short tons	3	5	1	2	2	5	---	---
Guam:								
Sand and gravel ... do	---	---	---	---	19	24	1	1
Stone ... do	843	2,275	1,241	3,352	341	311	1,034	1,132
Total Guam	---	2,275	---	3,352	---	335	---	1,133
Johnston: Stone ... thousand short tons	(3)	(4)	12	33	---	---	---	---
Midway: Stone (crushed) ... do	(3)	2	---	---	203	304	3,875	6,700
Virgin Islands: Stone (crushed) ... do	4	17	1	5	12	32	11	31
Wake: Stone (crushed) ... do	1	1	1	3	22	22	5	6

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Production data for Canton and Wake furnished by the U. S. Department of Commerce, Civil Aeronautics Administration; Midway and Johnston, by the U. S. Department of the Navy; Guam by the Government of Guam; American Samoa, by the Government of American Samoa.
[3] Less than 1,000 short tons.
[4] Less than $1,000.

TABLE 7.—Mineral production [1] in the Commonwealth of Puerto Rico, 1954–57

Mineral	1954		1955		1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
Cement ... thousand 376-pound barrels	3,682	$9,663	4,117	$12,507	4,255	$14,065	5,552	$17,232
Clays ... thousand short tons	(2)	(2)	137	122	143	129	159	140
Lime ... do	8	199	10	254	(2)	(2)	(2)	(2)
Salt (common) ... do	9	98	10	112	10	101	10	104
Sand and gravel ... do	375	834	433	679	183	192	497	754
Stone ... do	[3] 1,752	[3] 2,493	1,784	2,516	2,076	2,556	2,452	3,505
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 2	-----	154	-----	-----	-----	195	-----	180
Total Puerto Rico [4]	-----	12,381	-----	14,917	-----	16,395	-----	20,265

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

TABLE 8.—Principal minerals imported for consumption in the United States, 1956–57

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

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
METALS				
Aluminum:				
Metal	216,401	$100,137	222,158	[1] $107,336
Scrap	25,992	[1] 10,770	16,271	[1] 5,396
Plates, sheets, bars, etc	22,582	[1] 16,480	19,633	[1] 15,099
Antimony:				
Ore (antimony content)	6,572	1,762	8,198	1,973
Needle or liquated	46	23	38	17
Metal	4,321	2,245	5,412	2,587
Oxide	1,479	636	1,893	790
Arsenic: White	6,422	745	10,135	794
Bauxite:				
Crude	[2] 5,669,833	44,414	[2] 7,100,998	60,951
Calcined:				
When imported for manufacture of fire brick ......long tons	138,716	3,198	67,172	1,522
Other ......do	9,960	221	50	([3])
Beryllium ore	12,371	4,459	7,290	2,526
Bismuth ......pounds	924,614	1,830	837,603	[1] 1,598
Boron carbide ......do	93,675	172	74,162	123
Cadmium:				
Metal ......do	3,115,638	4,640	1,585,547	2,424
Flue dust (cadmium content) ......do	1,451,889	876	1,399,851	837
Calcium:				
Metal ......do	8,387	10	24,204	[1] 39
Chloride	1,855	60	1,989	77
Chromate:				
Ore and concentrates (Cr_2O_3 content)	919,255	49,350	982,889	55.661
Ferrochrome (chromium content)	[4] 25,978	[4] 11,403	30,910	14.460
Metal	409	[1] 687	1,354	[1] 2,748
Cobalt:				
Alloy (cobalt content) ......pounds	2,013,463	([5])	816,501	([5])
Ore (cobalt content ......do	5,839	3	15,179	20
Metal ......do	12,974.393	32,910	[6] 16,240,327	[6] 32,559
Oxide (gross weight) ......do	828,450	[1] 1,413	646,750	853
Salts and compounds (gross weight) ......do	397,711	247	364,381	179
Columbium ore ......do	5,699,553	8,387	3,348,706	3,038
Copper (copper content):				
Ore	6,089	4,049	20,940	12,212
Concentrates	74,651	54,514	62,398	34,275
Regulus, black, coarse	5,198	4,395	5,324	3,196
Unrefined, black, blister	276,085	[1] 225.932	301,182	179,440
Refined in ingots, etc	191,812	157,944	162,309	97.025
Old and scrap	5,410	[1] 3,463	5,801	[1] 3,039
Old brass and clippings	4,310	[1] 3,003	4,643	[1] 2,393
Ferroalloys: Ferrosilicon (silicon content)	5,005	1,737	3,813	1,679
Gold:				
Ore and base bullion ......troy ounces	1,197,136	41,785	1,185,917	41,474
Bullion ......do	2,532,611	90,882	6,515,253	231,167
Iron ore:				
Ore ......long tons	[4] 30,410,652	[4] 250,490	33,653,048	285,060
Pyrites cinder ......do	1,430	6	567	[1] 2
Iron and steel:				
Pig iron	326,700	17,842	225,387	13,528
Iron and steel products (major):				
Semimanufactures	[4] 382,754	[1] 44,005	282,830	33,624
Manufactures	[4] 1,096.077	[1,4] 161,233	1,011,392	170,866
Scrap	222,936	[1] 10,381	203.407	9,078
Tin-plate scrap	32,633	[1] 932	35,203	1,072
Lead:				
Ore; flue dust, matte (lead content)	191,302	50,621	228,783	60,459
Base bullion (lead content)	31	11	25	8
Pigs and bars (lead content)	262,204	[1] 77,719	327,236	86,937
Reclaimed, scrap, etc (lead content)	20,464	[1] 5,268	7,610	[1] 1,646
Sheets, pipe, and shot	7,654	[1] 2,017	5,917	[1] 1,377
Babbitt metal and solder (lead content)	2,526	[1] 3,381	2,100	[1] 3,049
Type metal and antimonial lead (lead content)	8,500	2,763	4,858	1,527
Manufactures	235	[1] 184	659	[1] 360

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1956–57—Continued

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
METALS—continued				
Magnesium:				
Metallic and scrap	630	$304	982	[1] $480
Alloys (magnesium content)	24	203	35	283
Sheets, tubing, ribbons, wire and other forms (magnesium content)	2	[4] 9	8	17
Manganese:				
(Ore (35 percent or more manganese) (manganese content)	[4] 1,007,240	[4] 69,726	1,167,112	96,699
Ferromanganese (manganese content)	123,953	[4] 28,500	257,821	60,232
Spiegeleisen, less than 30 percent manganese, more than 1 percent carbon	234	18		
Mercury:				
Compounds ... pounds	27,985	[1] 100	19,221	[1] 68
Metal ... 76 pound flasks	47,316	11,010	42,005	9,333
Minor metals: Selenium and salts ... pounds	234,969	[1] 3,452	172,678	1,904
Molybdenum: Ore and concentrates (molybdenum content) ... do			27,461	55
Nickel:				
Ore and matte	12,820	4,592	13,177	5,202
Pigs, ingots, shot, cathodes	106,534	[1] 152,409	99,676	156,213
Scrap	1,078	[1] 1,479	410	573
Oxide	32,955	31,776	37,080	42,925
Platinum group:				
Unrefined materials:				
Ore and concentrates ... troy ounces			1,572	119
Grains and nuggets, including crude, dust, and residues ... troy ounces	34,016	2,854	26,628	1,960
Sponge and scrap ... do	[4] 6,234	[4] 551	2,129	160
Osmiridium ... do	971	56	2,851	168
Refined metal:				
Platinum ... do	[4] 436,757	[4] 40,982	306,195	25,141
Palladium ... do	530,686	[1] 10,958	327,558	6,303
Iridium ... do	2,323	203	1,431	109
Osmium ... do	347	25	126	9
Rhodium ... do	20,323	2,039	16,629	[1] 1,688
Ruthenium ... do	2,220	87	1,864	75
Radium:				
Radium salts ... milligrams	43,221	633	76,206	1,061
Radioactive substitutes	(7)	[1] 514	(7)	[1] 844
Rare earths: Ferrocerium and other cerium alloy ... pounds	12,536	40	7,948	[1] 26
Silver:				
Ore and base bullion ... troy ounces	63,125,065	52,900	99,925,905	78,260
Bullion ... do	99,706,716	75,209	106,192,994	79,400
Tantalum: Ore ... pounds	1,312,865	1,180	828,265	949
Tin:				
Ore (tin content) ... long tons	16,688	32,317	94	118
Blocks, pigs, grains, etc ... do	62,590	136,412	56,183	121,311
Dross, skimmings, scrap, residues, and tin alloys n.s.p.f ... pounds	11,364,288	[1] 9,430	11,382,988	9,488
Tinfoil, powder, flitters, etc	(7)	[1] 605	(7)	[1] 561
Titanium:				
Ilmenite	359,281	[1] 9,198	460,353	[1] 10,317
Rutile	48,906	7,148	84,837	11,843
Metal ... pounds	4,095,621	9,509	7,064,672	16,722
Ferrotitanium ... do	225,967	92	256,000	100
Compounds and mixtures ... do	1,387,548	[1] 354	135,116	[1] 79
Tungsten (tungsten content):				
Ore and concentrates ... do	20,860,153	[1] 58,011	14,018,140	[1] 34,525
Metal ... do	37,456	119	82,617	[1] 239
Ferrotungsten ... do	870,621	1,945	414,877	674
Other ... do	146,653	[1] 328	66,955	[1] 112
Zinc:				
Ores (zinc content)	462,379	49,231	679,322	88,491
Blocks, pigs, and slabs	244,726	65,034	268,852	[1] 64,057
Sheets	454	172	732	245

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1956–57—Continued

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
METALS—continued				
Zinc—Continued				
Old, dross, and skimmings	602	$97	590	$89
Dust	72	[1] 18	112	[1] 28
Manufactures	(7)	[1] 287	(7)	[1] 264
Zirconium: Ore, including zirconium sand	31,140	792	41,692	1,142
NONMETALS				
Abrasives: Diamonds (industrial) ... carats	[4] 16,413,281	[1] [4] 74,322	12,570,343	[1] 51,145
Asbestos	[4] 689,910	[1] [4] 61,939	682,732	[1] 60,140
Barite:				
Crude and ground	589,421	[1] [4] 3,615	833,049	[1] 5,875
Witherite	2,934	110	3,029	138
Chemicals	4,956	[1] 467	5,369	[1] 502
Bromine ... pounds	2,918	135	1,512	38
Cement ... 376-pound barrels	4,456,120	[1] 14,189	4,426,297	[1] 14,819
Clays:				
Raw	172,244	[1] 2,873	159,866	[1] 2,859
Manufactured	3,617	[1] 98	2,967	79
Cryolite	23,122	2,901	32,712	4,022
Feldspar: Crude ... long tons	258	9	72	7
Fluorspar	485,552	[1] 11,225	631,367	[1] 16,031
Gem stones:				
Diamonds ... carats	[4] 1,869,974	[1] [4] 162,012	1,612,471	[1] 142,560
Emeralds ... do	50,931	[1] 1,688	37,245	[1] 1,595
Other	(7)	[1] 24,009	(7)	[1] 24,417
Graphite	47,888	[1] 2,594	41,530	2,107
Gypsum:				
Crude, ground, calcined	[4] 4,347,281	[1] 7,853	4,335,337	[1] 7,604
Manufactures	(7)	[1] 693	(7)	[1] 911
Iodine, crude ... pounds	1,704,868	2,180	2,685,489	2,769
Jewel bearings ... number, thousands	54,800	[1] 2,456	70,127	[1] 2,780
Kyanite	6,951	306	5,999	263
Lime:				
Hydrated	757	12	245	5
Other	31,903	549	39,002	687
Dead-burned dolomite	9,031	587	10,419	640
Magnesium:				
Magnesite	102,765	6,446	80,638	4,298
Compounds	13,423	[1] 497	12,582	510
Mica:				
Uncut sheet and punch ... pounds	1,958,907	[1] 3,748	1,841,840	[1] 3,359
Scrap	7,218	79	5,187	57
Manufactures	5,411	[1] 7,926	5,766	[1] 8,032
Mineral-earth pigments: Iron oxide pigments:				
Natural	3,168	138	3,079	[1] 125
Synthetic	5,997	[1] 879	7,033	[1] 1,046
Ocher, crude and refined	206	12	203	12
Siennas, crude and refined	722	[1] 71	676	56
Umber, crude and refined	2,762	89	1,944	[1] 65
Vandyke brown	200	12	139	10
Nitrogen compounds (major)	1,473,260	[1] 67,431	1,402,427	[1] 58,308
Phosphate, crude ... long tons	109,891	2,626	109,546	3,090
Phosphatic fertilizers ... do	32,251	1,906	29,175	[1] 2,246
Pigments and salts:				
Lead pigments and salts	5,851	[1] 1,530	8,565	1,912
Zinc pigments and salts	5,793	[1] 1,146	6,967	1,336
Potash	[4] 333,951	[1] 12,018	338,690	[1] 11,823
Pumice:				
Crude or unmanufactured	19,487	111	35,182	291
Whole or partly manufactured	1,315	51	2,124	[1] 70
Manufactures, n. s. p. f.	(7)	[1] 8	(7)	[1] 14
Quartz crystal (Brazilian pebble) ... pounds	1,166,460	1,249	1,546,236	729
Salt	368,212	[1] 2,354	654,149	[1] 3,546
Sand and gravel:				
Glass sand	478	393	683	621
Other sand	332,031	[1] 454	290,280	[1] 437
Gravel	179	(3)	14,877	[1] 22

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1956–57—Continued

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
NONMETALS—continued				
Sodium sulfate	103,249	$2,174	74,111	$1,511
Stone	(7)	7,609	(7)	[1] 8,504
Strontium: Mineral	9,439	192	6,525	131
Sulfur and pyrites:				
Sulfur:				
Ore ... long tons	14,750	359	14,454	350
Other forms, n. e. s ... do	[4] 197,479	4,975	481,214	[1] 11,882
Pyrites ... do	[8] 73,296	[1 8] 480	[8] 70,632	[1 8] 408
Talc: Unmanufactured	23,351	[1] 749	20,395	[1] 701
COAL, PETROLEUM, AND RELATED PRODUCTS				
Asphalt and related bitumen	4,116	99	3,972	104
Carbon black:				
Acetylene black ... pounds	8,373,224	1,383	7,571,116	1,342
Gas black and carbon black ... do	69,890	[1] 8	20	(3)
Coal:				
Anthracite	46	(3)	1,138	9
Bituminous, slack, culm, and lignite	355,701	[1] 2,885	366,506	[1] 3,146
Briquets	318	4	850	10
Coke	130,955	[1] 1,471	117,951	[1] 1,544
Peat:				
Fertilizer grade	233,394	[1] 9,764	236,370	[1] 10,700
Poultry and stable grade	14,295	[1] 766	10,389	[1] 587
Petroleum:				
Crude ... thousand barrels	354,727	[1 4] 837,626	386,209	[1] 980,893
Gasoline [9] ... do	9,311	[1] 40,506	11,483	48,202
Kerosine ... do	231	[1] 896	125	537
Distillate oil [10] ... do	5,572	[1] 17,908	9,148	[1] 31,277
Residual oil [11] ... do	[4] 165,756	[4] 366,448	176,021	464,960
Unfinished oils ... do	4,561	12,499	1,588	4,578
Asphalt (liquid and solid) ... do	3,602	8,768	6,419	16,749
Miscellaneous ... do	(3)	[1] 34	(3)	[1] 44

[1] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable to years before 1954.
[2] Adjusted by the Bureau of Mines.
[3] Less than 1,000.
[4] Revised figure.
[5] Data not available.
[6] Includes 4,903 pounds of scrap ($1,698).
[7] Weight not recorded.
[8] In addition to data shown an estimated 292,520 long tons ($865,020) was imported in 1956 and 282,400 long tons ($889,100) in 1957.
[9] Includes naphtha but excludes benzol, 1956—1,656,000 barrels ($17,813,000); 1957—1,317,212 barrels ($14,516,000).
[10] Includes quantities imported free of duty for supplies of vessels and aircraft.
[11] Includes quantities imported free for manufacture in bond and export, and for supplies of vessels and aircraft.

TABLE 9.—Principal minerals and products exported from the United States, 1956–57

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

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
METALS				
Aluminum:				
Ingots, slabs, crude	[1] 34,618	[1] $19,109	27,982	$14,051
Scrap	19,329	8,127	18,166	6,435
Plates, sheets, bars, etc	12,493	13,093	13,767	13,179
Castings and forgings	1,247	3,094	1,333	3,064
Antimony: Metals and alloys, crude	33	24	4	3
Arsenic: Calcium arsenate ... pounds	628,020	52	2,779,954	201
Bauxite, including bauxite concentrates ... long tons	14,921	834	60,993	4,847
Aluminum sulfate	16,130	583	19,689	834
Other aluminum compounds	22,452	3,183	48,390	5,251
Beryllium ... pounds	89,558	260	208,771	260
Bismuth:				
Metals and alloys ... do	287,092	559	158,393	213
Salts and compounds ... do	51,251	182	31,703	144
Cadmium ... do	1,284,248	1,932	692,758	1,060
Calcium chloride	32,523	1,057	47,965	1,628
Chrome:				
Ore and concentrates:				
Exports	1,727	99	837	53
Reexports	12,990	502	4,872	194
Chromic acid	637	351	674	388
Ferrochrome	5,538	2,891	4,535	2,419
Cobalt ... pounds	3,025,142	1,820	1,068,731	947
Columbium metals, alloys, and other forms ... do	10,500	9	59,241	47
Copper:				
Ores, concentrates, composition metal, and unrefined copper (copper content)	13,717	11,648	15,656	9,964
Refined copper and semimanufactures	280,575	253,615	430,446	288,936
Other copper manufactures	185	291	238	321
Copper sulfate or blue vitriol	30,177	8,036	33,644	6,534
Copper base alloys	(2)	54,847	(2)	56,371
Ferroalloys:				
Ferrosilicon ... pounds	4,229,074	483	5,297,681	502
Ferrophosphorus ... do	150,821,010	2,339	100,635,032	1,901
Gold:				
Ore and base bullion ... troy ounces	19,962	710	23,953	834
Bullion, refined ... do	713,900	25,851	4,781,780	167,498
Iron ore ... long tons	[1] 5,508,296	[1] 48,805	5,002,153	49,302
Iron and steel:				
Pig iron	[1] 269,477	[1] 15,084	882,342	57,202
Iron and steel products (major):				
Semimanufactures	[1] 3,026,901	[1] 496,688	3,395,118	574,548
Manufactured steel mill products	[1] 1,721,854	[1] 395,393	2,521,622	579,236
Advanced products	(2)	[1] 167,011	(2)	169,140
Iron and steel scrap: Ferrous scrap, including rerolling materials	[1] 6,446,463	[1] 300,620	6,746,314	328,703
Lead:				
Ore, matte, base bullion (lead content)	1,055	340	906	257
Pigs, bars, anodes	4,628	1,300	4,339	1,345
Scrap	2,136	578	885	215
Magnesium:				
Metal and alloys	3,388	2,240	1,208	1,114
Semifabricated forms, n. e. c	487	902	355	768
Powder	56	99	22	39
Manganese:				
Ore and concentrates	6,133	664	5,270	724
Ferromanganese	2,248	682	7,395	1,866
Mercury:				
Exports ... 76-pound flasks	1,080	284	1,919	484
Reexports ... do	2,025	476	3,275	763
Molybdenum:				
Ores and concentrates ... pounds	17,981,007	21,296	25,465,515	32,428
Metals and alloys, crude and scrap ... do	35,240	21	98,513	182
Wire ... do	11,440	202	13,750	231
Semifabricated forms, n. e. c ... do	4,853	28	4,289	49
Powder ... do	20,735	44	28,222	43
Ferromolybdenum ... do	944,671	1,052	383,271	447

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1956–57—Continued

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
METALS—continued				
Nickel:				
Ore	27,331	$556		
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc	16,361	18,019	12,756	$14,089
Nickel-chrome electric resistance wire	208	836	151	632
Semifabricated forms, n. e. c	626	1,878	508	1,797
Platimum:				
Bars, ingots, sheets, wire, sponge, and other forms including scrap troy ounces	23,823	2,383	17,199	1,329
Palladium, rhodium, iridium, osmiridium, ruthenium and osmium metals and alloys, including scrap troy ounces	18,249	634	23,155	374
Platinum group manufactures except jewelry	(2)	2,489	(2)	1,960
Radium metal (radium content) milligrams			750	7
Rare earths:				
Cerium ores, metal and alloy pounds	23,784	79	13,270	33
Lighter flints do	16,303	110	3,372	24
Silver:				
Ore and base bullion troy ounces	2,058,401	1,868	1,372,682	1,246
Bullion, refined do	3,442,479	3,154	8,926,674	8,238
Tantalum:				
Ore, metal, and other forms pounds	3,647	115	4,877	252
Powder do	6,080	245	5,997	228
Tin:				
Ingots, pigs, bars, etc.:				
Exports long tons	[1] 439	[1] 821	1,112	1,526
Reexports do	451	1,018	419	919
Tin scrap and other tin bearing material except tinplate scrap long tons	[1] 4,604	[1] 2,324	9,545	3,911
Tin cans finished or unfinished do	30,502	13,245	30,166	14,309
Tin compounds pounds	375,021	672	489,227	867
Titanium:				
Ores and concentrates	1,838	312	2,019	276
Sponge (including iodide titanium) and scrap	14	60	71	78
Intermediate mill shapes	469	5,509	698	7,174
Mill products n. e. c	90	2,796	81	2,230
Ferrotitanium	364	148	367	130
Dioxide and pigments	64,766	25,137	52,960	19,687
Tungsten: Ore and concentrates:				
Exports	117	225	164	227
Reexports	349	778	572	724
Vanadium ore and concentrates (vanadium content) pounds	[1] 1,856,594	[1] 4,046	1,000,340	2,115
Zinc:				
Ores and concentrates (zinc content)	854	162	7	(3)
Slabs, pigs, or blocks	8,813	2,465	10,785	2,553
Sheets, plates, strips or other forms, n. e. c	4,444	3,031	4,056	2,950
Scrap (zinc content)	14,921	1,540	5,469	822
Dust	372	136	595	195
Semifabricated forms, n. e. c	582	301	485	247
Zirconium:				
Ores and concentrates	1,048	90	3,160	315
Metals and alloys and other forms pounds	18,987	200	66,784	384
NONMETALS				
Abrasives:				
Grindstones pounds	859,231	64	660,057	54
Diamond dust and powder carats	210,841	616	199,252	622
Diamond grinding wheels do	187,438	948	194,934	1,135
Other natural and artificial metallic abrasives and products	(2)	25,217	(2)	25,777
Asbestos: Unmanufactured:				
Exports	2,797	338	2,775	340
Reexports	153	37	118	10
Boron: Boric acid, borates, crude and refined pounds	487,450,563	16,596	428,994,042	15,975
Bromine, bromides, and bromates do	6,111,363	2,557	10,510,719	3,053
Cement 376-pound barrels	[1] 1,980,804	[1] 7,292	1,330,520	5,322

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1956–57—Continued

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
NONMETALS—continued				
Clay:				
Kaolin or china clay	59,138	$1,298	54,879	$1,327
Fire clay	[1] 152,109	[1] 1,573	136,819	1,794
Other clays	[1] 299,687	[1] 9,722	292,921	10,407
Cryolite	213	58	165	55
Fluorspar	197	31	754	81
Graphite:				
Amorphous	790	90	902	93
Crystalline flake, lump, or chip	147	47	167	57
Natural, n. e. c.	125	24	280	75
Gypsum:				
Crude, calcined, crushed	20,757	711	24,447	763
Plasterboard, wallboard, and tile..square feet	7,026,932	364	8,866,572	520
Manufactures, n. e. c.	(2)	141	(2)	62
Iodine, iodide, iodates..pounds	505,274	750	232,973	335
Kyanite and allied minerals	1,331	63	2,588	130
Lime	82,737	1,546	65,195	1,329
Mica:				
Unmanufactured..pounds	546,673	92	911,006	46
Manufactured:				
Ground and pulverized..do	8,901,497	486	9,256,170	521
Other..do	343,159	1,139	541,432	983
Mineral-earth pigments: Iron oxide, natural and manufactured	5,071	909	3,675	1,038
Nitrogen compounds (major)	1,038,307	53,090	1,126,789	52,926
Phosphate rock..long tons	2,880,484	25,704	3,126,215	28,189
Phosphatic fertilizers..do	504,612	[1] 17,921	575,387	24,705
Pigments and salts (lead and zinc):				
Lead pigments	[1] 3,034	[1] 1,129	3,953	1,422
Zinc pigments	4,135	1,087	4,135	1,163
Lead salts	1,282	576	608	231
Potash:				
Fertilizer	390,716	13,705	459,699	16,096
Chemical	6,839	1,232	7,796	1,410
Quartz crystal (raw)	(2)	65	(2)	153
Radioactive isotopes, etc	(2)	906	(2)	1,367
Salt:				
Crude and refined	336,320	2,464	390,707	2,591
Shipments to noncontiguous Territories	11,649	881	10,975	857
Sodium and sodium compounds:				
Sodium sulfate	[1] 29,933	[1] 1,037	23,667	859
Sodium carbonate	[1] 241,948	[1] 8,219	173,756	6,282
Stone:				
Limestone, crushed, ground, broken	1,060,560	1,359	1,080,460	1,640
Marble and other building and monumental..cubic feet	344,210	976	415,903	1,158
Stone, crushed, ground, broken	175,364	2,890	129,559	2,699
Manufactures of stone	(2)	377	(2)	506
Sulfur:				
Crude..long tons	[1] 1,651,307	[1] 48,305	1,562,301	43,438
Crushed, ground, flowers of..do	[1] 24,024	[1] 1,777	17,420	1,528
Talc:				
Crude and ground	42,333	1,009	39,985	1,127
Manufactures, n. e. c.	69	74	291	138
Powders-talcum (face and compact)	(2)	1,371	(2)	1,322
COAL, PETROLEUM, AND RELATED PRODUCTS				
Asphalt and bitumen, natural:				
Unmanufactured	30,844	1,845	30,792	1,878
Manufactures, n. e. c.	(2)	937	(2)	885
Carbon black..thousand pounds	425,328	36,105	459,671	40,468
Coal:				
Anthracite	5,244,349	73,535	4,331,785	65,012
Bituminous	[1] 68,552,629	[1] 658,537	76,342,312	763,672
Briquets	107,452	1,716	86,464	1,383
Coke	655,717	11,468	822,244	14,356

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1956–57—Continued

Mineral	1956		1957	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
COAL, PETROLEUM, AND RELATED PRODUCTS—con.				
Petroleum:				
Crude ... thousand barrels	[1] 28,624	[1] $90,336	50,203	$173,206
Gasoline [4] ... do	28,202	191,233	30,792	206,914
Kerosine ... do	2,876	12,323	4,914	21,780
Distillate oil ... do	[1] 31,926	[1] 122,149	45,071	182,163
Residual oil ... do	22,147	[1] 52,812	32,875	95,951
Lubricating oil ... do	13,217	193,579	13,193	194,830
Asphalt ... do	1,294	7,478	1,545	9,992
Liquefied petroleum gases ... do	4,274	16,214	4,538	21,100
Wax ... do	920	20,851	1,023	22,741
Coke ... do	6,376	20,323	5,176	20,970
Petrolatum ... do	307	6,195	270	5,962
Miscellaneous products ... do	851	16,967	1,032	18,480

[1] Revised figure.
[2] Weight not recorded.
[3] Less than $1,000.
[4] Includes naphtha but excludes benzol: 1956—64,740 barrels ($1,114,968); 1957—64,158 barrels ($1,154,633).

TABLE 10.—Comparison of world and United States [1] production of principal metals and minerals, 1956–57

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

Mineral	1956			1957		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Coal:						
Bituminous	1,701,042	497,997	29	1,751,809	492,704	28
Lignite	621,868	2,878	(2)	657,596	2,638	(2)
Pennsylvania anthracite	156,200	28,900	19	157,700	25,338	16
Coke (excluding breeze):						
Gashouse [3]	52,812	182	(2)	51,645	(4)	(4)
Oven and beehive	282,556	74,483	26	294,475	75,951	26
Fuel briquets and packaged fuel	119,400	1,584	1	121,800	1,152	(2)
Natural gas ... million cubic feet	(5)	10,081,923	(5)	(5)	(5)	(5)
Peat	58,990	292	(2)	70,300	316	(2)
Petroleum (crude) ... thousand barrels	6,124,171	2,617,283	43	6,440,350	2,616,778	41
Nonmetals:						
Asbestos	1,970	41	2	2,050	44	2
Barite	3,100	1,352	44	3,300	1,305	40
Cement ... thousand barrels	1,377,428	333,472	24	1,443,993	313,756	22
Corundum	11	----	----	10	----	----
Diamonds ... thousand carats	18,300	----	----	20,800	----	----
Diatomite	760	368	48	750	368	49
Feldspar [6] ... thousand long tons	1,230	693	56	1,160	612	53
Fluorspar	1,790	330	18	1,775	329	19
Graphite	270	(4)	(4)	320	(4)	(4)
Gypsum	35,520	10,316	29	33,900	9,195	27
Magnesite	5,100	687	13	5,300	678	13
Mica (including scrap) thousand pounds	310,000	173,506	56	350,000	185,646	53
Nitrogen, agricultural [6 7]	7,385	2,178	29	7,826	2,230	28
Phosphate rock ... thousand long tons	33,750	15,747	47	32,350	13,976	43
Potash ... K_2O equivalent	8,300	2,172	26	8,700	2,266	26

See footnotes at end of table.

TABLE 10.—Comparison of world and United States [1] production of principal metals and minerals, 1956–57—Continued

Mineral	1956 World	1956 United States		1957 World	1957 United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Nonmetals—Continued						
Pumice	8,700	1,482	17	8,400	1,827	22
Pyrites ... thousand long tons	17,300	1,070	6	17,000	1,067	6
Salt	74,000	24,216	33	77,400	23,854	31
Strontium [6]	18	4	22	11	(4)	(4)
Sulfur, native ... thousand long tons	8,000	6,484	81	7,300	5,579	76
Talc, pyrophyllite, and soapstone	1,935	739	38	1,875	684	36
Vermiculite [6]	255	193	76	249	184	74
Metals:						
Mine basis:						
Antomony (content of ore and concentrate) [6]	55	(8)	1	53	(8)	1
Arsenic [6]	47	12	26	47	10	21
Bauxite ... thousand long tons	17,200	1,743	10	18,700	1,416	8
Beryllium concentrates	13	(9)	4	11	(9)	5
Bismuth ... thousand pounds	5,300	(4)	(4)	4,800	(4)	(4)
Cadmium ... do	19,950	10,604	53	20,430	10,549	52
Chormite	4,400	208	5	4,500	166	4
Cobalt (contained) ... short tons	16,000	1,269	8	15,500	1,649	11
Columbian- tantalum concentrates thousand pounds	9,150	217	2	7,760	368	5
Copper (content of ore and concentrates)	3,780	1,106	29	3,870	1,086	28
Gold ... thousand fine ounces	38,400	1,865	5	39,620	1,800	5
Iron ore ... thousand long tons	390,367	97,849	25	422,135	106,148	25
Lead (content of ore and concentrate)	2,440	353	14	2,540	338	13
Manganese ore (35 percent or more Mn)	12,319	345	3	13,000	366	3
Mercury ... thousand 76-pound flasks	215	24	11	235	33	14
Molybdenum (content of ore and concentrate) ... thousand pounds	63,500	57,462	91	66,800	60,753	91
Nickel (content of ore and concentrate)	283	7	2	314	10	3
Platinum groups (Pt, Pd, etc.) thousand troy ounces	980	21	2	1,190	19	2
Silver ... thousand fine ounces	224,200	38,739	17	228,700	38,720	17
Tin (content of ore and concentrate) ... thousand long tons	192	----------	--------	192	----------	--------
Titanium concentrates:						
Ilmenite	1,792	685	38	1,925	757	39
Rutile	122	12	10	158	11	7
Tungsten concentrate, 60 percent WO_3 ... (short tons)	82,500	14,737	18	72,700	5,520	8
Vanadium (content of ore and concentrate) [6] ... short tons	4,230	3,868	91	4,312	3,691	86
Zinc (content of ore and concentrate)	3,360	542	16	3,420	532	16
Smelter basis:						
Aluminum	3,720	1,679	45	3,730	1,648	44
Copper	3,990	1,231	31	4,040	1,178	29
Iron, pig (incl. ferroalloys)	222,200	77,667	35	232,900	81,144	35
Lead	2,370	542	23	2,490	533	21
Magnesium	157	68	43	168	81	48
Steel ingots and castings	312,600	115,216	37	322,300	112,715	35
Tin ... thousand long tons	193	18	9	186	2	1
Zinc	3,120	984	32	3,230	986	31

1 Including Alaska and noncontiguous Territories.
2 Less than 1 percent.
3 Includes low- and medium-temperature and gashouse coke.
4 Bureau of Mines not at liberty to publish United States figure separately.
5 Data not available.
6 World total exclusive of U. S. S. R.
7 Year ended June 30 of year stated (United Nations).
8 In 1956 United States production of antimony was 630 short tons and in 1957, 709 short tons.
9 In 1956 United States production of beryl was 460 short tons and in 1957, 521 short tons.

Employment and Injuries in the Metal and Nonmetal Industries

By John C. Machisak [1]

THIS CHAPTER of the Minerals Yearbook is confined to employment data and injury experience in the metal, nonmetal, and quarrying industries. Each industry is shown separately, and no attempt has been made to combine the data and show an overall picture for these sections of the mineral industries. Combined statistical data on the mineral industries as a whole are included in volume III.

Since no Federal law requires operators of metal and nonmetal mines to submit reports, the data have been reported on a voluntary basis, and the employment data and injury experience herein are based on reports received in the Branch of Accident Analysis. Response to the canvass has contributed greatly to the promotion of safety in the mineral industries.

METAL MINES

The overall injury experience at metal mines improved in 1957. The combined (fatal and nonfatal) frequency rate of injuries declined 23 percent. Fewer fatal injuries occurred, and the number of nonfatal disabling injuries decreased. Employment declined; 63,700 men were estimated to be working in 1957, while 67,788 were reported working in 1956. The number of active mine days increased by 2, and man-hours of employment declined slightly. The average length of shift worked was 7.98 hours each day, and the average employee worked 2,121 hours during the year.

Copper.—The injury-frequency rate for copper mines improved in 1957. The number of fatal injuries declined by 2; nonfatal injuries were reduced by 198—decreases of 7 and 14 percent, respectively. The combined (fatal and nonfatal) injury-frequency rate declined 15 percent from the rate of 32.43 reported for 1956 to an estimated 27.64 for 1957. A slight increase in the number of men employed and the number of man-hours worked is predicted, with an approximate decline of 9 working days. The length of shift worked was the same as that reported for 1956, and each employee averaged 2,459 hours of worktime.

Gold Placer.—Employment in the placer-gold-mining industry increased slightly in 1957. Nonfatal disabling work injuries decreased, and no fatal injuries are predicted. The average number of men

[1] Chief, Branch of Accident Analysis, Division of Safety.

TABLE 1.—Employment and injury experience at metal mines in the United States, 1931–57

Year	Men working daily	Average active mine days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1931	71,991	232	16,692	138,237	147	7,868	1.06	56.92
1932	46,602	209	9,748	80,213	100	4,486	1.25	55.93
1933	49,338	201	9,913	80,006	87	5,180	1.09	64.75
1934	58,411	219	12,776	100,959	108	7,105	1.07	70.38
1935	83,975	218	18,266	145,134	157	9,393	1.08	64.72
1936	90,552	249	22,521	180,803	195	13,606	1.08	75.25
1937	108,412	252	27,296	219,008	206	17,068	.94	77.93
1938	93,501	227	21,255	170,343	150	11,996	.88	70.42
1939	102,279	233	23,836	189,554	163	12,991	.86	68.53
1940	110,340	241	26,631	211,740	209	13,940	.99	65.84
1941	114,202	254	29,034	230,453	213	14,590	.92	63.31
1942	[1] 99,769	280	27,968	223,093	215	12,420	.96	55.67
1943	87,880	293	25,790	206,242	195	11,533	.95	55.92
1944	70,413	289	20,349	163,027	130	8,894	.80	54.56
1945	61,294	288	17,673	141,295	96	6,922	.68	48.99
1946	65,234	249	16,238	130,406	90	7,345	.69	56.32
1947	71,228	275	19,567	157,024	126	8,293	.80	52.81
1948	71,436	282	20,124	161,516	104	7,631	.64	47.25
1949	71,664	252	18,067	144,368	69	6,940	.48	48.07
1950	68,292	271	18,522	147,765	84	6,611	.57	44.74
1951	71,603	278	19,913	159,417	95	6,824	.60	42.81
1952	74,626	265	19,770	158,649	117	6,684	.74	42.13
1953	72,529	270	19,559	156,605	92	6,164	.59	39.36
1954	66,610	245	16,294	130,488	86	4,994	.66	38.27
1955	65,143	263	17,113	136,950	79	5,837	.58	42.62
1956	67,788	264	17,891	143,398	89	5,287	.62	36.87
1957 [2]	63,700	266	16,929	135,119	60	3,835	.44	28.38

[1] Fluorspar mines, previously included with lead-zinc data for the Mississippi Valley States, now included with nonmetal mines.
[2] Estimate.

working daily increased 4 percent—from 1,539 in 1956 to an estimated 1,600 in 1957. Man-hours increased 10 percent. The average length of shift worked was 8.48 hours, and the average worker accumulated 1,861 hours of worktime during the year.

Gold-Silver Lode.—Employment, as measured by the number of man-hours worked, declined in 1957 in the gold-silver lode mines. The overall injury-frequency rate (fatal and nonfatal) declined 21 percent, with 3 fewer fatalities and 70 fewer nonfatal injuries indicated by the preliminary estimate for these mines. The number of men employed increased slightly, with fewer working days, and each averaged an 8.05-hour shift each day. The average number of hours worked by each man for the year was 1,920.

Iron.—Man-hours worked in the Nation's iron industry were approximately the same as in 1956. The safety record improved, with 7-percent decrease in the combined (fatal and nonfatal) injury-frequency rates per million man-hours worked. There were 9 fewer fatal injuries estimated, and the nonfatal disabling work injuries were reduced by 43. An approximate 8-hour shift is indicated, with 2,079 hours of work for the average employee during the year.

Lead-Zinc.—A decline is indicated in the employment and the number of injuries in the lead-zinc mines for 1957, according to preliminary estimates of the branch. The overall (fatal and nonfatal) injury-frequency rate declined 24 percent. Fatalities were fewer by 4—a 17-percent decrease—and nonfatal injuries were 628 fewer than the number reported for the preceding year—a difference of 41 percent. The figures indicate an average of 2,023 hours for each worker while working a straight 8-hour shift per day.

Miscellaneous Metals.—This group of mines includes those producing antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, pyrite, titanium, tungsten, vanadium-uranium, magnesium, aluminum, and other minor metals. The safety record indicates improvement over that for the preceding year, with employment lower than for 1956. The combined (fatal and nonfatal) injury-frequency rates declined 19 percent. From preliminary

TABLE 2.—Employment and injury experience at metal mines in the United States, by industry groups, 1948–52 (average) and 1953–57

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:								
1948–52 (average)	15,775	299	4,721,969	37,743,235	21	1,281	0.57	33.94
1953	15,894	311	4,941,301	39,488,069	25	1,212	.63	30.69
1954	16,075	281	4,517,342	36,143,133	32	1,115	.89	30.85
1955	17,000	299	5,091,275	40,499,892	26	1,482	.64	36.59
1956	18,147	317	5,755,581	45,980,991	28	1,463	.61	31.82
1957 [1]	19,000	308	5,849,000	46,717,000	26	1,265	.56	27.08
Gold placer:								
1948–52 (average)	3,167	219	692,778	5,644,826	1	180	.18	31.89
1953	2,588	212	549,897	4,397,978	1	188	.23	42.75
1954	2,049	215	440,289	3,519,582	1	84	.28	23.87
1955	1,301	214	278,525	2,367,916	--------	132	--------	55.75
1956	1,539	206	317,416	2,697,505	--------	138	--------	51.16
1957 [1]	1,600	219	351,000	2,977,000	--------	55	--------	18.47
Gold-silver:								
1948–52 (average)	4,721	260	1,229,574	9,600,662	12	1,034	1.25	107.70
1953	3,214	254	817,573	6,529,816	6	680	.92	104.14
1954	3,011	257	773,283	6,185,439	6	593	.97	95.87
1955	2,894	266	770,659	6,160,793	10	485	1.62	78.72
1956	2,146	259	555,623	4,444,901	4	285	.90	64.12
1957 [1]	2,200	239	525,000	4,224,000	1	215	.24	50.90
Iron:								
1948–52 (average)	28,994	265	7,685,307	61,707,151	27	1,211	.44	18.65
1953	30,862	270	8,335,343	66,839,538	19	1,131	.28	16.92
1954	27,840	220	6,131,671	49,177,496	14	713	.28	14.50
1955	24,954	245	6,105,392	48,940,671	15	776	.31	15.86
1956	26,817	234	6,281,453	50,376,278	19	723	.38	14.35
1957 [1]	24,200	262	6,345,000	50,322,000	10	680	.20	13.51
Lead-zinc:								
1948–52 (average)	15,549	261	4,065,086	32,498,277	26	2,721	.80	83.74
1953	13,503	248	3,341,999	26,727,287	30	2,135	1.12	79.88
1954	10,755	256	2,754,503	22,038,722	19	1,421	.86	64.48
1955	11,656	256	2,983,694	23,880,106	16	1,583	.67	66.29
1956	11,041	269	2,966,982	23,745,126	23	1,548	.97	65.19
1957 [1]	9,200	253	2,327,000	18,616,000	19	920	1.02	49.42
Miscellaneous: [2]								
1948–52 (average)	3,317	267	884,643	7,148,813	6	510	.83	71.34
1953	6,468	243	1,573,139	12,622,249	11	818	.87	64.81
1954	6,880	244	1,676,576	13,424,116	14	1,068	1.04	79.56
1955	7,338	257	1,883,635	15,100,849	12	1,379	.79	91.32
1956	8,098	249	2,014,132	16,153,347	15	1,130	.93	69.95
1957 [1]	7,500	204	1,532,000	12,263,000	4	700	.33	57.08
Total:								
1948–52 (average)	71,523	269	19,279,357	154,342,964	93	6,937	.60	44.95
1953	72,529	270	19,559,252	156,604,937	92	6,164	.59	39.36
1954	66,610	245	16,293,664	130,488,488	86	4,994	.66	38.27
1955	65,143	263	17,113,180	136,950,227	79	5,837	.58	42.62
1956	67,788	264	17,891,187	143,398,148	89	5,287	.62	36.87
1957 [1]	63,700	266	16,929,000	135,119,000	60	3,835	.44	28.38

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

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estimates, fatal and nonfatal injuries for 1957 indicate a reduction from 1956. Approximately the same length of shift was worked, and the average worker accumulated 1,635 hours of worktime during the year.

NONMETAL MINES (EXCEPT STONE QUARRIES)

Nonmetal mines include those producing abrasives, asbestos, asphalt, barite, feldspar-mica-quartz, fluorspar, gypsum, magnesite, phosphate rock, potash, salt, sulfur, talc and soapstone, and minor nonmetals. A decline is indicated by preliminary estimates on employment data and injury experience for these mines. A drop is shown in both the fatal and the nonfatal injuries, and the overall (fatal and nonfatal) injury-frequency rate decreased 6 percent. The length of shift worked in 1957 was approximately the same as in 1956. The average nonmetal-mine worker had 2,045 hours of work to his credit.

Nonmetal Mills.—Employment in nonmetal mills increased in 1957 in both the number of men employed and in the man-hours worked. Disabling work injuries increased in the fatal group; the nonfatal group decreased, however, resulting in a 24-percent decline in the combined (fatal and nonfatal) injury-frequency rates. The average worker accumulated 2,223 hours during the year while working a 7.97-hour daily shift.

TABLE 3.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1931–57

Year	Men working daily	Average active mine days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1931	8,949	227	2,029	17,941	11	841	0.61	46.88
1932	6,686	201	1,347	11,825	7	528	.59	44.65
1933	7,678	225	1,729	14,134	8	745	.57	52.71
1934	8,234	236	1,947	15,187	8	787	.53	51.82
1935	8,339	250	2,086	16,168	7	813	.43	50.28
1936	10,380	259	2,689	21,556	4	1,044	.19	48.43
1937	10,017	256	2,561	20,536	13	987	.63	48.06
1938	9,526	236	2,251	17,827	6	726	.34	40.72
1939	9,630	228	2,196	17,281	10	719	.58	41.61
1940	9,780	247	2,416	18,988	14	826	.74	43.50
1941	11,088	263	2,920	23,225	17	1,182	.73	50.89
1942	[1] 12,677	274	3,473	28,093	22	1,537	.78	54.71
1943	12,713	269	3,426	27,999	25	1,471	.89	52.54
1944	11,261	282	3,173	25,760	17	1,283	.66	49.81
1945	10,371	291	3,016	24,613	16	1,145	.65	46.52
1946	11,312	291	3,297	26,877	26	1,369	.97	50.94
1947	12,176	292	3,555	28,809	12	1,308	.42	45.40
1948	11,950	287	3,432	27,784	15	1,176	.54	42.33
1949	12,077	277	3,340	26,948	10	1,125	.37	41.75
1950	11,977	293	3,512	28,456	19	1,238	.67	43.51
1951	12,500	298	3,729	30,130	17	1,351	.56	44.84
1952	12,447	288	3,588	28,954	14	1,171	.48	40.44
1953	12,765	292	3,727	30,488	22	1,419	.72	46.54
1954	12,810	284	3,638	29,564	9	956	.30	32.34
1955 [2]	14,504	264	3,836	31,093	19	1,156	.61	37.18
1956	15,595	268	4,178	33,963	17	1,036	.50	30.50
1957 [3]	16,000	253	4,041	32,718	7	950	.21	29.04

[1] Fluorspar for Illinois and Kentucky previously included with lead-zinc data for Mississippi Valley States, now included with nonmetal mines.
[2] Includes clay mines, not compiled before 1955.
[3] Estimate.

TABLE 4.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1948–52 (average) and 1953–57 [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
1948–52 (average)	12,190	289	3,520,398	28,454,601	15	1,212	0.53	42.59
1953	12,765	292	3,727,298	30,488,130	22	1,419	.72	46.54
1954	12,810	284	3,637,783	29,563,983	9	956	.30	32.34
1955 [2]	14,504	264	3,835,607	31,092,628	19	1,156	.61	37.18
1956	15,595	268	4,178,414	33,963,466	17	1,036	.50	30.50
1957 [3]	16,000	253	4,041,000	32,718,000	7	950	.21	29.04

[1] Includes abrasives, asbestos, asphalt, barite, clay, feldspar-mica-quartz, fluorspar, gypsum, magnesite, phosphate rock, potash, salt, sulfur, talc and soapstone, and minor nonmetals.
[2] Includes clay mines not compiled before 1955.
[3] Estimate.

TABLE 5.—Employment and injury experience at nonmetal mills in the United States, by nonmetallic groups, 1957 [1]

Nonmetallic group	Men working daily	Average active mine days	Man-days worked	Man-hours worked	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
Abrasives	720	292	210,000	1,668,000	2	25	1.20	14.99
Asbestos	150	240	36,000	290,000				
Asphalt	140	157	22,000	172,000		5		29.07
Barite	630	257	162,000	1,336,000		35		26.20
Feldspar-mica-quartz	430	256	110,000	900,000		15		16.67
Fluorspar	420	288	121,000	954,000		5		5.24
Gypsum	1,500	261	392,000	3,121,000		10		3.20
Magnesite	100	330	33,000	261,000		15		57.47
Phosphate rock	2,100	285	598,000	4,738,000	2	30	.42	6.33
Potash	1,200	333	400,000	3,172,000	2	75	.63	23.64
Salt	800	311	249,000	2,034,000	2	35	.98	17.21
Sulfur	10	100	1,000	8,000				
Talc and soapstone	800	279	223,000	1,803,000		55		30.50
Minor nonmetals	1,600	279	447,000	3,436,000	2	40	.58	11.64
Clay	8,300	274	2,271,000	18,128,000	2	555	.11	30.62
Total	18,900	279	5,275,000	42,021,000	12	900	.29	21.42

[1] Estimate.

Clay Mines.—Statistical data on clay mines for 1957 indicated a decline in employment when compared with the preceding year. Fewer injuries were predicted in both the fatal and the nonfatal groups, and the frequency rates for the combined groups decreased 5 percent. Clay mines operated on average 7.98-hour shift each day; and the average worker accumulated 1,548 hours during the year.

TABLE 6.—Employment data and injury experience at clay mines and mills in the United States, 1955–57

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
Mine:								
1955	3,501	223	779,446	6,342,600	7	247	1.10	38.94
1956	4,419	202	891,254	7,266,474	8	251	1.10	34.54
1957 [1]	4,200	194	815,000	6,502,000	5	215	.77	33.07
Mill:								
1955	(No figures for clay mills compiled in 1955)							
1956	7,759	280	2,176,125	17,552,075	2	709	.11	40.39
1957 [1]	8,300	274	2,271,000	18,128,000	2	555	.11	30.62

[1] Estimate.

METALLURGICAL PLANTS

Employment in metallurgical plants (ore-dressing and nonferrous reduction and refinery plants combined) declined slightly in 1957. According to the preliminary estimates, fewer fatal injuries are indicated, but an increased number of nonfatal injuries influenced the rise in the overall injury-frequency rate during the year. The combined (fatal and nonfatal) rate (15.60 per million man-hours of work for 1957) was 8 percent higher than the rate of 14.43 for 1956. Workers averaged 2,544 hours for the year while working a 7.97-hour daily shift.

TABLE 7.—Employment and injury experience at metallurgical plants in the United States, 1931–57

Year	Men working daily	Average active plant days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1931	28, 938	299	8, 642	70, 374	16	1, 393	0. 23	19. 79
1932	21, 564	257	5, 542	44, 856	8	837	. 18	18. 66
1933	21, 999	267	5, 875	46, 180	13	1, 079	. 28	23. 37
1934	26, 932	274	7, 366	57, 966	13	1, 320	. 22	22. 77
1935	36, 493	291	10, 632	83, 874	28	1, 962	. 33	23. 39
1936	41, 167	309	12, 727	101, 218	32	2, 240	. 32	22. 13
1937	47, 530	313	14, 899	117, 551	41	3, 217	. 35	27. 37
1938	39. 043	292	11, 383	90, 018	20	2, 273	. 22	25. 25
1939	41. 583	303	12, 594	96, 737	24	2, 171	. 25	22. 44
1940	49, 068	295	14, 484	113, 116	18	2, 582	. 16	22. 83
1941	54, 349	311	16, 916	132, 102	34	3, 410	. 26	25. 81
1942	51, 154	334	17, 073	134, 998	29	3, 674	. 21	27. 22
1943	64, 735	336	21, 755	173, 633	31	4, 666	. 18	26. 87
1944	58, 085	329	19, 113	152, 326	38	4, 158	. 25	27. 30
1945	46, 467	329	15, 268	121, 491	19	3, 271	. 16	26. 92
1946	44, 954	284	12, 783	101, 673	20	2, 794	. 20	27. 48
1947	49, 082	313	15, 353	122, 630	21	3, 228	. 17	26. 32
1948	47, 768	317	15, 121	121, 028	14	2, 749	. 12	22. 71
1949	47, 663	294	14, 031	112, 095	23	2, 567	. 21	22. 90
1950	46, 277	314	14, 539	116, 430	29	2, 574	. 25	22. 11
1951	48, 019	318	15, 247	122, 088	16	2, 714	. 13	22. 23
1952	49, 032	319	15, 628	124, 967	16	2, 853	. 13	22. 83
1953	55, 283	318	17, 603	138, 811	12	2, 824	. 09	20. 34
1954	54, 396	307	16, 713	133, 675	16	2, 578	. 12	19. 29
1955	57, 741	314	18, 150	145, 840	11	2, 694	. 08	18. 47
1956	63, 039	325	20, 508	164, 072	20	2, 348	. 12	14. 31
1957 [1]	60, 900	319	19, 442	154, 951	13	2, 405	. 08	15. 52

[1] Estimate.

ORE-DRESSING PLANTS

Ore-dressing plants include the crushing, screening, washing, jigging, magnetic separation, flotation, and other milling of metallic ores. Employment in ore-dressing plants for 1957 was slightly lower than in 1956; a decrease of 4 days active was noted, and the fatal and the nonfatal injuries were reduced 22 and 19 percent, respectively. Injury-frequency rates per million man-hours of work also declined accordingly. The plants were operated on an 8.10-hour daily shift during the year, and the average worker in ore-dressing plants worked 2,351 hours in 1957.

TABLE 8.—Employment and injury experience at ore-dressing plants in the United States, by industry groups, 1948–52 (average) and 1953–57 [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:								
1948–52 (average)	6,178	325	2,009,937	16,086,086	2	259	0.12	16.10
1953	6,243	345	2,156,732	17,253,852	1	211	.06	12.23
1954	7,096	294	2,087,365	16,698,943	4	273	.24	16.35
1955	6,222	314	1,951,804	15,854,424		209		13.18
1956	6,683	344	2,301,344	18,399,827	3	184	.16	10.00
1957 [2]	6,100	335	2,042,000	16,331,000	2	145	.12	8.88
Gold silver:								
1948–52 (average)	801	288	231,006	1,809,641	1	72	.55	39.78
1953	494	289	142,604	1,140,610		38		33.32
1954	385	301	116,066	925,843	1	34	1.08	36.72
1955	408	298	121,420	971,223		43		44.27
1956	343	298	102,214	816,244		24		29.40
1957 [2]	500	336	168,000	1,360,000		15		11.03
Iron:								
1948–52 (average)	3,606	238	857,140	6,936,041	1	79	.14	11.38
1953	4,439	244	1,082,748	8,721,861	2	88	.23	10.09
1954	4,153	226	939,314	7,574,213	3	80	.40	10.56
1955	4,055	258	1,044,212	8,383,134	2	87	.24	10.38
1956	5,114	241	1,231,247	9,937,172	1	92	.10	9.26
1957 [2]	5,300	281	1,488,000	11,572,000	2	65	.17	5.62
Lead zinc:								
1948–52 (average)	3,719	260	969,296	7,759,923	2	225	.26	29.00
1953	4,181	258	1,080,762	8,650,758	1	220	.12	25.43
1954	3,551	247	875,911	7,023,574	1	132	.14	18.79
1955	3,667	223	817,120	6,615,007		153		23.13
1956	2,977	274	816,509	6,532,420	1	86	.15	13.17
1957 [2]	2,800	250	701,000	6,532,000	1	115	.15	17.61
Miscellaneous metals: [3]								
1948–52 (average)	1,929	303	585,767	4,696,744	1	174	2.13	37.04
1953	4,400	314	1,380,298	11,045,420		269		24.35
1954	3,910	317	1,238,274	9,898,374	1	311	.10	31.42
1955	3,279	305	1,000,798	8,012,937	1	303	.12	37.81
1956	4,120	294	1,210,958	9,704,381	4	293	.41	30.19
1957 [2]	3,700	255	944,000	7,463,000	2	210	.27	28.14
Total:								
1948–52 (average)	16,233	286	4,653,146	37,288,435	7	809	.19	21.67
1953	19,757	296	5,843,144	46,812,501	4	826	.09	17.64
1954	19,095	275	5,256,930	42,120,947	10	830	.24	19.71
1955	17,631	280	4,935,354	39,836,725	3	795	.08	19.96
1956	19,237	294	5,662,272	45,390,044	9	679	.20	14.96
1957 [2]	18,400	290	5,343,000	43,258,000	7	550	.16	12.71

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

NONFERROUS REDUCTION PLANTS AND REFINERIES

Primary nonferrous reduction and refinery plants are engaged in extracting metals from ores and concentrates and in refining crude nonferrous metals, the only exclusion being iron and steel plants. Employment was lower in 1957 in these plants and refineries, and fatalities were estimated to be fewer by five. Nonfatal injuries show an 11-percent increase, however—from 1,669 in 1956 to 1,855 in 1957. This increase in nonfatal injuries caused an 18-percent increase in the combined (fatal and nonfatal) injury-frequency rates. The average hours worked per man per year were 2,628, and a 7.92-hour shift was worked daily by the average employee.

TABLE 9.—Employment and injury experience at primary nonferrous reduction and refinery plants in the United States, by industry groups, 1948–52 (average) and 1953–57 [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:								
1948–52 (average)	11,672	321	3,743,118	29,999,738	5	499	0.17	16.63
1953	11,177	324	3,617,642	28,942,736	1	332	.03	11.47
1954	11,244	303	3,408,422	27,316,287	4	323	.15	11.82
1955	11,691	312	3,651,422	29,661,324	5	401	.17	13.52
1956	12,194	323	3,936,906	31,497,463	2	469	.06	14.89
1957 [2]	12,000	322	3,860,000	30,878,000	1	780	.03	25.26
Lead:								
1948–52 (average)	3,921	311	1,218,673	9,746,353	2	147	.21	15.08
1953	3,753	292	1,095,526	8,764,219	1	80	.11	9.13
1954	3,259	314	1,021,980	8,175,841	1	93	.12	11.37
1955	3,506	284	996,977	7,975,797	1	137	.13	17.18
1956	3,758	314	1,181,157	9,449,245	6	138	.63	14.60
1957 [2]	3,300	312	1,030,000	8,241,000	2	135	.24	16.38
Zinc:								
1948–52 (average)	9,471	344	3,255,246	25,887,358	4	815	.15	31.48
1953	9,709	354	3,436,291	27,354,478	2	808	.07	29.54
1954	8,881	334	2,969,269	23,612,421	1	675	.04	28.59
1955	9,067	339	3,074,960	24,437,536	--------	692	--------	28.32
1956	9,619	326	3,133,552	24,982,673	1	666	.04	26.66
1957 [2]	9,400	306	2,876,000	22,927,000	2	645	.09	28.13
Miscellaneous metals: [3]								
1948–52 (average)	6,455	316	2,042,936	16,399,617	1	420	.06	25.61
1953	10,887	332	3,609,904	26,937,080	4	778	.15	28.88
1954	11,917	340	4,056,044	32,449,905	--------	657	--------	20.25
1955	15,846	347	5,491,137	43,929,084	2	669	.05	15.23
1956	18,231	362	6,594,118	52,752,350	2	396	.04	7.50
1957 [2]	17,800	356	6,333,000	49,647,000	1	295	.02	5.94
Total:								
1948–52 (average)	31,519	326	10,259,973	82,033,066	12	1,881	.15	22.93
1953	35,526	331	11,759,363	91,998,513	8	1,998	.09	21.72
1954	35,301	325	11,455,715	91,554,454	6	1,748	.07	19.09
1955	40,110	329	13,214,496	106,003,741	8	1,899	.08	17.91
1956	43,802	339	14,845,733	118,681,731	11	1,669	.09	14.06
1957 [2]	42,500	332	14,099,000	111,693,000	6	1,855	.05	16.61

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

STONE QUARRIES

The preliminary estimated data compiled for the quarrying industry from reports received by the Bureau of Mines revealed a slight decline in employment and in the number of injuries received. The combined injury-frequency rate for the fatal and nonfatal injuries, however, showed a 3-percent increase. Stone quarries and their related plants operated on an 8.15-hour daily shift during the year and averaged 2,213 hours per man in 1957.

Cement.—The safety record for the cement industry in 1957 improved over that reported for 1956. Fatal injuries decreased from 12 in 1956 to 8 in 1957 (33 percent), and nonfatal injuries decreased from 318 reported in 1956 to 235 in 1957 (26 percent). The overall (fatal and nonfatal) injury-frequency rate declined from 4.48 to 3.36 (25 percent). The number of man-hours worked indicated a 2-percent decrease. The industry worked 6 fewer days and averaged slightly over an 8-hour shift. Each worker accumulated 2,609 hours during the year.

TABLE 10.—Employment and injury experience at stone quarries in the United States, 1924–57

Year	Men working daily	Average active mine days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1924	94, 242	269	25, 328	236, 983	138	14, 777	0. 58	62. 35
1925	91, 872	273	25, 046	233, 222	149	14, 165	. 64	60. 74
1926	91, 146	271	24, 708	230, 464	154	13, 201	. 67	57. 28
1927	91, 517	271	24, 783	229, 806	135	13, 459	. 59	58. 57
1928	89, 667	272	24, 397	224, 953	119	10, 568	. 53	46. 98
1929	85, 561	268	22, 968	211, 766	126	9, 810	. 59	46. 32
1930	80, 633	255	20, 559	186, 502	105	7, 417	. 56	39. 77
1931	69, 200	224	15, 527	133, 750	61	5, 427	. 46	40. 58
1932	56, 866	195	11, 114	93, 710	32	3, 574	. 34	38. 14
1933	61, 927	183	11, 362	87, 888	59	3, 637	. 67	41. 38
1934	64, 331	204	13, 108	95, 259	60	3, 924	. 63	41. 19
1935	73, 005	200	14, 623	110, 033	51	4, 152	. 46	37. 73
1936	80, 022	236	18, 874	147, 064	91	5, 717	. 62	38. 87
1937	84, 094	241	20, 264	158, 299	77	6, 348	. 49	40. 10
1938	77, 497	223	17, 256	133, 766	82	5, 027	. 61	37. 58
1939	79, 449	236	18, 726	143, 847	48	5, 204	. 33	36. 18
1940	79, 509	240	19, 121	147, 244	72	5, 188	. 49	35. 23
1941	86, 123	260	22, 370	173, 165	76	6, 870	. 44	39. 67
1942	84, 270	271	22, 808	180, 836	112	6, 349	. 62	35. 11
1943	69, 877	274	19, 136	155, 280	80	5, 199	. 52	33. 48
1944	58, 476	268	15, 691	129, 302	73	4, 437	. 56	34. 32
1945	58, 180	264	15, 376	127, 168	53	4, 121	. 42	32. 41
1946	70, 265	274	19, 262	158, 528	55	5, 137	. 35	32. 40
1947	75, 245	279	20, 996	171, 979	75	5, 504	. 44	32. 00
1948	77, 344	284	21, 993	179, 111	75	4, 994	. 42	27. 88
1949	82, 209	275	22, 569	182, 258	66	4, 826	. 36	26. 48
1950	85, 730	272	23, 346	189, 535	54	4, 762	. 28	25. 12
1951	84, 802	277	23, 470	191, 113	57	4, 945	. 30	25. 87
1952	81, 879	279	22, 844	186, 552	74	4, 503	. 40	24. 14
1953	83, 641	278	23, 248	189, 777	43	4, 450	. 23	23. 45
1954	78, 910	273	21, 506	175, 817	34	3, 834	. 19	21. 81
1955	78, 238	274	21, 470	175, 775	53	3, 811	. 30	21. 68
1956	80, 093	272	21, 776	178, 281	50	3, 754	. 28	21. 06
1957 [1]	77, 900	272	21, 152	172, 387	44	3, 740	. 26	21. 70

[1] Estimate.

Granite.—The number of fatal injuries, as estimated for the granite industry, decreased by 50 percent—from 8 reported in 1956 to 4 in 1957; nonfatal injuries, however, increased 2 percent in 1957. The combined (fatal and nonfatal) injury-frequency rate increased 3 percent. Fewer men were employed, and the number of man-hours worked decreased. This group of stone quarries operated on an average 8.25-hour shift, and the average worker accumulated 1,935 hours.

Lime.—Quarries that produced limestone, chiefly for the manufacture of lime, reported no fatal injuries in the preliminary estimates for 1957. Nonfatal injuries increased 24 percent, however—from 423 reported in 1956 to 525 in 1957. The industry had fewer men working and fewer man-hours of work were performed; days active were approximately the same as in the preceding year, with an average of 2,305 hours of work per man for the year.

Limestone.—The safety record at limestone quarries and their related plants was not as favorable in 1957 as in 1956, as far as fatal injuries were concerned. Nonfatal injuries, however, were comparable. Fatal injuries increased by 11—65 percent—but the injury-frequency rate for the combined fatal and nonfatal injuries increased only slightly. A decrease was noted in the number of men employed, the man-days, and the man-hours worked. The length of shift averaged the same for both years, as did the number of hours worked per man per year.

Marble.—Marble quarries and their related plants operating in connection with the quarries had an improved safety record in 1957. The quarries operated 22 more days than in the preceding year, with fewer man-hours worked. No fatal injuries were indicated, and a drop of 11 in the nonfatal injuries (6 percent) was shown. The industry worked an average 8.33-hour shift, and each worker accumulated 2,293 hours during the year.

Sandstone.—The sandstone industry's safety record for 1957 was not as favorable as that for 1956, as indicated by preliminary estimates of the Bureau. The combined (fatal and nonfatal) injury-frequency rates per million man-hours of work performed increased 14 percent, owing to the drop in employment. The same number of fatal injuries and only 17 fewer nonfatal injuries were indicated, causing the higher frequency rate. Days active were 9 less than in 1956, with an 8.05-hour shift each day during the year and an average of 1,807 hours for each worker.

Slate.—Slate quarries and their related plants reported increased employment during 1957, offsetting the increased number of injuries predicted and making for a better safety record. The injury-frequency rate (41.19) decreased 4 percent from the rate for the preceding year (42.92). The length of shift worked was lower and the number of hours worked by each man during the year was less than in 1956.

Traprock.—Employment in the traprock industry was lower in 1957; fewer injuries were indicated. The combined (fatal and nonfatal) injury-frequency rate was reduced 6 percent. These quarries and related plants operated 17 more days in 1957 than in 1956, with approximately the same length of shift as in the preceding year and 1,943 hours of worktime credited to the average worker.

TABLE 11.—Employment and injury experience at stone quarries in the United States, by industry groups, 1948–52 (average) and 1953–57

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]								
1948–52 (average)	28,717	327	9,393,367	74,119,442	18	578	0.24	7.80
1953	28,925	329	9,504,900	75,800,327	16	388	.21	5.12
1954	27,718	320	8,879,804	71,058,012	6	322	.08	4.53
1955	29,141	320	9,328,414	74,735,071	9	287	.12	3.84
1956	27,923	329	9,183,005	73,553,558	12	318	.16	4.32
1957 [2]	27,700	323	8,956,000	72,279,000	8	235	.11	3.25
Granite:								
1948–52 (average)	6,809	249	1,692,198	14,056,496	7	582	.50	41.40
1953	6,484	252	1,631,700	13,506,490	2	552	.15	40.87
1954	6,469	243	1,571,232	13,018,657	4	457	.31	35.10
1955	6,222	239	1,487,312	12,319,008	4	499	.32	40.51
1956	6,052	233	1,408,521	11,657,989	8	472	.69	40.49
1957 [2]	5,900	235	1,384,000	11,417,000	4	480	.35	42.04
Lime: [1]								
1948–52 (average)	9,150	297	2,720,279	21,746,809	8	725	.37	33.34
1953	9,165	294	2,690,660	21,663,764	3	526	.14	24.28
1954	7,985	294	2,345,142	18,809,131	10	457	.53	24.30
1955	8,416	292	2,456,132	19,785,736	6	417	.30	21.08
1956	9,040	290	2,621,497	21,079,218	6	423	.28	20.07
1957 [2]	7,800	288	2,250,000	17,977,000		525		29.20
Limestone:								
1948–52 (average)	26,215	237	6,202,405	52,009,749	25	1,880	.48	36.15
1953	27,764	240	6,651,663	55,839,029	16	2,039	.29	36.52
1954	26,246	237	6,224,718	52,231,092	12	1,748	.23	33.47
1955	24,472	236	5,772,695	48,483,731	28	1,657	.58	34.18
1956	26,398	231	6,087,541	51,163,853	17	1,660	.33	32.44
1957 [2]	26,200	231	6,041,000	50,807,000	28	1,655	.55	32.57
Marble:								
1948–52 (average)	2,624	255	670,281	5,535,536	1	190	.18	34.32
1953	2,442	248	606,435	4,981,451	1	161	.20	32.32
1954	2,558	252	643,873	5,326,541		159		29.85
1955	2,221	251	557,180	4,669,780	1	210	.21	44.97
1956	2,523	253	638,656	5,303,538	2	191	.38	36.01
1957 [2]	2,300	275	633,000	5,273,000		180		34.14
Sandstone:								
1948–52 (average)	4,132	242	998,913	8,256,367	3	367	.36	44.45
1953	4,167	247	1,027,719	8,369,173	2	368	.24	43.97
1954	3,471	221	768,252	6,283,356		262		41.70
1955	3,410	241	820,864	6,717,942	2	369	.30	54.93
1956	3,522	234	824,296	6,754,007	1	327	.15	48.42
1957 [2]	3,100	225	696,000	5,601,000	1	310	.18	55.35
Slate:								
1948–52 (average)	1,903	266	506,633	4,334,764	1	215	.23	49.60
1953	1,682	263	442,689	3,615,041	1	186	.28	51.45
1954	1,506	261	393,270	3,276,274		181		55.25
1955	1,599	255	408,160	3,413,372	1	159	.29	46.58
1956	1,395	250	349,281	2,935,563		126		42.92
1957 [2]	2,000	275	549,000	3,399,000		140		41.19
Traprock:								
1948–52 (average)	2,842	232	660,422	5,654,572	3	271	.53	47.93
1953	3,012	230	692,605	6,001,314	2	230	.33	38.32
1954	2,957	230	679,468	5,814,087	2	248	.34	42.66
1955	2,757	232	639,623	5,650,812	2	213	.35	37.69
1956	3,240	205	663,694	5,833,263	4	237	.69	40.63
1957 [2]	2,900	222	643,000	5,634,000	3	215	.53	38.16
Total:								
1948–52 (average)	82,392	277	22,844,498	185,713,735	66	4,808	.36	25.89
1953	83,641	278	23,248,371	189,776,589	43	4,450	.23	23.45
1954	78,910	273	21,505,759	175,817,150	34	3,834	.19	21.81
1955	78,238	274	21,470,380	175,775,452	53	3,811	.30	21.68
1956	80,093	272	21,776,491	178,280,989	50	3,754	.28	21.06
1957 [2]	77,900	272	21,152,000	172,387,000	44	3,740	.26	21.70

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

Mineral Production

(Comparison of Bureau of Mines and Bureau of the Census 1954 Data)

By Robert E. Herman [1]

THIS CHAPTER compares Bureau of Mines mineral-commodity production data for 1954 with those of the Bureau of the Census, United States Department of Commerce, as presented in its 1954 Census of Mineral Industries reports.[2] Data are shown for continental United States, exclusive of Alaska, since priority is given in Bureau of the Census publications to showing detailed commodity figures for that area only.

Individual comparisons are designed to provide users of statistics of these agencies with a rough measure of the extent to which their coverages match. Table 1, which gives these comparisons,also includes industry shipments data from the Census reports to afford readers (1) an approximate measure of the extent to which a particular commodity is produced in the industry of which such commodity is the primary products; and (2) information of the extent to which that industry produces other commodities. This information should enable users to relate the statistics of the two agencies better.

The Bureau of Mines and the Bureau of the Census cooperated in gathering mineral-production and related data through the 1954 Census of Mineral Industries; this was the first such Census since that covering 1939. This cooperation involved various aspects, such as use of joint Census-Mines schedules in a number of mineral areas to collect 1954 data. The collection, editing, and processing of certain groups of such schedules were carried out for both agencies by Bureau of Mines personnel. In other areas each agency collected its data on a separate form, but provision was made for comparisons between agencies by means of tielines on individual forms. Last, in some areas each agency used its own form, with no tieline-comparison provision.[3] Each agency prepared its own tabulations and subsequent publications in accordance with its own needs and responsibilities.

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[1] Analytical statistician.

[2] U. S. Department of Commerce, Bureau of the Census, U. S. Census of Mineral Industries, 1954, Vol. I, Summary and Industry Statistics: Washington, D. C., 1958. (Issued earlier in subject and industry bulletin form.)

[3] Table 2 in this chapter indicates the relationship between 1954 Census of Mineral Industries report forms and Bureau of Mines report forms.

TABLE 1.—Comparison of the Bureau of Mines and

(Continental United

Mineral	Commodity data: Bureau of Mines data [3]: Measurement stage	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)	Bureau of the Census data: Measurement stage [4]	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)
MINERAL FUELS						
Asphalt and related bitumens (native).	Sales	1,414	6,410	Net shipments.	1,408	6,408
Coal:						
Bituminous [5]	Production	386,797	1,752,847	Net production.[6 7]	387,186	1,774,400
Lignite	do	4,243	10,330	do.[10]	4,245	10,347
Pennsylvania anthracite	do	29,083	247,870	do.[11]	29,255	250,699
Natural gas (billion cubic feet)	Marketed production.	8,743	882,501	Marketed production.	[12] 8,315	[13] 978,712
Petroleum, crude (million 42-gallon barrels).	Production	2,315	6,424,930	Production [14]	2,221	6,156,659
Natural-gas liquids:						
Natural gasoline and cycle products (million gallons).	do	5,385	402,418	Net production.	5,391	[16] 397,745
LP-gases (million gallons)	do	5,204	178,994	do	5,338	[16] 184,500
Peat (short tons)	do	244,163	2,258	Production	248,664	[16] 2,313
Other fuels [17]			3,413			
Total: Bureau of Mines value of mineral production.			9,912,000			
Values used in comparison.			9,912,000			9,762,000
NONMETALS (EXCEPT FUELS)						
Abrasive stone: [18] Pebbles (grinding) and tube-mill liners (natural) (short tons).	Sold or used	4,003	159	Gross shipments.	4,003	159
Asbestos (short tons)	do	47,621	4,698	do	50,033	4,874
Barite, crude	do	883	8,508	Net shipments.	[20] 903	[20] 8,698
Boron minerals	do.[24]	790	26,714	do	556	14,816
Cement (thousand 376-lb. barrels)	Shipments from mills.	[25] 274,703	[26] 763,413	Gross shipments.	280,400	[26] 779,932
Clays:						
Kaolin or china clay	Sold or used	1,873	32,187 (Kaolin and ball clay)	Net shipments.	[27] 1,847	[27] 32,702 (Kaolin and ball clay)
Ball clay	do	328		do	[27] 372	
Fire clay	do	8,797	33,327	do	[27] 8,731	[27] 31,179
Bentonite	do	1,278	14,723	do	1,477	21,157
Fuller's earth	do	376	6,862	do	311	6,029
Miscellaneous clay	do	29,713	36,062	do	[27] 30,350	[27] 36,854
Total	do	42,365	123,161	do	43,088	127,921
Emery and garnet (short tons)	do	23,941	1,104	Gross shipments.	24,088	1,668
Feldspar, crude (thousand long tons).	do	411	3,490	Net shipments.	[31] 412	[31] 3,084
Fluorspar	Shipments	246	12,333	do	266	12,774
Gypsum	Production	8,996	27,384	Production	[33] 9,057	[34] 27,171
Lime	Sold or used	8,612	[26] 101,273	Gross shipments.	[36] 7,485	[26 36] 93,483
Marl:						
Calcareous (except for cement)	do	206	152	Net shipments.	260	342
Greensand (short tons)	do	2,838	199	Gross shipments.	2,837	196

See footnotes at end of table.

Bureau of the Census mineral production data for 1954 [1]

States only)

Industry or industry group (unless otherwise stated, the mineral specified is the primary product)	Industry code	Total primary and secondary products produced in the industry	Primary products: Total	Primary products: Produced in specified industry	Primary products: Produced in other industries	Secondary products and services
Native asphalt and bitumens	1494	6,424	6,408	6,408	----------	16
Bituminous coal	1211	2,040,200	[8] 1,774,983	[8] 1,773,930	[9] 1,053	4,406
Lignite	1212	10,387	10,330	10,330	----------	57
Anthracite	1111	365,536	[8] 246,276	[8] 246,276	----------	2,237
Crude petroleum and natural gas	1312, 1313	7,070,097	7,095,624	7,035,108	[15] 60,516	34,989
Natural-gas liquids	1314, 1315	640,422	[8] 576,828	[8] 576,828	----------	6,038
Peat	1498	2,326	2,307	2,307	----------	19
Abrasive stones, natural (in part)	[19] 1462	----------	----------	----------	----------	----------
Asbestos (subindustry of 1499)	----------	4,877	4,874	4,874	----------	3
Barite	[21] 1472	18,269	18,298	([22])	([22])	([22 23])
Potash, soda, and borate minerals (in part).	[19] 1474	----------	----------	----------	----------	----------
Cement, hydraulic [26a]	[26] 3241	783,719	779,932	779,171	761	4,548
Kaolin and ball clay	1455	31,892	[8 27] 32,702	31,160	[28] 1,556	732
Fire clay	1453	22,206	[8 27] 31,179	20,808	[29] 10,831	1,398
Bentonite	1452	21,830	[8] 21,157	([22])	([22])	([22 23])
Fuller's earth	1454	6,012	[8] 6,029	([22])	([22])	([22 23])
Clay, ceramic, and refractory minerals n. e. c. (in part).	[30] 1459	----------	----------	----------	----------	----------
Natural abrasives, except sand n. e. c. (in part).	[19] 1469	----------	----------	----------	----------	----------
Feldspar	[21] 1456	6,669	[8] 7,478	[8] 5,824	[33] 1,654	415
Fluorspar	1473	15,461	[8] 12,774	14,502	----------	959
Gypsum	1492	6,631	[27] 31,843	6,613	[35] 25,230	18
Lime [26a]	[26] 3274	105,449	93,483	87,699	5,784	17,750
Crushed and broken limestone (in part)	[19] 1422	----------	----------	----------	----------	----------
Miscellaneous nonmetallic minerals, n. e. c. (in part).	[19] 1499	----------	----------	----------	----------	----------

Industry data (Bureau of the Census) [2]; Value of shipments and interplant transfers (thousand dollars; gross shipments unless otherwise stated)

TABLE 1.—Comparison of the Bureau of Mines and Bureau

Mineral	Commodity data: Bureau of Mines data[3]: Measurement stage	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)	Bureau of the Census data: Measurement stage[4]	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)
NONMETALS (EXCEPT FUELS)—con.						
Mica:						
Scrap (short tons)	Sold or used	81,073	1,734	Production	[37] 81,112	[37] 1,095
Sheet (thousand pounds)	do	669	2,393	Gross shipments.	[40] 500	[40] 2,498
Perlite[41] (short tons)	do	219,703	1,762	do	277,067	2,136
Phosphate rock (thousand long tons).	Marketable production	13,821	86,669			
	Sold or used	13,044	81,510	Net shipments.	13,386	82,516
Potassium salts (K_2O equivalent)	Sales	1,918	71,819	do	1,919	71,836
Pumice	Sold or used	1,552	2,935	Gross shipments.	1,937	3,489
Pyrites (thousand long tons)	Production	909	7,159	Production	912	[34] 7,484
Salt:						
Rock salt	Sold	4,825	28,320	Net shipments.	4,879	32,962
Evaporated salt	Sold or used	3,722	45,086	Gross shipments.	[47] 4,063	[47] 76,448
Salt in brine	do	12,113	32,064	(47a)	(47a)	(47a)
Total		20,660	105,470		8,942	109,410
Sand and gravel	do.[49]	549,401	496,672	Sold or used.[49a]	428,599	445,075
Slate:						
Dimension slate[52]	Sold by producers.	152	6,349	Net shipments.	162	6,419
Crushed (granules, flour and other).	do	609	6,612	do	947	8,199
Total	do	761	12,961	do	1,109	14,618
Sodium carbonate (natural)	Sold or used	527	13,536	do	527	13,535
Sodium sulfate (natural)	do	250	3,890	do	251	3,883
Stone:[54]						
Dimension stone:[52]						
Limestone	Sold or used	[55] 1,075	[55] 19,642	Net shipments.	1,246	19,985
Granite	do	634	24,505	do	738	26,691
Marble	do	85	9,855	do	109	8,905
Sandstone	do	401	9,947	do	547	10,327
Basalt and related rocks (traprock).	do	52	358	do	34	183
Other stone	do	34	2,578	do	112	1,185
Total, dimension stone	do	[55] 2,281	[55] 66,885	do	2,786	67,276
Crushed and broken stone:						
Limestone	do	313,429	401,192	do[56]	301,555	425,493
Granite	do	22,614	31,915	do	22,780	31,766
Marble	do	454	3,939	do	544	5,039
Basalt and related rocks (traprock).	do	29,325	46,299	do	23,574	40,280
Sandstone (including quartz)	do	[55] 11,717	[55] 25,375	do[56]	10,041	31,219
Shell	do	12,358	15,320	(61)	(61)	(61) 1
Other stone	do	15,268	15,100	Net shipments.	8,891	17,194
Total, crushed and broken stone.	do	[55] 405,165	[55] 539,140		367,385	550,991
Total, stone	do	407,427	605,987		370,171	618,267

See footnotes at end of table.

of the Census mineral production data for 1954 [1]—Continued

Industry data (Bureau of the Census)[2]						
Industry or industry group (unless otherwise stated, the mineral specified is the primary product)	Industry code	Value of shipments and interplant transfers (thousand dollars; gross shipments unless otherwise stated)				
		Total primary and secondary products produced in the industry	Primary products			Secondary products and services
			Total	Produced in specified industry	Produced in other industries	
Mica	[38] 1493	4,126	7,938	4,083	[39] 3,855	43
Perlite (subindustry of 1499)	---------	2,259	[42] 2,136	([22])	([22])	([22])
Phosphate rock	1475	117,976	[8] 82,516	[8] 82,516	----------	67
Potash, soda, and borate minerals (in part).	[19] 1474	---------	----------	----------	----------	---------
Pumice and pumicite	1495	3,393	3,489	3,324	165	69
Pyrites (subindustry of 1479)	---------	12,001	[43] 7,665	([22])	([22])	([22])
Rock salt	[44] 1476	35,658	32,962	30,769	[45] 2,193	[46] 4,889
Salt 26a	[48] 2898	71,933	[46] 76,448	69,400	[46] 7,048	[45] 2,533
Sand and gravel	[50] 1441	466,015	425,500	408,546	[51] 16,954	57,469
Dimension slate	[53] 1414	---------	6,438	----------	6,438	---------
Crushed and broken slate	1424	8,162	[8] 8,199	8,162	([22])	---------
Potash, soda, and borate minerals (in part).	[19] 1474	---------	----------	----------	----------	---------
do	[19] 1474	---------	----------	----------	----------	---------
Dimension limestone	[53] 1412	3,754	20,060	3,170	16,890	584
Dimension granite	[53] 1413	5,738	27,456	5,649	21,807	89
Dimension marble	[53] 1415	3,491	9,480	3,421	6,059	70
Dimension sandstone	[53] 1417	5,292	10,405	5,036	5,369	256
Dimension traprock Dimension stone, n. e. c.	[53] 1416 [53] 1419	670	1,368	651	717	19
Crushed and broken limestone	[57] 1422	328,757	[8] [27] 425,835	[58] 311,525	[58] [59] 114,310	17,790
Crushed and broken granite	1423	30,875	[8] 31,766	[58] 30,476	[58] [59] 1,290	859
Crushed and broken marble	1425	5,142	[8] 5,039	[58] 4,586	[58] 453	597
Crushed and broken traprock	1426	45,471	[8] 40,280	[58] 38,555	[58] [59] 1,725	6,497
Crushed and broken sandstone	[60] 1427	31,190	[8] [27] 29,180	28,351	([22])	2,839
Crushed and broken stone, n. e. c.	1429	15,657	[8] 17,194	[58] 16,883	[58] [59] 311	808

TABLE 1.—Comparison of the Bureau of Mines and Bureau

Mineral	Commodity data: Bureau of Mines data [3]: Measurement stage	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)	Bureau of the Census data: Measurement stage [4]	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)
NONMETALS (EXCEPT FUELS)—con.						
Sulfur:						
Frasch-process and other mines (thousand long tons).	Shipments	5,513	143,521	Net shipments.	5,510	140,661
Recovered, elemental [62] (thousand long tons).	Sold or used	400	11,209	do	333	9,341
Talc, pyrophyllite, and soapstone (short tons).	Production	618,994	3,493			
	Sold by producers.[63]	599,998	12,634	Net shipments.[63]	605,901	11,574
Tripoli (short tons)	Sold or used	41,625	1,459	Gross shipments.	45,549	1,513
Other nonmetals [65]			76,680			24,622
Total: Bureau of Mines value of mineral production.[66]			2,619,000			
Values used in comparison.[66]			2,623,000			2,532,000
METALS						
Bauxite (thousand long tons, dried equivalent).	Production	1,995	16,403			
	Shipments to consumers.	1,766	15,945	Shipments to consumers.	1,766	15,946
Beryllium concentrate (short tons, gross weight).	Shipments	669	304	Gross shipments.	[67] 650	[67] 320
Chromite (gross weight)	do	160	6,956	Net shipments.	[68] 154	[68] 6,937
Copper (recoverable content of ores, etc.) (short tons).	Production [70]	835,468	492,927	Production [71]	835,340	
Lead (recoverable content of ores, etc.) (short tons).	do [70]	325,419	89,165	do [71]	321,765	
Zinc (recoverable content of ores, etc.) (short tons).	do [70]	473,471	102,180	do [71]	455,740	
Gold (recoverable content of ores, etc.) (thousand troy ounces).	do [70]	1,589	55,608	do [71]	1,584	[73] 577,926
Silver (recoverable content of ores, etc.) (thousand troy ounces).	do [70]	36,908	33,403	do [71]	36,670	
Iron ore, usable (excluding by-product iron sinter) (thousand long tons, gross weight).	Shipments	76,126	525,818	Net shipments.[75]	76,999	537,688
Manganese and manganiferous ore:						
Manganese ore (35 percent or more Mn) (gross weight).	do	206	15,176	Gross shipments.[76]	244	19,574
Manganiferous ore (5 to 35 percent Mn) (gross weight).	do	558	3,079	do [75] [76]	700	11,963
Total (gross weight)	do	764	18,255	Net shipments.[75] [76]	524	26,155
Mercury (76-pound flasks)	Production	17,497	4,626	Production	17,487	[77] 4,160
Titanium concentrate:						
Ilmenite (short tons, gross weight)	Shipments	531,895	7,375	Gross shipments.[78]	531,924	[79] 7,455
Rutile (short tons, gross weight)	do	7,305	870	do [78]	9,595	1,192
Tungsten ore and concentrate (short tons, 60-percent WO_3 basis).	do	13,691	51,433	Net shipments.[68]	13,917	51,941

See footnotes at end of table.

of the Census mineral production data for 1954 [1]—Continued

Industry data (Bureau of the Census)[2]						
Industry or industry group (unless otherwise stated, the mineral specified is the primary product)	Industry code	Value of shipments and interplant transfers (thousand dollars; gross shipments unless otherwise stated)				
		Total primary and secondary products produced in the industry	Primary products			Secondary products and services
			Total	Produced in specified industry	Produced in other industries	
Sulfur	1477	140,685	140,661	140,661	----------	24
Chemical and fertilizer mineral mining, n. e. c. (in part).	[19] 1479	--------	----------	----------	----------	--------
Talc, soapstone, and pyrophyllite	1496	11,819	14,595	11,819	[64] 2,776	--------
Natural abrasives, except sand, n. e. c. (in part).	[19] 1469	--------	----------	----------	----------	--------
Bauxite and other aluminum ores	1051	16,819	[8] 15,946	[8] 15,946	----------	83
Metallic ores, n. e. c. (in part)	[19] 1099	--------	[67] 320	[67] 300	[67] 20	--------
Chromite ores (subindustry of 1069)	--------	7,398	[68] 6,937	[68] 6,937	([69])	--------
Copper ores [72]	1021	508,729	[8] 393,941	[8] 385,343	8,598	24,568
Lead and zinc ores [72]	103	175,947	[8] 138,617	[8] 136,787	1,830	3,345
Gold—Lode [72] and placer	1042, 1043	34,433	[74] 33,412	[74] 32,780	632	28
Silver ores [72]	1044	12,148	[8] 11,956	([22])	([22])	([22])
Iron ores	1011	547,218	[8] 537,688	([22])	([22])	([22])
Manganese ores	1062	32,398	[68] 26,155	[68] 25,916	239	1,100
Mercury ores	1092	4,519	4,519	4,519	----------	--------
Titanium ores	1093	12,750	8,647	8,647	----------	4,103
Tungsten ores	1064	60,737	[68] 51,941	[68] 49,331	2,610	515

TABLE 1.—Comparison of the Bureau of Mines and Bureau

Mineral	Commodity data					
	Bureau of Mines data [3]			Bureau of the Census data		
	Measurement stage	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)	Measurement stage [4]	Quantity (thousand short tons unless otherwise stated)	Value (thousand dollars)
METALS—continued						
Zirconium concentrate	Shipments	18	820	Net shipments	20	1,029
Other metallic minerals [80]			101,037			67,132
Metal total: Bureau of Mines value of mineral production.			1,507,000			
Values used in comparison.			1,507,000			1,298,000
Total: Bureau of Mines value of mineral production.			14,038,000			
Values used in comparison.			14,042,000			13,592,000

[1] In general, based on data published by the Bureau of Mines in Minerals Yearbook and by the Bureau of the Census in its 1954 Census of Mineral Industries, volume I. For discussion of the joint efforts of these agencies in collecting 1954 data, and general differences in methods of compiling mineral production data, see text.

[2] Unless otherwise stated data are for a mining industry as defined by the Bureau of the Census for purposes of the 1954 Census of Mineral Industries; that is, in general, the 1949 Standard Industrial Classification for nonmanufacturing industries, with a few modifications.

[3] For each mineral the series used in computing the Bureau of Mines value of mineral production is shown; however, in some instances it seemed necessary or desirable to compare with Census data at another measurement stage, data for which have then also been shown (that is, on the same line with Census data).

[4] The term "Gross shipments" is here used as an abbreviation of Census term "Gross shipments and interplant transfers." Gross shipments totals include some duplication to the extent that materials are transferred from 1 establishment to another for mineral preparation. "Net shipments" excludes this duplication. In general, net shipments for nonmetallic minerals represent gross shipments less quantity and value of minerals received from other establishments for preparation; for metals, gross shipments less milling ores shipped. Bureau of Mines shipments figures include no duplication.

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

[6] Includes net production (clean-coal equivalent of all coal mined, including coal produced and used at the same establishment for power or heat) of bituminous-coal industry (386,864,000 short tons—valued at Census average value of net shipments of that industry) and shipments of bituminous coal from operations in other industries (313,000 short tons) plus coal used for power or heat at such operations (9,000 short tons—valued at Census average value of net shipments from such operations).

[7] Bureau of Mines excludes from its statistics mines producing less than 1,000 tons, while the Census excludes only establishments for which neither value of shipments nor expenses for production, development, and maintenance work amounted to $500 or more. Shipments by such small mines amounted to only 366,000 tons.

[8] Net shipments.

[9] Includes $488,000 for coal produced at State-owned or State-operated mines for use at State institutions.

[10] Net production, as defined in footnote 6.

[11] Net production, as defined in footnote 6. At the national level, this represents for anthracite the sum of the breaker, washery, and dredge product; raw coal sold for use without preparation; and anthracite used for colliery fuel. Coal used for colliery fuel has been valued as follows: Raw coal at Census average value of raw sold, and prepared coal at Census average value of breaker, washery, and dredge product. Census figures cover some late reports and revisions processed by Census Bureau after Bureau of Mines had closed its tabulations.

[12] Approximated by Bureau of Mines from Census product data, that is, gross production less that (1) returned to underground formations for repressuring, pressure maintenance, and cycling and (2) vented to air, burned in flares and other losses; in order to be as comparable as possible with Bureau of Mines data, items (1) and (2) cover operations of natural-gas liquids plants as well as crude petroleum and natural gas establishments. Bureau of the Census gross production total was only 92 percent of that of Bureau of Mines figure. However, since deductions for Census amounted to only 18 percent of Census gross production as compared with 20 percent for Bureau of Mines, marketed production derived from Census data equals 95 percent of Bureau of Mines marketed production.

[13] Valued at Census average value, at well, of shipments, that is, net deliveries to natural-gasoline plants and deliveries to distributors, transmission companies, and consumers.

[14] Includes crude petroleum shipped, crude used in lease operations (valued at Census average value of crude shipped), and field condensate and drips shipped.

of the Census mineral production data for 1954 [1]—Continued

Industry data (Bureau of the Census)[2]						
Industry or industry group (unless otherwise stated, the mineral specified is the primary product)	Industry code	Value of shipments and interplant transfers (thousand dollars; gross shipments unless otherwise stated)				
		Total primary and secondary products produced in the industry	Primary products			Secondary products and services
			Total	Produced in specified industry	Produced in other industries	
Clay, ceramic, and refractory minerals n. e. c.	[19] 1459	--------	----------	----------	----------	--------

[15] Oil- and gas-field contract services industries (group 133).
[16] Valued at Census average values of net shipments.
[17] Includes helium ($3,202,000) not included in scope of the Census, since all is produced in Government owned and operated plants; and estimated value of carbon dioxide, natural ($211,000), not shown separately in Census reports.
[18] Data for other abrasive stones are included in "Other nonmetals."
[19] Commodity is one of several primary to this industry. Value data, if any, in succeeding columns are for shipments of this commodity only, not for entire industry.
[20] Net shipments of crude, ground (including flotation concentrates) and crushed, here valued at Census average value of crude shipped. Census reported 960,000 tons of crude produced (all in the barite and other mining industries) as compared with 926,000 reported by Bureau of Mines.
[21] Crushed and/or ground are considered primary products, as well as crude. Values given for industry are as-shipped.
[22] Withheld to avoid approximate disclosure of figures for individual companies.
[23] Less than 1 percent of total value of shipments and interplant transfers.
[24] Includes some production reported at finished-product stage but expressed in Bureau of Mines sold or used figures in crude equivalent.
[25] Before 1955 Bureau of Mines did not include shipments of prepared masonry cement by portland-cement plants in its tabulations (such shipments totaled 12,831,000 barrels in 1954) but did include in shipments of portland cement that used in making masonry cement (2,216,000 barrels in 1954). If Bureau of Mines published 1954 total is adjusted to include prepared masonry cement shipped by portland-cement plants and to exclude portland cement used in making masonry cement, the revised total would be 285,-318,000 barrels.
[26] Excludes cost of containers.
[26a] Manufacturing industry according to the Standard Industrial Classification.
[27] Includes quantity and/or estimated value for minerals produced and used at same establishment in producing manufactured products. (Note: The term "used" in the Bureau of Mines expression "sold or used" covers use of the mineral by the primary producer, whether in the same establishment where produced or in another plant of the same company.)
[28] Includes $1,532,000 for kaolin and ball clay operations in manufacturing industries all of which was produced and used in the same establishment.
[29] Includes about $9,600,000 for fire-clay operations in manufacturing establishments, including estimated value for clay produced and used in same establishment in producing manufactured products.
[30] Common clay is one of several minerals primary to this industry, total shipments of which were $13,504,000, about 5 percent of which was for secondary products. Of the total net shipments of common clay, 25,803,000 short tons with an estimated value of $25,287,000 represents that produced and used at the same establishment in the production of manufactured products. In addition, common clay operations in manufacturing establishments shipped $247,000 of such clay.
[31] Net shipments of crude and ground by the feldspar and other mining industries, here valued at Census average value of net shipments of crude.
[32] Includes ground feldspar valued at $1,503,000 produced at establishments classified in manufacturing industries.
[33] Only 27½ percent produced in mines and plants classified in gypsum-mining industry.
[34] Production valued at Census average value of shipments.
[35] Gypsum operations in manufacturing establishments. Includes estimated value for gypsum produced and used in same establishment.

[36] Lime made for use in same establishment is excluded; Bureau of Mines data include such lime. Value includes $677,000 for "Other lime" and $2,299,000 for "Lime, not specified by kind," quantities for which were not recorded.
[37] Approximation. Production of ground mica as reported by Bureau of the Census valued at Census average value of scrap shipped. Census shipments of scrap represent only that sold to consumers for grinding; that produced and consumed in the same establishment appears only in terms of shipments of ground mica. Bureau of Mines reported 80,072 short tons of ground mica valued at $4,889,000 sold by producers as opposed to shipments of 81,412 short tons valued at $4,694,000 reported by Census.
[38] As-shipped value included for ground mica.
[39] Includes ground mica valued at $3,155,000 produced at manufacturing establishments.
[40] Quantity includes full-trim sheet mica equivalent of hand-cobbed mica; value includes as-shipped value of such mica.
[41] Bureau of Mines reported 261,000 short tons produced as against 277,000 tons reported by Census Bureau.
[42] Bureau of the Census reports indicate that production, if any, in other than primary industry was less than 0.5 percent.
[43] Quantitywise, 93 percent of shipments was by pyrites subindustry.
[44] Represents establishments primarily engaged in mining, crushing, and screening rock salt.
[45] Includes value of rock salt shipped by salt industry; this value cannot be shown separately.
[46] Includes value of evaporated salt shipped by rock-salt industry.
[47] Represents shipments of (1) salt by the salt (2898) and other manufacturing industries (3,906,000 tons valued at $71,636,000) and (2) evaporated salt by rock-salt industry (157,000 tons valued at $4,812,000). These figures probably include some salt produced from "salt in brine" as reported by the Bureau of Mines. Figures include duplication to extent that shipments of salt from 1 establishment have been processed further at another.
[47a] Census does not collect information on salt in brine produced and used in same establishment in manufacturing chemicals. Such use accounts for most of Bureau of Mines totals for "salt in brine." See also, second sentence of footnote 47.
[48] Represents establishments primarily engaged in manufacturing edible salt from rock salt and from natural and artificial brines.
[49] Classified into 2 categories: Commercial, 395,924,000 tons valued at $414,753,000; and Government-and-contractor, 153,477,000 tons valued at $81,919,000. Government-and-contractor classification includes direct output by Government agencies and some output of private producers. All of production of a private producer must be on contract to a Government agency to have production classified as Government-and-contractor; if any part was sold, the entire production reverts to commercial classification.
[49a] Includes 24,410,000 short tons, valued at $21,581,000 reported as "For use by same company as contractor or subcontractor on Federal, State, or local government projects," part of which may have been produced by private producers all of whose production was on contract to Government agencies. Other than the Census data cover only commercial production.
[50] These data indicate that 96 percent of the value of shipments of sand and gravel was accounted for by establishments in the sand and gravel industry. However, "sold or used" value data reported indicate that such establishments accounted for only about 93 percent of the total value of sand and gravel sold or used. Further, actual proportion may have been still lower, since Census indicates that there may have been significant undercoverage of sand and gravel produced and used at same establishments in making ready-mixed concrete.
[51] Includes $12,290,000 for shipments of sand and gravel operations included in manufacturing and wholesale trade establishments.
[52] Bureau of the Census classifies quarries without dressing plants primarily engaged in producing this kind of dimension stone in the mining industry noted under "Industry code," with rough dimension stone being the primary product. Quarries operated in conjunction with a dressing plant are included in manufacturing Industry 3281, "Cut stone and stone products," with dressed dimension stone the primary product. Census figures on dimension stone cover shipments from these 2 types of operations but do not cover shipments from any dressing plant not operated in conjunction with a quarry, even though such plant may be an integral part of a company engaged in quarrying and dressing stone. Bureau of Mines production data are compiled on basis of quantities of rough blocks and finished products sold by primary producers (that is, companies that quarried the stone) or used by them in construction or another end use. Thus, if a particular company operates both a quarry with no dressing plant and a separately operated dressing plant, products of the quarry processed by the dressing plant are included by Bureau of Mines as finished products. Census includes such products at the rough-block stage. For this reason, Bureau of Mines shows less rough dimension and more dressed stone shipped by this company than Census. Further, overall dimension tonnage included for the company by Bureau of Mines is considerably less because of tonnage loss in converting rough blocks into finished products. On the other hand, Bureau of Mines value for the company is higher because of value added by processing.
[53] For purposes of this table, industry-shipments data have been rearranged by Bureau of Mines, considering dressed as well as rough stone a primary product of this mining industry, even though none was shipped by such industry. Thus, the column "Produced in other industries" covers not only shipments of rough stone by such industries but also all shipments of dressed stone. For dimension stone operations included in manufacturing (that is, Industry 3281) shipments of dressed and rough together included in this column for particular kind of stone are: Slate, $6,438,000; granite, $21,640,000; marble, $5,595,000 dressed plus no more than $448,000 rough (exact amount not available); limestone, $16,070,000; sandstone, $5,340,000; basalt and related stone, and Other stone, $582,000 dressed plus no more than $44,000 of rough (exact amount not available).
[54] "Noncommercial operations" are covered by Bureau of Mines but not by Census. Amounts included for such operations by the Bureau of Mines are as follows: All stone, 19,351,000 tons, $21,260,000; Dimension stone: Total, 32,000 tons, $93,000; limestone, 23,000 tons, $35,000; granite, 1,000 tons, $2,000; sandstone, 6,000 tons, $55,000; other stone, 2,000 tons, $1,000; Crushed and broken stone: Total, 19,319,000 tons, $21,167,000; limestone, 10,479,000 tons, $10,545,000; granite, 1,374,000 tons, $1,879,000; sandstone, 1,607,000 tons, $1,540,000; traprock, 3,562,000 tons, $5,342,000; other stone, 2,297,000 tons, $1,861,000.
[55] Figures for dimension limestone and crushed and broken sandstone together include a total of 19,000 tons valued at $38,000 to avoid disclosing individual company confidential data. These amounts not included in figures for "Stone, total."
[56] Includes quantity and estimated value for stone produced and used in same establishment in manufacturing cement and lime. Value was estimated by applying Census average value of actual net shipments to quantity of stone used. Bureau of Mines data cover such stone.
[57] Covers actual net shipments of calcareous marl, not included in commodity data for limestone, but shown separately elsewhere in this table.
[58] Net shipments. Data for all mining industries included in column "Produced in specified industry."

59 Includes following amounts of shipments of quarrying operations included in manufacturing establishments: Limestone, $113,949,000 (including estimated value of stone produced and used in same establishment in manufacturing cement and lime); granite, $355,000; traprock, $1,398,000; and stone, n. e. c., $546,000.
60 Does not cover quartz, which is classified in Industry 1469, Natural abrasives, except sand, n. e. c.
61 Information on oystershell not collected by Bureau of the Census.
62 Bureau of Mines reported total production of 361,000 tons as opposed to 366,000 tons reported by Census.
63 Census data cover dimension soapstone, which the Bureau of Mines includes in its figures for "Other dimension stone." Both agencies' data cover crude, sawed, crushed, and ground. However, Bureau of Mines figures cover a greater proportion of production measured at ground stage, which accounts for some of difference between two agencies' figures.
64 Represents ground talc, soapstone, and pyrophyllite produced at establishments classified in manufacturing industry, "Minerals and earths: Ground and otherwise treated."
65 Data for both agencies include vermiculite, graphite, lithium minerals, iron-oxide-pigment materials (crude), wollastonite, aplite, olivine, kyanite, brucite, magnesite, diatomite, sharpening stones, millstones, grindstones, and pulpstones. Bureau of Mines data included an estimated total for gem stones, while Census data include a reported figure on gem materials. In addition, Bureau of Mines total covers calcium-magnesium chloride, iodine, epsom salts from epsomite, titanium-iron concentrate (nontitanium use), strontium minerals, bromine, and magnesium compounds from sea water and brines (except for metals), for which minerals data are not available from Bureau of the Census reports. The latter agency's total includes calcite (Iceland spar), miscellaneous sulfur-bearing materials, bismuthnite, lignaceous shale, mineral-soil builders, and bat guano, not covered by Bureau of Mines figures.
66 Totals have been adjusted to eliminate duplicating value of clays and stone used in cement and lime. For Bureau of the Census total adjustment for stone consisted of deduction of estimated value of stone cited in footnote 56. Lacking enough data to compute a comparable clay deduction (estimated value of clay produced and used in same establishment, included in clay-commodity figures, covers not only that used in cement but also that used in clay, ceramic and, refractory products), clay value employed to adjust Bureau of Mines total has been used.
67 Census estimate based on receipts at mills.
68 Net shipments approximated by Bureau of Mines by subtracting from gross shipments quantity and/or value of minerals received for preparation by establishments classified in primary industry. Duplication may still exist to extent that establishments classified in other industries also received minerals for preparation.
69 Value of chromium concentrates not produced in chromium ores subindustry was only about $1,000.
70 Includes recoverable metal content of gravel washed (placer operations), ore milled, old tailings, slimes, etc., re-treated, and ore, old tailings, copper precipitates, old slag, mill cleanings, etc. shipped directly to smelters.
71 Recoverable content of concentrates produced and of shipments of direct smelting and leaching ores, old tailings, precipitates, mill bullion, and placer gold. Census reports indicate that differences between Bureau of Mines figures and those of Bureau of the Census arise principally from differences in methods followed and objectives sought by the two agencies in compiling and presenting statistics. Further, that for lead and zinc difference is due almost entirely to inclusion by Bureau of Mines of lead and zinc recovered at smelters from old slag and smelter cleanings if this material was not included in their statistics for earlier years. Census figures include only metals recoverable from ores mined or milled in 1954.
72 Primary products of industry are ores and concentrates valued chiefly for recoverable content of indicated metal. Bureau of the Census data on recoverable metal produced, by industry, indicate that following proportions of metal specified were produced in the mining industry or industry group of the same name: Copper, 96.5 percent; lead-zinc, 97.3 percent (Census data were valued at Bureau of Mines average lead and zinc prices to combine these 2 metals); gold (lode and placer), 59.1 percent; and silver, 32.4 percent.
73 Value of shipments of concentrates and other materials cited in footnote 71. Bureau of Mines values are recoverable contents valued as follows: Gold, at price under authority of Gold Reserve Act of Jan. 31, 1934; silver, at Treasury buying price for newly mined silver; copper, lead, and zinc, each at yearly average weighted price of all grades of respective primary metal sold by producers (except for New Jersey—see footnote in Statistical summary chapter of this volume).
74 Net shipments for "lode-gold" industry; gross shipments for "placer-gold" industry.
75 Data for iron ore include, and those for manganiferous ore exclude, manganiferous iron ores valued chiefly for their iron content regardless of percentage of manganese contained. Net shipments of such ores (direct shipping ores plus concentrates) amounted to 487,000 long tons valued at $2,881,000. Of such ores, Bureau of Mines includes those containing 5 percent or more manganese in its data on manganiferous ore.
76 Census data on manganese and manganiferous ores and concentrates include ores shipped to General Services Administration depots at Wenden, Ariz.; Deming, N. Mex.; and Butte and Philipsburg, Mont.; such shipments are excluded by the Bureau of Mines. Bureau of Mines data contain no duplication. Census statistics on gross shipments contain some duplication since they include milling ores shipped to beneficiation plants. Such duplication is approximately eliminated in the net shipments totals here shown which were computed by the Bureau of Mines as indicated in footnote 68.
77 Valued at average value per flask determined from Census shipments data. Bureau of Mines production is valued at the average price at New York.
78 Includes foreign ore concentrated at mills in United States. Bureau of Mines data apply only to domestic ores.
79 Includes value of small quantity of titanium ore shipped for concentration, amounting to less than 1 percent of the value for all titanium concentrates.
80 Covers cobalt, nickel, columbium-tantalum concentrate, antimony, tin, molybdenum, platinum-group metals, and rare-earth-minerals concentrate, with the following qualifications. For the Bureau of the Census data, this represents shipments of the Metallic ores, n. e. c. industry (1099) less the estimated shipments of beryllium (shown elsewhere in this table), the remainder being reduced one-third to approximate net shipments; and approximate net shipments of molybdenum-ores industry (1063) and ferroalloys (except vanadium and chromium) n. e. c. subindustry (part of industry 1069) plus the shipments of molybdenum concentrates by the copper-ores industry. Except for latter inclusion, no data are included for shipments by other industries of products listed (that is, as secondary products). Bureau of Mines data in addition to covering all shipments of the products indicated, regardless of industry classification, cover vanadium, magnesium chloride for metal, and manganiferous residium, data for which are not available separately from Census reports.

The Bureau of Mines regularly collects annually from mineral producers, processors, and users—on a voluntary basis—information on mineral commodities at various stages in their progression from mine to end use. For most minerals there are monthly or quarterly canvasses as well. Production data are generally tabulated and published on a commodity basis; that is, the total of a mineral commodity produced, regardless of the industry classification (very roughly, the major activity) of the producer.

The Bureau of the Census in its economic census program (which includes the Census of Mineral Industries) collects data on expenses, capital expenditures, horsepower of equipment, energy use, water intake, and other items related to production as well as product data. These data are collected on an establishment basis; each establishment is then classified for purposes of tabulation and publication according to its major activity into an industry as defined by the Standard Industrial Classification.[4]

Census industry data indicate that, in a number of instances, all of a particular mineral commodity is produced by establishments classified in the mining industry of which the commodity is the primary product. As regards most minerals, however, some is produced by establishments classified in other industries. Some mining operations are part of establishments classified in manufacturing or other nonmining industries, and the economic data relating to the mining operations are not separable from those relating to the establishments' major and nonmining activity. Such operations are not included in the 1954 Census of Mineral Industries. However, as part of the 1954 Census of Manufactures, selected economic data were collected on mine or quarry operations at cement, lime, clay-products, and gypsum-products plants. For dimension-stone quarries operated with dressing plants (which are classified by Census in manufactures) complete product and economic data reports comparable to those for the minerals census were obtained. Data for such stone, clay, and gypsum operations are shown both separately and in combination with the corresponding mining-industry data in the Census of Mineral Industries reports.[5] Also some economic data are included for sand and gravel mining operations included in establishments classified in the manufacturing and wholesale trade industries.

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[4] The Standard Industrial Classification used in the 1954 Census of Mineral Industries was that for nonmanufacturing industries issued in May 1949. A revised classification for all industries was issued in 1957.

[5] In table 1 of this chapter the value of shipments of primary products by such operations is indicated, where possible, in a footnote to industry data given in the column "Produced in other industries." This value, plus that given for shipments of the primary products by the "specified industry," constitutes the portion of all shipments of primary products by all industries for which separable economic data (in whole or in part) are available in the Census reports (after due allowance is made for secondary products and services of the primary industry).

TABLE 2.—1954 Census of Mineral Industries reporting forms and related Bureau of Mines forms

Census form		Relation to Bureau of Mines annual surveys [1]	Related Bureau of Mines form	
Number	Name		Number	Name
MC-10A	Iron and Manganese Ores	Joint survey	6-1066A 6-1085A	Iron Ore. Manganese and Manganiferous Ores.
MC-10B	Copper, Lead, Zinc, Lode Gold, and Silver Ores.	do	6-1177A 6-1177S 6-1178A	Production of Lead and Zinc. Custom Lead and Zinc Ore Milled. Lode-Mine Production of Gold, Silver, Copper, Lead, and Zinc.
MC-10D	Placer Gold, Silver, and Platinum-Group Metals.	do	6-1176A	Placer-Mine Production of Gold, Silver, and Platinum.
MC-10D1	Placer Gold, Silver, and Platinum-Group Metals (for use in Alaska only).			
MC-10E	Bauxite	do	6-1010A	Bauxite.
MC-10F	Tungsten Ores	do	6-1140A	Tungsten Ore and Concentrate.
MC-10G	Chromium, Cobalt, Molybdenum, and Nickel Ores.	do	6-1035A 6-1040A 6-1100A	Chromite. Cobalt-Bearing Ore. Molybdenum Ore and Concentrate.
MC-10H	General Minerals Form	None		
MC-10J	Mercury, Titanium, and Miscellaneous Metal Ores.	Joint survey	6-1015A 6-1090A 6-1130A 6-1135A 6-1096A 6-1272A	Antimony Ore and Concentrate. Mercury. Tin. Production of Ilmenite and Rutile. Columbium, Tantalum, Zirconium, and Hafnium. Monazite Sand and Rare Earths.
MC-10K	Mineral Contract Services	None		
MC-10S	Metallic Ores (short form)	Joint survey		See MC-10A, MC-10B, MC-10D, MC-10E, MC-10F, MC-10G, and MC-10J above.
MC-11A	Pennsylvania Anthracite	do	6-1385A 6-1386A 6-1388A	Pennsylvania Anthracite. Pennsylvania Anthracite: Mines Without Preparation Plants. Pennsylvania Anthracite: Dredge Report.
MC-11B	Pennsylvania Anthracite Stripping Contract Services.	do	6-1387A	Pennsylvania Anthracite from Strip Pits and Culm Banks: Contractors' Report.
MC-12A	Bituminous Coal and Lignite	do	6-1401A	Bituminous Coal and Lignite Production and Mine Operation.
MC-12B	Distribution of Bituminous Coal and Lignite Shipments.	None		
MC-12S	Coal (short form)	Joint survey		See MC-11A and MC-12A above.
MC-13A	Crude Petroleum and Natural Gas.	None		
MC-13B	Natural-Gas Liquids	Joint survey	6-1237A 6-1343A	Sulfur, Hydrogen Sulfide and Liquid Sulfur Dioxide Recovered as a Byproduct (joint for producers of natural-gas liquids only). Natural-Gasoline and Cycling Plants.
MC-13C	Oil- and Gas-Field Contract Services.	None		
MC-13X	Offshore Oil and Gas Operations.	None		
MC-13S	Oil and Gas (short form)	None		
MC-14A	Stone	Tieline	6-1222A 6-1278A 6-1279A 6-1280A 6-1281A 6-1282A 6-1283A 6-1285A 6-1292A	Calcareous Marl. Granite. Limestone and Dolomite. Marble. Sandstone and Quartzite. Slate. Stone. Production of Stone by Railroads. Production of Miscellaneous Minerals.

See footnote at end of table.

TABLE 2.—1954 Census of Mineral Industries reporting forms and related Bureau of Mines forms—Continued

Census form		Relation to Bureau of Mines annual surveys [1]	Related Bureau of Mines form	
Number	Name		Number	Name
MC-14B	Sand and Gravel	Joint survey	6-1273A	Sand and Gravel.
MC-14C	Sand and Gravel (short form)	do	6-1273A	Do.
MC-14D	Clay, Ceramic, and Refractory Minerals.	Tieline	6-1244A	Ball Clay.
			6-1254A	Bentonite and Fuller's Earth.
			6-1255A	Fireclay, Stoneware Clay, and Miscellaneous Clay or Shale.
			6-1262A	Kaolin or China Clay.
MC-14E	Feldspar, Mica, and Other Pegmatite Minerals.	Joint survey	6-1294A	Crude Feldspar, Mica, and Miscellaneous Minerals.
MC-14F	Barite, Fluorspar, Talc, Soapstone, and Pyrophyllite.	Tieline	6-1060A	Flurospar.
			6-1060AS	Do.
			6-1227A	Barite (Crude, Crushed, and Ground).
			6-1290A	Talc, Soapstone, and Pyrophyllite.
MC-14G	Potash, Soda, and Borate Minerals.	Joint survey	6-1233A	Natural Salines (Miscellaneous) (joint for mineral products only).
			6-1252A	Potash.
MC-14H	Phosphate Rock	Tieline	6-1251A	Phosphate-Rock Production, Sold or Used, and Stocks of Your Plants.
MC-14J	Sulfur and Pyrites	Joint survey	6-1236A	Pyrites.
			6-1239A	Sulfur.
MC-14K	Native Asphalt, Bitumens, Peat, and Graphite.	do	6-1292A	Production of Miscellaneous Minerals.
			6-1328A	Native Bitumens and Allied Substances.
			6-1391A	Peat.
MC-14L	Miscellaneous Nonmetallic Minerals.	Tieline	6-1202A	Diatomite.
			6-1203A	Millstones, Chasers, Pulpstones, Grindstones, Oilstones, Whetstone, Scythestone, Hones, and Rubbing Stones.
			6-1204A	Pumice and Pumicite (Volcanic Ash).
			6-1206A	Tripoli.
			6-1207A	Production of Crude Vermiculite.
			6-1210A	Asbestos.
			6-1218A	Gypsum and Gypsum Products.
			6-1232A	Magnesium Compounds.
			6-1235A	Salt.
			6-1263A	Crude Iron Oxide Pigment Materials.
			6-1292A	Production of Miscellaneous Minerals.
			6-1298A	Production of Crude Perlite.
MC-14S	Minerals (short form)	None	----------	
MC-14SM	do	Joint survey	----------	See MC-14E, MC-14G, MC-14J, and MC-14K above.

[1] See text regarding cooperative efforts of the two bureaus in collecting 1954 data. Where joint survey is indicated the related Bureau of Mines forms were not used in 1954, both agencies obtaining their information from the Census form.

Abrasive Materials

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

Contents

DURING 1957 natural and artificial abrasive materials sold or used in the United States increased 7 percent in tonnage and 16 percent in value over 1956. Sales of abrasive grinding wheels, surface-coated abrasives, and graded abrasive grain advanced during the first 9 months of 1957 over 1956 but declined during the final 3 months.

TABLE 1.—Salient statistics of the abrasives industries in the United States, 1948–52 (average) and 1953–57

Kind	1948–52 (average)	1953	1954	1955	1956	1957
Natural abrasives (domestic) sold or used by producers:						
Tripoli: [1]						
Short tons	33,805	36,183	41,625	49,662	45,009	50,717
Thousand dollars	944	1,139	1,459	213	203	195
Quartz, ground sand and sandstone: [2]						
Short tons	167,925	188,019	214,152	239,030	281,894	269,178
Thousand dollars	1,255	1,422	1,651	1,844	2,067	2,103
Special silica-stone products: [3]						
Short tons	9,559	6,190	6,221	4,929	6,180	5,847
Thousand dollars	440	338	323	264	411	331
Garnet:						
Short tons	9,872	10,520	14,183	11,835	9,812	9,776
Thousand dollars	823	989	971	1,191	1,073	1,080
Emery:						
Short tons	7,650	10,562	9,758	10,735	12,153	11,893
Thousand dollars	102	144	132	151	174	184
Artificial abrasives: [4]						
Short tons	384,788	466,937	404,376	428,243	431,461	484,702
Thousand dollars	36,940	50,036	44,480	51,081	55,692	65,634
Foreign trade (natural and artificial abrasives):						
Imports ... thousand dollars	[5] 50,670	77,684	72,023	89,795	[6] 99,968	84,718
Exports ... do	18,649	18,535	20,757	24,876	26,845	27,589
Reexports ... do	----------	----------	6,264	6,444	7,755	8,702

[1] Figures are for processed tripoli sold or used in 1948–54 and for crude tripoli sold or used in 1955–57.
[2] For abrasive purposes.
[3] Includes grindstones, pulpstones (1948–52), oilstones and other sharpending stones (1956), value of millstones (1948–53 and 1956–57), grinding pebbles, and tube-mill liners (1948–54 and 1956–57).
[4] Production of silicon carbide and aluminum oxide (United States and Canada); shipments of metallic abrasives (United States).
[5] Includes value of pumice, 1948–49.
[6] Revised figure.

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

Production of silicon carbide and aluminum oxide in the United States and Canada both advanced in tonnage and value. The production of metallic abrasives in the United States decreased in tonnage, but its value was unchanged. Production of tripoli increased; that of garnet and emery declined.

Imports of abrasive materials into the United States decreased in value, mainly because imports of industrial diamond were reduced. Exports and reexports of abrasive materials increased slightly.

NATURAL SILICA ABRASIVES

Tripoli.—During 1957 sales of processed tripoli, amorphous silica, and rottenstone increased 2 percent in tonnage and 3 percent in value over 1956. A small quantity was imported. Of the domestic sales, 71 percent was for abrasive purposes.

Companies mining and processing tripoli, amorphous silica, or rottenstone in 1957 were: Ozark Minerals Co., Cairo, Ill. (amorphous silica); Tamms Industries Co., Tamms, Ill. (amorphous silica); American Tripoli Division, The Carborundum Co., Seneca, Mo., and Ottawa County, Okla. (tripoli); Penn Paint & Filler Co., Antes Fort, Pa. (rottenstone); and Keystone Filler & Manufacturing Co., Muncy, Pa. (rottenstone).

Price quotations on tripoli in E&MJ Metal and Mineral Markets were as follows (per short ton, paper bags, minimum carlot 30 tons, f. o. b. Missouri): Once-ground through 40-mesh, rose and cream, $50; double-ground through 110-mesh, rose and cream, $52; and air-floated through 200-mesh, $55.

TABLE 2.—Processed tripoli [1] sold or used by producers in the United States, 1948–52 (average) and 1953–57, by uses [2]

Year	Abrasives		Filler		Other, including foundry facings		Total	
	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons	Thousand dollars
1948–52 (average)	26,206	760	5,257	112	2,342	72	33,805	944
1953	25,000	852	7,000	163	4,183	124	36,183	1,139
1954	31,050	1,181	8,719	203	1,856	75	41,625	1,459
1955	32,870	1,376	[3] 8,189	[3] 189	[4] 5,910	[4] 237	46,969	1,802
1956	32,189	1,328	7,274	173	3,875	116	43,338	1,617
1957	31,326	1,300	7,429	171	5,533	194	44,288	1,665

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

Abrasive Sands.—Glass grinding, stone polishing, sand blasting, and similar industries used substantial tonnages of natural sands with a high-silica content as abrasive materials. Sales of these sands totaled 1,911,218 short tons valued at $5,574,176 in 1957, compared with 1,668,502 short tons valued at $5,250,606 in 1956. The 1957 figure includes 916,231 short tons of blast sand valued at $3,756,695.

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

The tonnage of graded quartz used by the coated abrasive industry decreased from the preceding year.

TABLE 3.—Ground sand and sandstone, quartz, and quartzite used for abrasive purposes, 1948–52 (average) and 1953–57

Year	Ground sand		Sandstone, quartz and quartzite		Total	
	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons	Thousand dollars
1948–52 (average)	(1)	(1)	(1)	(1)	167,925	1,255
1953	171,974	1,329	16,045	93	188,019	1,422
1954	182,046	1,467	32,106	184	214,152	1,651
1955	209,729	1,692	29,301	152	239,030	1,844
1956	257,656	1,939	24,238	128	281,894	2,067
1957	191,978	1,716	77,200	387	269,178	2,103

[1] Distribution not available for 1948–51.

SPECIAL SILICA-STONE PRODUCTS

Grindstones and Pulpstones.—Ohio was the only State reporting production of grindstones. Sales of natural pulpstones were last reported in 1952.

Oilstones and Other Sharpening Stones.—Sales of sharpening stones increased 52 percent in tonnage and 4 percent in value in 1957, compared with 1956. The crude material for oilstones was mined in Arkansas; for whetstones, in Arkansas and Indiana; and for scythestones, in New Hampshire.

Millstones.—Rowan County, N. C., was the only area in the United States where millstones were made in 1957. No output of chasers was reported.

Grinding Pebbles and Tube-Mill Liners.—Sales of grinding pebbles increased 25 percent in tonnage and 21 percent in value; tube-mill liners increased 36 percent in tonnage and 46 percent in value over the previous year.

TABLE 4.—Grindstones and pulpstones sold by producers in the United States, 1948–52 (average) and 1953–57

Year	Grindstones		Pulpstones		
	Short tons	Thousand dollars	Quantity: Pieces	Quantity: Equivalent short tons	Thousand dollars
1948–52 (average)	5,269	288	8	26	2
1953	2,499	170			
1954	2,218	164			
1955	2,799	196			
1956	[1] 2,789	[1] 262			
1957	1,505	132			

[1] Includes oilstones and other sharpening stones.

Sales of grinding pebbles were reported from Minnesota, North Carolina, Texas, Washington, and Wisconsin. Tube-mill liners were reported from Minnesota, North Carolina, and Wisconsin.

TABLE 5.—Value of millstones and chasers sold by producers in the United States, 1948–52 (average) and 1953–57 [1]

Year	Number of producers	Thousand dollars	Year	Number of producers	Thousand dollars
1948–52 (average)	2	11	1955	1	(2)
1953	2	18	1956	1	4
1954	2	(2)	1957	1	5

[1] Produced in New York (1948 and 1953–54), North Carolina, and Virginia (1948–50 only).
[2] Figure withheld to avoid disclosing individual company confidential data.

TABLE 6.—Grinding pebbles and tube-mill liners sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Grinding pebbles		Tube-mill liners		Total	
	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons	Thousand dollars
1948–52 (average)	2,969	80	1,295	59	4,264	139
1953	2,472	81	1,219	69	3,691	150
1954	3,070	100	933	59	4,003	159
1955	2,130	68	(1)	(1)	(1)	(1)
1956	2,330	71	1,061	74	3,391	145
1957	2,902	86	1,440	108	4,342	194

[1] Figure withheld to avoid disclosing individual company confidential data.

NATURAL SILICATE ABRASIVES

Garnet.—Garnet sales during 1957 showed little change in either tonnage or value from the preceding year. The domestic producers were: Baumhoff-Marshall, Boise, Idaho; Idaho Garnet Abrasive Co., Fernwood, Idaho; Barton Mines Corp., North Creek, N. Y.; and Cabot Carbon Co., Willsboro, N. Y. New York was the leading garnet-producing State.

The tonnage of garnet used in manufacturing coated abrasives in 1957 was about the same as in 1956.

A shipment of 30 long tons of garnet was exported from Tanganyika to the United Kingdom.[3] A shipment of garnet from Madagascar to France was reported.[4]

The use of garnet in manufacturing ferrites was suggested.[5]

Sales of garnet since 1920 are presented graphically in figure 1.

[3] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 30; vol. 45, No. 4, October 1957, pp. 37–38.
[4] U. S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 161: Jan. 23, 1958, p. 1.
[5] Electronics, Business Edition, Garnets Enter Electronics: Vol. 30, No. 68, June 20, 1957, p. 30.

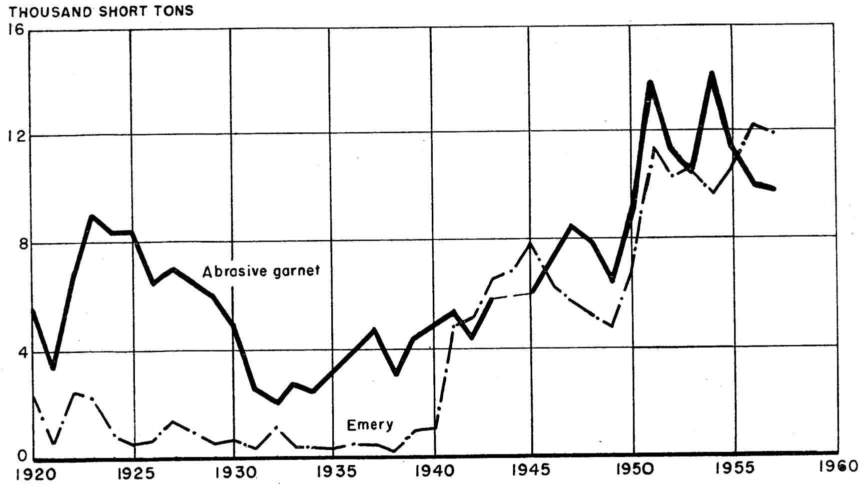

FIGURE 1.—Marketed production of abrasive garnet and emery in the United States, 1920–57.

TABLE 7.—Abrasive garnet sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Thousand dollars	Year	Short tons	Thousand dollars
1948–52 (average)	9,872	823	1955	11,835	1,191
1953	10,520	989	1956	9,812	1,073
1954	14,183	971	1957	9,776	1,080

NATURAL ALUMINA ABRASIVES

Corundum.—Imports of corundum into the United States during 1957 increased 121 percent in tonnage and 186 percent in value over 1956. Nearly all came from the Union of South Africa. The average import value in 1957 was $58 a short ton. There was no commercial production in either the United States or Canada during 1957.

A description of a corundum-sillimanite deposit in the Union of South Africa indicated that large reserves of this material were available. However, the material was apparently better suited for refractory than for abrasive purposes.[6]

Prices for crude corundum were quoted in E&MJ Metal and Mineral Markets as $100 to $120 per short ton, c. i. f. United States ports.

The price of graded corundum quoted by a domestic processor, in sizes 8 to 240, inclusive, was 15 cents a pound, in carlots.

[6] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, pp. 23–25.

TABLE 8.—World production of corundum by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Argentina	14	(3)	(3)	(3)	(3)	(3)
Australia	12	—	—	10	—	—
India	725	363	527	149	395	142
Madagascar	2	—	—	—	—	—
Malaya, Federation of	12	—	—	[4] 2	[4] 100	(3)
Mozambique	4	1	1	9	—	—
Rhodesia and Nyasaland, Federation of:						
Nyasaland	100	—	17	20	—	—
Southern Rhodesia	25	843	2,840	1,168	4,448	4,506
South-West Africa	2	—	—	—	—	—
Union of South Africa	3,650	1,865	1,443	834	2,068	1,547
World total (estimate)[1] [2]	10,200	10,000	10,000	8,000	11,000	10,000

[1] In addition to countries listed, corundum is produced in U. S. S. R., but data on production are not available; estimate is included in the total.
[2] This table incorporates a number of revisions of data published in previous Abrasive Materials chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Data not available; estimate by senior author of chapter included in total.
[4] Exports.

Emery.—Domestic production of emery decreased 2 percent in tonnage but increased 6 percent in value over 1956. The average value of emery ore at the mine was $15.47 a short ton, an increase of 8 percent over the preceding year. The principal use of emery was for nonskid surfaces. A plant for processing emery ore operated at Peekskill, N. Y. The only domestic producers were DeLuca Emery Mine and DiRubbo & Ellis, both of Peekskill, N. Y. Domestic production of emery is presented graphically in figure 1. Emery imports declined.

The preparation and uses of emery were described.[7]

In 1956 the output of emery in Turkey was 4,980 metric tons,[8] and in Greece, 7,000 metric tons.[9] It was reported that a plant to produce emery paper and files was to be built in Alexandria, Egypt.[10]

TABLE 9.—Emery sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Thousand dollars	Year	Short tons	Thousand dollars
1948–52 (average)	7,650	102	1955	10,735	151
1953	10,562	144	1956	12,153	174
1954	9,758	132	1957	11,893	184

INDUSTRIAL DIAMOND

Appraisals of the diamond industry and its outlook were made in English and South African publications. The opinions expressed indicated that the selling arrangements between the producers and

[7] Friedman, G. M., Emery: Min. Eng., vol. 9, No. 7, July 1957, pp. 745–746.
[8] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 22.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 20.
[10] U. S. Embassy, Cairo, Egypt, State Department Dispatch 401: Oct. 19, 1957, p. 15.

the Diamond Corp. had a stabilizing effect on the diamond market, but that they applied more to gem material than to industrial diamond.[11]

Manufactured diamond was available in sizes from 60 to 600 mesh.[12] The use of manufactured diamond in various grinding operations showed that its abrasive qualities are equal to the natural material in many industrial applications. Continued experimentation covering various phases of its manufacture and use indicated that it might soon be produced in commercial quantities at prices competitive with natural diamond.[13]

Production.—World production of industrial diamond during 1957 rose to 20.8 million carats, an increase of 14 percent over the previous year. During the first half of 1957, conditions in the industrial diamond market called for increased output. Expansion took place wherever possible, and prospecting activity rose.[14]

TABLE 10.—World production of industrial diamond, by countries, 1955–57, in thousand carats [1]

Country	1955	1956	1957
Africa:			
Angola	305	300	350
Belgian Congo	12,480	13,280	15,100
French Equatorial Africa	90	95	70
French West Africa	210	260	150
Ghana (Gold Coast)	1,770	1,415	1,950
Sierra Leone [2 3]	540	780	1,000
South-West Africa	80	100	100
Tanganyika	150	187	200
Union of South Africa:			
"Pipe" mines:			
Premier	1,050	1,100	1,150
DeBeers group	450	400	400
Others	100	100	90
"Alluvial" mines	65	60	40
Total Africa	17,300	18,100	20,600
Other areas:			
Brazil [3]	100	150	150
British Guiana	20	18	15
Venezuela	100	75	70
Australia, Borneo, India, and U. S. S. R.[3]	3	3	5
World total	17,500	18,300	20,800

[1] Prepared jointly by the Bureau of Mines and Dr. George Switzer, Smithsonian Institution.
[2] Includes unofficial production of Liberia.
[3] Estimate.

[11] Economist (London), The Diamond Ring: Vol. 185, No. 5962, Nov. 30, 1957, pp. 791–793.
Leeper, Sir Reginald, The Development of the Diamond Industry: Optima (Johannesburg), vol. 7, No. 3, September 1957, pp. 125–129.
Mining Journal (London), The Outlook for Industrial Diamonds: Vol. 248, No. 6352, May 17, 1957, p. 627.
South African Mining and Engineering Journal (Johannesburg), vol. 68, pt. 1, No. 3354, May 24, 1957, p. 1015.

[12] Beardslee, K. R., Man-Made Diamond Ready for Market: Carbide Eng., vol. 9, No. 11, November 1957, pp. 5–9.

[13] Wentorf, R. H., Jr., A Hard-Rock Scientist: New York Times, Feb. 13, 1957, p. C29.
Mining Journal (London), The Shadow of Man-Made Diamonds: Vol. 249, No. 6375, Oct. 25, 1957, pp. 491–492.
Chemical Engineering News, Man-Made Gems Go to Market: Vol. 35, No. 44, Nov. 4, 1957, p. 60.
Chemistry, Man-Made Diamonds Going Into Production: Vol. 31, No. 4, December 1957, p. 22.
Slawson, C. B., Hardness of Synthetic Diamonds: Am. Mineral, vol. 42, No. 3–4, March-April 1957, pp. 299–300.

[14] South African Mining and Engineering Journal (Johannesburg), Diamond Production: Vol. 68, pt. I, No. 3358, June 21, 1957, p. 1229.
Mining Journal (London), Increased Demand for Gems: Vol. 249, No. 6360, July 12, 1957, p. 57.

Although demand slackened in the United States during the last half of 1957, no apparent world oversupply developed and other consuming areas seemed to absorb the available material.[15]

The principal increase in the world industrial diamond supply during 1957 occurred in Belgian Congo where production at the Bakwanga mine increased 12 percent over 1956, and was about 14 million carats.[16]

An unconfirmed increase in the Sierra Leone-Liberia industrial diamond production may have been as much as 500,000 carats.

The U. S. S. R. reported that diamonds were found over a large area in central Siberia, but apparently no commercial production was reported.[17]

Prices.—London prices for certain types of industrial diamond advanced during the year.[18]

Foreign Trade.—Owing to slackening industrial demand and reduced national stockpile purchases, imports of industrial diamond into the United States during 1957 decreased 25 percent in weight and 32 percent in value from 1956.

TABLE 11.—Industrial diamond (excluding diamond dust and manufactured bort) imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Thousand carats	Thousand dollars	Year	Thousand carats	Thousand dollars
1948–52 (average)	10,666	36,842	1955	14,952	65,672
1953	12,769	46,882	1956	[1] 16,166	[1] 73,291
1954	13,807	48,018	1957	12,178	49,684

[1] Revised figure.

[15] Mining Magazine (London), Diamonds: Vol. 156, No. 6, June 1957, p. 326.
South African Mining and Engineering Journal (Johannesburg), Demand for Diamonds: Vol. 68, No. 3357, June 14, 1957, p. 1175; Diamond Sales, pt. II, No. 3374, Oct. 11, 1957, p. 359.
Mining Journal (London), Diamond Demand Unabated: Vol. 248, No. 6355, June 7, 1957, p. 729.

[16] Moyar, A., Brussels, Belgium, Letter to the Bureau of Mines: Jan. 30, 1958.

[17] Davidson, C. F., The Diamond Fields of Yakutia: Min. Mag. (London), vol. 97, No. 6, December 1957, pp. 329–338.
Times Review of Industry (London), Siberian Diamonds for Soviets: Vol. 11, No. 127, August 1957, pp. 77–79.
South African Mining and Engineering Journal (Johannesburg), Diamonds for Soviet Industry: Vol. 68, No. 3379, Nov. 15, 1957, p. 611.

[18] South African Mining and Engineering Journal (Johannesburg), Industrial Diamonds: Vol. 68, pt. II, No. 3375, Oct. 18, 1957, p. 409.
Wall Street Journal, Price of Some Diamond Drill Stones Increased in London: Vol. 150, No. 69, Oct. 7, 1957, p. 5.

TABLE 12.—Industrial diamond (including diamond dust and manufactured bort) imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	Bort manufactured (diamond dies)		Crushing bort (including all types of bort suitable for crushing)		Other industrial diamond (including glaziers' and engravers' diamond unset and miners')		Carbonado and ballas		Dust and powder	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value	Carats	Value
1956										
North America:										
Bermuda					6,342	$79,407				
Canada	192	$1,528	64,066	$218,807	540,839	3,578,769			10,392	$14,984
Mexico			301	724	609	5,251				
Total	192	1,528	64,367	219,531	547,790	3,663,427			10,392	14,984
South America:										
Brazil					11,642	230,478	1,549	$23,539		
British Guiana					240	4,382				
Venezuela			2,549	55,996	11,236	282,019				
Total			2,549	55,996	23,118	516,879	1,549	23,539		
Europe:										
Belgium-Luxembourg					1,044,053	13,258,472			5,475	30,428
France	3,003	218,349			123,077	1,084,553			1,250	3,563
Germany, West	362	28,655			3,926	52,459				
Netherlands	2,824	65,558	2,160	6,696	168,161	1,390,212			1,500	5,750
Sweden	122	7,484								
Switzerland	62	3,950			1,300	13,793				
United Kingdom	2,275	5,501	1,822,634	4,404,413	3,955,712	24,324,606	1,150	16,516	17,613	70,596
Total	8,648	329,497	1,824,794	4,411,109	5,296,229	40,124,095	1,150	16,516	25,838	110,337
Asia:										
Hong Kong					207	827				
India					626	17,625				
Israel					3,067	21,287				
Japan					1,871	5,840				
Total					5,771	45,579				
Africa:										
Belgian Congo			[1]6,601,947	[1]15,312,310	378,140	1,386,115			81,270	227,633
British West Africa, n. e. c.					6,937	52,346				
French Equatorial Africa					22,523	368,936				
Liberia					3,169	56,074	949	29,419		
Union of South Africa	214	1,887	323,347	871,324	1,060,648	6,136,823			121,250	344,780
Total	214	1,887	[1]6,925,294	[1]16,183,634	1,471,417	8,000,294	949	29,419	202,520	572,413
Oceania: Australia					500	1,285				
Grand total, 1956	9,054	[2]332,912	[1]8,817,004	[1]20,870,270	7,344,825	[2]52,351,559	3,648	69,474	238,750	697,734

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

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TABLE 12.—Industrial diamond (including diamond dust and manufactured bort) imported for consumption in the United States, 1956–57, by countries—Con.

Country	Bort manufactured (diamond dies)		Crushing bort (including all types of bort suitable for crushing)		Other industrial diamond (including glaziers' and engravers' diamond unset and miners')		Carbonado and ballas		Dust and powder	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value	Carats	Value
1957										
North America:										
Bermuda	------	------	------	------	1, 998	$31, 550	------	------	------	------
Canada	------	------	53, 600	$209, 946	714, 086	5, 011, 011	------	------	20, 117	$43, 735
Total	------	------	53, 600	209, 946	716, 084	5, 042, 561	------	------	20, 117	43, 735
South America:										
Brazil	------	------	------	------	13, 582	315, 900	600	$8, 145	------	------
British Guiana	------	------	------	------	12, 108	324, 126	------	------	------	------
Venezuela	------	------	------	------	729	9, 475	------	------	------	------
Total	------	------	------	------	26, 419	649, 501	600	8, 145	------	------
Europe:										
Belgium-Luxembourg	17	$2, 264	------	------	348, 167	3, 176, 817	------	------	1, 000	3, 750
France	1, 621	148, 937	------	------	18, 692	179, 679	------	------	------	------
Germany, West	465	52, 784	------	------	1, 691	62, 397	------	------	------	------
Italy	------	------	------	------	61	1, 600	------	------	------	------
Netherlands	138	15, 651	1, 000	2, 500	33, 671	294, 604	------	------	3, 820	12, 340
Sweden	22	2, 051	------	------	222	3, 855	------	------	------	------
Switzerland	29	8, 933	------	------	5, 335	28, 090	586	4, 913	------	------
United Kingdom	3, 739	42, 624	1, 989, 484	5, 147, 294	3, 076, 441	16, 377, 752	894	5, 285	77, 215	228, 301
Total	6, 031	273, 244	1, 990, 484	5, 149, 794	3, 484, 280	20, 124, 794	1, 480	10, 198	82, 035	244, 391
Asia:										
India	------	------	------	------	230	8, 263	------	------	------	------
Israel	26	776	------	------	290	14, 626	------	------	------	------
Japan	------	------	------	------	500	10, 000	------	------	------	------
Total	26	776	------	------	1, 020	32, 889	------	------	------	------
Africa:										
Belgian Congo	------	------	4, 501, 977	11, 602, 696	258, 712	1, 121, 992	------	------	92, 737	281, 509
British West Africa, n. e. c.	------	------	5, 000	13, 975	------	------	------	------	------	------
French West Africa	------	------	------	------	36	248	------	------	------	------
Ghana	------	------	------	------	802	2, 747	------	------	------	------
Liberia	------	------	------	------	6, 331	85, 672	------	------	------	------
Union of South Africa	(3)	980	282, 176	825, 962	849, 082	4, 803, 098	------	------	191, 314	616, 592
Total	(3)	980	4, 789, 153	12, 442, 633	1, 114, 963	6, 013, 757	------	------	284, 051	898, 101
Grand total 1957	6, 057	[2] 275,000	6, 833, 237	17, 802, 373	5, 342, 766	31, 863, 502	2, 080	18, 343	386, 203	1,186,227

[3] Less than 1 carat.

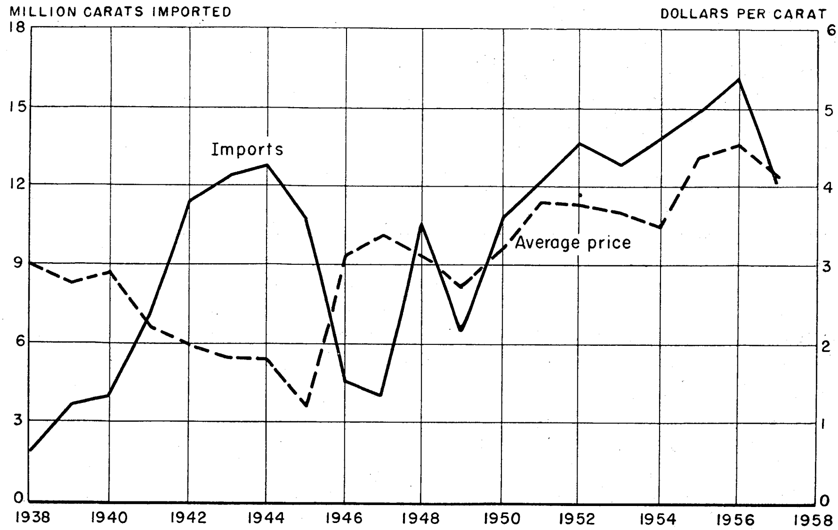

FIGURE 2.—United States imports and average price per carat of industrial diamond, 1938–57.

World Review.—Reviews of the world diamond industry in 1956 were published during 1957.[19]

The Portuguese Government was considering processing and grading, in Portugal, diamond from Angola. A drop in grade of the diamond-bearing gravel in Angola was offset by an increase in quantity mined, resulting in increased total diamond production.[20]

At the Mwadui mine of Williamson Diamonds, Ltd., Tanganyika, a new recovery plant using heavy-medium separation and grease tables, began operating. Owing to the higher efficiency of this plant, the proportion of smaller and less valuable diamonds recovered was larger than in the past.[21]

In Ghana all production of licensed diamond miners was sold through the Government Diamond Market where three private firms bought in competition. A duty of 9 percent on the appraised value was collected on diamond exports. A new washing plant capable of treating 300,000 cubic yards of diamond-bearing gravel annually was planned for the Akwatia district in Ghana.[22]

Diamond discoveries were reported in South-West Africa, and several prospecting concessions were granted.[23]

Of the diamond output from the Union of South Africa, 86 percent came from "pipe" mines.[24]

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[19] Moyar, A., L'Industrie du diamant in 1956: Brussels, Belgium, November 1957, 181 pp.
Switzer, George, 32d Annual Report on the Diamond Industry, 1956: Jewelers' Circ.-Keystone, 1957, 16 pp.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 5, May 1957, pp. 26–28.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 37.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, pp. 20–21.
[23] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, pp. 21–22.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, pp. 22–23.

The diamond production of Venezuela was 20 percent gem stones, 71 percent industrial stones, and 9 percent bort. Of the diamond exports, 58 percent went to the United States.[25]

Technology.—Articles summarizing recent geological studies of diamond-bearing kimberlite in Arkansas,[26] Tanganyika,[27] and the marine terrain of Namaqualand [28] appeared in the technical press.

Two American mining companies jointly examined diamond-mining areas in French Equatorial Africa with the view to dredging them—a new development in diamond mining.[29]

Descriptions of diamond-mining activities and new developments in mining and recovery appeared in the technical press.[30]

Increased interest was shown in recovering diamond from grinding sludges, and new types of equipment were devised for that purpose. The removal of impurities, including organic materials, magnetic substances, silica, and alumina from industrial waste containing diamond was explained in some detail.[31]

Continued demand for closer tolerances and automation in industry have increased the use of diamond tools and grinding wheels, and choosing the right diamond for the job has become more important.[32] Studies in the use of industrial diamond indicate that a proper orientation of the diamond in a cutting tool is necessary to get the maximum results.[33]

Various factors that influence the choice of diamond or silicon carbide grinding wheels for sharpening cemented carbide tools were

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[25] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 5, May 1957, p. 28.

[26] Leiper, H., Arkansas Diamonds: Jour. Gemmology, vol. 6, No. 2, April 1957, pp. 63–71.

[27] Tremblay, M., The Geology of the Williamson Diamond Mine: Canadian Min. Jour., vol. 77, No. 12, December 1957, p. 92.

[28] Sinclair, W. E., Notes on Namaqualand and Its Mineral Potential: Min. Mag., vol. 97, No. 2, August 1957, pp. 73–78.

[29] California Mining Journal, Natomas Company Joins Tin Operators Mining for Diamonds in South Africa: Vol. 27, No. 4, December 1957, p. 23.

[30] South African Mining and Engineering Journal (Johannesburg), Companhia de Diamantes de Angola: Vol. 68, No. 3344, Mar. 15, 1957, p. 475; Tanganyika Mining Industry in 1956, pt. 1, No. 3347, Apr. 5, 1957, p. 605.

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Loftus, W. K. B., and Thorburn, G., Raising Vertical Ore Passes in Diamond Mines: Min. Mag. (London), vol. 117, No. 2, August 1957, pp. 82–85.

[31] Abel, J., Reclamation of Diamond Powder From Industrial Wastes: Ind. Diamond Rev., vol. 17, No. 195, February 1957, pp. 25–27.

Hunter, R. H., Diamond Swarf Collection, Is It Worthwhile?: Grits and Grinds, vol. 48, No. 3, March 1957, pp. 14–15.

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Automotive Industry, Buick Installation Reclaims Diamond Dust From Grinding: Vol. 117, No. 3, July 15, 1957, p. 33.

Industrial Diamond Review, Reclamation of Diamond: Vol. 17, No. 204, November 1957, p. 213.

Swimmer, J., Diamond Powder Reclamation: Ind. Diamond Rev., vol. 17, No. 198, May 1957, p. 96.

[32] Iron Age, Diamonds Reflect Industry Pace: Vol, 180, No. 11, Sept. 12, 1957, p. 92.

Engineering and Mining Journal, Choose the Right Diamond for the Job: Vol. 158, No. 6, June 1957, pp. 89–91; Choosing the Right Diamond for the Drilling Job, No. 12, December 1957, p. 106.

Ripple, J. W., Faster Carbide Grinding With Metal-Bonded Diamond Wheels: Ind. Diamond Rev., vol. 17, No. 196, March 1957, pp. 56-57.

Mine and Quarry Engineering (London), Tooled and Tools: Vol. 23, No. 5, May 1957, p. 193.

[33] Denning, R. M., The Grinding Hardness of Diamond in a Principal Cutting Direction: Am. Mineral., vol. 46, No. 5–6, May–June 1957, pp. 362–366.

explained.[34] Several methods of dressing diamond-grinding wheels were suggested, and the reasons for using different methods were explained.[35] Increased use of diamond material for lapping was noted, and advice was given on the use of diamond compounds.[36] New standard diamond-grinding wheel shapes were listed, and diamond-wheel designations were explained. Also, a list of United States diamond-tool firms and an index of their products were published.[37] The value of determining the ratio between the diamond content of a grinding wheel and its bonding material was emphasized.[38] Industrial diamond was used to grind boron carbide for gages and applications requiring high wear-resistance.[39] Several new techniques for grinding sintered carbide cutting tools, without using diamond grinding wheels, were described.[40] In a general survey of the use of diamonds in the wire industry, the hardness of individual stones and the quality of diamond powder used were considered.[41]

ARTIFICIAL ABRASIVES

During 1957, both the tonnage and value of artificial abrasives produced in the United States and Canada increased, compared with 1956. Silicon carbide increased 30 percent in tonnage and 28 percent in value; aluminum oxide increased 17 percent in tonnage and 25 percent in value.

TABLE 13.—Crude artificial abrasives produced in the United States and Canada, 1948–52 (average) and 1953–57

Year	Silicon carbide [1]		Aluminum oxide [1] (abrasive grade)		Metallic abrasives [2]		Total	
	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons	Thousand dollars
1948–52 (average)	77, 521	8, 602	163, 567	13, 999	143, 700	14, 339	384, 788	36, 940
1953	62, 301	8, 190	244, 136	23, 808	160, 500	18, 038	466, 937	50, 036
1954	66, 972	8, 787	219, 308	22, 421	118, 096	13, 272	404, 376	44, 480
1955	74, 805	11, 027	195, 822	22, 142	157, 616	17, 912	428, 243	51, 081
1956	95, 778	14, 937	195, 228	22, 554	140, 455	18, 201	431, 461	55, 692
1957	124, 688	19, 152	228, 511	28, 202	131, 503	18, 280	484, 702	65, 634

[1] Figures include material used for refractories and other nonabrasive purposes.
[2] Shipments from United States plants only.

[34] Pond, J. P., Factors That Influence the Choice of the Right Diamond Wheel: Carbide Eng., vol. 9, No. 5, May 1957, pp. 14–16.
Sinclair, E. L., Carbide Tool Grinding Starts With Wheel Selection: Grits and Grinds, vol. 48, No. 4, April 1957, pp. 7–13.
[35] Ripple, J. W., What You Need to Know About Diamond-Wheel Dressing: Carbide Eng., vol. 9, No. 7, July 1957, pp. 14–16.
[36] Grinding and Finishing, Lapping With Diamonds: Vol. 3, No. 2, June 1957, pp. 32–35.
Pond, J. P., What You Should Know About Diamond Abrasive Compounds: Carbide Eng., vol. 9, No. 5, May 1957, pp. 32–36.
[37] Grinding Wheel Institute, Diamond Wheel Shapes: Am. Machinist, vol. 101, No. 14, July 15, 1957, pp. 167–169; Diamond Wheel Shapes III, IV, No. 15, July 29, 1957, pp. 123–125.
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[38] Lindblad, F. W., Determining Diamond Concentration in a Diamond Wheel: Grinding and Finishing, vol. 2, No. 2, June 1957, p. 51.
[39] Palm, A. I., How to Grind Boron Carbide: Ind. Diamond Rev., vol. 17, No. 196, March 1957, pp. 54–57.
[40] Mechanical World, Carbide Grinding Methods: Vol. 137, No. 3455, June 1957, pp. 258–289.
[41] Zucker, L. A., Industrial Diamonds in the Wire Mill: Ind. Diamond Rev vol. 17, No. 202, September 1957, pp. 173–175, 179.

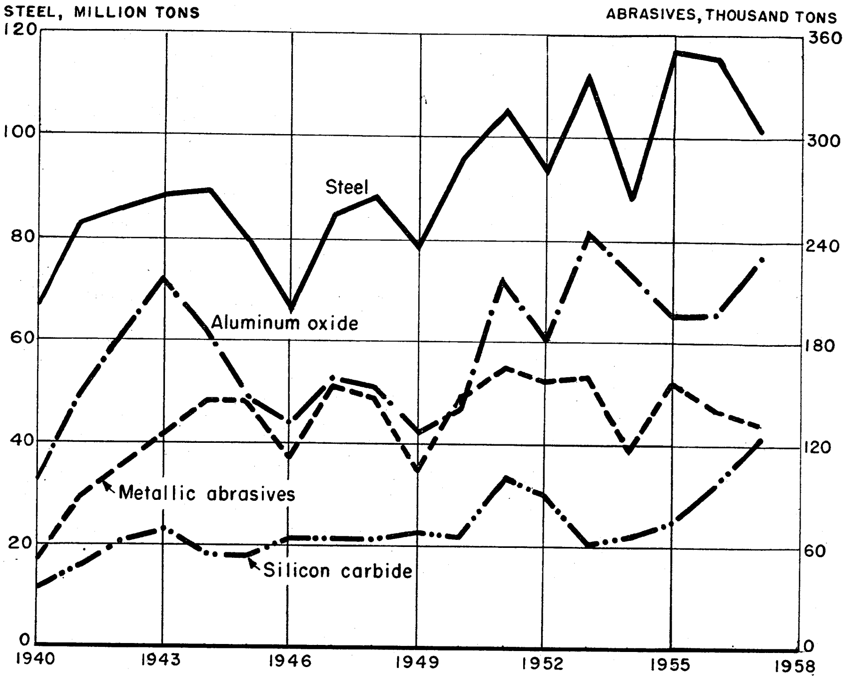

FIGURE 3.—Relationship between ingot-steel and artificial abrasive production, 1940–57.

TABLE 14.—Production, shipments, and stocks of metallic abrasives in the United States, 1956–57, by products

Product	Manufactured during year		Sold or used during year		Stocks on hand Dec. 31		Average annual capacity
	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons	Thousand dollars	Short tons
1956							
Chilled iron shot and grit	72,048	6,944	72,410	7,171	[1] 8,802	[2] 789	[2] 166,134
Annealed iron shot and grit	36,501	3,912	35,917	4,514	[1] 2,241	[2] 279	69,484
Steel shot	28,577	5,338	27,553	5,484	[1] 4,145	[2] 769	45,025
Other types (including cut wire shot)	5,438	1,197	4,575	1,032	[1] 1,320	[2] 346	9,875
Total	142,564	17,391	140,455	18,201	[1] 16,508	[2] 2,183	[2] 290,518
1957							
Chilled iron shot and grit	60,774	5,847	61,181	6,336	8,395	736	164,294
Annealed iron shot and grit	35,634	4,404	36,111	4,708	1,764	225	69,044
Steel shot	29,098	5,420	27,986	5,849	5,257	980	53,100
Other types (including cut wire shot)	6,808	1,423	6,225	1,387	1,903	506	11,190
Total	132,314	17,094	131,503	18,280	17,319	2,447	297,628

[1] Stock adjustment.
[2] Revised figure.

The aluminum oxide production included 26,490 short tons of "white high-purity" material, valued at $4,695,940. Nonabrasive uses consumed 38.4 percent of the silicon carbide and 4.9 percent of the aluminum oxide. In 1957, production was 95 percent of plant capacity for silicon carbide, compared with 81 percent in 1956; aluminum oxide production was 77 percent of plant capacity in 1957, compared with 69 percent in 1956.

TABLE 15.—Stocks of crude artificial abrasives and capacity of manufacturing plants, as reported by producers in the United States and Canada, 1948–52 (average) and 1953–57, 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
1948–52 (average)	14, 650	91, 342	39, 698	242, 634	9, 397	230, 447
1953	18, 587	110, 900	25, 165	273, 200	11, 913	255, 624
1954	27, 852	120, 000	29, 924	280, 200	14, 414	254, 950
1955	10, 966	118, 820	39, 895	282, 200	14, 552	264, 282
1956	10, 314	118, 900	38, 551	283, 500	[2] 16, 508	[2] 290, 518
1957	13, 996	131, 853	36, 660	298, 700	17, 319	297, 628

[1] Figures pertain to United States plants only.
[2] Revised figure.

The value of the domestic sales of abrasive grinding wheels in 1957 was $174,207,000—a decline of less than 1 percent from 1956. Domestic coated-abrasives sales for 1957 were 2,175,591 reams, a decline of 4 percent from 1956, but their value increased 1 percent for the same period.

Domestic production of metallic abrasives in 1957 declined 7 percent in tonnage from 1956. A drop in production of chilled iron shot and grit furnished the decrease. There was virtually no change in the total value. In 1957, production of metallic abrasives was 44 percent of plant capacity, compared with 49 percent in 1956.

The modernization and expansion of The Carborundum Co. silicon carbide plants at Niagara Falls, N. Y., Vancouver, Wash., and Shawinigan Falls, Quebec, were described.[42] Two abrasive companies were expanding their facilities for producing aluminum oxide in Brazil.[43]

Adequate manufacturing capacity and the availability of raw materials during 1957 assured a sufficient supply of abrasives for industry.[44] Physical and chemical reactions are involved in abrasive grinding and influence the choice of grinding wheel for the intended work.[45] A comprehensive study of grinding-wheel manufacture explained some of the processes that are used in making the correct

[42] Daily Metal Reporter, Carborundum Co. Launches Expansion: Vol. 57, No. 124, June 28, 1957, pp. 1, 9.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, p. 26.
[44] Grinding Wheel Institute, 2130 Keith Bldg., Cleveland, Ohio, Simplified Practice Recommendation R45-56, 1957.
Iron Age, No Strain in Buying Abrasives: Vol. 179, No. 25, June 30, 1957, p. 144.
[45] Gardner, A. G., Grinding Wheels—Their Selection and Application: Mech. World, vol. 137, No. 3460, November 1957, pp. 486–492.

wheel for each grinding job.[46] A comparison of the chemical and physical properties of natural and synthetic corundum were described.[47] A new grinding-wheel plant in California, providing a local supply of abrasives, was described.[48]

Increased use stimulated the development of new equipment for manufacturing coated abrasives.[49]

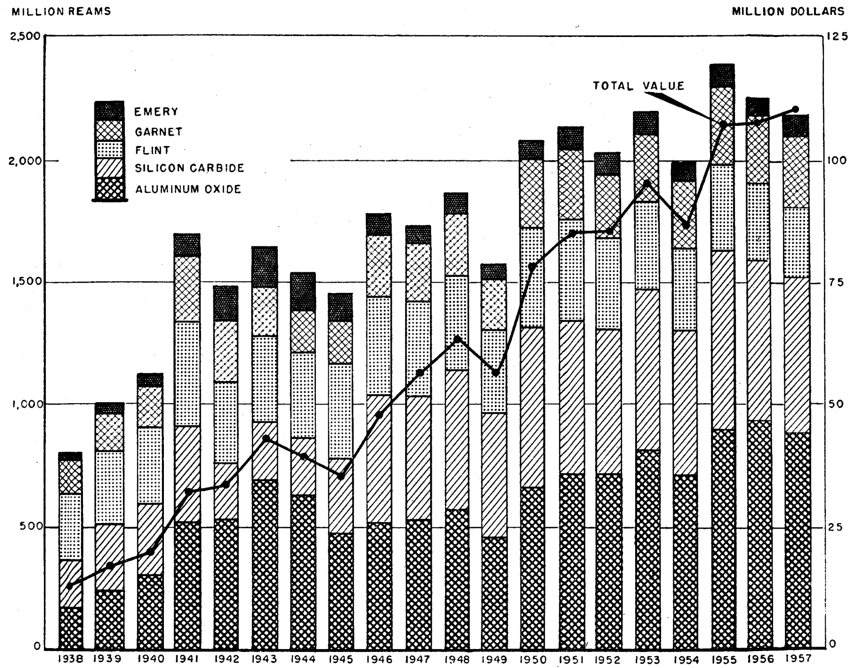

FIGURE 4.—Coated-abrasives industry in the United States, 1938–57.

Ceramic cutting tools, using aluminum oxide as the abrasive component, have shown increased cutting speed, more cuts per tool edge, and less machine idle time resulting in fewer tool changes in certain metal-cutting operations.[50] The number of machine operations where ceramic tools were used to advantage was increasing.[51]

General Electric Co. announced the synthesis of a new material, boron nitride in cubic form, under the trade name Borazon. The ma-

[46] Houchins, H. A., The Manufacture of Vitrified Grinding Wheels: Ceram. Age, vol. 69, No. 1, January 1957, pp. 12–15.
[47] Barata, C., The Production and Properties of Synthetic Corundum: Ind. Diamond Rev., vol. 17, No. 201, August 1957, pp. 147–150, 152.
[48] Pacific Gas & Electric Progress, San Francisco, Grinding Wheels Custom Made: Vol. 34, No. 11, November 1957, p. 2.
[49] Metal Industry (London), Coated Abrasives: Vol. 91, No. 3, July 19, 1957, pp. 45–46.
[50] Machine and Tool Blue Book, How Ford Increased Production With Ceramic Tools: Vol. 21, No. 1, January 1957, pp. 140–143.
[51] Haeme, A. O., and Hook, R. T. (Warner & Swasey Co.), Industrial Application of Ceramic Tools: Am. Soc. Tool Eng. Ann. Collected Papers, 1957, No. 24, 8 pp.
Materials and Design Engineering, New Developments in Ceramic Materials: Vol. 46, No. 5, October 1957, pp. 214, 216, 218, 220, 222.

terial was reported to withstand a temperature of 3,500° F., to resist oxidation, and to have a hardness equal to that of diamond. The resistance to oxidation might allow wheels and tools made with Borazon to be operated at higher speeds than previously possible although there was no commercial production.[52]

MISCELLANEOUS MINERAL-ABRASIVE MATERIALS

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

Cerium.—An article on the production and uses of cerium appeared in a technical journal.[53]

A patent was issued for a polishing composition consisting essentially of cerium oxide.[54]

FOREIGN TRADE [55]

Imports.—The decline in industrial-diamond imports was the principal reason for a 15-percent drop in the total value of abrasive material imports into the United States during 1957. During the same period there was an increase of 21 percent in tonnage and 31 percent in value of the total imports of artificial abrasives. The import value of coated abrasives increased; that of grinding wheels decreased. Imports of corundum ore increased substantially, but imports of emery ore decreased.

Exports.—Exports of abrasive materials during 1957 gained 3 percent in total value over 1956. Coated abrasives furnished 23 percent of the total; artificial abrasives, 21 percent; natural abrasives, 20 percent; grinding wheels and pulpstones, 19 percent; industrial diamond products, 8 percent; metallic abrasives, 4 percent; and other abrasive products, 5 percent.

Industrial-diamond material comprised over 99 percent of the total value of the reexports of abrasive material in 1957. These reexports went to the following countries: Canada, 64 percent; Belgium, 17 percent; United Kingdom, 7 percent; West Germany, 4 percent; Japan, 4 percent; and 9 other countries, 4 percent.

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[52] American Mineralogist, News and Notes: Vol. 42, No. 3–4, March–April 1957, p. 301.
New York Times, G. E. Makes Matter Hard as Diamond: Feb. 13, 1957, pp. 1, 29.
Industrial and Engineering Chemistry, Abrasives: Vol. 49, pt. II, No. 9, September 1957, p. 1589.
Electronic News, Industry Sees Many Uses for Borazon: Vol. 2, No. 16, Feb. 18, 1957, p. 12.

[53] Lomas, J., Cerium: Canadian Min. Jour., vol. 78, No. 5, May 1957, pp. 115–116.

[54] Wilansky, Harold (assigned to Corning Glass Works, Corning, N. Y.), Cerium Oxide Polishing Compound: U. S. Patent 2,816,824, Dec. 17, 1957.

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

TABLE 16.—Abrasive materials (natural and artificial) imported for consumption in the United States, 1955–57, by kinds

[Bureau of the Census]

Kind	1955		1956		1957	
	Quantity	Value	Quantity	Value	Quantity	Value
Burrstones:						
Unmanufactured short tons					65	$432
Bound up into millstones short tons			(1)	$480		
Hones, oilstones, and whetstones number	58,903	2 $31,523	98,689	2 39,508	30,007	2 27,711
Corundum (including emery):						
Corundum ore short tons	1,399	96,762	1,857	83,141	4,104	238,106
Emery ore do	840	10,686	1,960	33,775	1,334	17,300
Grains, ground, pulverized, or refined short tons	566	118,163	480	107,890	722	168,962
Paper and cloth coated with emery or corundum reams	3 27,012	319,565	32,317	2 331,425	(4)	2 531,757
Wheels, files, and other manufactures of emery short tons	34	2 61,467	48	2 75,030	31	2 63,802
Wheels of corundum or silicon carbide short tons	4	2 10,640	10	2 22,312	13	2 18,842
Garnet in grains, or ground, pulverized, etc short tons			2	280	2	240
Tripoli, rottenstone, and diatomaceous earth short tons	28	1,029			9	322
Diamond:						
Bort, manufactured carats	2,771	205,139	9,054	2 332,912	6,057	2 275,000
Crushing bort (including all types of bort suitable for crushing) carats	6,502,397	14,630,408	5 8,817,004	5 20,870,270	6,833,237	17,802,373
Other industrial diamond (including glaziers' and engravers' diamonds unset and miners') carats	8,449,010	51,016,224	7,344,825	2 52,351,559	5,342,766	31,863,502
Carbonado and ballas carats	1,175	25,602	3,648	69,474	2,080	18,343
Dust and powder do	152,732	435,120	238,750	697,734	386,203	1,186,227
Flint, flints, and flintstones, unground short tons	7,809	2 169,612	9,492	2 243,166	11,502	2 280,740
Grit, shot, and sand, of iron and steel short tons	886	181,658	836	222,715	852	298,764
Artificial abrasives:						
Crude, not separately provided for:						
Carbides of silicon (carborundum, crystalon, carbolon, and electrolon) short tons	67,691	7,914,696	72,659	8,906,901	84,040	11,205,376
Aluminous abrasives, alundum, aloxite, exolon, and lionite short tons	151,720	14,201,390	156,982	15,044,908	192,778	19,872,664
Other do	1,390	109,288	2,198	205,006	4,695	456,322
Manufactures:						
Grains, ground, pulverized, refined, or manufactured short tons	1,246	250,168	1,370	299,915	1,624	2 350,508
Wheels, files, and other manufactures, not separately provided for short tons	3	5,849	17	2 29,370	14	2 41,015
Total		2 89,794,989		2 5 99,967,771		2 84,718,308

1 Less than 1 ton.
2 Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.
3 Adjusted by Bureau of Mines: Bureau of the Census shows 271,012 reams
4 Not recorded.
5 Revised figure.

TABLE 17.—Abrasive materials exported from the United States, 1955–57

[Bureau of the Census]

Kind	1955		1956		1957	
	Quantity	Value	Quantity	Value	Quantity	Value
Natural abrasives:						
Diamond grinding wheels, sticks, hones and laps carats	180,405	$850,225	187,438	$948,007	194,934	$1,134,871
Diamond dust and powder carats	215,787	515,555	210,841	616,038	199,252	622,480
Diamond suitable only for industrial use carats	1,168	16,320	11,725	97,937	54,413	543,793
Grindstones and pulpstones short tons	452	85,167	430	64,303	330	54,306
Emery powder, grains, and grits (natural) pounds	2,800,285	179,810	3,869,277	248,403	2,343,422	204,829
Corundum (natural) do	310,975	44,497	496,357	73,989	417,576	78,822
Whetstones, sticks, etc. (natural) pounds	211,134	95,161	125,580	95,987	196,128	109,216
Natural abrasives [1] not elsewhere classified pounds	131,419,734	4,699,379	142,196,239	5,124,926	147,057 093	5,394,900
Manufactured abrasives:						
Aluminum oxide, fused, crude and grains pounds	26,390,434	3,221,190	24,815,955	3,292,934	21,475,167	3,146,515
Silicon carbide, fused, crude and grains pounds	14,141,545	2,288,373	15,682,429	2,737,896	15,299,644	2,729,166
Alumina, unfused do	235,866	25,370	67,403	7,641	112,791	14,357
Manufactured abrasives, not elsewhere classified pounds	113,247	37,412	158,681	45,061	308,337	59,491
Abrasive pastes, compounds and cake pounds	744,911	170,608	518,767	159,551	750,902	186,216
Grinding wheels, except diamond wheels pounds	4,908,799	4,018,404	4,926,902	4,262,429	5,368,241	4,530,502
Pulpstones of manufactured abrasives pounds	2,670,963	617,831	3,374,244	860,078	2,488,732	655,817
Whetstones, etc., of manufactured abrasives pounds	419,979	539,141	560,661	714,606	363,955	687,033
Abrasive paper and cloth (natural abrasives) reams	69,222	1,185,061	55,814	1,068,057	68,237	1,225,363
Abrasive paper and cloth (artificial abrasives) reams	151,706	5,474,299	158,441	5,567,078	142,910	5,124,091
Metallic abrasives (except steel wool) pounds	11,413,127	812,390	11,547,717	860,559	12,409,004	1,087,050
Total		24,876,193		26,845,480		27,588,818

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

TABLE 18.—Abrasive materials reexported from the United States, 1955–57, by kinds

[Bureau of the Census]

Kind	1955		1956		1957	
	Quantity	Value	Quantity	Value	Quantity	Value
Natural abrasives:						
Diamond grinding wheels, sticks, hones, and laps..........carats..	711	$12 495	----------	----------	937	$4,165
Diamond dust and powder.....do....	29,933	70,200	55,137	$152,991	71,378	221,804
Diamond suitable only for industrial use.........................carats..	1,179,752	6,347,745	1,198,589	7,586,414	1,261,209	8,465,637
Natural abrasives [1] not elsewhere classified..................pounds..	65,660	1,400	----------	----------	----------	----------
Manufactured abrasives:						
Aluminum oxide, fused, crude and grains.....................pounds..	----------	----------	10,197	13,000	129,600	5,800
Silicon carbide, fused, crude and grains.....................pounds..	27,215	3,257	----------	----------	----------	----------
Grinding wheels, except diamond wheels.....................pounds..	6,025	6,002	1,200	856	450	543
Abrasive paper and cloth (natural abrasives).................reams..	30	1,158	----------	----------	61	3,610
Abrasive paper and cloth (artificial abrasives).................reams..	53	1,899	----------	----------	----------	----------
Metallic abrasives (except steel wool) pounds..	----------	----------	23,243	2,189	----------	----------
Total..............................	----------	6,444,156	----------	7,755,450	----------	8,701,559

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

Aluminum

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

DURING 1957 the supplies of primary aluminum, especially in the Western Hemisphere, continued to exceed the demand. Despite the apparent surplus, world primary production in 1957 was slightly greater than in 1956; however, production in the United States was down 2 percent and in Canada down 9 percent from the preceding year.

Part of the surplus production in the United States was shipped to the Government under the terms of contracts negotiated during the Korean war.

At the end of the year two companies that had not produced primary aluminum before were planning to complete new reduction plants in 1958. Work also was continuing on other new facilities, so that the annual primary aluminum capacity in the United States, which at the end of 1957 exceeded 1.8 million short tons, would be nearly 2.4 million tons before the end of 1959.

TABLE 1.—Salient statistics of the aluminum industry, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Primary production short tons	743,950	1,252,013	1,460,565	1,565,721	1,678,954	1,647,709
Value	$251,286,000	$496,315,000	$592,837,000	$684,038,000	$805,782,000	$836,944,000
Average ingot price per pound cents	17.8	20.9	21.8	23.7	26.0	27.5
Secondary recovery short tons	261,667	368,566	[1] 292,041	[1] 335,994	[1] 339,768	[1] 359,666
Imports (crude and semicrude) short tons	170,894	359,481	243,750	239,475	264,975	258,062
Exports (crude and semicrude) short tons	28,189	15,355	50,096	33,834	[2] 68,032	61,429
World: Production short tons	1,750,000	2,725,000	3,090,000	3,460,000	3,720,000	3,730,000

[1] Not strictly comparable with previous years' data. The 1954–57 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.
[2] Revised figure.

A second firm began producing primary aluminum in Canada when the Canadian British Aluminium Co., Ltd., poured metal at its new Baie Comeau plant in Quebec. A new plant at Edea, French Cameroon, early in the year yielded the first primary ingot ever produced in Africa.

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

LEGISLATION AND GOVERNMENT PROGRAMS

The increased capacity for production, and increased supplies of aluminum, in the face of lessening demand resulted in changes in the Government's approach to assuring ample supplies of the metal during possible emergencies.

Late in 1956 the Office of Defense Mobilization (ODM) announced that there would be no calls for aluminum during the first half of 1957. In May 1957 it was stated that no calls would be made during the last 6 months of the year. From the end of April to the end of May the U. S. Department of Agriculture suspended the barter program under which aluminum and other commodities could be obtained by the Government in exchange for surplus agriculture commodities. In August ODM removed aluminum from the list of materials which could be acquired by barter. Reexamination of the need for additional stockpiles of aluminum in the light of domestic supply prompted the decision.

During the year the three major primary aluminum producers, Aluminum Company of America, Kaiser Aluminum & Chemical Corp., and Reynolds Metals Co., invoked the "put-right" provision of their Government supply contracts. Under the contracts, through which the Government encouraged expansion of the industry during the Korean war, the companies had the right to sell to the Government metal that nonintegrated consumers do not purchase. By the end of December 324,327 tons had been shipped to the Government. Of this total, Alcoa shipped 104,998 tons; Kaiser, 116,801; and Reynolds, 102,528. At the end of the year it appeared that such shipments would continue into 1958. Most of the contracts were scheduled to expire during 1958.

The Congressional Joint Committee on Defense Production held hearings on the Government's obligations under these contracts. The original contracts, which were ruled valid by the Comptroller General, obliged the Government to take up to 658,475 short tons of aluminum for a year. However, the General Services Administration (GSA) negotiated with the producers, with the result that major aspects of the contracts were modified as follows:

1. The producers will deduct from the metal that can be tendered to the Government any primary aluminum obtained from other sources (imports).
2. The metal delivered shall be of stockpile grade.
3. The price shall be that prevailing at the time of production rather than the price at time of shipment.
4. Each year for 15 years after the expiration of the "put rights," 230,466 tons or 35 percent of the expanded production shall be made available to nonintegrated consumers.

The GSA estimated that under the revisions the maximum saving to the Government could be $98 million.

In November, Subcommittee 3 of the Select Committee on Small Business of the House of Representatives, under the chairmanship of Congressman Sidney R. Yates, held hearings on the role of small business in the aluminum industry. Of particular interest was the determination of the effect of the so-called "hot-metal" contracts between Reynolds and Ford and Reynolds and General Motors. Representatives from the 3 major aluminum producers and 3 leading automobile manufacturers testified.[4] Price policy, "hot-metal" contracts, aluminum's price history, outlook of the industry, and the future of aluminum in the automotive industry were discussed.

Under the Defense Materials system effective since July 1953 that portion of the aluminum supply available in the United States above the quantity set aside for defense and atomic energy requirements and the national stockpile was free for civilian consumption without Government restriction. The total metal set aside, exclusive of the stockpile, consisted of an "A" allotment for specifically designed military equipment and a "B" allotment for aluminum required by manufacturers of civilian-type items incorporated in military end items. During 1957 the total of the two allotments, by quarters, as announced by Business and Defense Services Administration, was:

	Short tons		Short tons
First quarter	68, 500	Third quarter	72, 500
Second quarter	70, 000	Fourth quarter	64, 000

The grand total of 275,000 tons was a decrease of 16,500 tons (6 percent) from the preceding year.

The antitrust suit filed in 1937 by the Government against the Aluminum Company of America was closed in June, when the court denied a Department of Justice petition that would have permitted the Government to maintain watchdog jurisdiction over the company through 1962. The original suit asked the court to dissolve Alcoa, which at that time was the only primary aluminum producer; however, in a 1950 decision in the case the court required that holders of both Alcoa and Aluminium, Ltd., stock sell their holdings in one or the other company. The court in its 1957 decision held that, with 3 large and 2 smaller producers in or about to enter the field, such jurisdiction was unnecessary.

DOMESTIC PRODUCTION

PRIMARY

Primary aluminum production in the United States was nearly 1.65 million tons, a decrease of over 30,000 tons or 2 percent from 1956. This was the first year since 1949 that aluminum production had not gained over the preceding year. Production, by companies, was: Alcoa, 712,000 tons; Reynolds, 466,100 tons; Kaiser, 417,500 tons; and Anaconda, 52,000 tons.

As a result of technological advances in the aluminum-smelting process since 1942, the industry began, in 1957, to advertise pig of 99.5-percent minimum purity instead of 99-percent minimum average purity, as was sold previously.

Interruptible power in the Pacific Northwest was curtailed during January, February, and part of March. Some curtailment occurred in the period September-December. Much of the loss early in the year was replaced with steam-generated power; but, as aluminum supplies continued to be abundant, primary production in the area was curtailed at the year end. Production at Alcoa, Alcoa, Tenn., plant was curtailed during January as a result of low water conditions in the Tennessee Valley area.

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4 Modern Metals, Competition in Aluminum: Vol. 13, No. 11, December 1957, pp. 82–94; and vol. 13, No. 12, January 1958, pp. 58, 60, 62, 64, 68, 70–72.

TABLE 2.—Production of primary aluminum in the United States, 1953–57, by quarters,[1] in short tons

Quarter	1953	1954	1955	1956	1957
First	287,004	349,069	374,711	419,052	401,794
Second	311,687	366,330	385,156	441,252	422,333
Third	329,163	371,789	396,826	376,346	414,768
Fourth	324,159	373,377	409,028	442,304	408,814
Total	1,252,013	1,460,565	1,565,721	1,678,954	1,647,709

[1] Quarterly production adjusted to final annual totals.

TABLE 3.—Primary-aluminum production capacity in the United States

(Short tons per year)

Company and plant	End of 1956	End of 1957	Being built in 1957	Total [1]
Aluminum Company of America:				
Alcoa, Tenn	157,100	157,100		157,100
Badin, N. C	47,150	47,150		47,150
Massena, N. Y	112,250	112,250	37,500	149,750
Point Comfort, Tex	120,000	120,000	20,000	140,000
Rockdale, Tex	150,000	150,000		150,000
Vancouver, Wash	97,500	97,500		97,500
Wenatchee, Wash	108,500	108,500		108,500
Evansville, Ind			150,000	150,000
Total	792,500	792,500	207,500	1,000,000
Reynolds Metals Co.:				
Arkadelphia, Ark	55,000	55,000		55,000
Jones Mills, Ark	109,000	109,000		109,000
Listerhill, Ala. (I)	77,500	77,500		77,500
Longview, Wash	60,500	60,500		60,500
San Patricio, Tex	95,000	95,000		95,000
Troutdale, Oreg	91,500	91,500		91,500
Listerhill, Ala. (II)			112,500	112,500
Massena, N. Y			100,000	100,000
Total	488,500	488,500	212,500	701,000
Kaiser Aluminum & Chemical Corp.:				
Chalmette, La	220,000	247,500		247,500
Mead, Wash	176,000	176,000		176,000
Tacoma, Wash	38,500	41,000		41,000
Ravenswood, W. Va		36,250	108,750	145,000
Total	434,500	500,750	108,750	609,500
Anaconda Aluminum Co.: Columbia Falls, Mont	60,000	60,000		60,000
Harvey Aluminum Co.: The Dalles, Oreg			54,000	54,000
Ormet Corp.: Clarington, Ohio			180,000	180,000
Grand total	1,775,500	1,841,750	762,750	2,604,500

[1] Expected to be in production before or during 1959.

The Anaconda Aluminum Co. plant at Columbia Falls, Mont., operated somewhat below its capacity of 60,000 tons. The plant operated at capacity until June, at which time, owing to a surplus of finished metal in inventory, production was curtailed 12.5 percent; again, on July 1, production was curtailed an additional 12.5 percent. The rate was increased to 88 percent of capacity on January 1, 1958. Acquisition by The Anaconda Co. of Harvey Aluminum Company's 5-percent interest in Anaconda Aluminum Co. resulted in its becoming a 100-percent-owned subsidiary of The Anaconda Co.

An unauthorized work stoppage at Kaiser's Chalmette, La., plant reduced its production late in September; although the strike was short lived, freezing of the cells resulted in a lengthy shutdown.

Primary aluminum production in the Ohio Valley became a reality with pouring in November of metal from the first potline at Kaiser's plant at Ravenswood, W. Va. The first line, with an annual capacity of 36,250 tons, was to be followed by a second line of equal capacity early in 1958. Provision was made for adding two more lines when market conditions warranted. The ultimate capacity of the plant, therefore, was 145,000 tons.

Each potline consists of 164 cells measuring 10 by 20 feet and is designed for 80,000-ampere operation. Each pot is equipped with prebaked carbon electrodes, which are raised and lowered by a mechanized positioning system. Alumina was to be supplied by a new plant under construction at Gramercy, La., which was to use Jamaican bauxite as the raw material. The Ravenswood facility utilized coal for generating power. Early in 1957 cold-rolling facilities were placed in operation at Ravenswood and a hotline was scheduled to start operation in 1958.

Kaiser also added a ninth potline to its reduction plant at Chalmette, La. The new line, with a capacity of 27,500 tons, brought the total plant capacity to 247,500 tons of aluminum a year.

A number of new reduction plants were under construction most of the year and were to be completed in 1958 or 1959. Reynolds had nearly completed a new 112,500-ton-annual-capacity plant at Listerhill, Ala., and late in December the first line was being baked out before activation. Following approval of the power contract by the Governor of New York, Reynolds in mid-June broke ground for a new 100,000-ton plant at Rooseveltown near Massena, N. Y., along the St. Lawrence Seaway. Plans called for pouring the first metal in mid-1959. Reynolds had made arrangements to sell substantial quantities of metal in the molten state ("hot-metal" contracts) from both facilities. Molten metal from the Listerhill plant was to be shipped to an adjacent new foundry of the Ford Motor Co. and from the Massena plant to a foundry of the Chevrolet Division of General Motors Corp. being constructed nearby.

In 1957 Alcoa had expansions underway at Point Comfort, Tex., and Massena, N. Y., and was building a new 150,000-ton reduction plant at Evansville, Ind. In Texas, capacity was to be increased by 20,000 tons to 140,000 tons. The two new potlines at Massena were to utilize power from the St. Lawrence project and would replace facilities scheduled to become inoperable upon its completion. Ultimately Alcoa's capacity at this location was to be increased from 112,250 to 149,750 annual tons. All three plants were expected to produce metal before the end of 1958.

Ormet Corp. (originally called Olin Revere Metals Corp.) was constructing its 180,000-ton plant in the Ohio Valley at Omal near Clarington, Ohio. Completion was scheduled for early 1958.

Harvey Aluminum Co. was also continuing construction of a 54,000-ton plant at The Dalles, Oreg. The plant was scheduled to be in partial operation early in 1958.

The long-term optimism of the industry was reflected in Alcoa's announcement in July that it had agreed to pay 23 percent of the cost of Rocky Reach Dam on the Columbia River in Washington and 23 percent of the subsequent operating costs in return for 23 percent of the power to be generated. The agreement was contingent on a pro-

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vision that final costs do not exceed certain limits.

Alcoa also signed a letter of intent with the Government of Surinam that required Alcoa to build an alumina plant in Surinam within the next 12 years. A 60,000-ton-annual-capacity aluminum plant was also to be built by the company. Upon completion, this was to be the first alumina or aluminum plant built by a domestic company outside of the United States. (See Surinam in World Review, p. 184.)

The three major producers also expanded their fabricating facilities in 1957. Alcoa, at its Davenport, Iowa, works, completed installations costing $54 million. Among the 10 new units were a 160-inch hot-rolling mill—widest in the industry; a 16-million pound plate stretcher; a 100-inch cold mill; and foil-rolling equipment with an annual capacity of 24 million pounds. Additions were also made at the Cleveland, Ohio, and Vernon, Calif., works.

New installations by Kaiser included a horizontal heat-treat furnace for production of stress-relieved heavy aluminum plate at its Trentwood plant, Spokane, Wash. New extrusion presses and auxiliary equipment at the Halethorpe plant, Baltimore, Md., were placed in operation. A new hydraulic press began operation at the Erie, Pa., plant.

Reynolds opened a new $5.5 million extrusion plant near Richmond, Va. The plant, which contained four 2,300-ton extrusion presses, had a productive capacity of up to 2 million pounds per month. In conjunction with the United States Navy, Reynolds expanded facilities at its McCook, Ill., plant. The total cost of the new equipment installed was $20 million; the Navy owned 75 percent of the units. Included were a 145-inch tapered rolling mill, 2 fixed-bed gantry-type skin millers, and a plate stretcher with a pulling force of 16 million pounds.

A series of three articles discussed the aluminum industry in the United States.[5] The first provided a brief history of the industry described its structure. The second dealt with the market for aluminum and various factors that influence the demand for the metal. The final article was concerned with the economic factors in the location of the aluminum industry and the influence of technological changes on the cost structure.

SECONDARY

Domestic recovery of secondary aluminum from new and old scrap totaled 360,000 short tons in 1957. Recovery from new scrap increased 7 percent to 288,000 tons, and recovery from old scrap was unchanged from the preceding year at 72,000 tons. Secondary aluminum was recovered from the 463,000 tons of aluminum scrap consumed in the United States (360,000 tons of new scrap and 103,000 tons of old scrap) and also from the aluminum contained in copper-, zinc-, and magnesium-base alloys produced from scrap. Used or discarded items that had been remelted were classified as old scrap; waste generated in fabrication or as rejected products was new scrap. Scrap was imported in both pig and unmelted forms. An estimated

[5] Monthly Review, Federal Reserve Bank of San Francisco, The Aluminum Industry—Part I: Development of Production: August 1957, pp. 97–109; Part II; Growth of the Market: October 1957, pp. 145–152; Part III: Location Factors and Aluminum in the Pacific Northwest: January 1958, pp. 6–13.

90-percent recovery factor was applied to scrap imports to compensate for duplication and losses incident to remelting.

Recovery was calculated from reports to the Bureau of Mines on consumption of purchased and toll-treated scraps, excluding all home scrap (scrap produced and consumed at the same plant). Aluminum-scrap consumption was reported by the nonintegrated secondary smelters, primary producers, foundries, fabricators, chemical producers, and other miscellaneous consumers. Scrap imports were 16,000 tons compared with 26,000 tons in 1956, and exports in 1957 were 18,000 tons compared with 19,000 tons in 1956. Imports of scrap in the 3-year period 1955 to 1957 have decreased sharply from 41,000 tons to 16,000, while exports have remained unchanged at approximately 18,000 tons.

CONSUMPTION AND USES

For the first time since 1949 the apparent consumption of primary aluminum decreased from the preceding year. Apparent consumption in 1957 (1,778,000 short tons) represented a 4,000-ton decrease from 1956. The consumption for the years before 1957 include shipments to the national stockpile, which could not be shown separately. However, in 1957, when the primary producers invoked their rights to sell metal to the Government, the quantity of their shipments was released. Under these rights the companies shipped 324,327 tons to the Government in 1957.

The new supply of aluminum was calculated as the sum of domestic primary production, secondary recovery from both old and new pur-

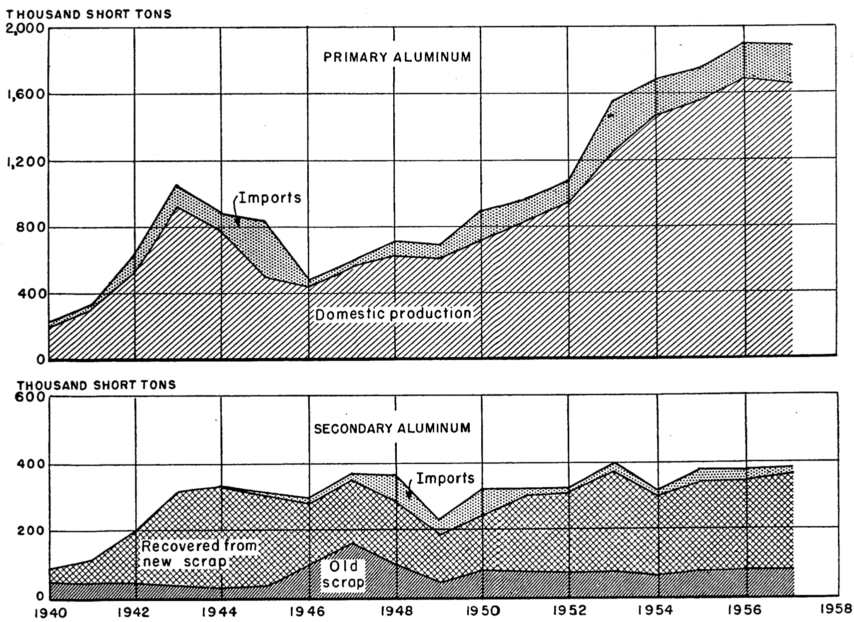

FIGURE 1.—United States production and imports of primary- and secondary-aluminum pig and ingot, 1940–57.

chased and toll-treated scrap, imports of pig and ingot, and the ingot equivalent of imported scrap. Exports of crude forms of the metal were considered a type of consumption. In 1957 primary production was 1,648,000 tons, secondary recovery 360,000 tons, and imports of crude and scrap 237,000 tons, to give a total new supply of 2,244,000 tons. This represented a decrease of 15,000 tons from 1956.

A demand for 4.2 to 4.5 million tons of aluminum in 1965 was forecast.[6] Three methods for determining the consumption were used.

TABLE 4.—Apparent consumption of primary aluminum and ingot equivalent of secondary aluminum in the United States, 1948–52 (average) and 1953–57, in short tons

Year	Primary			Secondary		
	Sold or used by producers	Imports (net) [1] [2]	Apparent consumption [2]	Domestic recovery: From old scrap	Domestic recovery: From new scrap	Imports, scrap (net) [3]
1948–52 (average)	745, 605	102, 166	847, 771	72, 891	188, 776	36, 483
1953	1, 219, 968	322, 086	1, 542, 054	78, 940	289, 626	19, 836
1954	1, 478, 740	218, 147	1, 696, 887	[4] 59, 989	[4] 232, 052	−22, 044
1955	1, 571, 845	183, 080	1, 754, 925	[4] 76, 372	[4] 259, 622	20, 305
1956	1, 591, 478	[5] 190, 280	[5] 1, 781, 758	[4] 71, 673	[4] 268, 095	5, 997
1957	[6] 1, 579, 063	198, 528	1, 777, 591	[4] 71, 642	[4] 288, 024	−1, 706

[1] Crude and semifabricated, excluding scrap. May include some secondary.
[2] Figures include mill shapes.
[3] Ingot equivalent of net imports (wt. × 0.9). Imports are largely scrap pig. Some duplication of secondary aluminum occurs because of small amount of loose scrap imported, which is included as secondary recovery from old scrap.
[4] Not strictly comparable with previous years' data. The 1954–57 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.
[5] Revised figure.
[6] Includes 324,327 tons shipped to the Government.

TABLE 5.—Sources of aluminum supply—crude and scrap,[1] 1948–52 (average) and 1953–57, in short tons

Year	Primary production	Recovery from scrap: Old	Recovery from scrap: New	Imports [2]	Total supply	Exports [2]
1948–52 (average)	743, 950	72, 891	188, 776	154, 815	1, 160, 432	3, 195
1953	1, 252, 013	78, 940	289, 626	324, 888	1, 945, 467	6, 499
1954	1, 460, 565	[3] 59, 989	[3] 232, 052	228, 611	1, 981, 217	39, 448
1955	1, 565, 721	[3] 76, 372	[3] 259, 622	214, 418	2, 116, 133	22, 430
1956	1, 678, 954	[3] 71, 673	[3] 268, 095	239, 794	2, 258, 516	[4] 52, 014
1957	1, 647, 709	[3] 71, 642	[3] 288, 024	236, 802	2, 244, 177	44, 331

[1] Ingot equivalent of scrap.
[2] Crude metal (ingot, pig, slabs, etc.) plus ingot equivalent (wt. × 0.9) of scrap.
[3] Not strictly comparable with previous years' data. The 1954–57 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.
[4] Revised figure.

A survey compared the percentage distribution of aluminum end uses during selected 6-month periods from the latter half of 1954 through 1957.[7] The data showed that 22 percent of the shipments in the July–December 1957 period went to building-materials industries and 16 percent to transportation. These figures represented an in-

[6] Rosenzweig, James E., The Demand for Aluminum; a Case Study in Long-Range Forecasting: Univ. of Illinois Bull. 54, No. 63, April 1957, 67 pp.
[7] American Metal Market, Aluminum Association End-Use Statistics: Vol. 65, No. 98, May 21, 1958, pp. 9–10; and vol. 65, No. 99, May 22, 1958, p. 9.

crease for building materials and a decrease for transportation from the preceding 6-month period. Shipments of sand castings to industrial and commercial machines, equipment, and tools during latest period was 35 percent of the total, up from 29 percent in the preceding period. Seventy percent of the permanent mold castings was shipped to transportation, motor vehicles (excludes military), during the last half of 1957. An additional 10 percent was shipped to the home appliances, furnishings, and equipment industries.

The data in table 6 present shipments of wrought products and castings, which decreased 7 percent from the preceding year to 1,715,000 short tons. The largest percent decreases occurred in plate, sheet and strip, forgings, and sand castings. The following distribution for wrought products also was obtained from figures published by the Bureau of the Census:

	Percent	
	1956	*1957*
Plate, sheet and strip:		
Non-heat-treatable	36.4	35.2
Heat-treatable	11.3	9.3
Foil	6.6	7.6
Rolled structural shapes:		
Rod, bar, etc	4.1	4.3
Cable, bare (including steel-reinforced)	6.5	6.8
Wire and cable, covered or insulated	1.9	1.9
Bare wire conductor and nonconductor	2.1	1.9
Extruded shapes (including tube blooms):		
Soft alloys	22.2	24.1
Hard alloys	2.2	2.3
Tubing:		
Drawn, soft and hard alloys	2.1	2.1
Welded, non-heat-treatable [1]	1.0	1.0
Powder, flake, and paste:		
Atomized	.3	.3
Flaked	.2	.2
Paste	.5	.6
Forgings	2.6	2.4
	100.0	100.0

[1] Includes some heat-treatable welded tube.

A survey of the light-metals-consuming industries was released. The list tabulated more than 25,000 plants by State and consuming industry. These plants accounted for over 98 percent of the light metals consumed in the United States in 1957. Major consumers were the building industry, with 7,000 plants and consumption of 475,000 tons; consumer durables, consuming 270,000 tons in 2,000 plants; and containers and packaging, with 600 plants, utilizing 165,000 tons. Western States had 15 percent of the total number of plants, Central States 45 percent, and Eastern States 40 percent of the total.[8]

The automotive industry continued to be an important aluminum consumer. Surveys were made on the aluminum content per car, and the long-range outlook was discussed.[9] The 1958 model auto-

[8] Modern Metals, A Market Survey of the Light-Metals-Consuming Industries: Vol. 13, No. 10, November 1957, pp. 100–101.

[9] Darby, Kim, For Aluminum in '58 Autos: Modern Metals, vol. 13, No. 11, December 1957, pp. 33–34, 36, 38, 40.

Barr, H. F., What's Ahead for Aluminum in Autos: Modern Metals, vol. 13, No. 9, October 1957, pp. 39, 40, 42.

TABLE 6.—Net shipments [1] of aluminum wrought and cast products by producers, 1953–57, in short tons

[Bureau of the Census]

	1953	1954	1955	1956	1957
Wrought products:					
Plate, sheet, and strip	684,083	582,538	771,362	784,059	698,251
Rolled structural shapes, rod, bar, and wire	211,023	180,641	183,976	210,600	199,520
Extruded shapes, tube bloom, and tubing	225,961	256,650	387,546	396,202	394,715
Powder, flake, and paste	22,366	23,452	17,840	14,210	14,094
Forgings			35,172	37,833	32,132
Total	1,143,433	1,043,281	1,395,896	1,442,904	1,338,712
Castings:					
Sand	107,277	78,277	82,741	85,890	72,061
Permanent mold	100,012	107,204	149,174	122,711	116,163
Die	119,665	122,645	177,602	188,115	184,543
Other	2,057	3,401	(2)	(2)	(2)
Total	329,011	311,527	410,390	397,291	375,828
Grand total	1,472,444	1,354,808	1,806,286	1,840,195	1,714,540

1 Net shipments consist of total shipments less shipments to other metal mills for further fabrication.
2 Withheld because estimates did not meet publication standards of the Bureau of the Census owing to the associated standard error.

mobile contained an average of about 45 pounds per car—an increase of 5 pounds (13 percent) over 1957 models. The lower priced models contained 31 to 52 pounds per car, however, of the more expensive models one was said to contain over 200 pounds of aluminum. A detailed breakdown of the utilization of aluminum in a 1958 model that required 64 pounds of aluminum was published.[10] Major aluminum items were pistons, 17 pounds; automatic transmission parts, 19 pounds; and air-conditioner parts, 12 pounds. Based on a 5-million-car year aluminum consumed by the industry would exceed 100,000 tons.

One manufacturer introduced aluminum brake drums in the front wheels of its 1957 model. Such drums were made standard equipment in four 1958 models. The use of aluminum was reported to result in lower temperature operation of the drum. Research continued on development of aluminum engine blocks and radiators.

The announcement in September by Reynolds Metals Co. and Esso Standard Oil Co. of the signing of the first contract in the United States calling for production of aluminum cans signalized a major achievement in the aluminum industry's attempt to enter the can market. Under the contract Reynolds was to supply the metal for 35 to 60 million 1-quart oilcans and collect and reclaim the used cans as scrap.[11] Shortly thereafter Kaiser Aluminum & Chemical Corp. announced jointly with the Kraft Foods Division of National Dairy Products Corp., that an order for 5.5 million aluminum cans had been placed by Kraft.[12] Manufacture of the cans would require approxi-

10 Automotive Industries, Edsel Uses Estimated 64.2 Pounds of Aluminum: Vol. 117, No. 11, Dec. 1, 1957 p. 59.

11 American Metal Market, Esso Standard Signs Contract for Aluminum Cans for Motor Oil: Vol. 64, No. 185, Sept. 25, 1957, pp. 1, 9.
Wall Street Journal, Reynolds Metals Gets Industry's First Big Order for Aluminum Cans: Vol. 150, No. 61, Sept. 25, 1957, p. 8.
McManus, G. J., Can Aluminum Hit Can Market?: Iron Age, vol. 180, No. 15, Oct. 10, 1957, pp. 76–77.
Carr, G. G., Rebuttal to Aluminum-Can Critics: Iron Age, vol. 180, No. 18, Oct. 31, 1957, pp. 24, 25.

12 Modern Metals, Kaiser Makes Cans for Kraft: Vol. 13, No. 10, November 1957, pp. 94, 96, 98.

mately 35 pounds of aluminum per 1,000 units produced or a total of 96 tons. A commercial prototype canmaking facility, utilizing a deep drawing process, was installed at Kaiser's Wanatah, Ind., container plant.

The first fully automatic can-making line was installed by a subsidiary of Aluminium Ltd. in Germany. The flexibility of the line was demonstrated by the range of can sizes that could be produced. These range from 2 to 3 inches in diameter and 2 to 6 inches in height.[13] Other methods for producing cans were described.[14]

A number of other companies were investigating methods of producing aluminum cans. One company, Victor Metal Products Corp., Newport, Ark., was constructing a plant to produce Aerosol-type cans to sell at $45 per 1,000 which was said to be competitive with tin-plate Aerosol cans.[15]

For several years Reynolds had been engaged in missile development work. At its plant at Sheffield, Ala., Reynolds fabricated ballistic shells for the Redstone and Jupiter-C missiles. Components for the shell, fabricated of aluminum, included the tail, center, and top sections and the spin launcher. Important components of the Explorer and the first successfully fired reentry missile were also fabricated of aluminum.

To popularize the use of aluminum in home construction, the Aluminum Company of America had houses built at 24 locations throughout the United States. Each "Care-Free" home utilized 7,500 pounds of aluminum compared with 30 pounds in the average dwelling. Components using aluminum included the roof, exterior walls, doors, and vents.[16]

Kaiser developed a new structural dome design suitable for factories, auditoriums, and stores.[17] The first of these was an auditorium without pillars or any other interior support and having a seating capacity of 1,800 to 2,000. The aluminum shell was 49 feet high and 145 feet in diameter. The cost of the dome was approximately $4 per square foot.

The multi-billion-dollar Federal and State highway program was expected to use large quantities of aluminum in such applications as signs, signal supports, railings, lighting standards, and fencing. It was estimated that under the projected program over 500,000 tons of aluminum would be consumed for this purpose by 1965.[18]

STOCKS

Inventories of primary aluminum at reduction plants on December 31, 1957, were 171,000 short tons, an increase of 69,000 tons (67 percent) above those on hand at the end of the preceding year. Dur-

[13] Maeder, E. G., and Lovell, A. V., Automatic Plant Makes Aluminum Cans Faster, Cheaper: Modern Metals, vol. 13, No. 3, April 1957, pp. 36–38, 40.

[14] Materials in Design Engineering, Aluminum Cans are Made by . . .: Vol. 47, No. 1, January 1958, pp. 10–11.

[15] Obertance, Charles, Seamless, Rustless Aluminum Cans Near Low-Cost Stage Spurred by New Processes: Wall Street Jour., vol. 149, No. 92, May 10, 1957, p. 6.

[16] Farrell, E. A., Prototype of Tomorrow's House—Aluminum Makes It Care-Free: Modern Metals, vol. 13, No. 11, December 1957, pp. 72, 74, 76, 78, 80.

[17] Light Metal Age, New Structural Design for Aluminum "Hula" Hut: Vol. 15, Nos. 1 and 2, February 1957, p. 13.
American Metal Market, Design for Bank Includes Use of Aluminum Dome: Vol. 65, No. 1, Jan. 1, 1958, p. 9.

[18] American Metal Market, Aluminum—New Bridge Points Up Increasing Use of Lighter Structurals: Vol. 64, No. 54, Mar. 20, 1957, p. 9. Aluminum—Highway Program Needs Seen as 500,000 Tons Over 10 Years: Vol. 64, No. 112, June 12, 1957, p. 10.

ing January and February stocks increased rapidly to 166,000 tons and then throughout the remainder of the year fluctuated between 160,000 and 195,000 tons. At the end of May stocks were at an all-time high of 195,000 tons. Based on the December rate of production, the year-end stocks at primary plants were equivalent to 38 days' output. In addition to the pig-aluminum stocks reported, reduction plants also had inventories of ingot and aluminum in process.

Inventories of secondary aluminum pig and ingot at secondary smelters (18,700 tons at the end of 1957) had decreased approximately 6 percent from the beginning of the year. The low point occurred in July, when they were 15,800 tons, but during the remainder of the year these stocks approximated 18,000 tons. Consumers' stocks of aluminum-base scrap increased 3 percent to 25,200 tons at the end of the year. Stocks of scrap decreased during the first quarter of 1957 from the end of the previous year and then fluctuated between 22,000 and 25,600 tons.

TABLE 7.—Stocks of primary aluminum at reduction plants in the United States, 1953–57, by quarters, in short tons

Quarter ended	1953	1954	1955	1956	1957
Mar. 31	15,257	63,246	11,970	19,240	160,501
June 30	17,810	66,555	12,630	17,399	192,856
Sept. 30	26,991	46,611	9,898	47,179	175,085
Dec. 31	39,319	21,144	15,020	102,496	171,142

PRICES

The base price of aluminum pig, 99-percent average guaranteed minimum (which on January 1, 1957, was 25.00 cents per pound), remained unchanged until August 1, when it was increased 1 cent to 26.00 cents per pound. When the price change was made, the quoted purity was changed from 99-percent average guaranteed minimum to 99.5-percent guaranteed minimum. The corresponding prices for ingot, 99-percent-plus, were 27.10 cents and 28.10 cents per pound. The new prices were in effect at the end of the year. All prices were base prices, f. o. b. shipping point, with freight allowance to United States destinations. The producers stated that the increases resulted from an automatic wage increase effective August 1, increased salaries for white-collar employees, and rising costs of materials, transportation, and services.

The combined average price for copper-silicon alloys 108 and 380 (AXS–679), as secondary ingot, was 22.54 cents per pound as compiled from quotations published daily in the American Metal Market. The average price in 1957 was 4.47 cents per pound below the 1956 average. The American Metal Market listed the following closing market prices on December 31, 1957: Alloy 195, 25.25 to 26.75 cents per pound, No. 12, 22.00 to 23.00, and Nos. 108, 319, 380, 22.25 to 23.50 cents per pound. These prices ranged from unchanged to 1.5 cents less per pound from the end of the preceding year.

Dealers' buying prices for new aluminum clips averaged 14.07 cents per pound, down from 16.99 cents in 1956. These prices were relatively stable, with the monthly averages ranging from a high of 14.98 cents per pound in January to a low of 13.75 cents per pound from

TABLE 8.—Prices of aluminum, other selected metals, and the Bureau of Labor Statistics wholesale price index, 1936–57 [1]

Year	Aluminum, primary ingot (cents per pound)	Copper electrolytic, New York (cents per pound)	Composite finished steel (cents per pound)	Zinc, Prime Western, East St. Louis (cents per pound)	Wholesale price index (1947–49=100)
1936–40 (average)	19.85	11.08	2.66	5.50	52.2
1941–45 (average)	15.30	11.87	2.67	8.10	64.9
1946–50 (average)	16.09	19.62	3.79	11.77	96.4
1951–55 (average)	20.96	28.97	5.12	13.61	111.5
1956 (average)	26.01	41.88	6.00	13.49	114.3
1957:					
First quarter	27.10	33.56	6.31	13.50	116.9
Second quarter	27.10	31.47	6.34	12.09	117.2
Third quarter	27.78	28.12	6.77	10.00	118.2
Fourth quarter	28.10	26.82	6.77	10.00	118.1
Average	27.52	29.99	6.55	11.40	117.6
Increase from 1936–40 average to 1957 average—percent	38.6	170.7	146.2	107.3	125.3

[1] Source: Metal Statistics, 1958 (American Metal Market).

March through June. Cast-aluminum-scrap prices averaged 10.86 cents per pound—3.13 cents below the 1956 average. The third-quarter average (11.19 cents per pound) was the high and the March average (10.25 cents per pound) was the low point during the year. The closing market prices for scrap on December 31, 1957, according to the American Metal Market, were: 2S, 3S, 51S, and 52S, 17.00 to 17.50 cents per pound; 75S clips, 12.00 to 13.00 cents per pound; and aluminum borings and turnings, 14.00 to 15.00 cents per pound. These prices were down 1 to 3.25 cents per pound from the end of the preceding year.

FOREIGN TRADE [19]

Imports.—The tariff on imports of crude aluminum during the first half of 1957 was 1.40 cents per pound. In July 1957, as a result of the General Agreement on Tariffs and Trade of 1956, the duty was reduced to 1.3 cents per pound. It was scheduled to be reduced further to 1.25 cents per pound in July 1958.

Suspension of the 1½-cent-per-pound duty on scrap was continued in 1957.

Aluminum imported for consumption in 1957 totaled 258,000 short tons—a slight decrease from the preceding year. Eighty-six percent of the total was crude metal and alloys; 8 percent plates, sheets, and bars; and 6 percent scrap. Shipments of metals and alloys, crude, from Canada, increased 3 percent over 1956. Imports of crude metal from West Germany (7 tons in 1956) increased to 780 tons in 1957. In 1957 imports of crude from Taiwan were 441 tons, in contrast to no imports from this source in 1956. As in 1956, Canada supplied 92 percent of the crude imports in 1957. Norway supplied 7 percent, and the remainder came from 7 European countries and 2 Asiatic countries. Thirty-one percent of the semifabricated shapes was received from Belgium-Luxembourg, 23 percent from United Kingdom, and 17 percent from Canada. Other major suppliers of the semifabricated shapes included Italy, West Germany, Japan, and France.

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

TABLE 9.—Aluminum imported for consumption in the United States, 1955–57, by classes

[Bureau of the Census]

Class	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude and semicrude:						
Metals and alloys, crude	177,652	[1] $74,694,865	216,401	$100,136,584	222,158	$107,335,561
Plates, sheets, bars, etc	20,972	[1] 13,972,690	22,582	[1] 16,479,851	19,633	15,099,111
Scrap	40,851	[1] 16,393,332	25,992	[1] 10,769,830	16,271	5,395,868
Total	239,475	[1] 105,060,887	264,975	[1] 127,386,265	258,062	127,830,540
Manufactures:						
Foil less than 0.006-inch thick	1,758	[1] 2,963,111	1,653	[1] 2,608,869	1,752	2,881,843
Folding rules	(2)	31	(2)	[1] 636	(2)	5,014
Leaf (5½ by 5½ inches)	(3)	7,972	(3)	[1] 8,171	(3)	10,713
Powder and powdered foil (aluminum bronze)	25	28,329	81	79,836	60	67,312
Table, kitchen, hospital utensils, etc	2,720	[1] 4,266,911	2,431	[1] 3,969,914	2,015	3,495,053
Other manufactures	(4)	[1] 1,239,292	(4)	[1] 2,139,104	(4)	2,332,438
Total	(4)	[1] 8,505,646	(4)	[1] 8,806,530	(4)	8,792,373
Grand total	(4)	[1] 113,566,533	(4)	[1] 136,192,795	(4)	136,622,913

[1] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.
[2] Number: 1955, 100; 1956, 1,200; 1957, 2,400; equivalent weight not recorded.
[3] Leaves: 1955, 2,466,054; 1956, 3,030,097; 1957, 3,050,680.
[4] Quantity not recorded.

Aluminum-base-scrap imports decreased 37 percent from 1956. Canada supplied 76 percent of the scrap in 1957. The next most important suppliers of scrap were the United Kingdom and France.

The average values of aluminum imported into the United States in 1957 were 24.2 cents per pound for crude, 38.5 cents for semifabricated, and 16.6 cents for scrap.

Exports.—United States exports of crude, scrap, and semicrude aluminum in 1957 were 61,000 short tons—10 percent less than those in 1956. Exports of ingots, slabs, and crude were down 19 percent to 28,000 tons. Argentina received 20 percent of the exports of crude metal, the United Kingdom 12 percent, Brazil and Japan 11 percent each, and Mexico and the Philippines 10 percent each. Exports of plates, sheets, bars, castings, forgings, and unclassified semifabricated shapes increased slightly over the previous years. Canada, India, Venezuela, and Cuba were the major recipients. Exports of these shapes to India increased nearly four times to 3,250 tons. Aluminum-base-scrap exports decreased slightly from the previous year, going mainly to West Germany, Japan, Italy, and India.

The average values of aluminum exports in 1957 were as follows: 25.1 cents per pound for crude, 53.8 cents for semifabricated, and 17.7 cents for scrap. These values were all lower than in 1956.

TABLE 10.—Aluminum imported for consumption in the United States, 1956–57, by classes and countries, in short tons

[Bureau of the Census]

Country	1956			1957		
	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap
North America:						
Canada	199,919	3,149	19,350	205,343	3,346	12,335
Other North America			165			36
Total	199,919	3,149	19,515	205,343	3,346	12,371
South America			33			
Europe:						
Austria	220	12	58	5	54	
Belgium-Luxembourg	13	6,184	168	5	5,998	
Denmark			53			121
France	301	2,093	897	178	639	805
Germany, West	7	2,131	314	780	1,616	357
Italy		1,901	(1)		1,926	
Netherlands		312	1,889		246	337
Norway	14,715	2	116	14,862		55
Sweden	156		229			188
Switzerland	496	525	46	160	299	227
United Kingdom	133	4,462	2,017	217	4,431	1,005
Yugoslavia	441	15		165	324	
Other Europe			284			699
Total	16,482	17,637	6,071	16,372	15,533	3,794
Asia:						
India			33			
Indonesia			61			21
Japan		1,796		2	753	
Southern and Southeastern Asia, n. e. c.			68			10
Taiwan				441		
Total		1,796	162	443	753	31
Africa			131		1	
Oceania			80			75
Grand total: Short tons	216,401	22,582	25,992	222,158	19,633	16,271
Value	$100,136,584	[2]$16,479,851	[2]$10,769,830	$107,335,561	$15,099,111	$5,395,868

[1] Less than 1 ton.
[2] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

TABLE 11.—Aluminum exported from the United States, 1955–57, by classes

[Bureau of the Census]

Class	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude and semicrude:						
Ingots, slabs, and crude	5,969	$2,773,040	[1]34,618	[1]$19,108,867	27,982	$14,051,019
Scrap	18,290	6,501,382	19,329	8,127,293	18,166	6,435,269
Plates, sheets, bars, etc	8,009	7,518,319	12,493	13,092,897	13,767	13,178,860
Castings and forgings	1,139	2,424,571	1,247	3,093,903	1,333	3,063,509
Semifabricated forms, n.e.c	427	474,395	345	376,943	181	192,489
Total	33,834	19,691,707	[1]68,032	[1]43,799,903	61,429	36,921,146
Manufactures:						
Foil and leaf	543	957,653	425	675,985	887	1,138,221
Powders and pastes (aluminum and aluminum bronze) (aluminum content)	297	314,814	351	419,373	475	572,833
Cooking, kitchen, and hospital utensils	1,422	2,847,748	1,222	2,863,168	1,308	3,055,554
Sash sections, frames (door and window)	570	1,034,373	760	1,531,357	730	1,322,701
Venetian blinds and parts	2,390	2,151,654	2,875	2,830,531	1,836	2,099,450
Wire and cable	6,581	3,700,399	3,288	2,543,250	4,977	3,612,581
Construction materials, n.e.c	3,058	5,301,981	3,644	6,511,631	4,610	8,552,384
Other manufactures	(2)	229,444	(2)	204,918	(2)	349,926
Total	(3)	16,538,066	(3)	17,580,213	(3)	20,703,650
Grand total	(3)	36,229,773	(3)	[1]61,380,116	(3)	57,624,796

[1] Revised figure.
[2] Weight not recorded.
[3] Quantity not recorded.

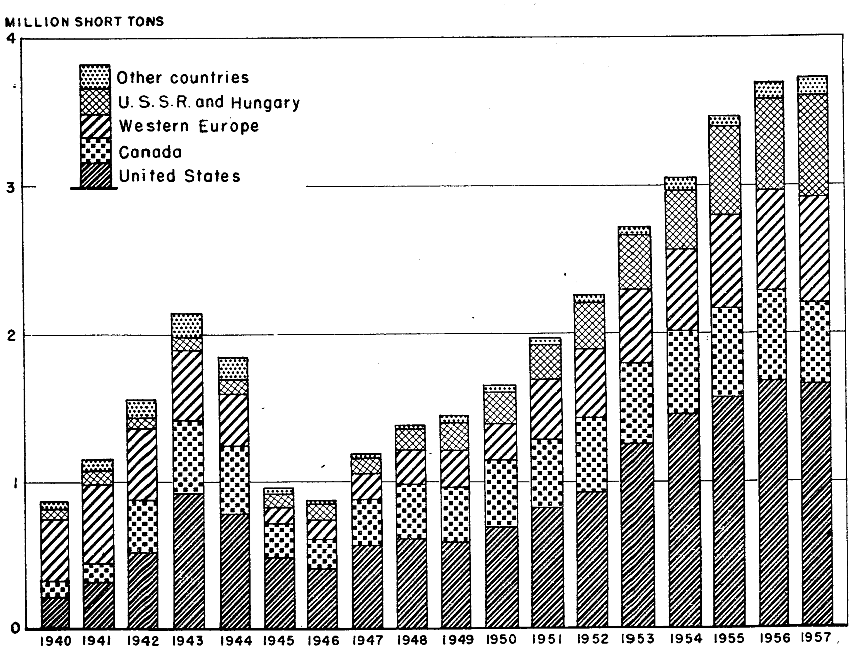

FIGURE 2.—Trends in world production of primary aluminum, 1940–57.

TABLE 12.—Aluminum exported from the United States, 1956–57, by classes and countries, in short tons

[Bureau of the Census]

Country	1956 Ingots, slabs, and crude	1956 Plates, sheets, bars, etc. [1]	1956 Scrap	1957 Ingots, slabs, and crude	1957 Plates, sheets, bars, etc. [1]	1957 Scrap
North America:						
Canada	1,422	7,428	1,235	684	6,331	253
Cuba	60	1,180	4	31	1,309	
Mexico	3,466	180	210	2,804	196	50
Other North America		727	44	8	803	10
Total	4,948	9,515	1,493	3,527	8,639	318
South America:						
Argentina	7,942	160		5,542	25	
Brazil	309	187		3,094	73	10
Chile	755	5		487	96	
Colombia	1,390	124		1,298	536	
Venezuela	30	1,321		38	1,319	
Other South America		150		45	219	
Total	10,426	1,947		10,504	2,268	10
Europe:						
Denmark		25			44	
Finland		2			5	
France	1,362	29	20		72	
Germany, West	303	13	7,839	516	6	8,140
Ireland	300	56		616		
Italy	[2] 3,464	34	5,734	770	25	2,777
Netherlands		12	180	50	25	98
Spain	220	114			33	
United Kingdom	10,392	155	14	3,486	105	17
Other Europe	37	68		122	76	42
Total	[2] 16,078	508	13,787	5,560	391	11,074
Asia:						
India		848	855	1,240	3,250	1,438
Japan	770	25	3,187	2,982	69	5,312
Philippines	1,999	165	4	2,681	65	14
Turkey		292		1	37	
Other Asia	297	287		1,481	289	
Total	3,066	1,617	4,046	8,385	3,710	6,764
Africa	100	194	3	6	243	
Oceania		304			30	
Grand total: Short tons	[2] 34,618	14,085	19,329	27,982	15,281	18,166
Value	[2] $19,108,867	$16,563,743	$8,127,293	$14,051,019	$16,434,858	$6,435,269

[1] Includes plates, sheets, bars, extrusions, castings, forgings, and unclassified "semifabricated forms."
[2] Revised figure.

During 1957 the Bureau of Foreign Commerce set the following export quotas on aluminum scrap:

	Tons
First quarter	7,000.
Second quarter	8,000.
Third quarter	Open ended.
Fourth quarter	Do.

The first quarter quota was originally set at 5,000 tons, but later revised to 7,000 tons. During the second quarter of the year exports of aluminum scrap from United States Territories and possessions were excluded from the quota.

WORLD REVIEW

The estimated world aluminum production, 3.7 million short tons in 1957, was virtually unchanged from the previous year. However, the North American production of 2.2 million tons was down 4 percent, while European production, including the Soviet Bloc, at 1.4 million tons represents a 6-percent increase over 1956.

North America produced approximately 60 percent of the world total, and the Soviet Bloc supplied an estimated 20 percent. During 1957 Soviet aluminum became available on the world market, especially in the United Kingdom, indicating that the metal supplies were as ample in the U. S. S. R. as they were in most parts of the world.

TABLE 13.—World production of aluminum, by countries, 1948–52 (average) and 1953–57, in short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	416,056	548,445	557,897	612,543	620,321	557,105
United States	743,950	1,252,013	1,460,565	1,565,721	1,678,954	1,647,709
Total	1,160,006	1,800,458	2,018,462	2,178,264	2,299,275	2,204,814
South America: Brazil	[2] 820	1,322	1,612	1,834	6,920	[3] 9,800
Europe:						
Austria	24,082	47,924	52,920	63,051	65,490	62,125
Czechoslovakia	----------	3,000	17,000	26,900	23,400	18,400
France	82,619	124,581	132,426	142,191	165,082	176,603
Germany:						
East	[4] 6,200	10,700	23,100	29,100	37,800	[3] 37,500
West	52,602	117,881	142,439	151,089	162,439	169,576
Hungary	19,136	30,576	36,115	40,740	38,374	28,700
Italy	43,672	61,136	63,462	67,741	69,896	72,962
Norway	47,434	58,610	67,573	79,102	102,184	105,434
Poland	----------	----------	[3] 2,800	22,500	24,000	[3] 22,400
Rumania [3]	----------	----------	----------	6,200	8,800	11,000
Spain	2,683	4,823	4,545	3,466	14,283	16,452
Sweden (includes alloys)	5,777	10,635	11,768	11,063	13,734	16,806
Switzerland	25,000	32,518	28,660	33,069	33,069	34,172
U. S. S. R. [3]	208,000	325,000	375,000	475,000	500,000	550,000
United Kingdom	32,609	34,626	35,395	27,378	30,892	39,513
Yugoslavia	2,579	3,078	3,854	12,675	16,162	19,989
Total [3]	552,400	865,000	995,000	1,190,000	1,305,000	1,380,000
Asia:						
China (Manchuria)	----------	(5)	[3] 3,300	[3] 7,700	[3] 11,000	[3] 22,000
India	4,001	4,209	5,439	8,091	7,281	8,718
Japan	29,215	50,145	58,544	63,392	72,749	74,931
Korea, North [3]	840	(5)	(5)	(5)	(5)	(5)
Taiwan	2,738	5,407	7,861	7,717	9,655	9,104
Total	36,794	59,761	[3] 75,100	[3] 86,900	[3] 100,700	[3] 114,800
Africa: French Cameroon	----------	----------	----------	----------	----------	8,379
Oceania: Australia	----------	----------	----------	1,398	10,240	11,899
World total (estimate)[1]	1,750,000	2,725,000	3,090,000	3,460,000	3,720,000	3,730,000

[1] This table incorporates a number of revisions of data published in previous Aluminum chapters. Data do not add to totals shown because of rounding where estimated figures are included in the detail.
[2] Average for 1951–52.
[3] Estimate.
[4] Average for 1950–52.
[5] Negligible.

Primary metal was produced for the first time in Africa when the plant at Edea, French Cameroon, began producing. One article briefly reviewed the primary aluminum industry throughout the world.[20]

NORTH AMERICA

Canada.—Canadian British Aluminium Co., Ltd., a subsidiary of British Aluminium Co., Ltd., and Quebec North Shore Paper Co., became Canada's second aluminum producer when its plant began operations at Baie Comeau, Quebec, December 23, 1957. The first stage of development consisted of 2 cellrooms, each with 2 rows of 42 pots, capable of producing a total of 45,000 short tons of ingot annually.[21]

Aluminum Company of Canada, Ltd. (Alcan), produced 557,100 short tons of primary aluminum in 1957, 10 percent below that in 1956. The decline was attributed to the 4-month strike at the Arvida, Quebec, plant, a 10-day power breakdown in December at Kitimat, British Columbia, and to changing market conditions. Output in Quebec declined 20 percent to approximately 397,000 tons, whereas that of British Columbia increased 29 percent to 160,000 tons. As a result of lessened demand for aluminum, curtailments in production were being made at the end of the year at Arvida, Shawinigan Falls, and Kitimat.[22]

TABLE 14.—Primary-aluminum production capacity in Canada

(Short tons per year)

	End of 1957	Being built or planned	Total
Aluminum Company of Canada:			
Arvida, Quebec	367, 500	------------	367, 500
Beauharnois, Quebec	37, 000	------------	37, 000
Isle Maligne, Quebec	113, 400	------------	113, 400
Kitimat, British Columbia	186, 000	[1] 77, 000	263, 000
Saguenay area, Quebec	------------	[1] 120, 000	120, 000
Shawinigan Falls, Quebec	70, 800	------------	70, 800
Total	774, 700	197, 000	971, 700
Canadian British Aluminium Co., Ltd.: Baie Comeau, Quebec	45, 000	45, 000	90, 000
Grand total	819, 700	242, 000	1, 061, 700

[1] Reactivation of these projects depends upon improvement of world markets for aluminum.

During the first half of 1957 the company postponed indefinitely construction of the eighth potline at Kitimat and construction of a new smelter in Quebec, which together would have added about 160,000 tons of annual capacity. In October the expansion program was adjusted further, and work on two potlines then under construction at Kitimat was suspended. This postponement involved 80,000 tons of additional capacity, which was more than 60 percent completed. Development of hydroelectric facilities in British Columbia and Quebec and alumina plants in Jamaica were not affected by the cutbacks.

[20] Light Metals (London), Industry in the World Today: Vol. 21, No. 240, March 1958, pp. 94–96.
[21] Metallurgia (Manchester), New Aluminum Smelter in Production, First Metal Poured at Baie Comeau: Vol. 57, No. 339, January 1958, pp. 31-32.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, pp. 3–9.

Exports of primary aluminum declined 6 percent in 1957 to 479,000 tons. The United States, with 215,000 tons, and the United Kingdom, with 173,000 tons, took 81 percent of the exports.

SOUTH AMERICA

Brazil.—Two primary aluminum plants in Brazil produced an estimated 9,800 short tons of aluminum in 1957. Various reports indicated that Kaiser was considering building a reduction plant in Maceio, State of Alagoas. Kaiser had previously voiced interest in building at Recife in the State of Pernambuco. Reynolds Metals Co. considered building a plant on the San Francisco River. There also were reports that the Government of Brazil may build an aluminum plant on the borders of the States of Baía Pernambuco, and Alagoas.

Surinam.—The Aluminum Company of America signed a letter of intent to build a 66,000-short-ton aluminum plant in Surinam. The Government of Surinam agreed to finance the construction of a hydroelectric project to supply power to the plant. Initially Alcoa would construct only a smelter, at an estimated cost of $45 million. The company would build an alumina plant within 12 years of the signing of the agreement or within 8 years after completion of the smelter.

EUROPE

Austria.—Aluminum production reached a high of 65,000 tons in 1956 but declined to 62,000 tons in 1957. An article describing development of the aluminum industry was published.[23]

France.—The output of primary aluminum increased 7 percent in 1957 and reached a new high of 176,600 short tons. Société Péchiney increased output 4 percent to 145,000 tons and Société Ugine 24 percent to 31,000 tons.

Plans for expanding the aluminum industry in France by using Lacq-area natural gas of southwestern France to produce thermal electricity were completed. The project was to consist of three installations: The thermal power station was to consist of 4 125,000 kilowatt groups each, 2 of which were to be used by Péchiney and Ugine; a 55,000-short-ton aluminum plant already under construction by Péchiney on the left bank of the Gave de Pau; and a new 25,000-ton plant to be built by Ugine near the company's existing plant. The total cost of the project was placed at $85 to $90 million, $30 million of which would be used for producing and transporting electric power, and $55–$60 million for the aluminum plants.[24]

The price of aluminum, which had been frozen at 174.3 francs per kilogram by the government since August 1955, was increased to 183 francs in March, 184 francs in July, 184.5 francs in August, and 198 francs in October, where it remained for the rest of the year. In October the government removed all controls on aluminum prices.

Germany, West.—Primary aluminum output increased 4 percent in 1957 to about 170,000 short tons, of which Vereinigte Aluminium Werke (VAW) produced 72 percent and Aluminium Hütte G. m. b. H.

[23] Nachtigall, Eduard, Development of the Aluminum Industry in Austria: Metal Progress, vol. 71, No. 1, January 1957, pp. 77–81.

[24] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, pp. 3–5.

the remaining 28 percent. During the latter part of the year Lippe Aluminium Werke of VAW reported a 30-percent cut in production at its Luenen plant, but no other reductions were reported. An article describing the present position and plans of the West German aluminum industry gave its capacity at the end of 1957 as 176,000 tons.[25]

Production of secondary aluminum reversed the downward trend of 1956 and gained 3 percent to a total of 99,000 tons. The consumption of primary aluminum gained 7 percent in 1957 to 204,000 tons, but secondary aluminum consumption dropped 7 percent to 90,000 tons. The 1957 consumption paralleled that in 1956, when 24 percent was consumed in transportation, 16 percent in electrical industry, 14 percent in household goods, 13 percent in machinery, 10 percent in packaging, 6 percent in building, and 17 percent in other uses. Scrap consumption declined 32 percent to 17,000 tons, chiefly because of high prices.

The price of primary aluminum remained constant at DM233 per 100 kilograms (about US$0.25 per pound) delivered at railhead, throughout the year.

Imports of crude aluminum and aluminum scrap totaled 65,000 short tons in 1957, a 6-percent decrease from those of 1956. Major sources of imports were Canada, 21,000 tons; and Austria, 13,000 tons. Smaller amounts were imported from a number of other countries.

Greece.—The Greek Government was promoting interest in establishing an aluminum industry in Greece. Kaiser Aluminum & Chemical Corp. and Reynolds Metals Co. were reported to be interested. Greek bauxite, which is now exported at the rate of 650,000 tons a year, would be used as raw material.

Italy.—Additions to primary aluminum production capacity during the year brought the total capacity in Italy to about 92,000 short tons. Montecatini-Settore Alluminio (SEAL) supplied 58 percent of the 1957 output of 73,000 short tons, Societa Alluminio Veneto Anonima (SAVA) 36 percent, and Societa dell'Alluminio Italiano (SAI) 6 percent. Imports of primary aluminum totaled 21,000 short tons and exports 1,300 tons.

Norway.—The 3 aluminum companies, with 5 plants, operated at capacity during the year and produced 105,000 short tons of aluminum, of which 80,000 tons was exported. The United Kingdom was the principal recipient, with 19,000 tons, followed by the United States, with 12,000 tons; Sweden, with 11,000 tons; Belgium-Luxembourg, with 8,000 tons; and West Germany, with 7,000 tons. The remainder went to numerous other countries.

Elektrokemish S. A. expected to complete the first stage of its plant at Mosjøen by the end of 1958, thus increasing Norwegian capacity 27,000 short tons. The total capacity of the plant upon completion was to be 99,000 tons. A/S Aardal og Sunndal Verk announced plans for a new plant, Aardal III. Aardal I had an annual capacity of 30,000 short tons, Aardal II, which was being constructed, was scheduled to be operating by 1961 with an estimated output of 40,000 tons. Aardal III was scheduled to begin initial production in 1963, with full operation of 35,000 tons by 1965. This company also operated a 44,000-ton plant at Sunndalsøra and was planning a new

[25] Light Metals (London), The Industry in the World Today: Vol. 20, No. 236, November 1957, pp. 356–357.

plant of 11,000 tons annual capacity at the same location. Upon completion of Aardal II, Aardal III, and Sunndal II, the company's annual capacity would reach nearly 160,000 tons.[26]

Spain.—Sociedad Aluminio de Galicia was formed in the latter part of the year to build and manage a 22,000-short-ton aluminum and aluminum-alloy plant in the Province of Galicia. Necessary power for the plant would be supplied by three hydroelectric plants in the vicinity.

Aluminio Iberico S. A. proposed building an aluminum plant in the vicinity of Madrid capable of producing 4,400 short tons of primary aluminum, 4,400 tons of special alloys for sheet and foil, and 2,200 tons of alloys for production of sections.

Output of aluminum reached a high of 16,000 tons as new facilities came into production.

U. S. S. R.—Construction of 20 new aluminum plants was reported to be included in the U. S. S. R. current Five-Year Plan.[27]

United Kingdom.—Aluminum output increased 28 percent in 1957 to 39,500 short tons. Imports of aluminum ingots in 1957 totaled 239,800 short tons, principally from Canada, 191,500 tons; Norway, 20,000 tons; and the Soviet Bloc, 19,000 tons. The history and status of the aluminum industry in 1957 in Scotland, where the Foyers plant produced superpurity aluminum, and the Kinlockleven and Lochaber plants produced primary aluminum, were reviewed.[28]

Imports from the Soviet Bloc, 90 percent of which were from U. S. S. R., represented a sharp increase from 1956, when only 1,000 tons was imported from this source. This increase in imports was the result of Soviet metal being offered in United Kingdom markets at about 1 cent per pound under the price for Canadian metal. It was further reported that the Soviets would sell metal at 1 cent below any Canadian price. Late in the year the Aluminum Company of Canada, in order to protect its important British market, requested that the United Kingdom Board of Trade impose an antidumping duty on crude-aluminum imports from U. S. S. R. No action had been taken by the end of the year.

Yugoslavia.—Aluminum output increased 24 percent to 19,990 short tons in 1957. The Kidricevo plant produced 16,490 short tons and the Lozovac plant 3,500.

The agreement signed in August 1956 between the Government of Yugoslavia, The Soviet Union, and the German Democratic Republic, whereby the Soviet Union and East Germany would loan $175 million for constructing an aluminum plant near Titograd, Montenegro, was canceled in April 1957. Later in the year the agreement was renewed, and construction of the 55,000-short-ton plant was to begin in 1958. The aluminum combine project was to include hydroelectric developments at Perucia and Komarnica and expansion of the caustic soda plant at Inkavac and the ferroalloys plant at Šibenik, as well as the aluminum plant in Titograd. It was reported that $20 million was to be spent on the project during 1958 and that work on the powerplants was begun in the latter part of the year. The entire project was scheduled to be completed by 1964.

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[26] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, p. 5.
[27] Mining World, vol. 19, No. 13, December 1957, p. 89
[28] Schofield, M., The Scottish Non-Ferrous Metal Industries: Metal Industry (London), vol. 91, No. 13, Sept. 27, 1957, pp. 269–273.

The aluminum industry in Yugoslavia was reviewed in several articles.[29]

ASIA

India.—In 1957 the Indian Aluminium Co., Ltd., a subsidiary of the Canadian company, Aluminium, Ltd., produced primary metal at its 5,500-short-ton plant at Alwaye. The only other producer (the Aluminium Corporation of India, Ltd., which is wholly Indian-owned), operated a 2,800-ton plant at Asansol.[30]

Progress was made on the expansion program during the year. The new plant of the Indian Aluminium Co., Ltd., at Hirakud in Orissa was expected to begin operations early in 1959, thus adding 10,000 tons of aluminum capacity. The company applied to the Government for permission to expand the plant to 20,000 tons.

An article discussing possibility of starting an aluminum industry in central India had been published in 1956.[31]

Japan.—Aluminum output continued its upward trend in 1957, with a record high 74,900 short tons of primary aluminum and 21,000 tons of secondary aluminum. The aluminum industry since the Peace Treaty in 1952 was reviewed.[32]

Showa Denko was reported to have completed a new plant with an annual capacity of 5,500 short tons near its Kitagata plant. This plant increased company capacity to 30,000 tons.

Japan Light Metal Co. announced that the reconstructed Niigata plant would be ready to operate in May 1958. The plant was equipped with 68 cells and was said to be capable of producing 11,000 short tons of aluminum a year, bringing total company capacity to 45,000 tons. The capacity of the Niigata plant was to be raised to 22,000 tons by 1960.

Primary aluminum-production capacity, which in 1957 was approximately 76,000 short tons, by 1960 would be 100,000 tons upon completion of all scheduled expansion.

AFRICA

Belgian Congo.—The Belgian Government approved the program for constructing dams and power stations at Inga estimated to cost £1,130 million. Construction was scheduled to begin in 1959. The British Aluminium Co., Ltd., joined the syndicate ALUMINGA, which included Belgian, United States, French, Swiss, German, and Italian companies.

French Africa.—The most important development during the year was the beginning of operations at the Edea aluminum plant of Compagnie Camerounaise de l'Aluminium Péchiney-Ugine (ALUCAM) in February 1957. Of the 8,400 short tons of aluminum produced

[29] Commercial Information, Federal Chamber of Foreign Trade, Belgrade, [The Boris Kidrič Alumina and Aluminum Works]: Vol. 10, No. 8, August 1957, pp. 16–17.
Djukič, Branko, The Yugoslav Aluminium Industry: Mining Mag. (London), vol. 97, No. 5, November 1957, pp. 278–280.
Baudart, G. A., [Aluminium in Yugoslavia]: Revue de l'Aluminium (Paris), vol. 34, No. 240, February 1957, pp. 151–154.

[30] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, pp. 6–10.

[31] Mahendra, Balram K., A Plan for Establishing Aluminium Industry in Central India Near Rihand Dam Uttar Pradesh: Bull. Geol., Min., and Met. Soc. India, No. 16, March 1956, 32 pp.

[32] Light Metals (London), The Industry in the World Today: Japan: Vol. 20, No. 235, October 1957 pp. 326–327.

during the year, 4,000 tons was exported to France. France reported shipping 26,600 short tons of alumina to French Cameroon in 1957 compared with 2,000 tons in 1956.

An article[33] on the Edea project stated that the 208 electrolytic cells each produced 1,400 pounds of aluminum daily. Latest production techniques were incorporated in the plant, which was said to be one of the most modern in the world. Production of 1 pound of aluminum required 1.9 pounds of alumina, 0.52 pound of carbon, and under 7.5 kw.-hr. of power. The production cost for 1 kw.-hr. of electricity was estimated at 0.7 franc (about ⅙ 1 cent), whereas the costs of electricity in France varied from 2 to 4 francs per kw.-hr.

It was announced in September 1957 that the French Cabinet had decided to build the dam and powerplant in French Guinea on the Konkouré River near Souapiti. Société Civile d'Études Hydroélectriques de Konkouré et du Kouilou was formed to study harnessing the hydroelectric resources of the rivers.[34]

TECHNOLOGY

During 1957, as aluminum supplies increased in the face of decreasing demand, marketing and technical research efforts were intensified. To meet the expected long-range increase in demand for aluminum, areas of fundamental research that required intensified activity were: (1) Investigation of primary raw materials other than high-grade bauxite; (2) development of new sources of energy; (3) modification of the Bayer alumina process or development of other alumina processes if different ores are used; (4) better efficiency of electrolytic cells and rectifiers; and (5) improvement in techniques and economics of recovering secondary aluminum.[35]

A British article which reviewed the industry in 1957 also included an extensive bibliography.[36] Results of research during the year in production, melting and casting, working, joining, properties, corrosion and protection, and applications were discussed, with references.

A process for producing honeycomb aluminum making the metal almost as light as balsa wood, was announced by Bjorksten Research Laboratories.[37] The metal could be made in densities ranging from 12 to 40 pounds per cubic foot, and the cells could be as small as 1/64 inch or as large as ¼ inch, and could be open or closed. Compressive and tensile strengths were low, and the material was said to have great rigidity. The material was produced by releasing hydrogen gas that resulted from adding gas-forming solids, such as titanium and zirconium hydrides, to molten aluminum.

Another application utilized aluminum as the foaming agent in producing foamed concrete. Two plants with a combined capacity of 350 cubic yards of blocks per day were put into operation in the West-

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[33] Victor, Maurice, Edea, Première Usine Africaine de Production d'Aluminium: Revue de l'Aluminium, vol. 34, No. 246, August 1957, pp. 843–874.

[34] The Mining Journal (London), Aluminium in French Africa: Vol. 249, No. 6376, Nov. 1, 1957, pp. 516–517.

[35] Modern Metals, Needed: More Research: Vol. 13, No. 6, July 1957, p. 14.
Ginsberg, H., [The Expansion of Production as Governing Factors of Fundamental Research in the Field of the Chemical Technology of Light Metals] (in German): Metall (Berlin), vol. 11, No. 3, March 1957, pp. 176–179.

[36] Elliott, E., Aluminium and Its Alloys in 1957, Some Aspects of Research and Technical Progress Reported: Metallurgia (Manchester), vol. 57, No. 340, February 1958, pp. 79–92.

[37] Chemical and Engineering News, Meet Foamed Aluminum: Vol. 35, No. 30, July 29, 1957, p. 56.

ern United States. The process was based upon the reaction between calcium hydroxide and aluminum to produce hydrogen, which formed small bubbles throughout the mass. The density of the product ranged from 675 to 1,215 pounds per cubic yard, which compared with a density of 2,700 pounds per cubic yard for cinder aggregate.[38]

Properties, uses, and methods for preparing superpurity aluminum were described. Such metal has total impurities of only 0.01 percent and was used in ornamental trim, automobile hardware, furniture fittings, costume jewelry, and watchcases and as foil in electrolytic condensers.[39]

A two-section article reviewed alloy developments, fabrication procedures, joining methods, and newly developed finishing methods and indicated advantages to be gained by using aluminum in manufacturing processes.[40]

Loss of strength at moderately elevated temperatures threatened the use of aluminum in some parts of supersonic aircraft. Aluminum alloys used had significantly inferior physical properties in the 250° to 350° F. range, thereby limiting their usefulness to aircraft speeds below 1,300 miles per hour. Alcoa announced development of a new alloy containing lithium, designated X2020, that maintained high strength at temperatures up to 400° F. The new alloy had a high modulus of elasticity, was lighter than alloys previously available for aircraft, and would be useful at speeds up to 1,600 miles per hour.[41]

Aluminum powder metallurgy parts (APMP) became commercially available in 1957. APMP products included extruded shapes, forgings, sheet, foil, drawn extruded tube, compact extrusions, fasteners, and wire. At temperatures above 400° F. these products were stronger and more stable than any aluminum alloy produced by conventional methods. Certain products could withstand temperatures up to 900° F., an advance of 300° to 400° over previous limits.[42] The improved properties of the extrusions or forgings produced from compacts of aluminum-flake powders were found to result from the oxide content of the powder. The higher the oxide content the higher the tensile strength, yield strength, and hardness and the lower the ductility of the extrusion or forging. Properties of the powders and extrusion were studied.[43] Variables investigated included particle size, flake thickness, and oxide content.

A series of articles discussed the technology of anodizing aluminum and discussed the efficiency of the operation, abrasion resistance of films obtained by different methods, and the surface appearance.[44]

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[38] Chemical Engineering, Powdered Aluminum Makes Concrete Foam: Vol. 64, No. 11, November 1957, pp. 162–164.

[39] Bloch, E. A., and Muller, P. H., Superpurity Aluminum: Metal Progress, vol. 72, No. 2, August 1957, pp. 91–96.

[40] Iron Age, How To Get More for Your Aluminum Dollar; sec. 1, Selection: Your Margin to Profit: Vol. 179, No. 5, Jan. 31, 1957, pp. 58–66; sec. 2, Ways To Get the Most From Aluminum: Vol. 179, No. 5, Jan. 31, 1957, pp. 67–72.

[41] Materials in Design Engineering, Lithium Improves Properties in Aluminum Alloy: Vol. 46, No. 7, December 1957, p. 159.

[42] Modern Metals, Aluminum Powder Parts Withstand High Heat: Vol. 13, No. 10, November 1957, p. 102.

[43] Lenel, F. V., Ansell, G. S., and Nelson, E. C., Metallography of Aluminum-Powder Extrusions: Jour. Metals, Trans. sec., vol. 9, No. 1, January 1957, pp. 117–124.

Lenel, F. V., Backensto, Jr., A. B., and Rose, M. V., Properties of Aluminum Powders and of Extrusions Produced From Them: Jour. Metals, Trans. sec., vol. 9, No. 1, January 1957, pp. 124–130.

[44] Kape, J. M., Thick Oxide Films on Aluminium Alloys: Metal Industry (London), vol. 91, No. 4, July 26, 1957, pp. 63–65; vol. 91, No. 5, Aug. 2, 1957, pp. 90–92; vol. 91, No. 6, Aug. 9, 1957, pp. 109–111; vol. 91, No. 7 Aug. 16, 1957, pp. 129–131; vol. 91, No. 8, Aug. 23, 1957, pp. 148–150; vol. 91, No. 9, Aug. 30, 1957, pp. 171–172, vol. 91, No. 10, Sept. 6, 1957, pp. 198–201; vol. 91, No. 11, Sept. 13, 1957, pp. 217–219; vol. 91, No. 12, Sept. 20, 1957, pp. 239–240.

Methods for cleaning and etching aluminum and compositions of baths used to brighten the metal during anodizing were also described.[45] Mechanical finishes for aluminum are important from both the decorative and functional standpoint. An article was published listing different surfaces, methods of obtaining them, and the advantages and disadvantages of each surface and method.[46]

The casting industry consumed approximately 20 percent of the aluminum used in 1957. The major casting methods were die, permanent mold, and sand. These and less common methods were subjects of an article, which also included information on cleaning, finishing, and heat-treating the castings.[47] Another series of articles was based on the report of a tour of United States plants by European experts sponsored by the Organization for European Economic Cooperation.[48]

With the advent of nuclear reactors, studies on the behavior of aluminum alloys under high temperature-pressure stresses have increased. These studies showed that some commercial alloys resisted attack by high-purity water at 200° C. Other alloys were resistant at temperatures up to 350° C.[49]

The Gilsonite refinery, opened in August by American Gilsonite Co., was designed to produce 55,000 gallons of high-octane gasoline and 275 tons of low-sulfur-content coke suitable for electrodes used in the reduction of aluminum.[50]

A method for extracting aluminum from aluminum-silicon alloys, developed in Bureau of Mines laboratories, was patented.[51] Aluminum is extracted from the alloy, under reduced pressure, by liquid zinc; the silicon is undissolved. The zinc is recovered from the aluminum by distillation and is used for further extraction of the aluminum-silicon alloy until extraction is completed. The zinc vapors are then condensed apart from the aluminum and silicon.

[45] Foulke, D. Gardner, and Irgens, O. Kendle, How to Clean and Etch Aluminum: Modern Metals, vol. 13, No. 4, May 1957, pp. 44, 46, and 48.
Brace, A. W., Chemical Brightening of Aluminium: Metal Industry (London), vol. 90, No. 8, Feb. 22, 1957, pp. 147–150, 153.

[46] Vanden Berg, R. V., Selecting Mechanical Finishes for Aluminum: Materials in Design Eng., vol. 46, No. 2, August 1957, pp. 102–106.

[47] Stewart, W. D., Cast Aluminum Products: Modern Metals, vol. 13, No. 10, November 1957, pp. 82, 84, 86, 90, and 92.

[48] Modern Metals, Die Casting Aluminum and Zinc: Part 1, vol. 13, No. 5, June 1957, pp. 72, 76, 78, 80, 82, 84, 86, 88, 90, 91; Part 2, vol. 13, No. 6, July 1957, pp. 74, 76, 78, 80, 82, 84, 85; Part 3, vol. 13, No. 7, August 1957, pp. 48, 50, 52, 54.

[49] Groot, Cornelius, and Wilson, R. E., Intergranular Corrosion of Aluminum in Superheated Steam: Ind. Eng. Chem., vol. 49, No. 8, August 1957, pp. 1251–1254.

[50] American Metal Market, New Gilsonite Refinery Will Supply Electro Coke to Aluminum Industry: Vol. 64, No. 148, Aug. 2, 1957, pp. 1, 14.

[51] Spendlove, Max J., and Caldwell, Herbert S. (assigned to United States of America, as represented by the Secretary of the Interior), Method of Extracting Aluminum From Aluminum-Silicon Alloys by Low Pressure: U. S. Patent 2,810,637, October 1957; appl. filed Feb. 13, 1953, patented.

Antimony

By H. M. Callaway [1] and Edith E. den Hartog [2]

DOMESTIC antimony supply in 1957 exceeded consumption by a considerable margin. Although domestic smelter output decreased, the increased volume of imports oversupplied the diminished industrial market. Government procurement tended to stabilize prices and prevent industrial stock buildups.

A 4-percent decline in world production of antimony was attributed to lower prices and limited demand for ores and concentrates.

TABLE 1.—Salient statistics of antimony in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Production:						
Primary:						
Mine	3,251	372	766	633	590	709
Smelter [1]	14,071	9,890	9,868	10,201	12,070	11,559
Secondary	21,709	22,360	22,358	23,702	24,106	22,565
General imports	15,401	12,842	9,566	14,417	13,577	15,265
Ore and concentrate	10,151	7,778	4,722	7,514	6,572	8,198
Metal	3,098	2,627	2,825	3,671	4,693	5,052
Oxide	833	1,076	1,225	1,834	1,236	1,571
Sulfide	95	11	23	32	32	27
Antimonial lead (antimony content)	1,224	1,350	771	1,366	1,044	417
Exports of ore, metal and alloys	259	24	44	212	65	68
Consumption of primary antimony [1]	17,412	17,090	14,136	14,504	14,962	11,931
Average price of antimony at New York (cents per pound)	38.60	35.90	30.47	32.15	34.97	35.09
World: Production	50,000	37,000	44,000	51,000	55,000	53,000

[1] Includes antimony content of antimonial lead produced from foreign and domestic ores. In previous years this class of material was reported separately.

LEGISLATION AND GOVERNMENT PROGRAMS

Government inventories in 1957 substantially equaled the current procurement priority level; however, domestic primary antimony producers continued deliveries in fulfilling prior contract commitments.

Commodity Credit Corporation, under authority of the Agricultural Trade Development and Assistance Act of 1954, continued to barter domestic agricultural surpluses for selected foreign minerals and metals. Antimony remained on the list of eligible commodities during 1957, and deliveries to Government under barter contracts constituted a substantial portion of total United States imports during the year.

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

DOMESTIC PRODUCTION

MINE PRODUCTION

In 1957 the output from domestic antimony mines was 45 tons of contained antimony. Although many domestic mine ores contain minor quantities of antimony that eventually reports as byproduct domestic smelter production, data on the quantities redeemed from individual deposits are lacking. The tetrahedrite-rich ores of the Sunshine Mining Co., Shoshone County, Idaho, are an exception. Historically, the Bureau of Mines tabulates this company's output of impure cathode antimony as domestic mine production. In 1957, the Sunshine Mining Co. produced 664 tons.

TABLE 2.—Antimony-bearing concentrates, produced (shipped) in the United States and Alaska, 1948–52 (average) and 1953–57, in short tons

Year	Gross weight	Average percent antimony	Net weight antimony content	Year	Gross weight	Average percent antimony	Net weight antimony content
1948–52 (average)	8,528	37.8	3,251	1955	3,967	16.0	633
1953	2,161	17.2	372	1956	3,505	16.8	590
1954	4,686	16.3	766	1957	4,192	16.9	709

SMELTER PRODUCTION

Primary.—United States primary smelter production of antimony in 1957 was 11,600 tons, 4 percent below the quantity produced in 1956. Metal and oxide, in approximately equal quantities, constituted 77 percent of the total output; antimony content of antimonial lead accounted for an additional 17 percent, and industrially consumed residues and sulfide comprised the remaining 6 percent. Foreign antimony ores and concentrates supplied 65 percent of the source material from which domestic smelter production was derived. Approximately 29 percent of the total smelter output was byproduct metal, oxide, and antimonial lead derived from refining lead bullion. The bullion, in turn, was derived from smelting of both foreign and domestic ore concentrates. According to the best available estimates, the portion that originated in domestic ores totaled 1,950 tons, or 17 percent of the total domestic primary smelter output. The remaining 6 percent of total smelter feed was from stock drawdowns and domestically mined ore concentrates.

Companies that reported primary antimony production in 1957 were: American Smelting & Refining Co., Foote Mineral Co., Harshaw Chemical Co., Hummel Chemical Co., McGean Chemical Co., Metal & Thermit Corp., National Lead Co., and Bradley Mining Co. Bradley Mining Co. announced shutdown of its Stibnite, Idaho, antimony smelter and mill in May. Previously the company had reopened the smelter to refine impure cathode antimony purchased from the Sunshine Mining Co.

The output of secondary antimony, all in antimonial alloys, totaled 23,000 short tons from all plants. This quantity includes 1,150 tons in antimonial lead produced from scrap at primary lead refineries.

Secondary.—Secondary antimony recovered in 1957 totaled 22,600 short tons, valued at $15.8 million, compared with 24,100 tons, valued at $16.9 million, recovered in 1956. Of the 1957 total, secondary smelters recovered 91 percent, primary producers 5 percent, and manufacturers and foundries 4 percent.

Recovery of antimony from battery plate scrap (13,600 tons) comprised 60 percent of the total recovered compared with 58 percent in 1956. From type-metal scrap 3,200 tons of antimony was reclaimed, from lead dross 2,500 tons, from bearing metals 1,700 tons, and from antimonial lead scrap 1,200 tons. In addition to antimony recovered from scrap, 6,100 tons of primary antimony was consumed in making lead and tin alloys. Of this total 65 percent was used in making antimonial lead.

Although all secondary antimony recoverable was redeemed from antimony-bearing lead or tin scrap and was recovered in lead or tin alloys, the operation usually involved more than simple remelting. Most of the scrap was battery plates containing oxides that had to be reduced by smelting in a blast or reverberatory furnace. The antimony content of the antimonial lead produced from smelting battery-plate scrap was usually too low for the alloy to be used in making battery grids, and more antimony was added. Such antimony was often obtained by softening some of the antimonial lead produced.

TABLE 3.—Antimony recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1956–57, in short tons

Kind of scrap	1956	1957	Form of recovery	1956	1957
New scrap:					
Lead-base	3,044	2,531	In antimonial lead [1]	16,462	15,722
Tin-base	75	50	In other lead alloys	7,599	6,808
			In tin-base alloys	45	35
Total	3,119	2,581	Grand total	24,106	22,565
Old scrap:					
Lead-base	20,931	19,933			
Tin-base	56	51			
Total	20,987	19,984			
Grand total	24,106	22,565			

[1] Includes 1,283 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1956 and 1,149 tons in 1957.

TABLE 4.—Smelter production of primary antimony in the United States, 1948–52 (average) and 1953–57, in short tons, antimony content

Year	Class of material produced					Total
	Metal	Oxide	Sulfide	Residues	Byproduct antimonial-lead	
1948–52 (average)	4,082	6,362	109	(1)	2,563	14,071
1953	2,000	4,600	100	400	2,790	9,890
1954	2,178	4,925	124	685	1,956	9,868
1955	2,138	5,390	92	549	2,032	10,201
1956	4,291	4,731	129	854	2,065	12,070
1957	4,658	4,210	107	629	1,955	11,559

[1] Data not available.

This process yielded a high-antimony dross, which was resmelted with plate scrap to produce an alloy with higher antimony content. Of the secondary metal content of antimonial lead produced, 6 percent was reclaimed antimony.

TABLE 5.—Antimony metal, alloys, and compounds, produced in the United States, 1948–52 (average) and 1953–57, 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	
1948–52 (average)	11, 508	65, 518	1, 906	657	1, 929	4, 492	6. 9	21, 709
1953	7, 100	62, 373	1, 684	1, 106	1, 747	4, 537	7. 3	22, 360
1954	7, 912	59, 873	1, 299	657	1, 565	3, 521	5. 9	22, 358
1955	8, 169	64, 044	1, 307	725	1, 523	3, 555	5. 6	23, 702
1956	10, 005	66, 826	1, 320	745	1, 283	3, 348	5. 0	24, 106
1957	9, 644	67, 786	1, 300	615	1, 149	3, 064	4. 5	22, 565

[1] Includes primary residues and small amount of antimony ore.
[2] Includes foreign base bullion and small quantities of foreign antimony ore.
[3] Includes antimony content of antimonial lead produced at lead refineries from scrap.

CONSUMPTION AND USES

In 1957 industrial users of primary antimony in the United States consumed 12,000 tons—20 percent less than in 1956. The magnitude of the decrease was considerably greater than that for other base metals with which antimony is closely allied. Consumption was divided nearly equally between metal and nonmetal products. The largest use was in antimonial lead (including battery metal), which in previous years represented approximately one-third of the total domestic industrial consumption. However, this use in 1957 declined nearly 20 percent, paralleling the general restricted consumption of antimony. The glass and ceramics industry used 14 percent of the total antimony consumed in all industries during 1957, but only 74 percent of that used in glass and ceramics in 1956.

TABLE 6.—Industrial consumption of primary antimony in the United States, 1949–52 (average) and 1953–57, in short tons, antimony content

Year	Class of material consumed						Total
	Ore and concentrate	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	
1949–52 (average) [1]	2, 672	5, 049	6, 979	149	(2)	2, 398	17, 247
1953	2, 100	5, 400	5, 800	100	900	2, 790	17, 090
1954	768	4, 609	5, 885	94	824	1, 956	14, 136
1955	491	4, 041	7, 051	127	762	2, 032	14, 504
1956	1, 149	4, 154	6, 843	112	639	2, 065	14, 962
1957	677	3, 638	5, 129	103	429	1, 955	11, 931

[1] Breakdown not available before 1949.
[2] Data not available.

TABLE 7.—Industrial consumption of primary antimony in the United States, 1948–52 (average) and 1953–57, by class of material produced, in short tons, antimony content [1]

Product	1948–52 (average)[2]	1953	1954	1955	1956	1957
Metal products:						
Ammunition	9	3	5	5	14	12
Antimonial lead	7,726	8,090	5,070	4,551	4,972	3,983
Bearing metal and bearings	1,324	1,000	816	831	1,077	944
Cable covering	89	60	156	146	190	183
Castings	83	80	70	67	57	106
Collapsible tubes and foil	24	60	47	24	12	20
Sheet and pipe	210	170	238	157	300	258
Solder	146	200	148	131	144	90
Type metal	741	700	613	598	528	399
Other	124	127	118	161	137	153
Total metal products	10,476	10,490	7,281	6,671	7,431	6,148
Nonmetal products:						
Ammunition primers	13	30	22	20	13	14
Fireworks	(3)	50	27	32	37	37
Flameproofing chemicals and compounds	1,136	1,230	1,266	1,218	1,082	760
Ceramics and glass	1,798	1,700	1,469	2,048	2,188	1,611
Matches	35	20	15	17	18	26
Pigments	849	1,170	1,418	1,283	1,471	1,085
Plastics	568	560	620	767	976	748
Rubber products	57	20	49	78	156	284
Other	2,480	1,820	1,969	2,370	1,590	1,218
Total nonmetal products	6,936	6,600	6,855	7,833	7,531	5,783
Grand total	17,412	17,090	14,136	14,504	14,962	11,931

[1] The 1957 consumption components have been reclassified and previous years' figures have been revised to make all quantities of the table directly comparable.
[2] Data for 1948–52 are not wholly comparable with those of following years, but comparisons may indicate general trends.
[3] Included with other nonmetal products.

STOCKS

Despite decreased consumption and a large volume of imports, industrial stocks declined 12 percent. Essentially, all stock drawdowns were in metal; stocks of oxide and ores and concentrates changed only slightly. Deliveries to Government account effectively prevented industry stock buildups.

TABLE 8.—Industry stocks of primary antimony in the United States at end of year, 1953–57, in short tons, antimony content

	1953	1954	1955	1956	1957
Ores and concentrates	2,232	2,421	3,568	2,474	2,337
Metal	1,254	1,577	1,267	2,236	1,300
Oxide	2,851	2,751	3,234	2,638	2,510
Sulfide	142	135	94	159	160
Residues and slags	584	522	445	598	746
Antimonial lead [1]	1,135	891	539	506	522
Total	8,198	8,297	9,147	8,611	7,575

[1] Inventories at primary lead smelters only.

PRICES

The domestic price of antimony metal, RMM brand, in bulk, 99½ percent f. o. b. Laredo, Tex., was 33.00 cents per pound throughout 1957. The equivalent New York price rose from 34.97 to 35.09 cents on January 2, reflecting higher freight rates.

News items from London indicated Chinese, Russian, and Czechoslovak metal of 99.6-percent minimum purity were quoted within the range 19.7 to 20.6 cents per pound. English metal of comparable quality sold for 26.2 to 27.8 cents during the first 10 months but dropped to a low of 23.5 cents toward the end of the year after resisting pressure of lower ore and concentrate prices for many months.

TABLE 9.—E&MJ Metal and Mineral Markets openings and subsequent changes in nominal quotations for antimony ore, 1957, antimony content, per unit (20 pounds)

Date	50–55 percent	Min. 60 percent	Min. 65 percent
January 3	$3.00–$3.10	$3.55–$3.65	$3.90–$4.00
June 20	3.00– 3.05	3.45– 3.55	3.80– 3.90
July 11	2.80– 2.90	3.20– 3.30	3.60– 3.65
September 12	2.50– 2.75	2.85– 3.00	3.10– 3.25
September 19	2.25– 2.40	2.40– 2.60	2.85– 2.95
October 3	2.25– 2.40	2.40– 2.60	2.90– 3.00
December 5	2.25– 2.40	2.40– 2.60	3.00– 3.10

TABLE 10.—Foreign metal prices, New York, 1957, antimony content, cents per pound[1]

[American Metal Market]

Date	99.6 percent	99.5 percent	99 percent
January 2	28.00–29.00	27.50–28.00	27.00–27.50
November 12	26.00–27.00	25.50–26.50	25.00–26.00

[1] Duty paid New York—lots of 5 tons or more.

TABLE 11.—Antimony oxide prices, New York, 1957, cents per pound

[E&MJ Metal and Mineral Markets]

Date	Carlots in bags	Less than carlots
January 3	27.00–29.00	28.50–30.50
December 6	24.00	26.00

FOREIGN TRADE[3]

Imports of all categories of antimony totaled 15,300 tons in 1957, a 12-percent increase over 1956. Approximately 18,000 tons of imported ores and concentrates supplied 65 percent of the source material that entered dometic primary antimony production in 1957. Imports of metal, oxide and antimonial lead, as well as 680 tons of ore concentrates, were directly consumed in industry. The United Kingdom and Yugoslavia were the largest contributors of metal, supplying 37 percent and 24 percent, respectively. Other European countries supplied 24 percent and the remaining metal imports were from Mexico and Peru. Nearly 80 percent of the imported ores and

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

concentrates came from the Western Hemisphere. Mexico and Bolivia alone furnished 71 percent. Approximately 17 percent of the imported ore came from Union of South Africa.

Exports of antimony in 1957, as in prior years, were nominal.

Tariff on antimony and antimonial products remained unchanged in 1957. Ores and concentrates were admitted duty-free. Metal was dutiable at 2 cents per pound and oxide at 1 cent.

TABLE 12.—Antimony imported for consumption in the United States, 1948–52 (average) and 1953–57 [1]

[Bureau of the Census]

Year	Antimony ore			Needle or liquated antimony		Antimony metal		Type metal and antimonial lead [2] (short tons)	Antimony oxide	
	Short tons (gross weight)	Antimony content: Short tons	Antimony content: Value	Short tons (gross weight)	Value	Short tons	Value		Short tons (gross weight)	Value
1948–52 (average)	25,343	10,075	$3,284,745	135	$78,579	3,054	$1,917,773	1,224	1,004	$607,396
1953	17,242	7,778	2,035,125	17	8,678	2,612	1,402,226	1,350	1,296	579,600
1954	12,870	4,722	1,289,782	33	17,101	2,802	1,349,179	771	1,476	645,057
1955	16,307	7,514	1,876,601	46	18,628	3,667	1,859,906	1,366	2,210	926,312
1956	17,424	6,572	1,762,210	46	22,715	4,321	2,245,194	1,044	1,479	635,808
1957	21,374	8,198	1,973,269	38	17,297	5,412	2,587,234	417	1,893	790,367

[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.

TABLE 13.—Antimony imported into the United States, 1948–52 (average), 1953–55 (totals), and 1956–57, by countries [1]

[Bureau of the Census]

Country	Antimony ore			Needle or liquated antimony		Antimony metal		Antimony oxide	
	Short tons (gross weight)	Antimony content: Short tons	Antimony content: Value	Short tons (gross weight)	Value	Short tons	Value	Short tons (gross weight)	Value
1948–52 (average)	25,625	10,151	$3,303,798	135	$78,798	3,098	$1,943,124	1,004	$607,396
1953	17,242	7,778	2,035,125	15	7,582	2,627	1,407,424	1,296	579,600
1954	12,870	4,722	1,289,782	33	17,101	2,825	1,359,497	1,476	645,057
1955	16,307	7,514	1,876,601	46	18,628	3,671	1,860,472	2,210	926,312
1956									
North America:									
Canada	386	201	41,989					25	12,463
Mexico	11,106	2,977	624,742			791	521,232		
Total	11,492	3,178	666,731			791	521,232	25	12,463
South America:									
Bolivia [2]	2,013	1,306	454,854						
Chile [2]	221	98	29,420						
Peru [2]	377	231	78,021			200	79,081		
Total	2,611	1,635	562,295			200	79,081		

See footnotes at end of table.

TABLE 13.—Antimony imported into the United States, 1948–52 (average), 1953–55 (totals), and 1956–57, by countries [1]—Continued

[Bureau of the Census]

Country	Antimony ore			Needle or liquated antimony		Antimony metal		Antimony oxide	
	Short tons (gross weight)	Antimony content		Short tons (gross weight)	Value	Short tons	Value	Short tons (gross weight)	Value
		Short tons	Value						
1956									
Europe:									
Austria	16	11	$3,883	6	$2,688	–	–	–	–
Belgium-Luxembourg	–	–	–	2	1,030	964	$472,060	178	$81,686
France	–	–	–	–	–	131	65,656	–	–
Germany, West	–	–	–	7	2,873	56	26,113	202	83,528
Italy	–	–	–	–	–	44	21,818	–	–
United Kingdom	6	4	2,660	9	4,256	1,346	657,856	1,084	462,247
Yugoslavia	–	–	–	22	11,868	1,161	579,978	–	–
Total	22	15	6,543	46	22,715	3,702	1,823,481	1,464	627,461
Asia: Turkey	82	44	14,512	–	–	–	–	–	–
Africa:									
Algeria	744	260	41,664	–	–	–	–	–	–
Union of South Africa	2,473	1,440	470,465	–	–	–	–	–	–
Total	3,217	1,700	512,129	–	–	–	–	–	–
Grand total, 1956	17,424	6,572	1,762,210	46	22,715	4,693	2,423,794	1,489	639,924
1957									
North America:									
Canada	523	248	47,432	–	–	–	–	–	–
Guatemala	26	13	3,323	–	–	–	–	–	–
Mexico	14,232	3,869	712,151	–	–	494	325,750	–	–
Total	14,781	4,130	762,906	–	–	494	325,750	–	–
South America:									
Bolivia [2]	3,075	1,957	565,379	–	–	–	–	–	–
Chile [2]	198	127	27,552	–	–	–	–	–	–
Peru [2]	397	236	52,708	–	–	258	101,762	–	–
Total	3,670	2,320	645,639	–	–	258	101,762	–	–
Europe:									
Austria	5	3	1,345	–	–	–	–	–	–
Belgium-Luxembourg	–	–	–	18	7,912	840	369,178	388	166,951
France	–	–	–	–	–	45	19,344	–	–
Germany, West	–	–	–	2	1,016	102	40,535	258	106,071
Italy	–	–	–	–	–	220	87,539	–	–
Netherlands	–	–	–	–	–	–	–	7	2,981
Portugal	22	15	4,872	–	–	–	–	–	–
United Kingdom	–	–	–	17	7,906	1,865	906,688	1,240	514,364
Yugoslavia	–	–	–	1	463	1,228	562,413	–	–
Total	27	18	6,217	38	17,297	4,300	1,985,697	1,893	790,367
Asia: Turkey	358	215	61,418	–	–	–	–	–	–
Africa:									
Mozambique	169	104	31,649	–	–	–	–	–	–
Union of South Africa	2,369	1,411	465,440	–	–	–	–	–	–
Total	2,538	1,515	497,089	–	–	–	–	–	–
Grand total, 1957	21,374	8,198	1,973,269	38	17,297	5,052	2,413,209	1,893	790,367

[1] Data are general imports, that is, include antimony imported for immediate consumption, plus material entering the country under bond. Table does not include antimony contained in lead-silver ores.
[2] Imports shown from Chile probably were mined in Bolivia or Peru and shipped from a port in Chile.

WORLD REVIEW

Belgium-Luxembourg.—Antimony was produced from imported ore in excess of internal need, and approximately 1,200 short tons of metal and oxides was exported to the United States.

Bolivia.—No antimony was produced from nationalized mines. The total output from the privately owned properties was 3,800 short tons, of which 1,960 was shipped to the United States.

China.—Reports from London and from concerned United States antimony producers indicate that China assumed an increasingly active position in the antimony trade during 1957. Having large reserves, low production cost, and ability to produce high-grade metal, China may reasonably be expected to recoup its dominant position in the world open market. Estimated production during 1957 was 16,500 short tons.

Mexico.—The production of antimony in Mexico closely follows United States requirements. In 1957 output totaled 5,730 short tons—a considerable increase from the 5,000 tons produced in 1956. Total exports were 4,850 tons; the United States was the only recipient.

Union of South Africa.—Consolidated Murchison (Transvaal) Goldfields & Development Co., Ltd., recovered antimony from gold-antimony ores in the Pietersburg district of the Transvaal. A production of 17,550 short tons of 63-percent antimony concentrates was reported for 1957. Of this total, 14,360 tons was exported. The United States received approximately 16 percent. Following the export pattern of previous years the balance probably was shipped to the United Kingdom.

United Kingdom.—Second only to the United States in consumption of antimony, the United Kingdom has developed a large domestic smelter capacity that is fed exclusively by imported concentrate. When economics permits, excess production enters world trade; however, competition from lower-priced Chinese and Russian high-grade metal in 1957 reduced the export outlet considerably and threatened to capture a portion of United Kingdom's domestic market. The Government considered an industry proposal to increase the metal import tax to a more protective level, but no action had been taken by the end of 1957. The total industrial consumption of primary antimony in the United Kingdom was 5,177 short tons, and an additional 4,760 tons of secondary antimony was used in antimonial lead.

Yugoslavia.—Yugoslavia was the outstanding mine producer of antimony in Europe. The country's smelters, producing only from domestic ores, had an output of 1,950 short tons in 1957. Of this total, the United States received 1,228 tons—nearly 63 percent.

TABLE 14.—World production of antimony (content of ore),[1] by countries,[2] 1948–52 (average) and 1953–57, in short tons [3]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [2]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada [4]	1,014	744	651	1,011	1,070	706
Guatemala	—	—	—	—	—	15
Mexico [4]	6,913	4,063	4,610	4,209	5,022	5,732
United States	3,251	372	766	633	630	709
Total	11,178	5,179	6,027	5,853	6,722	7,162
South America:						
Argentina	[5] 45	(6)	(6)	7	2	[5] 2
Bolivia (exports)	11,671	6,376	5,751	5,907	5,629	[5] 6,600
Peru	1,095	1,062	933	960	953	[7] 865
Total	12,811	[5] 7,490	[5] 6,740	6,874	6,584	[5] 7,500
Europe:						
Austria	464	543	429	493	489	440
Czechoslovakia [5]	2,490	1,800	1,800	1,800	1,800	1,800
France	464	330	—	90	251	[5] 220
Greece	276	660	[5] 60	—	—	—
Italy	679	465	326	402	314	138
Portugal	52	1	10	—	—	—
Spain	244	254	120	210	250	230
Yugoslavia (metal)	1,657	1,554	1,711	1,769	1,767	1,950
Total [2] [5]	6,600	5,900	4,600	4,900	5,000	4,800
Asia:						
Burma [5]	110	130	55	65	90	80
China [5]	6,230	11,000	12,000	13,000	13,000	16,500
Iran [8]	177	110	50	63	(6)	(6)
Japan	202	354	291	357	619	473
Thailand	128	50	78	28	41	[5] 33
Turkey	1,441	951	1,080	1,841	3,700	(6)
Total [5]	8,300	12,600	13,600	15,400	17,500	20,400
Africa:						
Algeria	1,290	2,134	2,845	1,086	2,370	[5] 1,600
Morocco:						
Northern Zone	313	341	330	397	330	364
Southern Zone	817	46	434	327	—	—
Rhodesia and Nyasaland, Fed. of:						
Southern Rhodesia	52	26	72	223	72	83
Union of South Africa	8,806	3,009	9,528	15,641	15,689	11,021
Total	11,278	5,556	13,209	17,674	18,461	13,068
Oceania:						
Australia	281	251	131	344	322	[5] 330
New Zealand	3	12	—	—	—	—
Total	284	263	131	344	322	[5] 330
World total (estimate) [2]	50,000	37,000	44,000	51,000	55,000	53,000

[1] Approximate metal content of ore produced, exclusive of antimonial lead ores.
[2] Antimony is also produced in Hungary and U. S. S. R.; an estimate for Hungary by the author of the chapter is included in the total, but there is too little information to include an estimate for U. S. S. R.
[3] This table incorporates a number of revisions of data published in previous Antimony chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[4] Includes antimony content of miscellaneous smelter products.
[5] Estimate.
[6] Data not available; estimate by author of chapter included in total.
[7] Exports.
[8] Year ended March 20 of year following that stated.

WORLD RESERVES

There are few deposits of antimony wherein ore is developed in advance of current mining requirements. World reserves therefore are necessarily based on known correlative data, such as historical production levels and geologic patterns of occurrence.

China is the dominant possessor of reserves. Estimates range from 2 to 5.7 million tons of contained antimony—a quantity that dwarfs the reserves of any other country. Bolivia is second to China, with an estimated 400,000 tons. Mexico, the Union of South Africa, and U. S. S. R. are estimated to have approximately the same level of reserves—each is assigned 250,000 tons of contained antimony. The United States, Yugoslavia, Australia, and Algeria-Morocco each are assigned 100,000 tons. Canada, Peru, Turkey, and Czechoslovakia have approximately the same reserve level and collectively have an estimated 225,000 tons. An additional reserve in many small deposits throughout Austria, Hungary, France, and Japan totals 175,000 tons of antimony. Total world reserves, excluding China, are therefore estimated at approximately 2 million tons.

TECHNOLOGY

In an effort to contribute toward more economic redemption of byproduct antimony from domestic ores, the Bureau of Mines continued laboratory-scale studies of the leaching and precipitation of antimony from ore concentrates. Sodium sulfide leaching of tetrahedrite concentrate, followed by organic complexing and extraction, produced discouraging results. Autoclave leaching with oxygenated water caused oxidation of the sulfide and generation of sulfuric acid. Both electrolysis and direct hydrogen reduction of the antimony component of the pregnant solution gave results yet to be fully evaluated.

Two American companies and one British company announced commercial production of superpurity antimony for the electronics industry. Previously, the use of antimonial intermetallic compounds has been restricted by lack of pure enough metal. Two promising antimonial semiconductors that now may be developed commercially are indium-antimony and aluminum-antimony. When an indium-antimony current-carrying conductor is placed in a properly oriented magnetic field it is polarized transverse to the current flow. By suitable electrocoupling a transverse secondary current is generated, giving rise to a flux field that opposes current flow in the primary circuit. The resulting effective resistance is proportional to the applied magnetic field intensity. The sensitivity and strength of the response are such that many uses are anticipated in control circuits. Aluminum-antimony has essentially the same crystal structure as germanium and responds electrically in similar ways. Controlled processing of the alloy has yielded electrical resistivities varying by a factor of more than 500,000. Past experiments also indicate photoelectric properties of aluminum-antimony that have potential uses in light-controlled electric circuits and electric generation from light energy sources.

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Hemeon Associates (air-pollution researchers of Pittsburgh) announced a newly developed technique of tracing, quantitatively, a selected industrial smoke to its source. The method involves additions of extremely fine powdered antimony oxide to the stream of gases issuing from smokestacks within a given area. Previously positioned automatic instruments dispersed at proper stations within the area take air samples from which calculations can be made. Radioactivation of the tracer antimony is deferred until the smoke sample is safely confined to the laboratory preparatory to analysis.

Arsenic

By A. D. McMahon [1] and Gertrude N. Greenspoon [2]

DOMESTIC output of white arsenic in 1957 was 10,500 short tons, 14 percent less than in 1956 and lower than in any year since 1946. Shipments exceeded production and producers' stocks on December 31, 1957 were reduced to 2,500 tons. Apparent consumption was 9 percent below 1956.

Imports of white arsenic in 1957 increased 58 percent over 1956, and the total available for domestic consumption rose 11 percent. United States refinery production from domestic and foreign ores accounted for 51 percent of the total supply (66 percent in 1956) and imports for 49 percent (34 percent in 1956).

World production, estimated at 47,000 short tons in 1957, was unchanged from 1956.

TABLE 1.—Salient statistics of white arsenic, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Production	15, 314	10, 873	13, 167	10, 780	12, 201	10, 493
Shipments	13, 214	11, 315	11, 523	11, 673	18, 876	12, 785
Imports	9, 561	4, 717	4, 848	7, 222	6, 422	10, 135
Producers' stocks at end of year	6, 123	10, 820	12, 464	11, 571	[1] 4, 827	2, 535
Apparent consumption [2]	22, 775	16, 032	16, 371	18, 895	25, 298	22, 920
Price [3] ......cents per pound	6	5½	5½	5½	5½	5½
World: Production	55, 000	30, 000	38, 000	46, 000	47, 000	47, 000

[1] Revised figure.
[2] Producers' shipments, plus imports, minus exports; no exports were reported by producers, 1948–57.
[3] Refined white arsenic, carlots, as quoted by E&MJ Metal and Mineral Markets.

DOMESTIC PRODUCTION

Domestic production of white arsenic dropped 14 percent in 1957 to the lowest quantity since 1946. White arsenic was produced by The Anaconda Co., Anaconda, Mont. (copper smelter), United States Smelting, Refining and Mining Co., Midvale, Utah (lead smelter), and American Smelting and Refining Co., Tacoma, Wash. (copper smelter). The entire domestic output of arsenic was a byproduct of smelting complex copper and lead ores. Arsenic metal was not produced in 1957.

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

TABLE 2.—Production and shipments of white arsenic by United States producers, 1948–52 (average) and 1953–57

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
1948–52 (average)	14,387	12,300	$869,497	927	914	$79,763	15,314	13,214	$949,260
1953	10,345	10,816	495,673	528	499	43,383	10,873	11,315	539,056
1954	12,630	10,921	492,562	537	602	48,516	13,167	11,523	541,078
1955	9,968	10,986	501,104	812	687	53,557	10,780	11,673	554,661
1956	11,423	18,048	685,145	778	828	69,524	12,201	18,876	754,669
1957	9,814	11,980	475,629	679	805	54,721	10,493	12,785	530,350

[1] Excludes crude consumed in making refined.

CONSUMPTION AND USES

Apparent consumption of white arsenic in 1957 was 22,900 tons, a 9-percent decrease from 1956. The major portion of the output of white arsenic was used in manufacturing lead and calcium arsenate insecticides. Consumption of white arsenic varies with the severity of boll-weevil infestations of cotton in the southern cotton-producing States.

Arsenic also was used in weedkillers, glass manufacture, cattle and sheepdips, dyestuffs, and wood preservatives. Sodium arsenite was reported [3] to be used more than aromatic solvents to control submerged aquatic plants in parks when no flow of water was expected for 2 or 3 days after treatment. Sodium arsenite, when used properly, is not harmful to fish life.

TABLE 3.—Production of arsenical insecticides and consumption of arsenic wood preservatives in the United States, 1948–52 (average) and 1953–57, in short tons

Year	Production of insecticides [1]		Consumption of wood preservatives [2]
	Lead arsenate (acid and basic)	Calcium arsenate (70 percent $Ca_3(AsO_4)_2$)	Wolman salts (25 percent sodium arsenate)
1948–52 (average)	12,064	13,712	669
1953	7,098	3,630	950
1954	7,810	1,379	983
1955	7,388	1,885	1,067
1956	5,878	13,553	1,005
1957 [3]	6,076	9,763	987

[1] Bureau of the Census, U. S. Department of Commerce.
[2] Forest Service, U. S. Department of Agriculture.
[3] Preliminary figures.

STOCKS

Producers' stocks of white arsenic were 2,500 tons at the end of 1957—47 percent below 1956 and lower than in any year since 1950.

[3] National Conference on State Parks, Park Practice Grist Supplement: Vol. 1, No. 4, 1957, 4 pp.

Year-end inventories of calcium arsenate and lead arsenate were 2,028 and 1,366 tons, compared with 2,000 and 1,373 tons, respectively, at the end of 1956.

PRICES

White arsenic was quoted at 5½ cents per pound (powdered, in barrels, carlots) throughout 1957. According to the Oil, Paint and Drug Reporter, calcium arsenate, in carlots, was quoted at 9–9½ cents per pound and lead arsenate, carlots (3-pound bags), at 27½ cents per pound throughout 1957. The domestic price for arsenic metal (54 cents per pound) has remained unchanged since December 1954.

The London price for white arsenic, per long ton, 98–100 percent, was £40–£45 nominal (equivalent to 5.00 to 5.63 cents per pound) throughout 1957 and for arsenic metal, per long ton, £400 (50.00 cents per pound).

FOREIGN TRADE [4]

Imports—Imports of white arsenic in 1957 totaled 10,100 short tons, a 58-percent increase over 1956 and larger than in any year since 1951.

Mexico continued to be the principal supplier of white arsenic with 68 percent of the total imports; Canada and France supplied 15 and 10 percent, respectively, and Sweden and Poland-Danzig supplied the remainder.

Sixty-eight tons of metallic arsenic was received in 1957, of which 36 tons came from Sweden, 15 tons from the United Kingdom, 14 tons from Poland-Danzig, and 3 tons from West Germany. Belgium-Luxembourg furnished 21 tons of arsenic sulfide, and the United Kingdom furnished 34 tons of arsenical sheepdips. Of the 164 tons of sodium arsenate imported in 1957, 101 came from the United Kingdom, 53 from France, and 10 from West Germany.

Exports.—Producers of white arsenic reported no direct foreign sales in 1957. Exports of calcium arsenate were 1,390 tons, valued at $201,409, and were more than 4 times those in 1956. Nicaragua received 648, Peru 589, Guatemala 61, Canada 55, El Salvador 25, and Cuba 12 tons.

Exports of lead arsenate totaled 608 tons, valued at $231,495, and were less than half those in 1956. Of the total exported, 501 tons went to Peru, 41 to Canada, 22 to France, 10 to Chile, and the remainder (in lots of less than 10 tons each) to 7 other countries.

Tariff.—White arsenic, arsenic sulfide, paris green, and sheepdip (certain varieties contain arsenic) were all free of duty. Arsenic acid was subject to duty at 3 cents per pound and lead arsenate at 1½ cents per pound. The duty on metallic arsenic was 2.8 cents per pound at the beginning of 1957 and was lowered to 2.7 cents per pound on June 30, 1957. Compounds of arsenic not specified in the Tariff Act were subject to duty at 12½ percent of their foreign market value.

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

TABLE 4.—White arsenic (As_2O_3 content) imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries

[Bureau of the Census]

Country	1948–52 (average)		1953		1954		1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:												
Canada	244	$23,559	292	$26,018	592	$48,690	683	$43,048	540	$49,387	1,508	$119,427
Mexico	7,891	820,420	4,378	543,443	4,212	493,681	6,431	713,911	5,831	691,354	6,851	604,932
Total	8,135	843,979	4,670	569,461	4,804	542,371	7,114	756,959	6,371	740,741	8,359	724,359
South America: Peru	32	3,066										
Europe:												
Belgium-Luxembourg	197	9,300										
France	505	59,966	47	4,605	44	2,597	75	5,880	12	927	981	34,770
Germany	2	151										
Italy	67	11,496							6	575	16	989
Poland-Danzig	17	1,563										
Portugal	16	1,523					33	2,413	33	2,954	779	34,317
Sweden	445	52,048										
U. S. S. R	90	9,864										
United Kingdom			(1)	3								
Total	1,339	145,911	47	4,608	44	2,597	108	8,293	51	4,456	1,776	70,676
Asia: Japan	55	7,836										
Grand total	9,561	1,000,792	4,717	574,069	4,848	544,968	7,222	765,252	6,422	745,197	10,135	794,435

[1] Less than 1 ton.

TABLE 5.—Arsenicals imported into and exported from the United States by classes, 1948–52 (average) and 1953–57, in pounds

[Bureau of the Census]

Class	1948–52 (average)	1953	1954	1955	1956	1957
Imports for consumption:						
White arsenic (As_2O_3 content)	19,123,037	9,434,212	9,695,722	14,443,828	12,843,816	20,270,069
Metallic arsenic	100,075	141,472	117,085	228,960	88,666	136,745
Sulfide	85,611	20,018	----------	93,717	84,894	42,094
Sheepdip	67,158	52,436	55,700	40,960	70,421	67,763
Lead arsenate	34,997	----------	----------	----------	----------	----------
Arsenic acid	1,560	----------	----------	----------	----------	----------
Calcium arsenate	394,882	----------	42,544	----------	60,000	----------
Sodium arsenate	71,083	79,520	173,565	172,175	229,616	328,049
Paris green	25,979	----------	----------	----------	----------	----------
Exports:						
Calcium arsenate	4,687,468	3,890,246	1,975,894	1,885,582	628,020	2,779,954
Lead arsenate	963,945	303,030	709,752	1,080,498	2,563,176	1,216,158

WORLD REVIEW

Canada.—Although arsenical ores are widely distributed in Canada, production of arsenic is limited to a few localities where it is recovered as a byproduct in treating gold or silver-cobalt ores. Output in 1957 was 1,700 tons—almost double that in 1956.

TABLE 6.—World production of white arsenic, by countries,[1] 1948–52 (average) and 1953–57, in short tons[2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	654	702	590	786	895	1,693
Mexico	7,885	2,204	2,675	3,255	2,913	5,076
United States	15,314	10,873	13,167	10,780	12,201	10,493
South America:						
Brazil	1,175	522	1,273	1,077	820	(3)
Peru	226	--------	105	--------	28	--------
Europe:						
Belgium (exports)	863	1,903	1,979	2,281	3,056	[4] 3,300
France	4,577	6,217	812	6,369	6,614	(3)
Germany: West (exports)	1,291	675	239	635	334	[4] 220
Greece	47	68	--------	42	44	(3)
Italy	1,385	1,179	1,243	1,166	1,173	[4] 1,800
Portugal	1,042	1,301	1,196	1,973	1,109	[4] 1,100
Spain	290	60	22	--------	--------	--------
Sweden	16,443	569	10,762	13,803	13,437	(3)
Asia:						
Iran	[5] 29	--------	--------	--------	--------	--------
Japan	1,735	1,576	1,584	1,910	1,833	[4] 1,800
Africa:						
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	250	416	459	508	1,084	[4] 950
Union of South Africa	3	--------	--------	--------	--------	--------
Oceania:						
Australia	261	--------	--------	--------	--------	--------
New Zealand	8	--------	--------	--------	--------	--------
World total (estimate)[1] [2]	55,000	30,000	38,000	46,000	47,000	47,000

[1] Arsenic is produced in Argentina, Austria, and East Germany, and estimates by the author of the chapter are included in the total. There is too little information to estimate production in China, Czechoslovakia, Finland, Hungary, U. S. S. R., and the United Kingdom.
[2] This table incorporates a number of revisions of data published in previous Arsenic chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Data not available; estimate by author of chapter included in total.
[4] Estimate.
[5] Year ended March 20 of year following that stated.

Mexico.—Byproduct white arsenic was recovered by Cia. Metalurgica Peñoles, A. S. (subsidiary of American Metal Climax, Inc.), at its Torreón, Coahuila, lead smelter, and at the American Smelting and Refining Co. copper smelter at San Luis Potosi. Production in 1957 totaled 5,100 tons, compared with 2,900 tons in 1956, and was larger than in any year since 1951.

Sweden.—The Boliden Mining Co. continued to be the largest producer of white arsenic in the world.

TECHNOLOGY

A report[5] published in 1957 includes the history of arsenic and describes arsenic production, preparation of its compounds, and uses.

At the International Mineral Dressing Congress held in Stockholm, Sweden, September 18–21, 1957, S. I. Mitrofanov,[6] of the U. S. S. R., reported that arsenopyrite can be separated from pyrite with pyrolusite. The following practice was used at the Darasum concentrator:

> Activated charcoal is added to the bulk concentrate to remove excess organic reagents, and then the finely-ground pyrolusite is added as the concentrate enters staged conditioners. Contact time is two hours.
>
> A lead-copper-pyrite concentrate is made with arsenical material remaining in the underflow. Charcoal consumption is 1.7 kg/ton and that of pyrolusite is 5 kg/ton.

The new hydrometallurgical Sill process[7] for winning cobalt from high-arsenic ores provides a method of direct byproduct recovery of calcium arsenate for insecticides. Alkaline-ore oxidation in an autoclave solubilizes arsenic and sulfur so that they leach from the ore. The clear solution filtered from autoclaved ore slurry contains arsenates and sulfates. Lime is added, precipitating calcium arsenate, which is filtered and sold as wet cake for insecticides.

[5] Arsenic, Chemistry: Vol. 30, No. 9, May 1957, pp. 59–61.
[6] Engineering Mining Journal, Stockholm Spotlights Process Trends: Vol. 158, No. 11, November 1957, pp. 79–84.
[7] Chemical Engineering, Leach Licks Arsenic Bugaboo in Metal Ore: Vol. 65, No. 1, Jan. 13, 1958, pp. 80–82.

Asbestos

By D. O. Kennedy [1] and Annie L. Mattila [2]

WORLD PRODUCTION of asbestos was somewhat higher in 1957 than in 1956. Production in Quebec increased 4 percent and in British Columbia 47 percent. Overall Canadian output was 5 percent higher than in 1956. Production in the United States reversed a 3-year decline by advancing slightly—3 percent over 1956. However, domestic production was only 2 percent of the world output.

Imports were slightly less in 1957 than in 1956, and their value declined 3 percent. Imports of low-iron chrysotile of Spinning-grade lengths from British Columbia increased 39 percent, and total imports from that source 17 percent. Imports of Canadian spinning fibers increased 4 percent compared with 1956.

TABLE 1.—Salient statistics of the asbestos industry in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Domestic asbestos:						
Produced short tons	45, 426	57, 950	45, 813	44, 752	41, 626	42, 967
Sold or used do	45, 684	54, 456	47, 621	[1] 44, 568	41, 312	43, 653
Value	$3, 194, 252	$4, 857, 359	$4, 697, 962	$4, 487, 428	$4, 742, 446	$4, 917, 548
Imports (unmanufactured) short tons	666, 810	692, 245	678, 390	740, 423	[1] 689, 910	682, 732
Value	$47, 864, 705	$59, 753, 583	[2] $55, 856, 606	[2] $60, 957, 578	[1 2] $61,938,889	[2] $60, 139, 815
Exports (unmanufactured) [3] short tons	15, 483	3, 076	1, 894	2, 787	2, 950	2, 893
Value	$3, 274, 916	$592, 222	$291, 157	$267, 776	$374, 964	$349, 602
Apparent consumption short tons	697, 011	743, 625	724, 117	[1] 782, 204	[1] 728, 272	723, 492
Exports of asbestos products [1]	$10, 898, 365	$10, 627, 293	$11, 484, 735	$12, 858, 504	$14, 181, 122	$15, 222, 659

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not strictly comparable with earlier years.
[3] Includes material that has been imported and subsequently exported without change.

DOMESTIC PRODUCTION

Asbestos production in the United States increased 3 percent compared with 1956, reflecting a 5-percent increase in Vermont and a 12-percent decrease in Arizona. Small quantities of amphibole asbestos were produced in California and North Carolina.

The Vermont Asbestos Mines Division of the Ruberoid Co., operating near Eden, Vt., continued to be the one large asbestos producer in the United States. Only a small percentage of spinning fiber was produced, and most of it was used in electrolytic cells rather than in textiles.

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[2] Statistical assistant.

The purchase program for acquiring Government warehouse stocks of Arizona asbestos established under Public Law 733, 84th Congress, dated July 19, 1956, was continued in 1957. Purchases were made for a time with funds remaining from the previous program; but with exhaustion of the funds purchases ceased in April 1957, and most of the mines became virtually inactive. However, new funds amounting to $2½ million were made available in the United States Department of Interior Appropriation Bill for 1958, and purchases were resumed on July 1, 1957. Production of the longer fibers (crudes Nos. 1, 2, and 3) decreased 10 percent compared with 1956, and production of the shorter grades increased 28 percent. During 1957, 98 percent of all crudes Nos. 1, 2, and 3 was purchased by the Government.

Some of the more important Arizona asbestos mines were described and illustrated.[3]

The following firms and individuals produced chrysotile in the Globe district of Arizona in 1957: American Asbestos Cement Corp., American Fiber Corp., Barry De Rose, Jaquays Mining Corp., Kyle Asbestos Mines of Arizona, Lawrence D. Poor, Metate Asbestos Corp., Phillips Asbestos Mines, Via Development Co., and Western Chemical Co.

A small output of short-fiber chrysotile was reported by the Tabor Mining Co., Phoenix mine, Napa County, Calif. Amphibole asbestos was produced in small quantity by Huntley Industrial Minerals, Inc., at Lone Pine, Inyo County, Calif. Powhatan Mining Co. produced a small tonnage of amphibole asbestos in Transylvania County, N. C.

A chrysotile deposit in Beaverhead County, southwestern Montana, was explored.[4]

CONSUMPTION AND USES

Consumption of chrysotile in the United States in 1957 was a little lower than in 1956; but amosite and crocidolite were consumed in substantially larger quantities, hence, the overall consumption was virtually the same in 1957 as in 1956. About 94 percent of the asbestos used was chrysotile; of this only 22,500 tons (approximately 3 percent) was of Spinning grade.

Asbestos was used extensively in building construction, and it also had many industrial applications. The relation of asbestos consumption to industrial production and total new construction is shown in figure 1.

TABLE 2.—Apparent consumption of raw asbestos in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	697,011	$47,784,041	1955	[1] 782,204	$65,177,230
1953	743,625	64,018,720	1956	[1] 728,272	[1] 66,306,371
1954	724,117	60,263,411	1957	723,492	64,707,761

[1] Revised figure.

[3] Jaquays, D. W., and Gerbardt, A. W., How Low-Iron Chrysotile Asbestos Is Mined and Milled in Central Arizona: Min. World, vol. 19, No. 8, July 1957, pp. 54–58.

[4] Boots, David A., A New Montana Chrysotile Discovery: Asbestos, vol. 39, No. 5, November 1957, pp. 2–6.

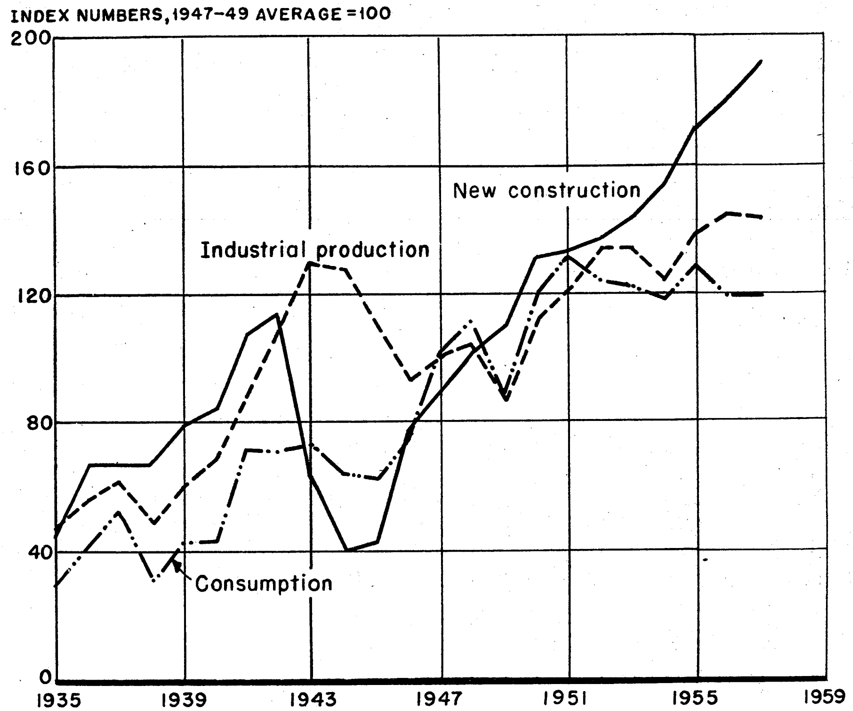

FIGURE 1.—Consumption of asbestos compared with total new construction and industrial production, 1935–57. Statistics on value of construction from Bureau of Foreign and Domestic Commerce and on industrial production from Federal Reserve Board.

PRICES

Prices of Quebec asbestos were advanced about 5 percent as of October 1, 1957. A requirement was added that payment must be in Canadian rather than United States funds. Under existing exchange rates such a requirement was, in effect an additional price advance. Following is the new schedule:

Grade:	*Price per ton*	
Crude No. 1	Can$1,475–	Can$1,850
Crude No. 2—Crude run-of-mine and sundry	790–	1,200
No. 3—Spinning fiber	370–	650
No. 4—Shingle fiber	180–	245
No. 5—Paper fiber	120–	150
No. 6—Plaster fiber	86	
No. 7—Shorts	40–	80

Prices of British Columbia chrysotile asbestos similarly advanced were quoted in E&MJ Metal and Mineral Markets reports in November 1957 as follows, in Canadian funds: Per short ton f. o. b. Vancouver, B. C., effective October 1, 1957, crude No. 1 $1,522, AAA $787, AA $682, A $494, AC $325, AK $220. The AAA fiber is said to be equivalent to Rhodesian C&G No. 1, AA to C&G No. 2, A to Canadian 3K, AC to Rhodesian C&G No. 3, and AK to Canadian 4K.

Vermont prices were increased in December 1957 to quotations higher than Canadian quotations for some grades to compensate for Canadian exchange differences. Vermont prices per short ton, f. o. b. Hyde Park or Morrisville, were as follows:

Group 3 (spinning and filtering)	$381–$440
Group 4 (shingle)	185– 205
Group 5 (paper)	123– 155
Group 6 (plaster)	88
Group 7 (shorts)	42– 77

Advanced prices for Arizona asbestos were quoted in December 1957 as follows:

Grade:	*Per short ton f. o. b. Globe*
No. 1 crude (soft)	$1, 500–$2, 000
No. 2 crude (soft)	1, 000– 1, 350
No. 3 crude (soft)	400– 675

No advances were quoted for filter grades or for semisoft crudes. No increases were paid by the Government during 1957 for stockpile grades, because prices were fixed by law at those of January 1956.

No market quotations are available for African or Australian asbestos as sales are made by negotiation with individual purchasers. United States Department of Commerce reports show the following average prices for imports in 1956 and 1957, per short ton:

Crocidolite:	*1956*	*1957*
Amosite, Union of South Africa	$126. 51	$145. 56
Bolivia	92. 74	75. 61
Australia	224. 00	230. 59
Union of South Africa	186. 46	197. 12

FOREIGN TRADE [5]

Imports.—During 1957 imports of chrysotile totaled 644,095 tons, a decline of nearly 2 percent from 1956. On the other hand, imports of amosite increased 21 percent and of crocidolite 9 percent. Although these items represented less than 6 percent of total imports, their increases were large enough to overcome the decline in chrysotile imports, with the result that the total imports (682,732 tons) were only slightly less than in 1956. About 92 percent of the 1957 imports originated in Canada, but so much of the Canadian material was low-priced short fiber that Canadian imports represented only 84 percent of the total value of all imports into the United States in 1957.

Spinning fiber, most of which was imported from Canada, was available in excess of United States requirements in 1957. Imports of low-iron chrysotile of Spinning grade from British Columbia increased from 4,143 tons in 1956 to 5,764 tons in 1957.

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

TABLE 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1948–52 (average), 1953–55 (totals), and 1956–57, by countries and classes

[Bureau of the Census]

Country	Crude (including blue fiber)		Mill fibers		Short fibers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948-52 (average)	35,818	$6,537,410	[1] 184,066	[1] $22,804,623	446,926	$18,522,672	666,810	$47,864,705
1953	39,201	9,052,007	170,692	27,521,438	482,352	23,180,138	692,245	59,753,583
1954	37,461	7,502,358	148,962	24,556,953	491,967	23,797,295	678,390	55,856,606
1955	40,648	8,049,533	168,152	27,597,527	531,623	25,310,518	740,423	60,957,578
1956								
North America: Canada	273	208,248	155,961	27,814,601	477,512	24,261,803	633,746	52,284,652
South America:								
Bolivia	34	3,153	-----	-----	-----	-----	34	3,153
Venezuela	120	17,866	14	2,740	11	2,316	145	22,922
Total	154	21,019	14	2,740	11	2,316	179	26,075
Europe:								
Germany, West	-----	-----	-----	-----	40	1,530	40	1,530
Greece	2	400	-----	-----	-----	-----	2	400
Italy	-----	-----	11	12,060	-----	-----	11	12,060
Portugal	5	560	-----	-----	-----	-----	5	560
U. S. S. R.	-----	-----	6	2,750	-----	-----	6	2,750
United Kingdom	-----	-----	[2] 127	[2] 32,671	193	48,688	320	81,359
Yugoslavia	3,735	141,275	-----	-----	-----	-----	3,735	141,275
Total	3,742	142,235	144	47,481	233	50,218	4,119	239,934
Africa:								
British East Africa	-----	-----	13	1,199	9	1,494	22	2,693
French Morocco	-----	-----	3	3,111	-----	-----	3	3,111
Rhodesia and Nyasaland, Federation of [3]	[4] 16,375	[4] 3,179,721	339	180,117	30	14,244	[4] 16,744	[4] 3,374,082
Union of South Africa [5]	[4] 31,546	[4] 5,239,219	199	28,097	202	35,146	[4] 31,947	[4] 5,302,462
Total	[4] 47,921	[4] 8,418,940	554	212,524	241	50,884	[4] 48,716	[4] 8,682,348
Oceania: Australia	3,150	705,880	-----	-----	-----	-----	3,150	705,880
Grand total	[4] 55,240	[4,6] 9,496,322	156,673	[6] 28,077,346	477,997	[6] 24,365,221	[4] 689,910	[4,6] 61,938,889
1957								
North America: Canada	590	239,627	136,505	24,886,273	489,055	25,067,526	626,150	50,193,426
South America:								
Bolivia	28	2,117	-----	-----	-----	-----	28	2,117
Venezuela	17	5,672	2	475	-----	-----	19	6,147
Total	45	7,789	2	475	-----	-----	47	8,264
Europe:								
Germany, West	3	4,278	-----	-----	6	458	9	4,736
Italy	496	21,839	9	10,351	4	3,290	509	35,480
Portugal	10	1,120	-----	-----	-----	-----	10	1,120
United Kingdom	-----	-----	[2] 69	[2] 25,472	261	62,954	330	88,426
Yugoslavia	1,920	50,742	-----	-----	-----	-----	1,920	50,742
Total	2,429	77,979	78	35,823	271	66,702	2,778	180,504

See footnotes at end of table.

TABLE 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1948–52 (average), 1953–55 (totals), and 1956–57, by countries and classes—Continued

[Bureau of the Census]

Country	Crude (including blue fiber)		Mill fibers		Short fibers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Africa:								
Algeria					7	$589	7	$589
Rhodesia and Nyasaland, Federation of [3]	11,083	$1,997,485	431	$96,595	202	28,980	11,716	2,123,060
Union of South Africa [5]	34,721	5,998,997	315	60,233	406	54,723	35,442	6,113,953
Total	45,804	7,996,482	746	156,828	615	84,292	47,165	8,237,602
Oceania: Australia	6,592	1,520,019					6,592	1,520,019
Grand total	55,460	9,841,896	137,331	25,079,399	489,941	25,218,520	682,732	60,139,815

[1] Includes 11 tons ($1,632) classified by the Bureau of the Census as "amosite, crude;" reclassified by Bureau of Mines as "mill fibers."
[2] Believed to have originated in the Union of South Africa and processed in the United Kingdom.
[3] All believed to be from Southern Rhodesia.
[4] Revised figure.
[5] Includes 1956: 225 tons ($57,304) of chrysotile crudes, 30 tons ($5,820) of blue crocidolite, and 15 tons ($3,875) of short fibers credited by the Bureau of the Census to Mozambique; 2 tons ($785) of amosite crude credited by the Bureau of the Census to the United Kingdom and 2 tons ($679) of blue crocidolite believed to have originated in the Union of South Africa and processed in the United Kingdom. 1957: 51 tons ($11,162) of blue crocidolite and 2 tons ($607) of mill fibers credited by the Bureau of the Census to Southern British Africa; 1 ton ($296) of short fibers credited by the Bureau of the Census to British East Africa; and 20 tons ($1,773) of short fibers credited by the Bureau of the Census to Mozambique.
[6] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with other years.

TABLE 4.—Asbestos (chrysotile) imported for consumption in the United States from Canada, by grades, 1948–52 (average) and 1953–57, in short tons

[Bureau of the Census]

Grades	1948–52 (average)	1953	1954	1955	1956	1957
Crude No. 1	227	168	82	65	50	44
Crude No. 2	266	207	181	164	217	162
Other crudes	422	467	844	644	6	384
Spinning or textile fiber	21,100	19,417	18,319	21,339	20,638	21,222
Shingle fiber	86,409	86,540	72,242	83,898	83,032	67,833
Paper fiber	74,164	63,139	57,465	61,954	52,291	47,450
Short fiber	446,884	482,179	491,149	531,023	477,512	489,055
Total	629,472	652,117	640,282	699,087	633,746	626,150

TABLE 5.—Asbestos (chrysotile) imported for consumption in the United States from Southern Rhodesia,[1] by grades, 1948–52 (average) and 1953–57, in short tons

[Bureau of the Census]

Grades	1948–52 (average)	1953	1954	1955	1956	1957
Crude No. 1	1,142	1,039	181	105	61	666
Crude No. 2	2,410	814	275	162	71	56
Spinning or textile fiber	172	730	156	76	339	344
Other crudes	[2] 6,404	7,304	6,243	7,901	[3] 16,243	10,361
Shingle fiber	49	103		161		87
Short fiber	6		364	15	30	202
Total	10,183	9,990	7,219	8,420	[3] 16,744	11,716

[1] Effective July 1, 1954, reported by the Bureau of the Census as Federation of Rhodesia and Nyasaland. All believed to be from Southern Rhodesia.
[2] Includes small amounts credited by the Bureau of the Census to Mozambique.
[3] Revised figure.

TABLE 6.—Asbestos (amosite, crocidolite, and chrysotile) imported for consumption in the United States from Union of South Africa, 1954–57, in short tons

[Bureau of the Census

	1954	1955	1956	1957
Amosite	14,634	11,745	[1 2] 11,433	14,197
Crocidolite	10,911	[2] 14,592	[1 2] 18,344	[2] 17,820
Chrysotile	1,855	2,363	[2] 2,170	[2] 3,425
Total	27,400	28,700	[1] 31,947	35,442

[1] Revised figure.
[2] Includes countries adjusted by Bureau of Mines. See table 3, footnote 5, for explanation.

Exports.—Exports of unmanufactured asbestos decreased slightly in 1957. Compared with imports they are insignificant.

TABLE 7.—Asbestos and asbestos products exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Unmanufactured asbestos				Asbestos products	
	Domestic [1]		Foreign [2]		Domestic [1]	Foreign [2]
	Short tons	Value	Short tons	Value	Value	Value
1948–52 (average)	13,539	$2,841,133	1,944	$433,743	$10,886,646	$11,719
1953	2,780	540,273	296	51,949	10,615,832	11,461
1954	1,847	275,778	47	15,379	11,475,082	9,653
1955	2,161	236,336	626	31,440	12,820,917	37,587
1956	2,797	337,696	153	37,268	14,171,309	9,813
1957	2,775	339,923	118	9,679	15,208,443	14,216

[1] Material of domestic origin, or foreign material that has been milled, blended, or otherwise processed in the United States.
[2] Material that has been imported and subsequently exported without change.

TABLE 8.—Asbestos and asbestos products exported from the United States, 1956–57, by kinds

[Bureau of the Census]

Products	1956		1957	
	Quantity	Value	Quantity	Value
Unmanufactured asbestos:				
Crude and spinning fibers ....short tons	514	$107,022	333	$90,826
Nonspinning fibers ....do	301	54,654	334	60,918
Waste and refuse ....do	1,982	176,020	2,108	188,179
Total unmanufactured ....do	2,797	337,696	2,775	339,923
Asbestos products:				
Brake lining and blocks:				
Molded, semimolded, and woven	(1)	5,380,551	(1)	5,117,533
Clutch facing and lining ....number	1,160,166	910,820	1,350,181	1,044,234
Construction materials ....short tons	19,076	3,749,659	17,489	4,034,530
Pipe covering and cement ....do	2,262	737,666	3,522	1,091,419
Textiles, yarn, and packing ....do	1,206	2,785,596	1,449	3,238,557
Manufactures, n. e. c.	(2)	607,017	(2)	682,170
Total products	------	14,171,309	------	15,208,443

[1] Values have been summarized; quantities not shown.
[2] Quantity not recorded.

WORLD REVIEW

World production of asbestos was higher in 1957 than in 1956. The increase was due in part to an upward estimate of production in the U. S. S. R. Production in Quebec increased about 4 percent, and the overall Canadian production was 5 percent greater than in 1956. United States output increased 6 percent.

NORTH AMERICA

Canada.—The remarkable engineering operations involved in draining Black Lake and stripping the heavy overburden from the asbestos deposit, chiefly by dredging methods, were described in some detail in several articles.[6] It was expected that stripping operations would continue into 1959 but that mining would begin by mid-1958 to furnish asbestos-bearing rock for the new mill having a capacity of 5,000 tons a day. Mining and milling operations were conducted by Lake Asbestos of Quebec, Ltd., a subsidiary of American Smelting and Refining Co.

The deposit at East Broughton mined by Quebec Asbestos Mines, a subsidiary of the Philip Carey Manufacturing Co., was nearly exhausted. A new deposit 3 miles eastward was under development, and a new mill on this property was expected to be operated in 1958 by the Carey-Canadian Mines, Ltd.

National Asbestos Mines, a subsidiary of National Gypsum, Ltd., expected to operate its new 3,000-ton-per-day mill a few miles northeast of Thetford Mines during 1958.

Nicolet Asbestos Mines introduced additional facilities to increase its mill capacity from 2,400 tons per day to 3,600.

The Beaver mill of the Asbestos Corp. was renovated and enlarged to handle the production of both the Beaver and King mines. The King mill will be dismantled.

A series of articles covering current progress in Quebec asbestos mining appeared late in 1957.[7]

The Jeffrey mill of Canadian Johns-Manville at Asbestos, Quebec, was described.[8]

Cassiar Asbestos Corp., Ltd., in British Columbia increased its milling capacity and improved its mining and transportation facilities. It acquired 3 additional asbestos properties, on 1 of which development work was conducted.

Advocate Mines, Ltd., was reported to have delineated an asbestos reserve of about 13 million tons on its property in northern Newfoundland. The fiber, unsuited for spinning, was a semiharsh, free-filtering type of chrysotile well adapted for manufacturing pipe and other asbestos-cement products. Two 600-pound bulk samples gave a 14.9-percent fiber recovery with a value of $21.53 per ton and 10.63-percent recovery with a value of $14.83 per ton, respectively.[9]

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6 Mine and Quarry Engineering, Developing a Quebec Asbestos Mine: Vol. 23, No. 9, September 1957, pp. 384–390.
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7 Guimond, Roger, and Canning, Hugh, The Asbestos Industry: Precambrian, vol. 30, No. 12, December 1957, pp. 12–31.

8 Pit and Quarry, World's Leading Asbestos Operation: Vol. 49, No. 12, June 1957, pp. 126–130, 136.

9 Northern Miner, Advocate's Asbestos Deposit Betters Grade and Tonnage: Vol. 42, No. 41, Jan. 3, 1957, pp. 1, 15.
Asbestos, Advocate Mines, Limited: Vol. 38, No. 8, February 1957, pp. 16–20.

TABLE 9.—World production of asbestos by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada (sales) [3]	813,911	911,226	924,116	1,063,802	1,014,249	1,046,086
United States (sold or used by producers)	45,684	54,456	47,621	44,568	41,312	43,653
Total	859,595	965,682	971,737	1,108,370	1,055,561	1,089,739
South America:						
Argentina	257	(4)	(4)	198	238	220
Bolivia (exports)	281	810	33	-----	62	121
Brazil	1,408	1,357	2,816	3,124	3,739	[5] 3,300
Chile	224	(4)	(4)	(4)	(4)	(4)
Venezuela	271	185	743	1,757	5,041	7,727
Total	2,441	[5] 2,800	[5] 4,000	[5] 5,300	[5] 9,300	[5] 11,600
Europe:						
Bulgaria	[5] 220	992	1,213	1,323	1,102	[5] 1,100
Finland [6]	12,016	12,047	7,853	18,674	8,282	10,031
France	5,404	11,419	14,449	10,913	9,370	15,432
Greece	23	1	2	3	6	-----
Italy	21,816	22,484	25,955	33,266	36,459	37,797
Portugal	275	105	30	56	35	[5] 30
Spain	41	-----	176	-----	-----	-----
U. S. S. R.[5]	224,000	300,000	375,000	450,000	500,000	500,000
Yugoslavia	1,509	4,131	3,598	4,305	4,165	6,128
Total [1] [5]	270,000	350,000	435,000	520,000	565,000	575,000
Asia:						
Cyprus	15,297	15,881	15,309	15,306	15,375	[7] 13,313
India	407	805	435	1,564	1,378	664
Iran [8]	12	-----	-----	110	39	[5] 55
Japan	5,482	4,495	6,916	6,932	9,914	13,330
Korea, Republic of	(4)	-----	233	66	54	96
Taiwan	294	-----	161	403	118	268
Turkey	172	-----	50	259	634	-----
Total [1] [5]	23,700	27,000	31,000	36,000	39,000	39,000
Africa:						
Bechuanaland	114	548	729	1,426	1,356	[5] 1,300
Egypt	730	220	-----	-----	-----	-----
Kenya	483	166	224	152	170	109
Madagascar	6	8	-----	-----	-----	-----
Morocco: Southern Zone	547	600	597	631	379	132
Mozambique	-----	-----	196	301	202	75
Rhodesia and Nyasaland, Fed. of: Southern Rhodesia	76,476	87,739	79,962	105,261	118,973	132,124
Swaziland	33,760	30,103	30,142	32,613	29,875	30,727
Uganda	-----	-----	7	2	2	-----
Union of South Africa	89,055	94,817	109,151	119,699	136,520	157,296
Total	201,171	214,201	221,008	260,085	287,477	321,763
Oceania:						
Australia	2,510	5,567	5,279	5,993	9,857	[5] 13,800
New Zealand	344	-----	-----	172	368	[5] 330
Total	2,854	5,567	5,279	6,165	10,225	[5] 14,130
World total (estimate) [1] [2]	1,360,000	1,565,000	1,670,000	1,935,000	1,970,000	2,050,000

[1] In addition to countries listed, asbestos is produced in China, Czechoslovakia, and North Korea. Estimates by author of chapter are included in the total.

[2] This table incorporates a number of revisions of data published in previous Asbestos chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.

[3] Exclusive of sand and gravel and stone (waste rock only), production of which is reported as follows: 1948–52 (average) 40,178 tons; 1953, 21,118 tons; 1954, 26,429 tons; 1955, 28,582 tons; 1956, 45,428 tons; 1957, 13,652 tons.

[4] Data not available; estimate by author of chapter included in total.

[5] Estimate.

[6] Includes asbestos flour.

[7] Exports.

[8] Year ended Mar. 20 of year following that stated.

TABLE 10.—Sales of asbestos in Canada 1956–57, by grades

[Dominion Bureau of Statistics]

Grades	1956			1957		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Crude No. 1, 2, and other	717	$692,677	$966	622	$589,410	$948
Milled group:						
3	33,929	14,071,703	415	34,320	14,210,634	414
4	246,295	42,124,569	171	259,268	45,848,069	177
5	112,759	13,200,835	117	110,428	13,161,082	119
6	168,942	12,685,874	75	159,098	12,222,231	77
7	428,159	16,676,452	39	460,539	18,041,742	39
8	23,448	407,859	17	21,811	416,263	19
Total, all grades	1,014,249	99,859,969	98	1,046,086	104,489,431	100
Waste rock	45,428	52,507	1	13,652	18,455	1
Rock mined	21,922,874			22,610,743		
Rock milled	13,740,326			14,096,117		

EUROPE

Greece.—Kennecott Copper Corp. conducted further geological studies and diamond-drill exploration of an asbestos deposit in Kozani Province, western Macedonia. Conclusive results of tests of samples of fiber from the deposit had not yet been announced.

Italy.—The Vittore-Balangero Mine (Torino) was reported to have attained a production of 35,300 short tons a year of chrysotile—about 98 percent of the total Italian production.[10]

AFRICA

Union of South Africa.—Difficult problems arose in mining both crocidolite and amosite in the Union. Crocidolite mining difficulties were largely overcome, and production increased steadily; but the

TABLE 11.—Asbestos produced in Southern Rhodesia, 1953–57

Year	Short tons	Value	Year	Short tons	Value
1953	87,739	£6,542,731	1956	118,973	£8,524,671
1954	79,962	5,922,724	1957	132,124	9,016,388
1955	105,261	7,051,831			

TABLE 12.—Asbestos produced in the Union of South Africa, 1953–57, by varieties and sources, in short tons

Variety and source	1953	1954	1955	1956	1957
Amosite (Transvaal)	38,258	45,922	50,137	50,097	56,798
Chrysotile (Transvaal)	18,840	19,373	20,535	24,336	25,646
Blue (Transvaal)	16,824	15,610	13,964	14,399	15,303
Blue (Cape)	20,883	28,136	34,878	47,688	59,549
Anthophyllite (Transvaal)	12	110	185		
Total	94,817	109,151	119,699	136,520	157,296

10 Mining World (London), Production Doubled at Italy's Largest Open-Pit Asbestos Mine: Vol. 19, No. 11, October 1957, p. 95.

TABLE 13.—Asbestos produced in and exported from the Union of South Africa, 1953–57

Year	Production (short tons)			Exports	
	Transvaal	Cape Province	Total	Short tons	Value
1953	73,934	20,883	94,817	71,971	£4,158,476
1954	81,015	28,136	109,151	94,322	5,453,116
1955	84,821	34,878	119,699	114,056	6,697,352
1956	88,832	47,688	136,520	122,867	7,336,037
1957	97,747	59,549	157,296	[1] 103,399	[1] 6,559,950

[1] January to September.

necessity for mining amosite at greater depths was attended with problems of pumping and ventilation that were not resolved.[11]

OCEANIA

Australia.—Production of crocidolite at Wittenoon Gorge, Western Australia, increased considerably in 1957. Additional milling capacity was constructed. Mining was difficult and costly because the 2 main fiber seams were about 20 feet apart and 200 feet above the gorge floor. The fiber and fiber-bearing rock removed from a series of adits and crosscuts were transported 2 miles to the milling plant. The nature of the fiber veins and mining methods pursued were described.[12]

TECHNOLOGY

A new type of lime product was marketed in California. It consisted of hydrated lime to which was added 10 percent asbestos fiber. It was claimed that addition of the asbestos increased workability, plasticity, water retentivity, and compressive and tensile strength. It was also said to improve fireproofing and insulating qualities. Finishing-coat plasters were prepared with even larger proportions of asbestos.[13]

A new gasket material consisting of rubber-coated asbestos fiber was introduced. It was said to have greater flexibility than conventional asbestos-fiber gasket products, and to have good sealing properties at temperatures up to 500° F., and at pressures up to 500 p. s. i.[14]

The importance of air currents in asbestos milling was described in some detail. Air is used as an aspirator or "lifter" of fiber from the screens, and is also employed for dust control, for pneumatic conveying, and in cyclone fiber collectors. It was estimated that the Quebec asbestos mills in toto use air at a rate of 10 million cubic feet per minute.[15]

A new filtering material that was claimed to have superior properties consisted of a combination of asbestos with diatomite.

[11] Mining Journal (London), Blue and Amosite: Vol. 248, No. 6356, June 14, 1957, p. 758.
[12] Mine and Quarry Engineering, Australian Blue Asbestos: Vol. 23, No. 7, July 1957, p. 322.
Mining Magazine (London), Wittenoon Blue Asbestos: Vol. 96, No. 2, February 1957, pp. 121–122.
Mining Journal (London), Mining Blue Asbestos in W. Australia: Vol. 248, No. 6340, Feb. 22, 1957, pp. 238–239.
[13] Pit and Quarry, Diamond Springs Lime Co. Markets 10 Percent Asbestos Lime: Vol. 50, No. 1, July 1957, p. 158.
[14] Materials and Methods, Coated Asbestos Fiber Used as Gaskets, Seals: Vol. 45, No. 5, May 1, 1957, p. 198.
[15] Rozovsky, H., Air in Asbestos Milling: Canadian Min. Jour., vol. 78, No. 5, May 1957, pp. 95–103.

The properties and qualities of the various types of African asbestos and their adaptability for ordinary and specialized uses were described. New and important applications were being developed, particularly in combination with plastics and resins.[16]

The composition, physical properties, qualities, and uses of amosite were described.[17]

Many patents relating to asbestos were recorded in 1957. Several related to improvements in asbestos milling processes, such as removal of dust and unopened fiber bundles, and a more complete recovery of short fibers.[18]

Improvements were devised in processes of manufacture of heat-insulating materials, such as asbestos paper and sheets, and 85-percent magnesia products; also in increasing their thermal efficiency.[19]

Patents were issued in 1957 relating to improved processes for making molded products, including regulation of molding pressure, orientation of asbestos fiber, and preparation of free-flowing mixtures.[20]

Patents were issued pertaining to methods of shaping and curing brake linings and other friction materials, and of making friction products from both long and short asbestos fibers.[21]

A new roofing and siding composition was patented consisting of 15 to 20 percent asbestos, together with 35 to 50 percent slate flour, and 25 to 35 percent portland cement.[22]

A method was devised for making a two-layer composition floor tile in which asbestos was used as a strengthener and whiting as a filler.[23]

A composition for demonstrating visually the efficiency of filtering materials consisted of a mixture of 3 to 15 percent of minimum 3-micron asbestos fiber together with viscose, cotton or other materials.[24]

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16 Sinclair, W. E., Asbestos in Industry: South African Min. and Eng. Jour., vol. 68, No. 3345, Mar. 22, 1957, pp. 519–521.

17 Sinclair, W. E., Amosite-Montasite the Unique Forms of Amphibole Asbestos: Asbestos, vol. 38, No. 9, March 1957, pp. 2–12.

18 Weston, D., and MacPherson, A. R., Movable Bed Stratifier With Constant Pneumatic Current: U. S. Patent 2,803,346, Aug. 20, 1957.

Sheldon, W. D., Jr., Apparatus for Removing Dust and Granular Material From Asbestos Fiber: U. S. Patent 2,813,306, Nov. 19, 1957.

Johnson, H. B., and Boss, C. C. (assigned to The Quaker Oats Co., Chicago, Ill.), Method of Separating Asbestos From Its Ores: U. S. Patent 2,813,626, Nov. 19, 1957.

19 Lillis, S. M. (assigned to Victor Manufacturing & Gasket Co., Chicago, Ill.), Method of Making Cement-Bound Asbestos Paper: U. S. Patent 2,791,159, May 7, 1957.

Spooner, L. W., and Joyner, G. A. (assigned to Westinghouse Electric Co.), Method of Making Asbestos Insulating Material With Improved Electrical Properties: U. S. Patent 2,804,908, Sept. 3, 1957.

Kloss, H. (assigned to Sued-Chemie-West G. m. b. H., New Ulm (Danube), Germany), Process of and Apparatus for Producing Continuous Layers of Fiber Material: U. S. Patent 2,811,195, Oct. 29, 1957.

Speil, S., and Barnett, I. (assigned to Johns-Manville Corp., New York, N. Y.), Inorganic Bonded Thermal Insulating Bodies and Method of Manufacture: U. S. Patent 2,811,457, Oct. 29, 1957.

Bruno, A. J., and Speil, S. (assigned to Johns-Manville Corp., New York, N. Y.), Thermal Insulating Bodies and Method of Manufacture: U. S. Patent 2,808,338, Oct. 1, 1957.

Seipt, W. R. (assigned to Keasbey & Mattison Co., Ambler, Pa.), Asphaltic Magnesia Composition and Method of Producing the Same: U. S. Patent 2,800,415, July 23, 1957.

Schwartz, A., and Fogelson, E. (assigned to Leobarb Corp., New York, N. Y.), Thermal Insulation: U. S. Patent 2,786,004, Mar. 19, 1957.

Fisher, E. J., Blending and Mixing Machine: U. S. Patent 2,764,392, May 14, 1957.

20 Reed, D. J. (assigned to A. O. Smith Corp., Milwaukee, Wis.), Fiber Reinforced Tubular Article: U. S. Patent 2,791,241, May 7, 1957.

Colliva, D. (assigned to Eternit Societa per Azioni, Genoa, Italy), Valve With Adjustable Weight for Automatically Varying the Moulding Pressure in Tube Moulding Machines: U. S. Patent 2,813,544, Nov. 19, 1957.

Thompson, J. S. (assigned to Parker Rust Proof Co.), Inorganic Molding Composition: U. S. Patent 2,795,510, June 11, 1957.

Hutchcroft, C. R., Seipt, W. R., and Schneider, R. A. (assigned to Keasbey & Mattison Co., Ambler, Pa.), Equipment for Charging Fiber-Containing Slurry Into Molds: U. S. Patent 2,816,321, Dec. 17, 1957.

21 Cofek, H. J. (assigned to Raybestos-Manhattan, Inc., Passaic, N. J.), Production of Friction Material: U. S. Patent 2,811,750, Nov. 5, 1957; Method for Curing Friction Compounds: U. S. Patent 2,790,206, Apr. 30, 1957.

22 Blake, C. L., Cementitious Material Containing Slate Flour: U. S. Patent 2,785,987, Mar. 19, 1957.

23 Banks, C. K. (assigned to Metal and Thermit Corp., New York, N. Y.), Floor Covering: U. S. Patent 2,816,852, Dec. 17, 1957.

24 Ayer, J. L. (assigned to Cambridge Filter Corp.), Filter Demonstration Device: U. S. Patent 2,790,253, Apr. 30, 1957.

A new self-lubricating packing material contained asbestos fiber agitated with a finely divided abrasive material, such as soot or ground glass, for the purpose of loosening the fibers. The material was mixed with ground talc or graphite and molded.[25]

Asbestos was an important constituent of a patented fire-resistant artificial fireplace log.[26]

A barrier material in an intermittent dehumidifying apparatus was made by suspending asbestos fiber in excess of ⅛ inch in length with a binder in a water slurry and collecting a mat of desired thickness on a screen.[27]

[25] Zagorski, J., and Zagorski, J., Method of Preparing Self-Lubricating, Asbestos Containing Stuffing-Box Packings: U. S. Patent 2,809,397, Oct. 15, 1957.

[26] Nielsen, H., Simulated-Log Fireplace Heater: U. S. Patent 2,762,362, May 14, 1957.

[27] Asker, G. C. F. (assigned to Desomatic Products, Inc., Falls Church, Va.), Valveless Intermittent Dehumidifier: U. S. Patent 2,801,706, Aug. 6, 1957.

Barite

By Albert E. Schreck [1] and James M. Foley [2]

DOMESTIC production and consumption of barite declined during 1957 from the record established in 1956. Imports, however, exceeded last year's high by over 240,000 tons and thus established a new mark. Several new production facilities began operation, and one of the larger barite operations was closed.

TABLE 1.—Salient statistics of the barite and barium-chemical industries in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Barite:						
Primary:						
Produced..short tons..	812, 193	920, 025	926, 036	1, 114, 117	1, 351, 913	1, 304, 542
Sold or used by producers:						
Short tons........	803, 014	944, 212	883, 283	1, 108, 103	1, 299, 888	1, 152, 882
Value........	$7, 059, 102	$9, 435, 749	$8, 508, 177	$10, 809, 119	$13, 497, 972	$11, 756, 249
Imports for consumption:						
Short tons........	59, 687	334, 788	317, 093	359, 636	[1] 589, 053	832, 626
Value........	$482, 158	$2, 514, 828	[2] $2, 274, 834	[2] $2, 181, 119	[1,2] $3,601,504	[2] $5, 864, 124
Consumption short tons [3]..	876, 944	1, 149, 451	1, 215, 678	1, 459, 671	[1] 2, 035, 389	1, 670, 720
Ground and crushed sold by producers:						
Short tons........	660, 251	920, 084	1, 037, 590	1, 232, 176	1, 503, 010	1, 467, 117
Value........	$12, 771, 142	$20, 372, 002	$24, 219, 785	$30, 613, 095	$41, 623, 390	$42, 352, 525
Barium chemicals sold by producers:						
Short tons........	74, 321	[1] 97, 770	[1] 86, 193	[1] 105, 171	[1] 106, 739	89, 757
Value........	$8, 863, 603	[1] $13,380,339	[1] $11,633,014	[1] $14,490,048	[1] $13,855,058	$12, 253, 526
Lithopone sold or used by producers:						
Short tons........	97, 737	52 439	44, 011	42, 845	38, 434	(4)
Value........	$12, 237, 692	$6, 923, 487	$5, 929, 789	$6, 002, 832	$5, 630, 991	(4)

[1] Revised figure.
[2] Owing to changes in tabulating procedures by Bureau of Census, data known to be not comparable with previous years.
[3] Includes some witherite.
[4] Figure withheld to avoid disclosing individual company confidential data.

DOMESTIC PRODUCTION

Output of domestic crude barite totaled 1.3 million short tons in 1957, a decrease of about 50,000 tons from the preceding year. Arkansas was again the leading producing State, with Missouri second, Georgia third, and Nevada fourth. Except for Nevada, production from the other three States increased compared with 1956. In addition to the foregoing States, output was also reported from

[1] Commodity specialist.
[2] Supervisory statistical assistant.

California, Idaho, Montana, New Mexico, South Carolina, Tennessee, and Washington.

Lithopone and barium chemical output was also below 1956 levels. Only two firms reported lithopone production to the Bureau of Mines in 1957. Of the barium chemicals produced, only barium oxide was produced in larger quantities than in the preceding year.

Late in the year, Magnet Cove Barium Corp., announced that it would suspend operations at its Malvern, Ark., mine.

TABLE 2.—Domestic barite sold or used by producers in the United States, 1948–52 (average) and 1953–57, by States

State	1948-52 (average)		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas	380,925	[1]$3,324,938	380,763	[1]$3,945,583	370,621	[1]$3,488,483
Georgia, South Carolina, Tennessee	79,361	862,234	81,846	1,066,368	75,492	1,062,016
Missouri	252,735	2,290,660	330,763	3,338,395	312,791	3,047,436
Nevada	60,905	359,223	99,525	614,686	83,833	517,492
Other States [2]	29,088	222,047	51,315	470,717	40,546	392,750
Total	803,014	7,059,102	944,212	9,435,749	883,283	8,508,177

State	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas	462,986	[1]$3,755,094	486,254	[1]$4,255,982	477,327	$3,493,606
Georgia, South Carolina, Tennessee	130,396	1,829,141	174,139	2,946,839	175,072	2,982,195
Missouri	363,692	4,003,842	381,642	4,461,955	317,350	3,938,486
Nevada	[1] 113,694	[1] 708,804	178,440	1,066,930	109,663	720,806
Other States [2]	37,335	512,238	79,413	766,266	73,470	621,156
Total	1,108,103	10,809,119	1,299,888	13,497,972	1,152,882	11,756,249

[1] Partly estimated.
[2] Includes Arizona (1948 55), California, Idaho (1949–57), Montana (1951–57), New Mexico (1949-57), and Washington (1953–55, and 1957).

A barite deposit discovered in 1956 near Austin, Nev., was reported to contain 5 million tons of 98 percent barite, having a specific gravity of 4.3 to 4.45.[3]

Seven barite claims, about 50 miles north of Wells, Nev., were purchased by the American Colloid Co.[4]

The newly formed Barite Corp. of America planned to build a $200,000 barite mill near Bernalillo, N. Mex., to process barite from deposits about 8 miles east of Bernalillo.

A new firm, the P. & R. Barium Co., began open-pit mining about 6 miles southeast of Gaffney, Cherokee County, S. C., in 1957.[5] A beneficiation plant under construction will have crushing, froth flotation, and drying equipment. Barite veins ranging from a few inches to several feet in width extend over an area 4 to 6 miles long. Mining

[3] California Mining Journal, Tonopah Men Uncover What May Be Nation's Biggest Barite Deposit: Vol. 27, No. 2, October 1957, p. 27.
[4] Chemical Week, vol. 80, No. 13, Mar. 30, 1957, p. 22.
[5] Hughes, Bill, Barite Mine Grew From Ranger's Curiosity: Charlotte News, Charlotte, N. C., Oct. 22, 1957, Sec. 2, p. B-1.

rights to 500 acres were held by the company plus an option on an additional 500 to 600 acres.[6]

An article describing the Macco Corp. barite operation in Tulare County, Calif., was published.[7] The mine is in the Sierra Nevadas, 17 miles west of the company concentrating plant near Inyokern, Kern County. The ore, averaging 75–80 percent barium sulfate, occurs as veins in granite and shale. The ore was beneficiated by jigging to produce a concentrate having 93–94 percent $BaSO_4$ and a specific gravity of 4.3. The barite concentrate was shipped to the company plant at Rosamund to be ground and packaged for use as drilling mud.

Barium metal in small quantities was produced by the Kemet Co., Cleveland, Ohio, and King Laboratories Inc., Syracuse, N. Y.

TABLE 3.—Ground (and crushed) barite produced and sold by producers in the United States, 1948–52 (average) and 1953–57

Year	Plants	Production (short tons)	Sales	
			Short tons	Value
1948–52 (average)	24	461, 072	660, 251	$12, 771, 142
1953	29	924, 392	920, 084	20, 372, 002
1954	29	1, 038, 649	1, 037, 590	24, 219, 785
1955	29	1, 314, 810	1, 232, 176	30, 613, 095
1956	30	1, 625, 879	1, 503, 010	41, 623, 390
1957	33	1, 480, 585	1, 467, 117	42, 352, 525

Sherwin-Williams Co., Chicago, Ill., planned construction of a $1 million barium monohydrate plant next to its barium carbonate plant at Coffeyville, Kans.[8] Production was expected to begin in early 1958. A new process developed by the firm, whereby a 99-percent-pure barium hydrate is made directly from barite ore, will be used.

CONSUMPTION AND USES

There was a pronounced reduction in consumption and sales of barite in 1957. The quantity of crude barite (domestic and imported) used in manufacturing crushed and ground, lithopone, and barium chemicals declined 18 percent from 1956. Producers had large stocks of barite on hand at the close of the year.

Crude-barite consumption totaled over 1.6 million tons in 1957. About 90 percent was used in manufacturing ground barite and the remainder in manufacturing lithopone and barium chemicals.

A contributing factor to the decline in crushed- and ground-barite sales was lessened activity in the oil- and gas-well-drilling industry, where barite is used as a weighting agent in drilling muds. Although the tonnage used was less in 1957, well drillers remained the largest consumers of ground barite, accounting for 95 percent of the total sales.

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[6] Pit and Quarry, Barite Shipments Reported From New South Carolina Operation: Vol. 50, No. 3, September 1957, p. 202.
[7] Lenhart, Walter B., The Story of Barite: Rock Products, vol. 60, No. 4, April 1957, pp. 120, 122, 125, 190.
[8] Oil, Paint and Drug Reporter, Barium Monohydrate Unit Planned by S. W.: Vol. 171, No. 16, Apr. 22, 1957, pp. 3, 54.

Consumption of crushed and ground barite by the glass, paint, and rubber industries was below 1956 levels.

Barium chemical sales also followed the downward trend. Total sales were about 16 percent less than in 1956. Of the many compounds produced, such as the carbonate, chloride, hydroxide, and sulfate, only barium oxide reflected an increase in sales.

TABLE 4.—Crude barite (domestic and imported) used in the manufacture of ground barite and barium chemicals in the United States, 1948–52 (average) and 1953–57, in short tons

Year	In manufacture of—			Total	Year	In manufacture of—			Tota
	Ground barite [1]	Litho-pone	Barium chemicals [2]			Ground barite [1]	Litho-pone	Barium chemicals [2]	
1948–52 (average)	669,278	98,699	108,967	876,944	1955	1,256,361	45,898	157,412	1,459,671
1953	933,673	52,308	163,470	1,149,451	1956	1,839,770	31,065	[3] 164,554	[3] 2,035,389
1954	1,044,094	35,866	135,718	1,215,678	1957	1,501,415	(4)	169,305	1,670,720

[1] Includes some crushed barite.
[2] Includes some witherite.
[3] Revised figure.
[4] Included with "Barium chemicals" to avoid disclosing individual company confidential data.

TABLE 5.—Ground (and crushed) barite sold by producers, 1948–52 (average) and 1953–57, by consuming industries

Industry	1948–52 (average)		1953		1954		1955		1956		1957	
	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	579,251	88	824,050	90	968,429	94	1,142,309	93	1,421,033	95	1,392,394	95
Glass	24,074	4	24,853	3	23,208	2	28,737	2	32,661	2	27,595	2
Paint	24,600	4	24,000	2	22,000	2	25,633	2	20,602	1	16,179	1
Rubber	16,800	2	21,000	2	20,000	2	25,104	2	22,101	2	21,782	1
Concrete aggregates	13,185	2	25,000	3	(1)	(1)	(1)	(1)			(1)	(1)
Undistributed	2,340		1,181	(2)	3,953	(2)	10,393	1	6,613	(2)	9,167	1
Total	660,251	100	920,084	100	1,037,590	100	1,232,176	100	1,503,010	100	1,467,117	100

[1] Included with "Undistributed."
[2] Less than 1 percent.

The quantity of barite used in manufacturing lithopone as well as sales of lithopone was less than in 1956. Increased competition from titanium dioxide as a white pigment in paints continued to be the primary reason for the decreasing use of lithopone in the field.

Barium metal was used as a getter to remove traces of gases from vacuum tubes to increase the efficiency of the tube and improve the vacuum.

TABLE 6.—Lithopone sold or used by producers in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Plants	7	5	5	4	4	2
Short tons	97,737	52,439	44,011	42,845	38,434	(1)
Value	$12,237,692	$6,923,487	$5,929,789	$6,002,832	$5,630,991	(1)

[1] Figure withheld to avoid disclosing individual company confidential data.

TABLE 7.—Distribution of lithopone shipments, 1948–52 (average) and 1953–57, by consuming industries

Industry	1948–52 (average)		1953		1954		1955		1956		1957	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints, varnishes, and lacquers	[1] 72,129	74	37,452	72	32,177	73	30,522	71	28,238	74		
Floor coverings	6,346	6	2,575	5	2,351	9	2,378	6	1,600	4		
Coated fabrics and textiles	6,699	7	5,806	11	3,995	5	4,242	10	(3)	(3)	(2)	(2)
Paper	3,806	4	2,096	4	1,841	4	1,970	4	(3)	(3)		
Rubber	3,269	4	1,723	3	1,701	4	2,163	5	(3)	(3)		
Other	5.288	5	2,787	5	1,946	5	1,570	4	8,596	22		
Total	97,737	100	52,439	100	44,011	100	42,845	100	38,434	100	(2)	(2)

[1] Includes a quantity, not separable, used for printing ink.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Included with "Other."

TABLE 8.—Barium chemicals produced and sold or used by producers in the United States, 1948–52 (average) and 1953–57, in short tons

Chemical	Plants	Produced	Used by producers [1] in other barium chemicals [2]	Sold by producers [3]	
				Short tons	Value
Black ash: [4]					
1948–52 (average)	13	130,979	130,113	462	$30,365
1953	11	138,980	137,801	1,126	81,647
1954	11	116,246	112,863	1,020	73,902
1955	9	135,455	134,202	1,943	165,502
1956	10	[5] 131,006	[5] 129,969	6,356	524,359
1957	9	112,048	110,900	1,087	79,474
Carbonate (synthetic):					
1948–52 (average)	4	49,353	15,972	33,708	2,622,886
1953	4	74,122	26,116	46,846	4,223,525
1954	4	65,319	[5] 25,307	43,325	3,985,674
1955	4	78,946	[5] 27,273	53,274	5,021,001
1956	5	[5] 82,043	[5] 31,022	[5] 50,524	[5] 4,783,453
1957	6	74,160	31,056	42,937	4,335,469
Chloride (100 percent $BaCl_2$):					
1948–52 (average)	3	13,584	3,724	9,665	1,208,745
1953	4	[5] 14,772	2,186	[5] 12,565	[5] 1,736,776
1954	3	[5] 9,940	45	[5] 10,181	[5] 1,441,431
1955	3	[5] 11,852	120	[5] 11,601	[5] 1,689,252
1956	3	[5] 11,746	130	[5] 11,174	[5] 1,706,683
1957	3	9,715	----------	9,373	1,538,809
Hydroxide:					
1948–52 (average)	5	8,410	226	8,016	1,688,227
1953	5	12,454	304	11,843	2,258,279
1954	5	12,616	326	11,697	2,200,510
1955	4	15,540	74	16,150	3,174,167
1956	5	16,957	120	16,762	3,051,368
1957	5	12,698	162	12,551	1,915,700
Oxide:					
1948–52 (average)	3	8,072	5,957	2,149	489,973
1953	3	14,578	7,604	6,820	1,678,969
1954	3	15,195	7,035	7,400	1,853,449
1955	3	16,509	8,102	8,722	2,128,911
1956	3	19,816	8,117	11,222	1,969,817
1957	3	20,452	5,446	14,159	2,585,193
Sulfate (synthetic):					
1948–52 (average)	6	16,202	1,013	14,976	1,496,927
1953	7	14,390	----------	13,448	1,653,507
1954	6	10,495	----------	10,486	1,356,346
1955	5	10,722	367	9,976	1,347,248
1956	6	9,981	192	9,281	1,263,575
1957	4	9,124	----------	8,719	1,281,657
Other barium chemicals: [6]					
1948–52 (average)	(7)	7,946	2,782	5,345	1,326,480
1953	(7)	7,822	1,762	5,122	1,747,636
1954	(7)	2,660	722	2,084	721,702
1955	(7)	2,396	176	3,505	963,967
1956	(7)	1,808	190	1,420	555,803
1957	(7)	1,252	137	931	517,224
Total: [8]					
1948–52 (average)	19	----------	----------	74,321	8,863,603
1953	18	----------	----------	[5] 97,770	[5] 13,380,339
1954	17	----------	----------	[5] 86,193	[5] 11,633,014
1955	16	----------	----------	[5] 105,171	[5] 14,490,048
1956	17	----------	----------	[5] 106,739	[5] 13,855,058
1957	15	----------	----------	89,757	12,253,526

[1] Of any barium chemical.
[2] Includes purchased material.
[3] Exclusive of purchased material and exclusive of sales by one producer to another.
[4] Black-ash data include lithopone plants.
[5] Revised figure.
[6] Includes barium acetate, nitrate, peroxide, sulfide, and other unspecified compounds. Specific chemicals may not be revealed by specific years.
[7] Plants included in above figures.
[8] A plant producing more than 1 product is counted but once in arriving at grand total.

PRICES

E&MJ Metal and Mineral Markets quoted the following market prices on barite during 1957: Barytes—f. o. b. cars: Georgia: Crude, jig and lump, $18 per net short ton; beneficiated, $21 per net short ton, in bulk, $23.50 to $25 in bags. The price remained unchanged throughout the year. Missouri: Per ton, water ground and floated, bleached, $45, carlots, f. o. b. works; the quotation was changed in March to read $45 to $49. Crude ore, minimum 94 percent $BaSO_4$, less than 1 percent iron, January through March $16; April to December $16 to $18. From January through March, crude, oil well drilling, minimum 4.3 specific gravity, bulk, short ton, $11.50 nominal; April to December $18. In April, and continuing to December a new quotation, some restricted sales $11.50, was added. Ground, oil-well grade, $26.75, April through December.

Foreign, crude-oil-well drilling, minimum 4.25 specific gravity, bulk, short ton c. i. f. Gulf ports $16 to $18.

Canadian ore, crude, in bulk, f. o. b. shipping point, $11 per long ton; ground, in bags, $16.50 per short ton.

TABLE 9.—Quotations on barium chemicals in 1957

[Oil, Paint and Drug Reporter]

	Jan. 7	Dec. 30
Barium carbonate, precipitated, bags, carlots, works____short tons__	$100.00	$106.50.[1]
Smaller lots, works____do____	110.00	121.50.[1]
Barium chlorate, kegs, works____pound__	.32-.36	0.32-.41.[2]
Barium chloride, anhydrous, bags, carlots, works____short tons__	165.00	176.00.[3]
Less carlots, works____do____	175.00	191.00.[3]
Barium chromate, bags, freight equaled____pound__	.35	Unchanged.
Barium dioxide (peroxide), drums, freight equaled____do____	.20	Do.
Barium hydrate, crystals, bags, carlots, ton lots, freight equaled___short ton__	208.00	Do.
Less carlots, less ton lots, freight equaled____do____	218.00	Do.
Barium nitrate, barrels, carlots, ton lots, delivered____pound__	.16	Do.
Less carlots, less ton lots, delivered____do____	.17	Do.
Barium oxide, ground, drums, carlots, ton lots, freight equaled___short ton__	275.00	Do.
Less carlots, less ton lots, freight equaled____do____	(4)	285.00.[5]
Blanc fixe, direct process, bags, carlots, works____do____	110.00	115.00.[6]
Less carlots, works____do____	120.00	125.00.[6]
New York warehouse____do____	155.00	165.00.[6]
Lithopone, ordinary, bags, carlots, delivered____pound__	.08 E	0.08⅜ E.[7]
Less carlots, delivered____do____	.08¾ E	0.09⅛ E.[7]
Titanated (high-strength), bags, carlots, delivered____do____	.10	0.11.[7]
Less carlots, delivered____do____	.11	0.12.[7]

[1] Prices increased Jan. 28 to $104 per short ton for carlots and $114 for smaller lots. The Dec. 30 price first published on Apr. 8.
[2] Increase published Feb. 4.
[3] Price increased on Feb. 4 to $172 for carlots and $182 for less than carlots; Dec. 30 price increase published Apr. 8.
[4] Not quoted.
[5] Published Feb. 4.
[6] Increase published Oct. 7.
[7] Increase published Apr. 1.
E=East.

FOREIGN TRADE[9]

Crude-barite imports totaled 832,600 tons in 1957—an increase of 243,000 tons over 1956—and a record quantity.

Canada (the leading source of crude imports for more than a decade) dropped to third place. Mexico replaced Canada as the principal supplier, and Peru ranked second.

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

Imports of crude witherite continued to increase for the third consecutive year. Of the total imported, the United Kingdom supplied 3,024 tons and West Germany the remainder. The small tonnage of ground witherite imported originated in Canada.

Barium-chemical imports for the most part continued to increase with West Germany and France the principal suppliers. The Netherlands, United Kingdom, Belgium, Luxembourg, and Switzerland contributed the remainder.

The declining exports of lithopone went primarily to Canada and Cuba.

TABLE 10.—Barite imported for consumption in the United States, 1954–57, by countries

[Bureau of the Census]

	1954		1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude barite:								
North America:								
Canada	165,612	$1,177,616	187,355	$1,364,285	240,650	$1,707,597	109,180	$745,394
Cuba							33,172	305,992
El Salvador					58	395		
Mexico	43,750	130,384	108,240	329,335	204,354	779,044	406,193	2,200,907
Total	209,362	1,308,000	295,595	1,693,620	445,062	2,487,036	548,545	3,252,293
South America:								
Brazil	6,184	35,461	4,960	22,500	16,069	84,877		
Peru					[1] 36,129	[1] 263,740	124,440	1,253,167
Total	6,184	35,461	4,960	22,500	[1] 52,198	[1] 348,617	124,440	1,253,167
Europe:								
Greece					22,365	151,757	79,528	443,097
Italy	5,600	37,000			26,559	265,794	25,490	231,166
Sweden					54	337		
Yugoslavia	95,947	894,373	59,081	464,999	42,815	347,963	54,623	684,401
Total	101,547	931,373	59,081	464,999	91,793	765,851	159,641	1,358,664
Grand total	317,093	2,274,834	359,636	[2] 2,181,119	[1] 589,053	[1 2] 3,601,504	832,626	5,864,124
Ground barite:								
North America:								
Mexico							297	6,530
Europe:								
Germany, West	63	2,346	45	1,614	49	2,077	53	1,618
Italy			18	509	74	2,212	73	2,473
Total	63	2,346	63	2,123	123	4,289	126	4,091
Africa: Algeria	189	6,351	232	7,839	245	8,630		
Grand total	252	8,697	295	9,962	368	12,919	423	10,621

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

TABLE 11.—Barium chemicals imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Lithopone		Blanc fixe (precipitated barium sulfate)		Barium chloride		Barium hydroxide	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	404	$66,945	20	$2,865	190	$22,105	94	$20,465
1953	30	5,658	1,005	57,346	50	4,567	22	3,018
1954	65	7,029	788	64,026	811	58,238	51	7,283
1955	30	4,355	901	91,341	994	[1] 75,069	15	2,431
1956	143	[1] 19,931	1,026	104,662	1,378	[1] 107,913	22	3,130
1957	57	8,124	1,447	115,627	1,407	120,080	113	18,905

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	240	$37,865	316	$26,325	34	$14,108
1953	235	36,433	4,219	297,187	513	103,100
1954	164	24,516	325	26,402	1,344	265,472
1955	77	14,906	1,638	105,240	841	[1] 170,345
1956	591	[1] 91,177	1,801	130,852	138	29,735
1957	798	120,075	1,543	105,046	61	22,209

[1] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

TABLE 12.—Lithopone exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1948–52 (average)	15,058	$2,277,677	$151.26	1955	1,892	$300,960	$159.07
1953	3,927	584,279	148.79	1956	1,387	239,892	172.96
1954	3,013	454,461	150.83	1957	991	177,891	179.51

TABLE 13.—Witherite, crude, unground, imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1948–52 (average)	2,772	$89,047	1955	2,363	$77,867
1953	4,928	178,846	1956	2,934	110,039
1954	4,415	153,139	1957	[2] 3,029	[2] 138,494

[1] Valued at port of shipment.
[2] In addition, 8 tons ($533) of crushed or ground witherite was imported. Class established June 1, 1956, no transactions.

TABLE 14.—World production of barite, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	90,835	247,227	221,472	253,736	320,835	216,325
Cuba (exports)	72	4,904	-----	-----	-----	37,842
Mexico (exports)	[3] 4,937	63,042	56,871	117,654	235,792	[4] 410,000
United States	812,193	920,025	926,036	1,114,117	1,351,913	1,304,542
Total	908,037	1,235,198	1,204,379	1,485,507	1,908,540	1,968,709
South America:						
Argentina	16,847	16,464	[4] 16,500	25,353	19,152	[4] 22,000
Brazil	6,574	[5] 15,863	[5] 6,272	[5] 5,071	[5] 16,378	[5] 23,755
Chile	1,809	1,556	3,546	3,466	476	[4] 1,100
Colombia	1,453	8,543	9,921	6,614	8,378	13,228
Peru	9,543	17,129	12,348	9,410	56,130	133,356
Total	36,226	59,555	[4] 48,600	49,914	100,514	[4] 193,000
Europe:						
Austria	8,163	2,116	4,802	4,365	3,413	3,902
France	43,603	43,869	52,361	70,507	52,911	[4] 55,000
Germany:						
East [4]	17,600	27,600	27,600	27,600	27,600	27,600
West	[6] 264,752	334,422	422,589	456,710	453,836	448,144
Greece	23,410	29,655	24,249	21,451	38,581	[4] 27,600
Ireland	6,148	-----	3,031	6,134	8,157	8,488
Italy	67,239	79,104	81,931	114,635	103,075	113,083
Portugal	507	347	385	357	346	[4] 330
Spain	12,628	19,727	11,740	9,833	8,505	19,365
Sweden	669	-----	108	137	-----	-----
U. S. S. R.[4]	103,600	110,000	110,000	110,000	110,000	110,000
United Kingdom [7]	110,493	77,175	81,967	92,906	84,670	89,898
Yugoslavia	34,054	89,457	114,640	109,129	71,209	86,725
Total [1] [4]	698,000	820,000	940,000	1,030,000	970,000	1,000,000
Asia:						
India	17,186	10,528	21,048	8,537	7,072	14,462
Japan	12,879	19,350	20,815	20,374	20,578	26,372
Korea, Republic of	175	1,210	336	933	744	8
Philippines	-----	-----	-----	-----	5,045	6,367
Total [1] [4]	39,900	42,000	53,000	46,000	55,000	69,000
Africa:						
Algeria	19,585	18,821	21,341	33,720	32,843	[4] 33,000
Egypt	18	33	35	67	88	[4] 70
Morocco: Southern Zone	[3] 3,192	55	10,246	27,170	32,622	16,276
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	256	268	-----	-----	-----	-----
Swaziland	336	455	362	449	516	351
Tunisia	203	-----	-----	-----	-----	-----
Union of South Africa	2,200	2,092	2,342	1,892	2,713	3,369
Total	25,790	21,724	34,326	63,298	68,782	53,066
Oceania: Australia	5,889	6,358	7,696	7,016	6,730	3,390
World total (estimate) [1] [2]	1,714,000	2,200,000	2,300,000	2,700,000	3,100,000	3,300,000

[1] In addition to countries listed, barite is produced in China, Czechoslovakia, and North Korea, but data on production are not available. Estimates by author of chapter included in total.

[2] This table incorporates a number of revisions of data published in previous Barite chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.

[3] Average for 1949–52.

[4] Estimate.

[5] Exports.

[6] Beginning in 1950, marketable production is shown.

[7] Includes witherite.

WORLD REVIEW

NORTH AMERICA

Canada.—Magnet Cove Barium Corp. and Eastern Northern Explorations, Ltd., entered an agreement to develop barite deposits in the Cobequid Mountains of Colchester, Nova Scotia. The deposits were discovered during a search for base metals by the latter firm. Analyses of the barite indicate that it is of high grade.[10]

Cuba.—The Cuban Government granted a port concession at Santa Lucia to the Mora Mining Co. to ship barite from the Pinar del Rio Province.

The major portion of Cuba's barite deposits was reportedly held by the Mora Mining Co. and the West Indies Iron & Metals Co. The Mora Co. was drilling to delineate its deposits, which were estimated to contain 500,000 long tons. This firm was expected to begin shipments to the United States and Caribbean countries in August 1957.

The West Indies Iron & Metals Co. began shipments to the New Orleans and Houston plants of the Baroid Division, National Lead Co. in February 1957 from the port of Mariel.[11]

SOUTH AMERICA

Peru.—The leading barite producer in Peru was the Peruvian Chemicals Corp. from deposits about 31 miles east of Lima in the Rimac River Valley. Reportedly barite from this deposit contains 95 percent $BaSO_4$ and has a specific gravity of 4.3. Open-pit mining was done and little mechanization employed. The ore was shipped to 2 company-owned grinding plants—1 in the Lima-Callao area and the other at Talara—for grinding to drilling mud specifications. Another important barite producer was Cia Minera Nor-Peruana which operated the large Suyo deposits in northern Peru near the Ecuadoran border. Output is consumed by oil companies in the Talara region.

The Mina Mercedes property in the interior of Chiclayo was another source of barite; however, the deposits did not meet expectations, and output had declined to less than 100 tons per month in the latter half of 1956.

Other barite deposits of undetermined size occur south of Lima near Pucusana and Ica and near Tarma in the central Andes. None of these deposits are now being developed commercially.

Barite exports increased from 21,309 short tons in 1955 to 60,288 tons in 1956, and in 1957 exports to the United States alone exceeded 124,000 tons.

A general surcharge on exports of barium sulfate or barite from Callao was reduced from $1.60 per metric ton, weight or volume, to $1.00 per metric ton on February 19, 1957. This was done to stimulate production.[12]

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[10] Canadian Mining Journal, Magnet Cove Barium Corp.: Vol. 78, No. 6, June 1957, p. 198.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 24.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 6, June 1957, p. 21.

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EUROPE

Ireland.—Benbulben Barytes, Ltd., mined barite from the Gleniff mines in County Sligo. The average annual production rate was reported to be about 6,000 tons.[13]

Greece.—Mykobar Mining Co., S. A., a Greek firm owned jointly by Dresser Industries and the Mykonos Mining Co., S. A., opened its new barite mine and crushing plant on the island of Mykonos.[14] New shiploading facilities on the island were also completed.[15] To protect its investment in this enterprise, Dresser Industries obtained a United States Government guarantee under the International Cooperation Administration investment insurance program.[16]

United Kingdom.—The price of barium chloride was reported to have increased.[17] It was also stated that the barium-chemical industry (which was established in 1953) had developed in capacity and range of products.[18]

AFRICA

Union of South Africa.—There were two barite producers in the Union in 1956: The Barytes Mining Co., Ltd., Barberton, Transvaal, and Bar Sul mine (Mrs. B. J. Pittendrigh), Duiwelskloof. Of the 2,713 tons produced, valued at $20,969 f. o. r., all went for local consumption.[19]

OCEANIA

Australia.—An article described the mine and new milling plant of South Australian Barytes, Ltd.[20] The mine is in the Flinders Range about 60 miles north-northeast of Hawker, and the mill is at Quorn about 200 miles north of Adelaide. The plant separates the barite from shale by jigging and tabling; the concentrate is then dry ground and bagged for shipment. Geology, mining methods, and plant processes are discussed.

TECHNOLOGY

An article on the heats of formation of crystalline, barium, and strontium silicates was published.[21] The heats of formation for barium metasilicate, orthosilicate, and disilicate and dibarium trisilicate were presented. The materials and the methods used to prepare the compounds, as well as the measurements and results, are discussed.

A patent was issued on a rubber and ground-barite mixture that can be used in road construction, roofing paints, and vehicle undercoats.[22] The free-flowing powder is made by taking a barite composition (at least 40 percent by weight $BaSO_4$) in the form of particles

[13] Mining Magazine (London), Barytes: Vol. 96, No. 6, June 1957, p. 362.
[14] Mining World, vol. 19, No. 11, October 1957, p. 57.
[15] Rock Products, Expands Barite Production: Vol. 60, No. 2, February 1957, p. 62.
[16] Chemical and Engineering News, vol. 35, No. 32, Aug. 12, 1957, p. 78.
[17] Chemical Age (London), Barium Chloride Reported Dearer: Vol. 78, No. 2004, Dec. 7, 1957, p. 939.
[18] Chemical Trade Journal (London), More Barium Chemicals: Vol. 140, No. 3654, June 14, 1957, p. 1416.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, p. 19.
[20] Jackson, Norton, New Barytes Treatment Plant: Chem. Eng. and Min. Rev., vol. 50, No. 1, Oct. 15, 1957, pp. 36–42.
[21] Barany, R., King, E. G., and Todd, S. S., Heats of Formation of Crystalline Silicates of Strontium and Barium: Jour. Am. Chem. Soc., vol. 79, No. 14, July 20, 1957, pp. 3639–3641.
[22] Endres, H. A., Shaw, J. W., Jr., and Pullar, H. B. (assigned to the Goodyear Tire & Rubber Co., Akron, Ohio), Rubber Barytes Compositions and Methods of Preparation: U. S. Patent 2,809,179, Oct. 8, 1957.

ranging in size from 5–50 microns, with 90 percent less than 10 microns, and adjusting the water content until an approximate 25–75 percent by weight barite-water slurry is formed. The pH of the slurry is then adjusted to 8.5 by adding sodium hydroxide, after which the slurry is mixed with rubber latex (30–70 percent rubber-serum by weight) in the proportion of about 20 percent by weight of rubber and 80 percent by weight of barite composition. By adding aluminum sulfate solution to the rubber-barite composition, barite particles individually coated with a film of rubber are precipitated. The material is then filtered until only about 33 percent by weight of water remains and dried and pulverized until only about 0.5 percent by weight of water remains and about 95 percent passes through a 100-mesh standard screen. This also ruptures the rubber films so that some surface area of the barite particles is exposed.

A barium titanate ceramic, having a high dielectric constant, was described in a patent.[23] It consisted primarily of a crystal lattice of barium titanate in combination with iron and calcium ions, the latter 2, being at a maximum, less than 4 percent by weight of the barium titanate and neither being less than 0.3 percent by weight of the barium titanate.

A process for making barium titanate crystals was patented.[24] Barium titanate is mixed with a fluxing agent, potassium fluoride, the flux comprising approximately 75 percent of the total weight of the mixture and heated to about 1,150° C. The mixture is maintained at this temperature for 6 to 12 hours and gradually cooled over a period of 6 hours to approximately 860° C., at which temperature the flux solidifies. It is then rapidly cooled to room temperature and the solidified potassium fluoride dissolved with water.

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[23] Oshry, H. T. (assigned to Erie Resistor Corp., Erie, Pa.), Barium Titanate Ceramic Dielectrics: U. S. Patent 2,803,533, Aug. 20, 1957.
[24] Karan, Clarence (assigned to International Business Machines Corp., New York, N. Y.), Method of Preparing Barium Titanate Crystals: U. S. Patent 2,803,519, Aug. 20, 1957.

Bauxite

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WORLD PRODUCTION of bauxite in 1957 increased 9 percent to continue the upward trend begun in 1951. Domestic production was 1.4 million tons, a 19-percent decline from 1956. However, consumption of domestic ore showed only a small decrease. Imports increased 25 percent and were 83 percent of the United States bauxite supply; the remainder came from domestic production. Jamaica became the leading world producer and supplied 51 percent of the United States imports. A new source of supply for the United States—Haiti—began to produce in the second quarter of the year.

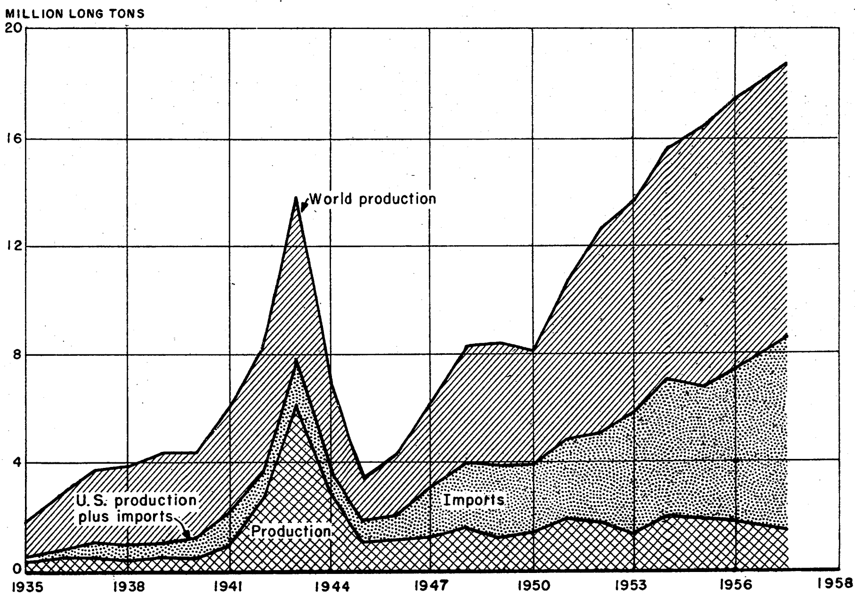

FIGURE 1.—United States supply and world production of bauxite, 1935–57.

In the United States about 3.5 million short tons of alumina and aluminum oxide products was produced from bauxite. Production of aluminum through utilization of alumina consumed 83 percent of the bauxite used. The Aluminum Company of America indefinitely suspended production at its East St. Louis, Ill., alumina plant, and Reynolds Metals Company added a new unit to its La Quinta, Tex., alumina plant. Construction of 1.7 million annual tons of new alumina-plant capacity was well under way; but, due to the reduced market for aluminum, completion dates were indefinite.

Aluminum is discussed in the Aluminum chapter of this volume.

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TABLE 1.—Salient statistics of the bauxite industry, 1948–52 (average) and 1953–57, in long tons

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Crude-ore production (dry equivalent)	1,491,238	1,579,739	1,994,896	1,788,341	1,743,344	1,416,172
Imports (as shipped)	2,802,188	4,390,576	5,258,530	5,225,188	6,075,051	7,725,919
Exports (as shipped)	53,100	27,907	16,174	14,117	14,921	60,993
Consumption (dry equivalent)	3,380,450	5,628,276	6,427,785	6,988,734	7,751,057	7,632,683
World: Production	9,800,000	13,600,000	[1] 15,500,000	[1] 16,500,000	[1] 17,200,000	18,700,000

[1] Revised figure.

DOMESTIC PRODUCTION

Production of crude bauxite in the United States during 1957 was 1.4 million long tons dried equivalent—a 19-percent decrease from 1956. In contrast, shipments, on a dry basis, of ore from domestic mines and processing plants to consumers showed a 7-percent increase when compared with 1956 shipments. The total domestic production of bauxite was 17 percent of the new supply, obtained by adding United States production to imports. This was the lowest percentage ever recorded. The dried-bauxite equivalent of the processed bauxite recovered was approximately the same as in the preceding year.

The combined bauxite production of Alabama and Georgia decreased 21 percent to 59,000 long dried tons; all was from open-pit mines. The D. M. Wilson Bauxite Co. and the R. E. Wilson Mining Co. both produced from mines in Barbour County, Ala. R. E. Wilson Mining Co. processed its ore at the company Eufaula drying plant, and D. M. Wilson Bauxite Co. shipped its ore in the crude state.

The American Cyanamid Co., with mines in Floyd, Macon, and Sumter Counties, was the only producer in Georgia. The crude ore was dried at its plant at Halls Station, Bartow County, for use in producing chemicals.

Production from the Arkansas mines (96 percent of the United States total) decreased 19 percent from 1956. Eighty-five percent of the Arkansas output was mined in Saline County and the remainder in Pulaski County. Open-pit operations supplied 80 percent.

The Aluminum Company of America was the leading producer in Arkansas during 1957, mining ore in Saline County. The second ranking producer was Reynolds Mining Co.—a subsidiary of Reynolds Metals Co. which produced ore in Saline County. Shipments at Reynolds were maintained from stocks, as well as underground and open-pit mines. Stripping was continued to develop open-pit tonnage. The ore of both companies was used at their own plants for producing alumina.

American Cyanamid Co. operated the Quapaw mine in Saline County and shipped from stocks at two mines in Pulaski County. Crude ore was received at the company mill in Pulaski County for drying before use in producing alum. A new mill was being constructed by the company at Bauxite in Saline County; this would concentrate ore to chemical-grade bauxite by a process developed by the Bureau of Mines.[4]

Dickinson McGeorge shipped crude ore from 3 mines in Pulaski County and 2 in Saline County. All ore was mined from open pits. Dulin Bauxite Co. had both open-pit and underground mines. It operated 4 mines in Pulaski County and 2 in Saline County. A portion of its ore was dried, and the remainder was shipped crude. The Norton Co. plant and mine were idle. Consolidated Chemical Industries, Inc., shipped crude ore from stocks to its own plant in Pulaski County; both dried and activated bauxite were produced for shipment.

The Campbell Bauxite Co. plant in Pulaski County purchased ore for preparing dried and activated bauxite. Activated bauxite also was produced by the Porocel Corp. in Pulaski County.

Harvey Aluminum Co. had optioned an area in Salem Hills, Oreg., with a view to the possible development of the ferruginous laterites.

TABLE 2.—Mine production of bauxite in the United States, 1953–57, by quarter years, in long tons [1]

(Dried-bauxite equivalent)

Quarter ended—	1953	1954	1955	1956	1957
Mar. 31	378, 806	399, 300	486, 743	490, 991	368, 705
June 30	411, 070	367, 750	474, 147	470, 816	370, 404
Sept. 30	387, 054	686, 323	402, 440	357, 320	375, 170
Dec. 31	402, 809	541, 523	425, 011	424, 217	301, 893
Total	1, 579, 739	1, 994, 896	1, 788, 341	1, 743, 344	1, 416, 172

[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, 1953–57, by States, in long tons

State and year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dried-bauxite equivalent	Value [1]	As shipped	Dried-bauxite equivalent	Value [1]
Alabama and Georgia:						
1953	61, 186	49, 763	$463, 149	59, 985	56, 085	$580, 471
1954	56, 431	45, 528	409, 501	58, 446	55, 050	705, 950
1955	89, 447	67, 098	516, 448	72, 952	67, 141	713, 906
1956	94, 444	74, 912	665, 392	73, 517	68, 248	728, 462
1957	76, 656	59, 274	554, 163	67, 142	62, 273	671, 644
Arkansas:						
1953	1, 802, 797	1, 529, 976	12, 975, 992	1, 889, 206	1, 689, 207	15, 042, 236
1954	2, 296, 528	1, 949, 368	15, 993, 887	1, 978, 216	1, 711, 386	15, 239, 244
1955	2, 049, 623	1, 721, 243	14, 026, 190	1, 938, 811	1, 660, 263	14, 844, 798
1956	1, 966, 320	1, 668, 432	13, 307, 341	1, 827, 832	1, 576, 028	13, 724, 443
1957	1, 625, 098	1, 356, 898	11, 600, 216	2, 004, 289	1, 695, 992	14, 948, 537
Total United States:						
1953	1, 863, 983	1, 579, 739	13, 439, 141	1, 949, 191	1, 745, 292	15, 622, 707
1954	2, 352, 959	1, 994, 896	16, 403, 388	2, 036, 662	1, 766, 436	15, 945, 194
1955	2, 139, 070	1, 788, 341	14, 542, 638	2, 011, 763	1, 727, 404	15, 558, 704
1956	2, 060, 764	1, 743, 344	13, 972, 733	1, 901, 349	1, 644, 276	14, 452, 905
1957	1, 701, 754	1, 416, 172	12, 154, 379	2, 071, 431	1, 758, 265	15, 620, 181

[1] Computed from selling prices and values assigned by producers and estimates of the Bureau of Mines.

[4] Calhoun, W. A., and Powell, H. E., Jr., Laboratory Investigation of Bauxite Ore From the Quapaw Deposit, Saline County, Ark.: Bureau of Mines Rept. of Investigations 5366, 1957, 11 pp.

By the end of 1957 exploration had outlined a total of about 360 square miles on the islands of Kauai, Maui, and Hawaii in the Territory of Hawaii that contained bauxitic laterite.[5] It became apparent that the deposits were low- to medium-grade, and concentration probably would be necessary for commercial utilization. Much of the aluminous material was on Territorial land; and, as the organic law of the Territory made inadequate provision for regulation of mineral rights on such lands, an act of Congress would be necessary before mining could be extensive.

TABLE 4.—Recovery of processed bauxite in the United States, 1948–52 (average) and 1953–57, in long tons

Year	Crude ore treated	Processed bauxite recovered			
		Dried	Calcined or activated	Total	
				As recovered	Dried-bauxite equivalent
1948–52 (average)	716,061	508,366	69,567	577,933	615,658
1953	200,970	100,632	34,288	134,920	155,248
1954	201,894	125,511	24,686	150,197	161,638
1955	199,313	114,863	23,166	138,029	151,333
1956	181,625	114,685	17,914	132,599	145,166
1957	187,921	128,509	13,093	141,602	147,508

CONSUMPTION AND USES

Domestic consumption of bauxite decreased 2 percent from that of 1956 to 7.6 million tons; this is the first decrease since 1949. The proportion of domestic ore consumed to total consumption was approximately the same as in 1956. Consumption of bauxite for uses other than alumina production increased 9 percent to 665,000 tons.

Of the domestic ore shipped from the mines in 1957, 8 percent was estimated to contain less than 8 percent silica, approximately 66 percent contained 8 to 15 percent silica, and the remaining 26 percent contained over 15 percent silica. The proportion of ore containing less than 8 percent silica decreased from 11 percent in 1956, and the proportion of ore containing over 15 percent increased from the 12 percent shipped in 1956.

The 6 domestic alumina plants operated by the aluminum companies produced 3,442,000 short tons of calcined alumina, and aluminum oxide products calculated on the basis of the calcined equivalent, which was virtually the same as the 1956 production. The actual weight of calcined alumina and aluminum oxide products was 3,489,000 short tons. Of this, 92 percent was shipped to aluminum-reduction plants, and about four-fifths of the remaining 8 percent was shipped as commercial trihydrate or as activated, calcined, or tabular alumina for use primarily by the chemical, abrasive, ceramic, and refractory industries. The output of calcined alumina was 3,317,000 short tons, almost as much as in 1956. The production of other forms of alumina increased 8 percent to 172,000 tons.

[5] Fellom, Roy, Jr., Hawaii Bauxite, Outlook for a New Alumina Industry in the West, pt. I: Light Metal Age, vol. 15, Nos. 3 and 4, April 1957, pp. 12–18.

At the end of 1957 the annual rated alumina-plant capacity in the United States was 3,533,000 short tons. This was a slight increase over the 3,501,000 tons reported at the beginning of the year. On November 1 the oldest alumina plant in the country—the Alcoa 328,500-ton-capacity plant at East St. Louis—suspended operation indefinitely. Laboratories and the cryolite plant at the same site were not affected. The loss was compensated by an upward revision of the rated capacities of 3 other alumina plants and by completion of an additional 182,500-ton-capacity unit at the Reynolds Metal Co. Sherwin plant, La Quinta, Tex.

TABLE 5.—Bauxite consumed in the United States, 1956–57, by industries, in long tons

(Dried-bauxite equivalent)

Industry	Domestic	Percent	Foreign	Percent	Total	Percent
1956						
Alumina	1,765,973	91.6	5,374,276	92.3	7,140,249	92.1
Abrasive [1]	7,000	.4	270,475	4.6	277,475	3.6
Chemical	87,776	4.5	100,865	1.7	188,641	2.4
Refractory	21,964	1.1	62,301	1.1	84,265	1.1
Other	46,057	2.4	14,370	.3	60,427	.8
Total [1]	1,928,770	100.0	5,822,287	100.0	7,751,057	100.0
Percent	24.9		75.1		100.0	
1957						
Alumina	1,693,181	91.8	5,274,638	91.1	6,967,819	91.3
Abrasive [1]	1,852	.1	316,633	5.5	318,485	4.2
Chemical	72,147	3.9	126,678	2.2	198,825	2.6
Refractory	17,377	1.0	64,622	1.1	81,999	1.1
Other	59,059	3.2	6,496	.1	65,555	.8
Total [1]	1,843,616	100.0	5,789,067	100.0	7,632,683	100.0
Percent	24.2		75.8		100.0	

[1] Includes consumption by Canadian abrasives industry.

TABLE 6.—Consumption of crude and processed bauxite in the United States by grades, 1957, in long tons

(Dried-bauxite equivalent)

	Domestic origin	Foreign origin	Total	Percent
Crude	1,706,650	7,393	1,714,043	22.5
Dried	116,730	5,414,615	5,531,345	72.5
Calcined	8,876	367,059	375,935	4.9
Activated	11,360		11,360	.1
Total	1,843,616	5,789,067	7,632,683	100.0
Percent	24.2	75.8	100.0	

Another 182,500-ton unit estimated to cost $16 million was being constructed at La Quinta and scheduled for completion in 1958. Construction also was proceeding on the 350,000-ton plant of the Ormet Corp. at Burnside, La., and the first production was expected in early 1958.

At the end of the year construction had been slowed on the 430,000-ton plant of the Kaiser Aluminum & Chemical Corp. at Gramercy, La., and the 750,000-ton plant of Alcoa at Point Comfort, Tex. Both plants were in an advanced stage of construction, but their completion would depend on an increased demand for aluminum. All of the new plants completed or under construction were designed to use foreign ores.

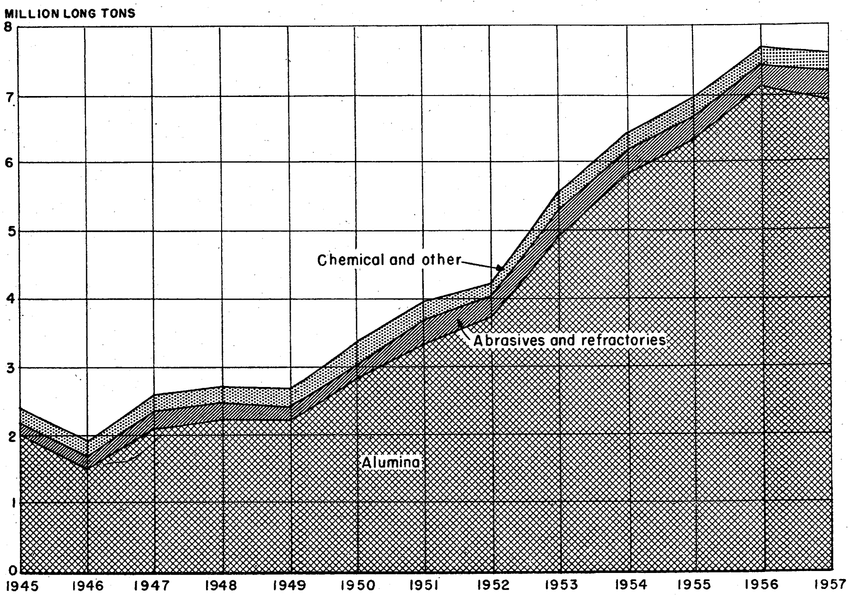

FIGURE 2.—Domestic consumption of bauxite, by uses, 1945–57.

TABLE 7.—Capacities of domestic alumina plants in operation and under construction

Company and plant	Capacity (short tons per year)		
	Operating plants, December 1957	Plants under construction	Total
Aluminum Company of America:			
Mobile, Ala	985,500		985,500
Bauxite, Ark	420,000		420,000
Point Comfort, Tex		750,000	750,000
Total	1,405,500	750,000	2,155,500
Reynolds Metals Co.:			
Hurricane Creek, Ark	730,000		730,000
La Quinta, Tex	547,500	182,500	730,000
Total	1,277,500	182,500	1,460,000
Kaiser Aluminum & Chemical Corp.:			
Baton Rouge, La	850,000		850,000
Gramercy, La		430,000	430,000
Total	850,000	430,000	1,280,000
Ormet Corp. Burnside, La		350,000	350,000
Total		350,000	350,000
Grand total	3,533,000	1,712,500	5,245,500

Calcined alumina consumed by the 18 aluminum-reduction plants in the United States during 1957 totaled 3,144,000 short tons, only 36,000 tons less than in 1956. An average of 2.024 long dry tons of bauxite was required to produce 1 short ton of alumina, and an average of 1.908 short tons of alumina was necessary to produce 1 short ton of aluminum metal. The overall ratio was 3.862 long dry tons of bauxite to 1 short ton of aluminum.

STOCKS

Bauxite stocks in the United States on December 31, 1957, totaled 5.3 million long dry tons and represented a 9-percent increase compared with the total stock figure for the preceding year. Consumers' inventories of crude and processed bauxite increased 37 percent, but those at mines and processing plants were 34 percent less than in 1956. There were no withdrawals from the Government-held nonstrategic stockpile in Arkansas. All figures exclude bauxite held for the national strategic stockpile. Metallurgical- and Refractory-grade bauxite remained on the Group I list of strategic materials for the national stockpile. Abrasive-grade ore was in Group II.

TABLE 8.—Stocks of bauxite in the United States, Dec. 31, 1953–57, in long tons [1]

Year	Producers and processors		Consumers		Government	Total	
	Crude	Processed [2]	Crude	Processed [2]	Crude	Crude and processed	Dried bauxite equivalent
1953	759,165	44,097	697,653	1,405,587	2,261,392	5,167,894	4,623,552
1954	964,162	5,810	762,944	1,637,920	2,261,392	5,632,228	5,041,936
1955	1,042,832	4,979	637,508	1,705,694	2,204,674	5,595,687	5,011,270
1956	1,132,644	5,812	[3] 483,173	[3] 1,605,262	2,204,674	[3] 5,431,565	[3] 4,889,308
1957	747,992	6,313	488,564	2,364,206	2,204,674	5,811,749	5,335,216

[1] Excludes strategic stockpile.
[2] Dried, calcined, and activated.
[3] Revised figure.

PRICES

No open-market price was in effect for bauxite mined in the United States, as the output was consumed mainly by the producing companies. The values in table 9 were determined from the approximate commercial value of the shipments and interplant transfers of crude and processed bauxite as assigned by the producers.

The average values in 1957 of bauxite as shipped and delivered to the domestic alumina plants were $10.28 per long ton for domestic ore and $15.18 per ton for imported ore.

The year-end prices quoted in the E&MJ Metal & Mineral Markets showed only two changes from those quoted in 1956. The price of imported, Abrasive-grade, crushed and calcined bauxite rose $0.95 to $19.95 and imported Refractory-grade bauxite rose $0.20 to $25.40.

During 1957 the average value of calcined alumina shipped was $0.0346 per pound, as determined by producer reports.

TABLE 9.—Average value of domestic bauxite in the United States, 1956–57 [1]

Type	Shipments f. o. b. mines or plants (per long ton)		Type	Shipments f. o. b. mines or plants (per long ton)	
	1956	1957		1956	1957
Crude (undried)	$6.94	$6.96	Calcined	$21.78	----------
Dried	9.68	10.83	Activated	74.25	$61.34

[1] Calculated from reports to the Bureau of Mines by bauxite producers.

TABLE 10.—Market quotations on bauxite in the United States on December 26, 1957

[E&MJ Metal and Mineral Markets]

Type of ore	Al_2O_3 percent	Price	Type of ore	Al_2O_3 percent	Price
Domestic (per long ton):			Domestic (per long ton)—Con.		
Crude [1]	50–52	$5.00–$5.50	Abrasive grade, crushed and calcined [1]	80–84	$17.00
Chemical, crushed and dried [2]	[3] 55–58	8.00– 8.50	Imported (per long ton):		
Other grades [1]	[4] 56–59	8.00– 8.50	Calcined, crushed (abrasive grade) [6]	86 min.	19.95
Pulverized and dried [1]	[5] 56–59	14.00–16.00	Refractory grade	----------	25.40

[1] F. o. b. Arkansas mines.
[2] F. o. b. Alabama and Arkansas mines.
[3] 1.5 to 2.5 percent Fe_2O_3.
[4] 5 to 8 percent SiO_2.
[5] 8 to 12 percent SiO_2.
[6] F. o. b. port of shipment, British Guiana.

TABLE 11.—Average value of bauxite imported into and exported from the United States, 1956–57, in long tons

[Bureau of the Census]

Type and country	Average value, port of shipment		Type and country	Average value, port of shipment	
	1956	1957		1956	1957
Crude and dried:			Calcined: [2]		
British Guiana	$6.81	$6.92	British Guiana	$23.05	$22.66
Haiti [1]	----------	9.05	Surinam	26.13	26.97
Jamaica [1]	9.12	9.28	Average	23.05	22.66
Surinam	6.77	7.84	Bauxite and bauxite concentrate exported	55.91	79.47
Average	7.83	8.58			

[1] Dry tons used for computation.
[2] For refractory use.

TABLE 12.—Market quotations on alumina and aluminum compounds

[Oil, Paint and Drug Reporter]

Compound	Dec. 31, 1956	Dec. 30, 1957
Alumina, calcined, bags, carlots, works ... pound [1]	$0.0455	$0.0475
Aluminum hydrate, heavy, bags, carlots, freight equalized ... do [1]	.032	.0335
Aluminum sulfate, commercial bulk, carlots, works ... ton [2]	37.00	41.00
Aluminum sulfate, iron free, bags, carlots, works, freight equalized 100 pounds	3.55	3.55

[1] First quoted Aug. 12, 1957.
[2] First quoted June 10, 1957.

FOREIGN TRADE [6]

United States bauxite imports in 1957 were 7.1 million tons, a 25-percent increase over 1956 imports. Surinam imports were almost the same as those for 1956 but declined as a percentage of the total from 49 percent to 39. Jamaican imports calculated on a dry basis increased 41 percent over 1956 and supplied 51 percent of total imports. British Guiana imports increased 43 percent but only supplied about 5 percent of the total. The remaining imports were supplied from Haiti, a new producer that first began shipping in the second quarter. Imports from Haiti totaled 372,769 long tons on an "as-shipped" basis, and after converting to a dry basis, by allowing for 14.6 percent contained free moisture, were 318,000 tons.

On an "as-received" basis, 34 percent of the bauxite imports entered through the Mobile (Ala.) customs district, 46 percent through the New Orleans (La.) customs district, 19 percent through the Galveston (Tex.) customs district, and 1 percent through other districts.

Except for 60 tons imported from Surinam in 1957, all calcined bauxite for refractory uses shown in table 14 was from British Guiana.

TABLE 13.—Bauxite (crude and dried [1]) imported for consumption in the United States, 1948–52 (average) and 1953–57, in long tons

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Haiti (dry equivalent)	----------	----------	----------	----------	----------	[2] 318,000
Jamaica (dry equivalent)	[2] 45,800	[2] 1,016,000	[2] 1,717,000	[2] 2,178,000	[2] 2,573,000	[2] 3,622,000
Trinidad and Tobago	8,808	----------	----------	----------	----------	----------
Other North America	34	----------	----------	----------	----------	----------
Total	54,642	1,016,000	1,717,000	2,178,000	2,573,000	3,940,000
South America:						
British Guiana	122,364	101,911	175,002	241,928	268,626	383,631
Surinam	2,272,769	3,099,554	3,096,120	2,462,565	2,797,713	2,777,367
Other South America	3,334	2,360	----------	----------	----------	----------
Total	2,398,467	3,203,825	3,271,122	2,704,493	3,066,339	3,160,998
Europe	----------	10,257	----------	----------	----------	----------
Asia: Indonesia	341,882	----------	----------	----------	----------	----------
Africa	(3)	----------	----------	----------	30,494	----------
Grand total: Long tons [2]	2,794,991	4,230,082	4,988,122	4,882,493	5,669,833	7,100,998
Value	$17,778,416	$29,585,129	$36,288,926	$36,656,142	$44,414,420	$60,951,253

[1] Only small quantities of undried bauxite were imported.
[2] Bureau of Census import figures adjusted by Bureau of Mines to dry equivalent by deducting 13.6 percent free moisture for Jamaican and 14.6 percent for Haitian bauxite.
[3] Less than 1 ton.

Aluminum compounds imported into the United States totaled 5,735 short tons; 37 percent came from Canada and the remainder from countries of Western Europe. Only 299 tons of this total was alumina for use in aluminum production.

The duties on imports of bauxite and alumina for use in aluminum production remained suspended during the year. Duties on imports of aluminum hydroxide and alumina not used for aluminum remained at one-fourth cent per pound.

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

TABLE 14.—Calcined bauxite imported for consumption into the United States, 1950–57, by grades and countries, in long tons

[Bureau of the Census]

	1950	1951	1952	1953	1954	1955	1956 [1]	1957 [1]
For refractory purposes:								
South America								
British Guiana	9	18,642	31,412	91,606	99,421	107,694	138,630	67,112
Surinam							86	60
Total	9	18,642	31,412	91,606	99,421	107,694	138,716	67,172
Value	$329	$405,438	$705,166	$2,116,121	$2,361,008	$2,453,331	$3,197,857	$1,522,236

[1] In addition calcined bauxite for other uses was imported as follows: 1956, British Guiana 9,960 tons ($221,112); 1957, Surinam 50 tons ($981).

Exports of bauxite and bauxite concentrate were four times those of 1956. Shipments to Canada were 96 percent of the total. Approximately four-fifths of the 19,689 short tons of aluminum sulfate exports went to Canada, Colombia, and Venezuela. Of the other aluminum compounds, totaling 48,390 short tons, 47 percent went to Norway and 46 percent to Canada and Mexico.

TABLE 15.—Bauxite (including bauxite concentrate [1]) exported from the United States, 1948–52 (average) and 1953–57, in long tons

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	52,119	26,880	14,777	13,115	13,337	58,654
Other North America	699	379	1,014	606	800	1,015
Total	52,818	27,259	15,791	13,721	14,137	59,669
South America	30	95	27	70	80	121
Europe	102	553	133	326	378	403
Asia	171		172		295	764
Africa	19		51		31	36
Grand total as exported	53,140	27,907	16,174	14,117	14,921	60,993
Dried-bauxite equivalent [2]	83,564	43,256	25,070	21,881	23,128	74,539
Total value	$1,186,673	$886,275	$666,459	$527,888	$834,169	$4,846,885

[1] Classified as "Aluminum ores and concentrates" by the Bureau of the Census.
[2] Calculated by Bureau of Mines.

The international flow of bauxite for 1955 is given in table 16. Total exports of 10.5 million tons represented only a 3-percent increase in relation to 1954. The most significant increase was in Jamaica, where exports increased 30 percent. Several other countries showed increases; the largest were in Greece, Malaya, and Yugoslavia. These increases were partly offset by decreased exports from Surinam (11 percent), Hungary (29 percent), and Ghana (29 percent).

Six countries received 97 percent of the total exports: The United States and Canada, 73 percent; Japan, West Germany, and the United Kingdom, 18 percent; and U. S. S. R., 6 percent.

TABLE 16.—Production and trade of bauxite in 1955, by major countries, in thousand long tons

[Compiled by Corra A. Barry and Berenice B. Mitchell]

Exports, by countries of origin	Production	Exports, by countries of destination: Exports	North America: Canada	North America: United States	Europe: Germany, West	Europe: Italy	Europe: U. S. S. R.[1]	Europe: United Kingdom	Europe: Other Europe	Asia: Japan	Other
North America:											
Jamaica	2,645	2,244	47	2,172	-------	-------	-------	-------	25	-------	-------
United States	1,788	14	13	-------	(2)	(2)	-------	(2)	(2)	-------	1
South America:											
Brazil	44	3	-------	-------	-------	-------	-------	-------	-------	-------	3
British Guiana	2,435	2,169	1,752	353	6	(2)	-------	19	27	7	5
Surinam	3,074	3,012	433	2,556	-------	-------	-------	-------	22	-------	1
Europe:											
Austria	19	8	-------	-------	8	-------	-------	-------	-------	-------	-------
France	1,470	346	-------	-------	204	-------	-------	124	7	-------	11
Germany, West	4	(2)	-------	-------	-------	-------	-------	-------	(2)	-------	-------
Greece	492	471	-------	-------	238	-------	119	44	57	-------	13
Hungary	1,221	545	-------	-------	-------	-------	545	-------	-------	-------	-------
Italy	322	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Rumania	[3] 16	(4)	-------	-------	-------	-------	-------	-------	-------	-------	-------
Spain	6	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
U. S. S. R.	[3] 980	(4)	-------	-------	-------	-------	-------	-------	-------	-------	-------
Yugoslavia	779	648	-------	-------	557	91	-------	-------	(2)	-------	-------
Other Europe	[3] 29	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Asia:											
India	81	9	-------	-------	-------	-------	-------	-------	-------	-------	9
Indonesia	260	259	-------	-------	86	-------	-------	-------	-------	173	-------
Malaya	222	260	-------	-------	-------	-------	-------	-------	-------	211	49
Pakistan	1	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Africa:											
French West Africa	485	442	382	-------	50	-------	-------	-------	10	-------	-------
Ghana	[5] 116	116	-------	-------	-------	-------	-------	116	-------	-------	-------
Mozambique	3	2	-------	-------	-------	-------	-------	-------	-------	-------	2
Oceania: Australia	8	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total	16,500	10,548	2,627	5,081	1,149	91	664	303	148	391	94

[1] Includes Czechoslovakia and Poland.
[2] Less than 500 tons.
[3] Estimate.
[4] Data not available.
[5] Exports.

WORLD REVIEW

World production of bauxite in 1957 increased 9 percent over 1956 and continued the upward trend begun in 1951. Jamaica became the world's leading producer; and Haiti—a new source—began commercial shipments to the United States in the second quarter of 1957.

Increased interest was shown in locating alumina plants in the tropics close to the sources of bauxite. At the end of 1957 a total of 1,815,000 annual short tons of alumina capacity was anticipated in French Africa, British Guiana, and Jamaica. This figure included completed plants, those under construction, and those for which firm financial commitments had been made. Plans for two additional plants in Surinam and Australia also were announced.

The countries that produced more than 50,000 tons of bauxite during 1957 and showed greater than a 5-percent change in production from the previous year were:

Country:	*Increase, percent*
Jamaica	48
Ghana	34
Malaya	23
Brazil	16
France	15
Greece	14
U. S. S. R.	14
Haiti—shipped for the first time.	

Country:	*Decrease, percent*
Indonesia	21
United States	19
French West Africa	19
Hungary	18

The Free World output was about 16.6 million tons, of which 60 percent was produced in Jamaica, Surinam, and British Guiana.

TABLE 17.—Relationship of world production of bauxite and aluminum, 1948–52 (average) and 1953–57, in million long tons

Commodity	1948–52 (average)	1953	1954	1955	1956	1957
Bauxite	9.8	13.6	[1] 15.5	[1] 16.5	[1] 17.2	18.7
Aluminum	1.6	2.4	[1] 2.8	3.1	3.3	3.3
Ratio of bauxite to aluminum production	6.1	5.7	[1] 5.5	5.3	[1] 5.2	5.7

[1] Revised figure.

NORTH AMERICA

Canada.—Canadian Alumina Corp. investigated the possibility of producing alumina from an aluminous shale near Chedabucto Bay, Nova Scotia. An acid-leach process was being developed by Federated Consultants.[7]

Imports of bauxite and alumina totaled 2,540,000 short tons in 1957, 2,269,000 tons of which were for the aluminum industry. This was 2 percent less than the 2,590,000 tons imported in 1956.

Dominican Republic.—A new contract for exploration and exploitation of bauxite was signed on February 7, 1957, between Alcoa Exploration Co. and the Government of the Dominican Republic. This contract supplemented and modified the original concession obtained in 1945. The revised concession was for 50 years, with an option for a 20-year extension. Construction of a bauxite-loading dock at Cabo Rojo and a road leading to the bauxite deposits to the north was continued.

Haiti.—Reynolds Haitian Mines, Inc., began commercial shipments of bauxite in April 1957 from a concession near Miragone. Shipments came from the mine and from a 250,000-ton stockpile that had been built up during the development and construction period. The ore went to the Reynolds Metals Co. alumina plant at La Quinta, Tex.

An article describing development of the mine stated that the ore was mined by 4 yard shovels, then trucked 8 miles downhill to the drying plant and pier, which were 3,000 feet lower in elevation than the mine. The ore, while similar geologically to that of Jamaica, was more uniform and easier to mine.[8]

[7] Northern Miner (Toronto), Canadian Alumina Tests New Process: Vol. 43, No. 44, Jan. 23, 1958, p. 5.
[8] Engineering and Mining Journal, Haitian Bauxite—From Mine to Ship: Vol. 158, No. 9, September 1957, pp. 93–96.

TABLE 18.—World production of bauxite, by countries, 1948–52 (average) and 1953–57, in long tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America (dried equivalent of crude ore):						
Haiti						262,946
Jamaica	[2] 340,222	1,154,172	2,043,786	2,645,345	3,141,330	4,643,220
United States	1,491,238	1,579,739	1,994,896	1,788,341	1,743,344	1,416,172
Total	1,831,460	2,733,911	4,038,682	4,433,686	4,884,674	6,322,338
South America:						
Brazil	16,319	18,524	27,182	44,359	55,089	[3] 64,000
British Guiana	1,920,996	2,274,598	2,309,934	2,435,298	[4] 2,107,657	[4] 2,021,207
Surinam	2,417,411	3,222,630	3,308,914	3,073,688	3,429,972	3,323,677
Total	4,354,726	5,515,752	5,646,030	5,553,345	5,592,718	5,408,884
Europe:						
Austria	7,694	17,932	16,993	18,836	21,744	21,972
France	917,525	1,137,864	1,266,959	1,470,013	1,442,655	1,653,473
Germany, West	4,194	7,724	4,153	3,814	4,817	[3] 4,900
Greece	121,869	323,058	347,937	492,273	688,947	[3] 787,000
Hungary	698,592	1,372,000	1,240,000	1,221,000	1,083,000	[3] 886,000
Italy	167,612	267,100	289,454	322,005	271,427	256,987
Rumania [3]	4,500	14,300	14,800	15,800	15,800	15,800
Spain	10,478	5,106	5,644	6,290	6,921	7,275
U. S. S. R.[3]	738,000	890,000	980,000	980,000	1,080,000	1,230,000
Yugoslavia	355,964	470,016	675,846	778,527	867,500	874,215
Total [3]	3,026,400	4,505,000	4,840,000	5,310,000	5,480,000	5,740,000
Asia:						
India	51,930	70,848	74,748	81,173	91,225	96,072
Indonesia	343,835	147,191	170,504	259,512	298,511	236,703
Malaya	4,359	152,171	165,622	222,164	264,445	325,631
Pakistan				1,025	3,000	3,315
Taiwan (Quemoy)	1,555	7,430				
Total	401,679	377,640	410,874	563,874	657,181	661,721
Africa:						
French West Africa	[5] 25,637	321,384	424,195	485,216	444,371	360,221
Ghana (exports)	118,923	115,076	163,517	116,285	137,873	185,404
Mozambique	2,251	3,058	2,398	2,611	3,705	4,963
Total	146,811	439,518	590,110	604,112	585,949	550,588
Oceania: Australia	5,345	4,052	5,487	7,563	10,329	6,296
World total (estimate)	9,800,000	13,600,000	15,500,000	16,500,000	17,200,000	18,700,000

[1] This table incorporates a number of revisions of data published in previous Bauxite chapters. Data do not add to totals shown because of rounding where estimated figures are included in detail.
[2] Average for 1 year only, as 1952 was the first year of commercial production.
[3] Estimate.
[4] Exports.
[5] Average for 1949–52.

The original concession, issued in February 1944, gives Reynolds Mining Corp. the right to explore and to exploit ores containing aluminum in six areas—Île de la Tortue, Region de Genavives, Île de la Gonave, Region de Carillon, Presque Île du Sud, and Region de Saint Mare. In 1952, after long exploratory work, the company relinquished the rights to all but the Ste. Croix area of Presque Île du Sud.

Jamaica.—Jamaica became the leading bauxite producer of the world in 1957 with a mined output of 4,643,000 long dry tons. First production was in 1952; by 1954 this had grown to 2 million tons per year and changes in progress in 1957 would result in a production capacity of 8 million tons of bauxite a year. Several articles [9] described the operations of the principal companies: Kaiser Bauxite Co., Reynolds Jamaica Mines, Ltd., and Alumina Jamaica, Ltd. Reynolds completed its expansion program for doubling production, and Kaiser's north coast project was in its initial stage.

Alumina production more than doubled in comparison with 1956 when 436,000 short tons was exported in 1957. Alumina Jamaica, Ltd., completed construction in March which raised the daily capacity of the Kirkvine alumina plant to 1,500 short tons and was building a new 670-ton-per-day alumina plant at Ewarton.

Harvey Aluminum Co. and American Metal Climax, Inc., procured licenses to prospect for bauxite on the island.

Estimates of bauxite reserves were revised upward and were placed at between 500 and 600 million tons.[10]

Reynolds and Kaiser signed new contracts with the Government establishing bauxite royalties and taxes for 25 years and guaranteeing the companies mining rights for 99 years. Under the agreement the companies were to pay a royalty dependent on the quantity of ore produced. An output of under 1 million long dry tons would pay 4 shillings (1 shilling=$0.14) per ton; production under 2 million tons would pay 3 shillings per ton; and all production in excess of 2 million tons would pay 2 shillings per ton. In addition, the assumed profit per ton of bauxite, which was the basis for income tax, was considerably increased. Half of both income taxes and royalties were to vary with the price of aluminum pig on the New York market. No export duty was to be imposed for 25 years, and no further taxes were to be levied on bauxite-mining operations. An important part of the contracts related to soil restoration of mined lands, and the Government stated that the companies were more than fulfilling their agricultural obligations.[11]

Panama.—The first bauxite concession granted in Panama was obtained by Kaiser Exploration Co., subsidiary of Kaiser Aluminum & Chemical Corp. The company was given exploration and mining rights in a large area of western Panama near the Costa Rican border. Preliminary studies by the company indicated that the deposits were extensive.

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[9] Engineering and Mining Journal, Mining in Jamaica Means More and More Bauxite: Vol. 158, No. 9, September 1957, p. 97; Reynolds Jamaica—Still Growing, p. 98; Kaiser Operations in Jamaica, p. 99; Alumina Jamaica—the Plant That Wouldn't Stop Growing, pp. 100–105.

[10] Metal Bulletin (London), Jamaican Bauxite Reserves: No. 4217, Aug. 9, 1957, p. 29.

[11] American Metal Market, Reynolds Signs Long-Term Bauxite Contract With Jamaica Government: Vol. 64, No. 57, Mar. 23, 1957, pp. 1, 5.

SOUTH AMERICA

British Guiana.—The 4-month strike at the Arvida, Quebec, aluminum smelter of Aluminium, Ltd., resulted in reduced bauxite shipments to Canada. Exports of bauxite registered a 4-percent decrease in 1957 as shown in the following table:

TABLE 19.—Bauxite exported from British Guiana, 1956–57 [1]

Country of destination	1956		1957	
	Long tons	Value BW$ [2]	Long tons	Value BW$ [2]
Canada	1,585,230	18,230,828	1,469,530	20,053,383
United States	440,527	8,641,709	450,658	6,099,945
United Kindgom	19,330	544,501	21,590	573,698
Other countries	62,556	2,118,061	79,416	2,792,202
Total	2,107,643	29,535,099	2,021,194	29,519,228

[1] Includes exports of calcined bauxite as follows: 1956—317,878 tons valued at BW$11,146,382 and 1957—287,130 tons valued at BW$9,946,478.
[2] 1 BW$=US$0.58.

Demerara Bauxite Co. produced 1,976,880 long dry tons of bauxite, of which 1,362,430 tons was from the Mackenzie mines and 614,450 tons from the Ituni mines. The company acquired mining rights to the Christianburg properties of Plantation Bauxite Co., Ltd., but no production was reported during the year.

Progress was made on the construction of Demerara's new 250,000-ton alumina plant at Mackenzie. The work was on schedule until November, when the adverse aluminum market caused the company to reduce the rate of construction so that completion would be in 1960 instead of 1959.

Reynolds Metals Co. continued exploration during the year and increased its bauxite exports to the United States.

Harvey Aluminum Co., after completing exploratory work on its 1-million-acre concession, decided to postpone mining operations.

The rate of royalty on bauxite processed into alumina was raised from $0.02 to $0.20 per ton. The export duty on calcined bauxite was reduced from $1 to $0.45 per ton—the rate that applied to dried bauxite.

Surinam.—Production and shipments of bauxite declined 3 percent in 1957 after reaching a record high of 3.4 million tons in 1956.

Mining area:	Shipments	
	1956, long tons	*1957, long tons*
Surinam Aluminum Co. (Alcoa):		
Moengo	2,104,441	1,968,039
Paranam	747,501	558,881
Billiton Co	575,552	799,606
	3,427,494	3,326,526

Shipments of bauxite to the United States totaled 2,983,000 tons, of which 88,000 tons was calcined ore and 80,000 tons Chemical-grade ore. Exports to Canada were 316,000 tons of Metal-grade ore and to the Netherlands 27,000 tons of calcined ore.

The Surinam Aluminum Co.—a subsidiary of Alcoa—was organized to replace the Surinam Bauxite Co. It took over the mines and concessions of the former company and, in addition, was to build and operate the aluminum-reduction facilities that were to be constructed in conformity with the Letter of Intent signed by Alcoa and the Government of Surinam. Cutbacks in the second half of the year resulted in a decrease of 325,000 tons in shipments compared with 1956. Total shipments of 2,527,000 tons included 115,700 tons of calcined ore and 80,400 tons of Chemical-grade ore. The suction dredge built for the company in the Netherlands was put in operation removing overburden at the Ororibo deposit. A new jig plant was added to the company dense-medium concentrator at Rorac, which treated ferruginous bauxite.

The Billiton Co. increased shipments 39 percent in 1957. The increase resulted from deliveries made under the 1956 contract with Olin Revere Metals Corp. Repairs to the wharf at the Trinidad Transfer Station resulted in a loss of about 20,000 tons in August shipments of bauxite. A million-dollar contract for the design and manufacture of a 2-mile conveyor system to handle overburden from a new bauxite deposit was concluded between the Billiton Co. and Hewitt-Robins, a Netherland subsidiary of Hewitt-Robins, Inc., of Buffalo, N. Y.

Four companies had requests pending at the end of the year for new exploration permits. Alcoa, under the agreement with the Surinam Government for the Brokopondo hydroelectric project, was to receive an exploration permit covering 500,000 hectares, from which 20,000 hectares was to be selected for exploitation over a 20-year period. Billiton Co. has had an exploration request pending since 1956 for an area in the Saramacca district. Reynolds Aluminum Co. asked for 20,600 hectares on the Maretokka River (5° to 6° N., 56° to 57° W.). Petromina-Surinam, following organization of a local company, asked for 49,500 hectares in the Kabelebo area of the Nickeric district between 4° to 5° N., 57° to 58° W.

EUROPE

France.—Bauxite production in 1957 was 1,653,000 long tons, a 15-percent increase over 1956. Société Péchiney supplied 50 percent of the output, and Société des Bauxites de France, Union des Bauxites, Société des Bauxites du Midi, and Société Ugine the remaining 50 percent.

During the year 23,000 long tons of bauxite was imported for refractory and abrasive use. Exports of 320,000 tons of bauxite went principally to West Germany, 172,000 tons; and the United Kingdom, 127,000 tons.

Exports of alumina reached 114,000 long tons compared with 96,000 tons in 1956. Shipments to French Cameroon increased from 1,800 to 24,000 tons, and to Spain from 4,000 to 19,000 tons. Other shipments included 46,000 tons to Switzerland, 15,000 to Norway, 9,000 to Canada, and the remainder to other countries.

Germany, West.—Imports of bauxite into West Germany decreased 4 percent in 1957 and were from the following countries:

Country of origin:	1956, long tons	1957, long tons
Austria	4, 608	6, 540
British Guiana	16, 413	21, 024
France	203, 081	177, 686
French Guiana	-----------	19, 140
French West Africa	77, 310	86, 742
Ghana	-----------	32, 849
Greece	271, 617	268, 124
Hungary	13, 780	-----------
Indonesia	133, 478	116, 854
Surinam	32, 375	16, 218
Yugoslavia	534, 302	491, 382
Other countries	4, 449	12
Total quantity	1, 291, 413	1, 236, 571
Value, DM [1]	69, 829, 000	70, 017, 000

[1] 1 DM—US$0.238.

Alumina exports in 1957 totaled 85,000 short tons, of which 68,000 tons went to Austria, 5,000 to Spain, 5,000 to Norway, 4,000 to Czechoslovakia, 1,000 to Switzerland, and 2,000 to other countries.

An article briefly reviewing the aluminum industry in Germany stated that alumina capacity at the end of 1957 was about 550,000 short tons.[12]

Greece.—The Greek Institute of Geology and Subsurface Research, as a result of investigations, estimated bauxite reserves at 84 million long tons.

Exports of bauxite totaled 769,000 long tons, 269,000 of which went to West Germany, 394,000 to the U. S. S. R., 43,000 to the United Kingdom, 34,000 to Norway, and the remainder to other countries. Under a trade agreement signed in January 1957, Greece was to export about 394,000 long tons of bauxite to the Soviet Union.

Hungary.—Estimated production showed a decline for the fourth year from the high of 1953. Deposits of bauxite were reported at Varoslod and Sumeg, in western Hungary.

Poland.—Construction of a large alumina plant in Gorka, Cracow, to use an ore from Lower Silesia was reported.[13]

U. S. S. R.—Three large deposits of nepheline syenite were reported near Krasnoyarsk, eastern Siberia. The U. S. S. R. adapted the lime-soda sinter process to this type of ore and operated an alumina plant that used the nepheline syenite tailings of apatite mines of the Kola Peninsula as raw material.[14]

Bauxite was first discovered in the Ukraine near the village of Shestunia in Dneprotrovsk region. The deposits were reported to extend 12 miles and to lie about 200 feet deep. Reserves were estimated to suffice to supply the Zaporozhye aluminum plant for 40 years.[15] It was estimated that this would be equivalent to 20 million tons.

Yugoslavia.—The agreement between the Government of Yugoslavia, the Soviet Union, and the German Democratic Republic, originally signed in August 1956, was abrogated in April 1957 and then reinstated later in the year. It included development of bauxite de-

[12] Light Metals (London), The Industry in the World Today: Vol. 20, No. 236, November 1957, pp. 356–357.
[13] Metal Bulletin (London), Polish Alumina Plant: No. 4237, Oct. 18, 1957, p. 17.
[14] Polutoff, Von N., Die Gewinnung von Aluminium aus Nephelin [The Production of Aluminum From Nepheline]: Aluminium, vol. 34, No. 4, April 1958, pp. 102–103.
[15] American Metal Market, Bauxite Located in Ukraine: Vol. 64, No. 242, Dec. 18, 1957, p. 10.

posits in Montenegro to support the proposed 55,000-short-ton aluminum plant. Two articles describing the bauxite deposits in Yugoslavia were published.[16]

The output of bauxite in the Mostar district of Herzegovina Province in 1957 was about 241,000 long tons. Preparations were made to expand the production capacity of the district from 300,000 to 350,000 tons a year.[17]

ASIA

Borneo.—Semetan Bauxite Co. completed preparation for the mining of bauxite in the Luneu district of western Sarawak. Mining was to begin in 1958 at the rate of 175,000 tons a year. The bauxite was to be shipped principally to Japan. The deposits, discovered in 1949, contained 2.5 million tons of proved ore.

Indonesia.—Exports of bauxite declined 19 percent in 1957 when compared with those of 1956. Shipments to Japan decreased 45 percent to 97,000 long tons and those to Europe decreased 10 percent to 102,000 tons. Exports to Australia, however, increased 170 percent to 50,000 tons.

Malaya.—The production of bauxite in 1957 increased 23 percent over 1956, due principally to increased demand from Japan. Of the 326,000 long tons produced, about 50,000 tons came from the South Asia Bauxite Co. (SEBA) property and the remainder from the Ramunia Bauxite Company deposits. Exports of bauxite during 1957 totaled 341,000 tons, 307,000 tons of which went to Japan and 33,000 tons to Taiwan.

AFRICA

French Africa.—A new company, Cie. Internationale pour la Production d'Alumine, was formed to develop the bauxite deposits of Fria, French Guinea. The project was being undertaken by the French companies, Société Péchiney and Société Ugine; the American company, Olin-Mathieson Chemical Corp.; the British Aluminium, Ltd.; and the Swiss Aluminium Industrie-Aktiengesellschaft. An alumina plant capable of producing 530,000 short tons a year was to be built to process the bauxite.[18]

The proposed alumina plant to be built on the Boké concession by Les Bauxites du Midi was to produce 240,000 short tons of alumina a year. Over 3 million tons of bauxite was expected from the Boké and Fria concessions by 1961; about half of it was to be shipped to Canada and the remainder processed in French Africa. It was estimated that a total of 200 to 300 million tons of bauxite has been developed in the Boké and Fria districts.[19]

Exploration for bauxite in western Cameroon near the British Cameroon border, begun in 1956 by the Direction of Mines, disclosed only limited deposits near Foumban, but the area around Fongo-Tongo yielded samples averaging 45–50 percent alumina and was

[16] Marušić, Richard, The Bauxite Deposits of Montenegro: Berg-u. hüttenmännische, Jahrbuch der Montanischen Hochschule, Leoben, vol. 102, June 1957, pp. 169–180.
Slobodan, Vučetić, Bauxitbergbau in Jugoslawien [Bauxite Industry in Yugoslavia]: Glückauf, Essen, vol. 93, No. 25/26, June 22, 1957, pp. 752–757.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, pp. 3–4.
[18] Moyal, Maurice, Canadian Interest in Aluminum Developments in French Africa: Canadian Min. Jour., vol. 78, No. 7, July 1957, pp. 94–96.
[19] Mining Journal (London), Aluminium in French Africa: Vol. 249, No. 6376, Nov. 1, 1957, pp. 516–517.

believed to be extensive. A reserve of 30 million tons of bauxite had been indicated in the area, and prospecting in 1958 was to be expanded. Should enough ore be found, plans for establishing an alumina plant at Nkongsamba was to be considered.

Bauxite deposits estimated to contain 5 million tons of 40 percent alumina ore were reported near Dschang about 170 miles from Edea, in French Cameroon. A permit was issued for further exploration.

Société Péchiney applied for prospecting permits over a large area in the Sudan after reports indicated that there were significant bauxite reserves in the area.

OCEANIA

Australia.—Development of Australian bauxite deposits continued. The reserves of economically usable bauxite could exceed 200 million tons.[20] The deposits on Cape York were composed of loose pisolitic gravels mixed with sand grains. In place the ore contained less than 50 percent alumina, but the gravel could be readily concentrated by washing to a commercial grade.

The ore bodies discovered on the Commonwealth Aluminum Corporation Pty., Ltd., concession on the west side of the Cape York Peninsula cover 2 areas totaling about 160 square miles, 1 near Pera Head and 1 near Weipa. The ore is 8 to 25 feet thick with up to 2 feet of overburden. At Pera Head the bauxite appears as a red strip 8 to 20 feet thick and extends 15 miles along the coastal cliffs.

Aluminium Laboratories, Ltd., prospected a belt inland from the original Commonwealth concession on the coast and another area on the western coast of the Gulf of Carpenteria in Arnhem Land, Northern Territory. Rio Tinto Australian Exploration Pty., Ltd., prospected a concession along the north coast of Arnhem Land, and the Reynolds Pacific Mines Pty., Ltd., explored a 6-million-acre concession inland and parallel to the north coast of Arnhem Land.

An agreement was entered into between the Queensland Government and Commonwealth Aluminium Corporation Pty., Ltd., for the mining lease of its prospecting concession covering 2,270 square miles on the west coast of the Cape York Peninsula and a prospecting option on 500 square miles on the east coast. The area was to be reduced over a 20-year period to a lease of 1,000 square miles. Export of bauxite was to be subject to Government approval but would be permitted in the early stages. The company was to build a harbor, town, and alumina plant. An aluminum-reduction plant may be constructed after 20 years if economic conditions warrant.

Fiji Islands.—Aluminium Laboratories, Ltd., subsidiary of Aluminum Company of Canada, was examining the Fiji Islands for possible bauxite deposits.

TECHNOLOGY

The Bureau of Mines published a report of investigations describing the successful beneficiation of high-silica, low-iron bauxite to Chemical grade.[21] Crude bauxite was calcined at a low temperature, crushed

[20] The Australian Mineral Industry, Quarterly Review, Background of Aluminum: Pt. 1, vol. 10, No. 2, November 1957, p. 22.

[21] Calhoun, W. A., and Powell, H. E., Jr., Laboratory Investigation of Bauxite Ore from the Quapaw Deposit, Saline County, Ark.: Bureau of Mines Rept. of Investigations 5366, 1957, 11 pp.

to 20-mesh, and passed over a magnetic separator. The iron oxide content was reduced from 3 percent to about 2. A commercial plant using the process was under construction by American Cyanamid Co. It was estimated that the result of this research would extend the life of the company reserve of Chemical-grade bauxite 20 years.

There was continued interest in low-grade bauxite and in various nonbauxitic materials as ores of aluminum. At the end of the year the Anaconda Aluminum Co. pilot plant for the production of alumina from clay was nearing completion. Clay from the company Latah County, Idaho, mines had been stockpiled at the plant in preparation for the test program.

A mineralogical investigation was made of some of the laterites of the Hawaiian Islands.[22] The hydrolhumic latosol soil occurring on beds of andesitic ash, found chiefly on the island of Hawaii, separates on drying into light- and dark-color aggregates. The light-color fraction was composed chiefly of gibbsite; the dark-color aggregates contain over 20 percent silica and 30 to 40 percent iron oxide. This fraction is strongly magnetic, suggesting a method of concentration.

A method of calcining aluminum hydrate in a fluidized bed to a substantially nonhygroscopic alumina was patented.[23] Two or more fluidized beds were used in the process. Partly calcined alumina entrained in the gas from the upper chamber was removed from the gas stream by a dust collector and returned to the lowest or cooling hearth.

It was claimed that the partly calcined fines mixed with the coarser particles of the cooling bed produce a product more uniformly calcined than the product from a rotary kiln. It also stated that reclamation of the fines without further heating resulted in a substantial heat saving.

Several articles [24] described the bauxite operations and methods of mining in Jamaica and Haiti and the production of alumina in Jamaica. The bauxite operations, which produced the equivalent of about 2 million long dry tons of bauxite in 1954, had increased to a production of about 5 million tons in 1957. Further expansion was underway at mines, transportation facilities, ports, and alumina facilities.

The future of the aluminum industry was examined [25] to determine the research objectives that should be stressed. It was concluded that the chief problems were development of the use of raw materials other than bauxite, development of new sources of energy, investigation of the Bayer process with respect to chemical reactions and the recovery of byproducts, efficiency of electrolytic cells and rectifiers, and recovery of secondary aluminum.

[22] Sherman, G. D., Formation of Gibbsite Aggregates in Latosols Developed on Volcanic Ash: Science, vol. 125, No. 3260, June 21, 1957, pp. 1243–1244.

[23] Smith, D. B., and others (assigned to Dorr-Oliver, Inc.), Process of Calcining Alumina Trihydrate in Fluidized Bed: U. S. Patent 2,799,558, July 16, 1957.

[24] Engineering and Mining Journal, Haitian Bauxite From Mine to Ship: Vol. 158, No. 9, September 1957, pp. 93–96; Mining in Jamaica Means More and More Bauxite, p. 97; Reynolds Jamaica—Still Growing, p. 98; Kaiser Operations in Jamacia, p. 99; Alumina Jamaica—The Plant That Wouldn't Stop Growing, pp. 100–105.

[25] Ginsberg, H., [The Expansion of Production as Governing Factors of Fundamental Research in the Field of the Chemical Technology of Light Metals] (in German): Metallurgia, vol. 11, No. 3, March 1955, pp. 176–179.

Beryllium

By Donald E. Eilertsen [1]

WORLD beryl production achieved its second highest annual record in 1957, and domestic beryl production ended a 3-year downward trend. In the United States 521 tons of beryl was produced, 7,290 tons imported, and 4,309 tons consumed.

Two new plants to produce Reactor-grade beryllium for the Atomic Energy Commission (AEC) were readied, and there was growing interest in developing the use of beryllium for aircraft, rockets, and missiles.

TABLE 1.—Salient statistics of beryllium, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Beryl, approximately 10–12 percent BeO:						
Domestic mine shipments	426	751	669	500	460	521
Imports	4,137	7,998	5,816	6,037	12,371	7,290
Exports	0.5		6.8	1.1	0.4	
Consumption	2,574	2,661	1,948	[1] 3,860	[1] 4,341	4,309
Industrial end-of-year stocks	1,979	4,987	4,101	2,888	[1] 4,643	7,270
Average value per ton, domestic	$349.65	$472.02	$453.88	$535.85	$514.67	$529.47
Approximate price per unit BeO, domestic	$35	$47	$45	$49	$47	$48
Price per ton, imported	$304.98	$469.21	$442.58	$368.73	$360.47	$346.51
Approximate price per unit BeO, imported	$30	$47	$44	$37	$36	$35
Metal, alloys, compounds, and scrap: Exports	81.4	9.7	3.8	16.9	44.4	104.4
World: Beryl production, 10–12 percent BeO	6,000	8,200	7,700	8,900	[1] 12,900	11,300

[1] Revised figure.

DOMESTIC PRODUCTION

Mine Production.—A total of 521 tons of beryl was produced from almost 200 operations in a dozen States. Individual shipments of beryl ranged from a few pounds to 165 tons, and the Boomer mine in Park County, Colo., was again the leading single producer.

South Dakota produced about 51 percent of the total domestic beryl; Colorado, 35 percent; New Mexico, 6 percent; and 9 other States, 8 percent.

The Government bought 492 short dry tons of beryl under the domestic purchase program, and by the end of the year 1,695 tons of beryl had been bought on this program. The Government beryl-

[1] Commodity specialist.

purchase program terminates June 30, 1962, or when deliveries of beryl total 4,500 short tons, whichever occurs first.

Beryl was eligible for Government aid under the Defense Mineral Exploration Administration (DMEA), but no contracts were made in 1957.

TABLE 2.—Beryl shipped from mines in the United States, 1948–52 (average) and 1953–57, by States, in short tons [1]

State	1948-52 (average)	1953	1954	1955	1956	1957
Colorado	84	75	59	46	179	182
New Hampshire	73	57	12	20	(2)	4
New Mexico	89	89	117	106	31	29
South Dakota	150	392	337	294	195	268
Other [3]	30	138	144	34	55	38
Total: Short tons	426	751	669	500	460	521
Value	$148,951	$354,487	$303,649	$267,927	$236,748	$275,855
Average value per ton	$349.65	$472.02	$453.88	$535.85	$514.67	$529.47

[1] Estimated 10-12 percent BeO.
[2] Included with "Other" to avoid disclosing individual company confidential data.
[3] Arizona (1949-51) and 1953-57; Connecticut, 1953-57; Georgia, 1952-57; Idaho, 1953-54, 1957; Maine, 1948-57; Maryland, 1954, 1957; New Hampshire, 1956; New York, 1954; North Carolina, 1949, 1951, 1953-57; Virginia, 1954-56; and Wyoming, 1956-57.

Refinery Production.—Two new plants were built to process beryl to Reactor-grade beryllium for the AEC, 1 at Hazelton, Pa., by the Beryllium Corp. of Reading, Pa., and 1 near Elmore, Ohio, by the Brush Beryllium Co. of Cleveland, Ohio.

The Beryllium Corp. also processed beryl at Reading, Pa., where it produced beryllium metal, beryllium-copper master alloy, beryllium-aluminum, beryllium-nickel, beryllium-iron, and beryllia. This corporation also had rolling, foundry, and fabricating facilities at Reading, Pa., a wire-manufacturing plant at Holyoke, Mass., and a precision alloy casting plant at Exton, Pa.

The Brush Beryllium Co. used its company-owned equipment in a Government-owned plant at Luckey, Ohio, to reduce beryl to beryllium hydroxide. Part of the beryllium hydroxide was used at the Luckey plant to produce beryllium metal, and the balance of the beryllium hydroxide was diverted to its plant near Elmore, Ohio, to produce beryllium-copper master alloy, other beryllium-copper alloys, beryllium-aluminum, and beryllium-nickel. The Brush Beryllium Co. also had rolling, foundry, and fabricating facilities near Elmore, Ohio, and a beryllium-powder metallurgical fabricating plant in Cleveland, Ohio, and it increased its rolling-mill and fabrication capabilities by acquiring the net assets of Penn Precision Products, Inc., Reading, Pa.

Four other consumers of beryl were: Beryl Ores Co., Arvada, Colo., which produced specialized materials for the ceramic industry; A. O. Smith Corp., Milwaukee, Wis., which produced ground-coat frit (glass) for ceramics; Lapp Insulator Co., LeRoy, N. Y., which used ground beryl as one of the materials for high-voltage electrical porcelain; and the Ceramic Division, Champion Spark Plug Co., Detroit, Mich., which used beryl as a minor constituent in special ceramic compositions.

CONSUMPTION AND USES

A little less beryl was consumed in 1957 than in 1956, and almost all of it was imported. Production of beryllium metal, beryllium-copper master alloy, and beryllium-aluminum increased in 1957 over 1956. Beryllium-copper continued to be the principal product of the two producers.

There was growing interest in the potential use of high-purity beryllium metal for aircraft structure material and in the use of beryllium precision-machined components and parts in ultrasensitive gyroscopes and related components for inertial guidance systems for advanced missiles. Beryllium was used in developing these applications and also for development purposes in connection with nuclear energy.

Most of the beryllium produced was alloyed, in small amounts, with copper to improve resistance to fatigue, corrosion, heat, and wear. Beryllium-copper was used in various compression, extension, torsion, and power springs for meters, motor brushes, electrical switches and relays, fuse clips, and in balance weights. The alloy was also used in bearings, gears, diaphragms, dies, screw machine and welder parts, pump impellers, fuel injectors, and nonsparking tools. In the manufacture of slides for zippers, a tiny beryllium-copper bail was used to connect the body, which fits around the teeth, to the pull tab.[2]

Beryllium-nickel was used in surgical instruments.

Beryllium hardens aluminum, and some beryllium-aluminum was used as aircraft structure material.

Beryllium oxide was used in crucibles and in crucible wash for coating graphite crucibles used in vacuum induction melting. Beryllia was also used for high-temperature electrical and thermal insulators and for development purposes in connection with nuclear energy.

STOCKS

End-of-year consumers stocks of beryl totaled 7,270 tons—the largest ever recorded—and stocks on hand of beryllium metal, beryllium-copper master alloy, beryllium-nickel, and beryllium-aluminum were larger than in the preceding year.

Some imported beryl was bought for the national stockpile, and quantities of beryl and beryllium-copper were obtained and placed in the national stockpile as a result of the United States Department of Agriculture barter program in which the Commodity Credit Corporation exchanges surplus farm commodities for strategic materials.

PRICES AND SPECIFICATIONS

E&MJ Metal and Mineral Markets quoted domestic beryl, 10–12 percent BeO, from $46–$48 per short-ton unit of BeO, f. o. b. mine. Quotations for imported ore per short-ton unit, based on 10–12 percent BeO, c. i. f. United States ports, ranged from $36–$38 per

[2] Steel, Strengthens Zipper: Vol. 140, No. 23, June 10, 1957, pp. 180, 182.

unit early in the year and remained at $36–$37 after February 20. Special ore was quoted at $39 per unit of BeO.

Domestically produced beryl crystals cobbed free of waste was purchased for Government stockpiles. Shipments of beryl up to 500 pounds were purchased on visual inspection at a flat price of $400 per short dry ton. Shipments accepted by sampling and chemical analysis were purchased on the basis of short-ton units (20 pounds) of contained BeO as follows: 8 to 8.9 percent, $40; 9 to 9.9 percent, $45; and 10 percent and over, $50.

The American Metal Market quoted the following prices: Beryllium metal, 97 percent lump or beads, f. o. b. Cleveland, Ohio, and Reading, Pa., $71.50 per pound. Beryllium-copper master alloy was quoted f. o. b. Reading, Pa., or Elmore, Ohio, and Reading, Pa., or Detroit, Mich., after June 28 at $43 per pound of contained beryllium, with the balance as copper at market price on date of shipment. Beryllium-aluminum was quoted f. o. b., Reading, Pa., and Detroit, Mich., at $74.75 per pound of contained beryllium plus aluminum at market price, for 5-pound ingot. The price of beryllium-copper strip ranged from $1.78 to $1.91 per pound and remained steady at $1.82 per pound after September 6. Beryllium-copper rod, bar, or wire was quoted at $1.77–$1.83 per pound until September 6 and then $1.80 per pound for the remainder of the year.

The price of Reactor-grade beryllium scheduled for annual delivery (at the rate of 200,000 pounds) to the Atomic Energy Commission over a period of 5 years was $47 per pound.

The Beryllium Corp. quoted the following prices per pound of beryllia: Grade 1, calcined, $10; grade 2, high-fired, $15; and grade 3, high-fired and ball-mill-ground, $20.

FOREIGN TRADE [3]

United States imports of beryl, totaling 7,290 short tons, were 41 percent lower than in 1956 but still greater than in any previous year except 1953. Shipments of beryl were received from 11 countries, and those from Brazil, Argentina, and India composed 68 percent of the total imported beryl. Imports of beryl far exceeded consumption.

Other imports for consumption included: 5,007 pounds of beryllium compounds valued at $32,594 from France and 2,204 pounds of beryllium compounds valued at $4,960 from West Germany.

Exports were: 90 pounds of beryllium and beryllium alloys (except beryllium-copper) valued at $6,900 and shipped to United Kingdom; 2,076 pounds of beryllium semifabricated forms valued at $7,121 and shipped mostly to Canada; and 206,605 pounds of beryllium metal and alloys in crude form and scrap (except beryllium-copper) valued at $246,101 and shipped mostly to Canada.

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

TABLE 3.—Beryllium ore (beryl concentrate) imported for consumption in the United States, 1954–57, by countries, in short tons

[Bureau of the Census]

Country	1954	1955	1956	1957	Total (short tons)	Percent of total
South America:						
Argentina		441	2,330	1,545	4,316	13.7
Brazil	1,828	1,735	2,607	2,165	8,335	26.5
Surinam	10				10	(1)
Total	1,838	2,176	4,937	3,710	12,661	40.2
Europe:						
Portugal	338	283	242	33	896	2.8
Sweden	5				5	(1)
Total	343	283	242	33	901	2.8
Asia:						
Afghanistan	11				11	(1)
Hong Kong			1		1	(1)
India	392	845	3,360	1,256	5,853	18.6
Korea	4	6			10	(1)
Pakistan			15	69	84	.3
Total	407	851	3,376	1,325	5,959	18.9
Africa:						
Belgian Congo	11	128	992	222	1,353	4.3
British East Africa (principally Uganda)	23	93	264	56	436	1.4
British Somaliland			29		29	.1
British West Africa, n. e. c.			22		22	.1
Madagascar	77	28	212	43	360	1.1
Morocco			26		26	.1
Mozambique	1,295	620	1,110	965	3,990	12.7
Nigeria		3			3	(1)
Rhodesia and Nyasaland, Federation of	957	861	559	266	2,643	8.4
Union of South Africa (includes South-West Africa)	865	994	602	670	3,131	9.9
Total	3,228	2,727	3,816	2,222	11,993	38.1
Grand total: Short tons	5,816	6,037	12,371	7,290	31,514	100.0
Value	$2,574,061	$2,226,068	$4,459,387	$2,526,068		

[1] Less than 0.1 percent.

WORLD REVIEW

World output of beryl was the second largest reported for any year. Of the 11,300 tons of beryl produced, the United States furnished less than 5 percent and imported nearly 65 percent. North America (United States) produced 5 percent; South America, 33 percent; Europe, 2 percent; Asia, 11 percent; Africa, 46 percent; and Australia, 3 percent.

Afghanistan.—Sixty tons of beryl produced from Chapa Dara during the past 3 years was sold to an American firm.[4]

United Kingdom.—The plant of Murex, Ltd., at Milford Haven, a producer of beryllium hydroxide since 1949, was placed under the control of the Atomic Energy Authority. Plans were made to enlarge operations.[5]

[4] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 6.

[5] Chemical Trade Journal and Chemical Engineer (London), Beryllium for Nuclear Reactors: Vol. 141, No. 3682, Dec. 27, 1957, p. 1554.

At the invitation of the Atomic Energy Authority, a small quantity of beryllium metal was produced from a pilot plant operated by Consolidated Zinc, Ltd. Rhodesian beryl was used.[6]

Temporary exemption of beryllium oxide from United Kingdom Key Industry Duty was extended from August 1957 to February 19, 1958.[7]

TABLE 4.—World production of beryl, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America: United States (mine shipments)	426	751	669	500	460	521
South America:						
Argentina	202	683	705	1,488	1,722	1,519
Brazil	2,325	2,126	1,581	1,954	2,321	[3] 2,165
Surinam		2	10			
Total	2,527	2,811	2,296	3,442	4,043	3,684
Europe: [1] Portugal	[4] 72	414	368	337	244	186
Asia:						
Afghanistan	[5] 3	11	30	33	30	[6] 30
India	[6] 230	[3] 200	[3] 392	[3] 845	[3] 3,360	[3] 1,256
Korea, Republic of		4	[3] 4	[3] 6		(7)
Total	233	215	426	884	3,390	1,286
Africa:						
Belgian Congo (including Ruanda-Urundi)		8	50	362	1,860	[6] 1,400
British Somaliland				19	17	
Kenya	[8] 1					6
Madagascar	320	516	648	316	169	[6] 165
Morocco: Southern Zone	117	36	17	2		
Mozambique	188	276	1,002	960	950	1,871
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	[5] 7	6	1	21	13	5
Southern Rhodesia	[4] 814	1,774	1,077	965	606	572
South-West Africa	503	590	564	472	454	385
Uganda	34	55	77	110	98	78
Union of South Africa	[4] 561	531	203	137	133	711
Total	2,545	3,792	3,639	3,364	4,300	5,193
Oceania: Australia	71	140	166	230	356	[6] 330
World total (estimate) [1]	6,000	8,200	7,700	8,900	12,900	11,300

[1] In addition to the countries listed, beryl has been produced in a number of countries, including France, Norway, Tanganyika, and U. S. S. R., for which no production data are available; except for U. S. S. R., their aggregate output is not significant. An estimate for U. S. S. R. is included in the world total.
[2] This table incorporates a number of revisions of data published in previous Beryl chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] United States imports.
[4] Average for 1949–52.
[5] Average for 1950–52.
[6] Estimate.
[7] Less than 0.5 ton.
[8] One year only, as 1952 was first year of commercial production.

TECHNOLOGY

In the interest of conserving mineral resources and finding adequate and dependable long-range supplies of beryl, the Bureau of Mines continued research on recovering low-grade beryl and other minerals from pegmatites and developing beryllium-extraction methods.

[6] Mining Journal (London), Beryllium in the U. K.: Vol. 248, No. 6347, Apr. 12, 1957, p. 463.
[7] Metal Bulletin (London), Beryllium Oxide Duty Exemption: No. 4225, Sept. 6, 1957, p. 20.

Work on beryl flotation was conducted at experiment stations at Tuscaloosa, Ala., College Park, Md., Rapid City, S. Dak., and Salt Lake City, Utah, and research on extracting beryllium from various grades of beryl concentrate was done at Rapid City and Salt Lake City.

At the Rapid City Experiment Station, 25 percent beryl concentrate was produced from pegmatite containing 2 pounds of beryl per ton of rock; and, on re-treatment using batch testing methods, 88- to 93-percent beryl concentrate was produced. Another test produced 88-percent beryl concentrate from rock having 2.5 percent beryl. The results obtained were good, but it was found that more research was needed to simplify and improve procedures.[8]

At the Bureau of Mines Southern Experiment Station in Tuscaloosa, Ala., pegmatite samples from the North Carolina tin-spodumene belt containing about 8 pounds of beryl per ton of rock were upgraded to 3 to 5 percent beryl concentrate. On re-treatment of this concentrate, 10-percent BeO beryl concentrate was made. More research was needed to improve procedures.

A report describing the Peerless pegmatite in South Dakota was published.[9]

The use of beryllium oxide for rocket nozzles was studied.[10]

With proper control of hazards during beryllium-metal machining, recommended standards can be met satisfactorily.[11]

The attack on beryllium in water at 600° F. was described,[12] and results of some studies of the ductility of beryllium were published.[13]

A new type of beryllium-copper strip free from surface oxides was produced for use in electronic and other fields.[14]

A patent was issued for beryllium-copper alloys having approximately 1 percent beryllium, 2 percent zinc, 0.35 percent cobalt, 0.40 percent iron, 0.15 percent aluminum, 0.35 percent silicon, 0.40 percent tin, and the balance copper.[15]

A patent was also issued for production of beryllium fluoride.[16]

Hambergite, a rare beryllium borate containing approximately 53 percent BeO, was discovered in California. Crystals up to 2 inches in length were found.[17]

Data were published on toxicity, fire hazards, storage, and handling of many beryllium materials.[18]

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[8] Runke, S. M., and Riley, J. M., Progress Report on Pegmatite Investigations in South Dakota for Fiscal Years 1954–56: Bureau of Mines Rept. of Investigations 5339, 1957, 18 pp.

[9] Sheridan, Douglas M., Stephens, Hal G., Staatz, Mortimer H., and Norton, James J., Geology and Beryl Deposits of the Peerless Pegmatite, Pennington County, S. Dak.: Geol. Survey Prof. Paper 297–A, 1957, 47 pp.

[10] Bielawski, Chester A., Harkulick, Theodore M., and Long, Russell E., A Study of Hot Pressing of Beryllia Rocket Nozzles: Wright Air Development Center (WADC), Rept. 57–32, Astia Document AD 118278, Office of Tech. Services, U. S. Dept. of Commerce, May 1957, 50 pp.

[11] Mitchell, R. N., and Hyatt, E. C., Beryllium-Hazard Evaluation and Control Covering a Five-Year Study: Am. Ind. Hyg. Assoc. Quart., vol. 18, No. 3, September 1957, pp. 207–213.

[12] Kneppel, D. S., Corrosion of Beryllium in 600° F. Water: U. S. Atomic Energy Comm., NMI–1190, Office of Tech. Services, U. S. Dept. of Commerce, September 1957, 21 pp.

[13] Greenspan, Jacob, Ductility in Beryllium Related to Grain Orientation and Grain Size: U. S. Atomic Energy Comm., NMI–1174, Office of Tech. Services, U. S. Dept. of Commerce, August 1957, 39 pp.

[14] American Metal Market, American Silver Co. Making New Type of Beryllium-Copper: Vol. 64, No. 20, Jan. 29, 1957, p. 5.

[15] Donachie, Matthew J. (assigned to Beryllium Corp., Reading, Pa.), Beryllium-Copper Alloys: U. S. Patent 2,789,899, Apr. 23, 1957.

[16] Morana, J. Simon, and Simmons, Gordon F. (assigned to Beryllium Corp., Reading, Pa.), Production of Beryllium Fluoride: U. S. Patent 2,804,372, Aug. 27, 1957.

[17] Mineral Information Service, State of California, Rare Mineral Found in California; Vol. 10, No. 9, Sept. 1, 1957, p. 5.

[18] Sax, N. Irving, Dangerous Properties of Industrial Materials: Reinhold Pub. Co., New York, N.Y., 1957, pp. 357–362.

Bismuth

By H. M. Callaway [1] and Edith den Hartog [2]

DOMESTIC production of bismuth in 1957 remained essentially the same as in 1956—a departure from the large annual increases recorded in 1955 and 1956. Consumption of bismuth metal by the domestic industry advanced slightly above the general business trend, registering a 7-percent gain over 1956.

Although the volume of imports was 8 percent below 1956, exports declined at a much greater rate, giving a large net increase in the segment of domestic supply obtained from foreign refiners.

Deliveries to Government account, although somewhat less than in 1956, were large enough to lessen considerably the effects of oversupply and to maintain a degree of stability in business transactions in bismuth.

TABLE 1.—Salient statistics of bismuth metal, 1948–52 (average) and 1953–57, in pounds

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Consumption	(1)	1,568,000	1,439,000	1,548,000	1,513,000	1,615,200
Imports	569,000	641,400	644,300	595,600	918,200	847,900
Exports [2]	226,800	127,000	137,900	203,700	287,100	158,400
Consumers' and dealers' stocks, Dec. 31	(1)	166,700	252,800	234,300	229,000	348,400
Price per pound, New York, ton lots	$2.10	$2.25	$2.25	$2.25	$2.25	$2.25
World: Production	3,900,000	4,600,000	3,700,000	4,200,000	5,300,000	4,800,000

[1] Data not available.
[2] Metal and alloys.

DOMESTIC PRODUCTION

Virtually the entire domestic output of bismuth metal in 1957 was a byproduct of lead refineries and came from bullion that contained bismuth as an impurity. The bullion, in turn, was derived from processing both domestic and foreign ores. After increasing 24 and 38 percent, respectively, in 1955 and 1956, production in 1957 remained virtually unchanged.

Companies reporting production in 1957 were American Smelting and Refining Co., The Anaconda Co., and United States Smelting Lead Refinery, Inc. (a subsidiary of United States Smelting, Refining & Mining Co.).

Secondary bismuth accounted for more than 60,000 pounds of the consumer supply in 1957, according to industrial sources.

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

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CONSUMPTION AND USES

In 1957 users of bismuth in the United States consumed 1.6 million pounds of metal—7 percent more than in 1956. The increase was due to expanded uses in fusible bismuth alloys and in experimental devices. Bismuth consumed in alloy fabrication composed 64 percent of the total; most of the remainder was consumed in pharmaceutical compounds. Because consumer items have been regrouped and uses reclassified, the components of consumption shown in table 2 are not directly comparable with those published in earlier years.

STOCKS

Stocks of metallic bismuth held by consumers and dealers rose 52 percent in 1957 to 348,400 pounds. This quantity is the largest recorded in the 7 years that the Bureau of Mines has assembled data on bismuth stocks.

Stocks at domestic refineries increased very little during 1957.

TABLE 2.—Bismuth metal consumed in the United States, 1954–57, by uses

Use	1954		1955		1956	
	Pounds	Percent of total	Pounds	Percent of total	Pounds	Percent of total
Fuse metal	192,300	13	176,000	11	179,600	12
Solder	139,600	10	122,000	8	152,800	10
Other alloys	415,000	29	568,000	37	601,300	40
Selenium rectifiers	42,600	3	26,400	2	13,000	1
Pharmaceuticals [1]	433,500	30	471,000	30	425,200	28
Other uses	216,000	15	184,600	12	141,100	9
Total	1,439,000	100	1,548,000	100	1,513,000	100

Use [2]	1957	
	Pounds	Percent of total
Fusible alloys	335,500	21
Other alloys	688,000	43
Pharmaceuticals	402,300	25
Experimental uses	83,600	5
Other uses	105,800	6
Total	1,615,200	100

[1] Includes industrial chemicals.
[2] The 1957 consumption components have been reclassified, and individual totals therefore are not directly comparable with those of preceding years.

PRICES

In 1957 the E&MJ Metal and Mineral Markets continued to quote the New York price for refined bismuth metal at $2.25 per pound, in ton lots—a price that has remained unchanged since September 1950. The Metal Bulletin (London) quotation also remained unchanged at $2.24 per pound. As commercial bismuth ore is not produced in this country, ore is not quoted on the domestic market. However, the Metal Bulletin (London) quoted $1.19 per pound of contained bismuth for concentrate having a minimum of 65 percent bismuth. Bismuth concentrate of lower grade commanded proportionally lower prices. Prices of bismuth chemicals and compounds, as listed in Oil, Paint and Drug Reporter, were recorded in the 1955 Minerals Yearbook chapter on Bismuth and remained unchanged in 1956 and 1957.

FOREIGN TRADE[3]

Imports of refined metal totaled 848,000 pounds in 1957, a decrease of 8 percent from the alltime peak of 1956 but 118,000 pounds above average annual imports for 1953–57. Peru was by far the principal contributor, furnishing 66 percent of the total, and Mexico was second, furnishing 25 percent. In order of their contribution Yugoslavia, Canada, and Netherlands supplied the remaining 9 percent.

Substantial quantities of bismuth also entered the United States as a minor constituent of ore concentrates, base-metal bullion, and impure bismuth-lead bars. The economically recoverable bismuth in the concentrates and bullion eventually entered the market as domestically refined bismuth. The greater portion of the bismuth-lead bars was consumed directly in making alloys and is not included in Bureau of Mines figures. This category of imported bismuth was estimated by industrial sources to have been 200,000 pounds in 1957.

TABLE 3.—Metallic bismuth imported [1] into the United States, 1954–57, in pounds

[Bureau of the Census]

Country	1954	1955	1956	1957
North America:				
Canada	34,723	54,788	50,096	21,695
Mexico	63,866	123,722	122,115	215,475
Total	98,589	178,510	172,211	237,170
South America: Peru	400,278	326,415	324,824	558,737
Europe:				
Netherlands	3,307	17,204		3,461
United Kingdom			396,866	
Yugoslavia	74,725	66,039	24,251	48,500
Total	78,032	83,243	421,117	51,961
Asia	[2] 67,358	[3] 7,398		
Grand total	644,257	595,566	918,152	847,868

[1] Data are "general" imports; that is, they include bismuth imported for consumption plus material entering the country under bond. [2] Republic of Korea. [3] Japan.

TABLE 4.—Bismuth metal and alloys exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Gross weight, pounds	Value	Year	Gross weight, pounds	Value
1948–52 (average)	226,791	$493,379	1955	203,667	363,186
1953	127,010	300,963	1956	287,092	558,601
1954	137,856	185,841	1957	158,393	213,313

The gross weight of bismuth metal and alloys exported from the United States in 1957 was 158,000 pounds. This figure is 55 percent below gross exports in 1956 but is considerably above average exports for earlier years. The decline in 1957 was due entirely to decreased shipments of refined metal.

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

WORLD REVIEW

Estimated world output of bismuth in 1957 was 4.8 million pounds—a substantial decrease from that in 1956; however, the trend of world production in earlier years indicates continuing long-range expansion in output of bismuth.

Bolivia.—Mines in Bolivia produced 84,000 pounds of contained bismuth. Approximately 80 percent was from nationalized units. Exports through September were only 12,000 pounds, most of which was shipped to United Kingdom refineries.

Canada.—Total production in 1957 was 277,000 pounds, of which approximately one-half was refined metal. Canada consumed about 100,000 pounds. Therefore, nearly 180,000 pounds was available for export. Net imports into the United States from Canada were 17,500 pounds of metal and an undetermined quantity of bismuth in intermediate metallurgical products.

TABLE 5.—World production of bismuth, by countries,[1] 1948–52 (average) and 1953–57, in pounds [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada (metal) [3]	185,489	117,366	258,675	265,896	285,861	276,791
Mexico [3]	606,765	739,209	795,900	773,800	1,391,100	782,600
South America:						
Argentina:						
Metal	[4] 220			16,300		
In ore [4]	220	1,340	10,140	20,700	13,700	13,000
Bolivia	[5] 67,079	[5] 138,731	[5] 101,467	[5] 94,600	100,000	84,000
Peru [3]	565,500	631,990	691,726	734,714	634,757	757,972
Europe:						
France (in ore)	162,699	159,000	24,300	69,500	142,200	141,100
Spain (metal)	36,559	56,006	32,985	48,234	[6] 139,000	[6] 210,000
Sweden [4]	26,500	132,000	110,000	145,500	88,000	120,000
Yugoslavia (metal)	146,315	217,047	241,842	229,516	245,039	219,805
Asia:						
China (in ore)	[4] 49,600	(7)	(7)	(7)	(7)	(7)
Japan (metal)	74,075	110,159	118,610	142,364	156,859	[4] 140,000
Korea, Republic of (in ore)	139,913	529,000	254,000	287,000	401,000	240,000
Africa:						
Belgian Congo (in ore)	1,041		2,000	70		
Mozambique	3,247	7,057	1,905	4,145	785	6,800
South-West Africa (in ore)	[8] 3,439	100	2,500	2,360	310	670
Uganda	8,851	1,100	400	3,100	660	[4] 1,000
Union of South Africa (in ore)	8,314	1,600	1,080	228	360	145
Oceania: Australia (in ore)	3,631	880	1,345	3,000	5,150	(7)
World total (estimate) [1] [2]	3,900,000	4,600,000	3,700,000	4,200,000	5,300,000	4,800,000

[1] United States production included in total; Bureau of Mines not at liberty to publish separately. Bismuth is believed to be produced also in Brazil and U. S. S. R. Production figures are not available for these countries, but estimates by senior author of chapter are included in total.
[2] This table incorporates a number of revisions of data published in previous Bismuth chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Refined metal plus bismuth content of bullion exported.
[4] Estimate.
[5] Bismuth content in ore and bullion exported, excluding that in tin concentrates.
[6] Estimated recoverable content of ore produced.
[7] Data not available; estimate by senior author of chapter included in total.
[8] Average for 1949–52.

Consolidated Mining & Smelting Co. of Canada, Trail, British Columbia, continued to be the leading Canadian producer. Most of the bismuth originated as a minor constituent of lead-zinc-silver ores mined at Kimberley, British Columbia. Molybdenite Corp. of Canada, Ltd., La Corne, Quebec, was the second largest producer, redeeming a semirefined bismuth metal from its molybdenum-bismuth ore. A small part of the country's production was recovered in bullion by Deloro Smelting & Refining Co., Ltd., at Deloro, Ontario, from silver-cobalt ores mined in northern Ontario.

France.—Estimated production of bismuth in France was 141,000 pounds in 1957. The entire output came from Mines et Usines de Salsigne at Meymac, France, where bismuth occurs in an ore body containing gold, tungsten, silver, and arsenic. A semirefined bismuth metal was produced at the company smelter. France is a net importer of bismuth, being one of the world's largest consumers. In addition to native production, France uses approximately 450,000 pounds annually. In 1957 the bulk of the French imports of bismuth came from the United Kingdom.

Japan.—Byproduct bismuth was derived from treating Japanese sulfide ores in excess of internal needs. Estimated production in 1957 was 140,000 pounds.

Korea, Republic of.—The Korea Tungsten Mining Co. produced byproduct bismuth from its San Dong tungsten mine. Estimated output was 240,000 pounds in 1957.

Mexico.—Production of bismuth in Mexico is estimated at 783,000 pounds in 1957. American Smelting and Refining Co., which produced a semirefined high-bismuth bullion at Monterrey, was the leading producer. Cia. Metalúrgica Penoles, S. A., a subsidiary of American Metal-Climax, Inc., was the only other producer. Since 1953, this company has produced bismuth metal of high purity at its refinery at Penoles. Except for an insignificant quantity of bismuth consumed within the country, Mexico's bismuth output was exported to the United States and Great Britain. Minor quantities have gone to the Netherlands, Belgium, and other European countries in some years.

Peru.—Cerro de Pasco Corp. produced bismuth at its La Oroya smelter as a byproduct of processing base-metal ore containing minor quantities of bismuth. Virtually the entire output was shipped to the United States to Cerro de Pasco's fusible-alloy fabrication plant. Estimated Peruvian bismuth production in 1957 was 758,000 pounds, of which approximately two-thirds was refined metal.

Spain.—Estimated production of bismuth in Spain was 210,000 pounds in 1957. Bismuth ores are mined from fissure veins in Córdoba Province. Reserves reportedly are sufficient to justify long-range development. German organizations have been granted investment concessions by the Spanish Government.

Sweden.—Bismuth was produced as a byproduct of sulfide ores from Boliden Co. mines. Sweden's production in 1957 was estimated at 120,000 pounds. Consumption within the country was about 20,000 pounds, leaving a balance of 100,000 pounds available for export.

United Kingdom.—Having no commercial primary source of bismuth, the United Kingdom is a major importer of foreign ores and metal. It is also the distribution center for other European consumers. In 1957 United Kingdom industries consumed an estimated 680,000 pounds of bismuth metal. Bismuth is traded freely between the United Kingdom and the United States as world supply-and-demand schedules shift.

Yugoslavia.—Estimates of 1957 output of bismuth in Yugoslavia were 220,000 pounds. Less than 10 percent was consumed internally, approximately 170,000 pounds being distributed according to bilateral trade agreements between Yugoslavia and other European countries. Owing to Yugoslavia's preference for dollars, the remaining output entered the United States. Production was from the lead-zinc ores of the Trepca mines.

TECHNOLOGY

The Franklin Institute, under sponsorship of a group of refrigeration companies, reported "very satisfactory" results in experiments to develop practicable thermoelectric heat pumps using bismuth telluride junctions. Battelle Memorial Institute announced an experimental cooling unit that operated with a temperature difference of 85° F. between an inner chamber and outside heat-conducting fins and with a power input of 20 watts.[4] The operation is based on the Peltier-Seebeck effect, a phenomenon that causes different temperatures to develop in two metals when an electric current is passed through their junction. Conversely, a current is generated in a circuit composed of such junctions having different temperatures. The effect is most pronounced in semiconductor materials. Bismuth telluride is the most widely recognized junction alloy. In previous experiments rapid backflow of heat generated by internal resistance at the junction has tended to nullify Peltier cooling. To overcome this problem, researchers have sought semiconductor materials having relatively high electrical and low thermal conductivity. Junction members are of different materials in which heat energy is transferred more readily through one member in the direction of current flow and through the other member in the opposite direction.

Babcock & Wilcox Co., under a contract signed in 1956 with the Atomic Energy Commission, was carrying forward engineering experiments preliminary to constructing a liquid-metal thermal reactor. The advantages of using a solution of uranium in molten bismuth as the fuel component of a nuclear reactor have long been recognized. The heat is transferred by the same mobile vehicle in which it is generated, thus allowing higher, more efficient operating temperatures in relatively simple, low-pressure systems. Also, an irradiated fertile material suspended in a bismuth blanket solution surrounding the core of the reactor may produce nuclear fuel as rapidly as it is exhausted in the core itself. Both the newly generated fuel and the fission products can be removed from the molten blanket and core, respectively, in a continuous-flow process. Bismuth's reasonably low neutron-capture cross section offers a minimum of interference to the neutron energy required to sustain fission in the core and transmute fertile material in the blanket. Its rather high density readily attenuates gamma radiation, reducing the mass of necessary external biological shielding, and its low melting point and low vapor pressure give a range of high temperatures for efficient operation at low pressure. An engineering problem that is being slowly solved is dynamic corrosion of the containing vessels by the bismuth fuel and blanket solutions. Some approaches to prevention are use of protective coatings, development of new alloys, and use of inhibiting additives.

[4] Battelle Technical Review, vol. 6, No. 8, 1957, p. 13.

Boron

By Henry E. Stipp [1] and Annie L. Mattila [2]

BORON received widespread attention in 1957 as one of the promising elements for use in high-energy fuels. Boron research also was heavily concentrated on developing high-energy fuels. The growing use of boron in other fields, such as atomic energy, metallurgy, and hard and refractory materials, also was noteworthy. Expansion of industrial production capacity continued.

TABLE 1.—Salient statistics of boron minerals and compounds in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Sold or used by producers:						
Short tons:						
Gross weight [1]	602, 577	715, 228	790, 449	924, 496	[2] 568, 087	597, 857
B_2O_3 content	175, 000	213, 300	230, 500	293, 165	[2] 282, 874	293, 483
Value	$14, 537, 000	$17, 668, 000	$26, 714, 000	$33, 816, 000	[2] $35, 722, 000	$40, 817, 000
Imports for consumption (refined):						
Pounds	1, 490	624		22, 046		
Value	$631	$216		$2, 400		
Exports:						
Short tons	127, 950	139, 317	205, 614	222, 588	243, 725	214, 497
Value	$7, 857, 000	$8, 972, 000	$12, 904, 000	$14, 533, 000	$16, 596, 000	$15, 975, 000
Apparent consumption:						
Short tons	474, 630	575, 911	584, 835	701, 919	[1 2] 324, 362	[1] 383, 360

[1] Gross weights reported for 1948 to 1955 included a higher proportion of crude ore to finished products than in 1956 and 1957.
[2] Revised figure.

DOMESTIC PRODUCTION

In the United States boron minerals were produced from the bedded deposits and natural brines of California. American Potash & Chemical Corp. recovered boron minerals from the brine of Searles Lake at Trona, Calif; Pacific Coast Borax Division of U. S. Borax & Chemical Corp. mined kernite and borax from a bedded deposit in the Kramer district near Boron, Calif., colemanite at Death Valley Junction, and ulexite from a deposit near Shoshone, Calif.; and West End Chemical Division of Stauffer Chemical Co. recovered boron minerals from the brine of Searles Lake at Westend, Calif.

The U. S. Borax & Chemical Corp. dedicated its $20 million open-pit mine and refinery at Boron, Calif., on November 13, 1957. Representatives from the United States Department of the Interior, the Air Force, the Navy, the State of California, and industry were among those participating in the ceremonies.

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

In constructing the open-pit mine, the company removed approximately 9,000,000 tons of alluvial material to reach the deposit at a depth of 137 feet. The underground Jenifer mine was closed soon after production from the open-pit mine began in May. The refinery, adjacent to the pit, covers an area of 80 acres and contains larger and more fully automated processing equipment than the older Wilmington refinery. The new refinery began operating in July; however, full production was not attained until the end of the year because of technical problems. All basic products were manufactured at Boron; however, boric acid and specialties were produced at the Wilmington (Calif.) refinery.

U. S. Borax & Chemical Corp. reported that dollar volume of domestic sales in 1957 was the highest in history, but total tonnage of all products sold was only slightly lower than in 1956.[3] Export sales of this firm were generally excellent until the end of June when demand eased.

CONSUMPTION AND USES

It was estimated that 50 percent of boron-minerals production was consumed in the glass and ceramics industries in 1957.[4] Other major uses included soaps, cleansers and detergents, fertilizers, and weedkillers. Boron compounds were used as the intermediate chemicals in many chemical and manufacturing industries. An application of special interest in 1957 was that in high-energy fuels. Three boron compounds reported used as intermediates in producing high-energy fuels are sodium borohydride, boron trichloride, and boron trifluoride. Sodium borohydride was also used as a reducing agent in manufacturing paper, pharmaceuticals, and fine chemicals. In addition to its use in producing high-energy fuel, boron trichloride was a catalyst in producing silicones and an extinguishing agent for magnesium fires. Boron trifluoride was employed in producing coumaron-indene resins and other coal and petroleum derivatives, dodecyl mercaptan dyes, and a variety of miscellaneous catalytic uses. It was used in recovering the boron-10 isotope, which is used to control neutrons in atomic reactors.

Boron carbide (B_4C) was used as a chemical intermediate, an abrasive, and a neutron-control material in atomic reactors.

Elemental boron was utilized as a deoxidizer and grain-refining alloy in nonferrous metals, as an igniter in rectifier and control tubes, as a neutron absorber in control rods and shields for atomic reactors, in fuses for rockets and flares, and in solar batteries. Organic compounds of boron were employed as antiknock additives in motor fuel to improve the removal of carbon deposits and prevent preignition firing. Borate esters were used as dehydrating agents, synthesis intermediates, special solvents, catalysts, plasticizers, adhesion additives for latex paint, and in soldering or brazing fluxes. Extremely small quantities of boron, in the form of boron compounds, were added to low- and medium-carbon and low-alloy steels to increase harden-

[3] U. S. Borax & Chemical Corp., Annual Report: 1957, p. 6.
[4] American Ceramic Society Bulletin, Borax and Boron Compounds: Vol. 36, No. 6, June 1957, pp. 208–210.

ability and save other alloying metals. Small additions of boron were increasingly used in stainless steels and related alloys to control corrosion and heat resistance, reduce hot shortness, and increase yield. During 1957, 64 net tons of boron metal (461 tons gross weight of alloying compounds) was consumed in manufacturing steel in the United States, as compared with 50 (revised figure) net tons of boron metal (468 tons gross weight of alloying compounds) in 1956.[5]

Expansion of boron-products capacity continued during 1957. Pilot-plant production of decaborane began at the Henderson, Nev., plant of American Potash & Chemical Corp.[6] This firm also announced that the production of boron trichloride and boron tribromide had begun at its Los Angeles plant.

American Potash & Chemical Corp., Food Machinery & Chemical Corp., and National Distillers & Chemical Corp. announced formation of a new firm, AFN, Inc.[7] The new, jointly owned firm was formed for development and pilot-plant work on boron fuels.

Anderson Chemical Co. began producing trimethoxyboroxine commercially.[8]

Callery Chemical Co. began constructing a $38 million plant near Muskogee, Okla., and a $4 million boron chemicals plant near Lawrence, Kans.[9]

The Hooker Electrochemical Co. plant has produced the boron–10 isotope since June 1954 at Model City, N. Y., under an AEC contract.

TABLE 2.—Production of alloy-steel ingots (other than stainless-steel ingots) in the United States, net tons [1]

Grade	1956		1957	
	Without boron	With boron	Without boron	With boron
Carbon-boron		29,173		18,911
Nickel	33,347		31,971	
Molybdenum	582,640	29,192	686,968	36,680
Manganese	205,270	38,696	145,945	27,526
Manganese-molybdenum	390,241		405,729	
Chromium	1,377,028	106,054	1,218,982	76,163
Chromium-vanadium	72,222		55,411	
Nickel-chromium	114,482		115,666	211
Chromium-molybdenum	1,195,359		898,900	8,531
Nickel-molybdenum	405,349	3,202	330,579	2,874
Nickel-chromium-molybdenum	1,330,686	65,400	1,024,922	37,979
Silico-manganese	111,788		72,472	
All other	582,269	26,379	533,786	49,094
Subtotal	6,400,681	298,096	5,521,331	257,969
High-strength steels	982,918	17,060	977,454	
Silcon sheet steels	1,313,313		1,036,925	
Total all grades	8,696,912	315,156	7,535,710	257,969

[1] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1957, p. 61.

[5] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1957, pp. 24, 25.

[6] Chemical and Engineering News, Boron Made News Again This Week: Vol. 35, No. 18, May 6, 1957, p. 7.

[7] Oil, Paint and Drug Reporter, Boron Fuel Project Engages Big Companies: Vol. 172, No. 14, Sept. 30, 1957, p. 3.

[8] Chemical and Engineering News, It's 18.7 Percent Boron: Vol. 35, No. 28, July 15, 1957, p. 62.

[9] Chemical Engineering Progress, New Callery Plant Will Be Major Producer of High-Energy Boron Fuels: Vol. 53, No. 4, April 1957, p. 46: Chemical Week, Boron Chemicals: Vol. 80, No. 28, July 13, 1957, p. 25.

The new sodium borohydride plant of Metal Hydrides, Inc., Danvers, Mass., was dedicated.

The completed Norton Co. plant at Huntsville, Ala., manufactured a variety of materials, including boron carbide.

Olin Mathieson Chemical Corp. dedicated a high-energy fuel plant, which it will operate for the Air Force.

Stauffer Chemical Co. completed a commercial plant for producing boron trichloride at Niagara Falls, N. Y. It also produced boron trichloride at Richmond, Calif., and at Chauncey, N. Y.

U. S. Borax & Chemical Corp. was constructing an $850,000 research laboratory at Anaheim, Calif. Completion was expected by late April 1957.

PRICES

The price of borax, boric acid, and certain borate compounds increased, effective January 1, 1957. The following prices were quoted by Oil, Paint and Drug Reporter:

	January-October	*November-December*
Borax, tech., anhydrous, bags, carlots, works, ton	$83.00	Unchanged.
Ton lots, exwarehouse, New York or Chicago, ton	137.25	Do.
Bulk, carlots, works, ton	74.00	Do.
Crystals, 99½ percent, bags, carlots, works, ton	71.00	$81.00.
Ton lots, exwarehouse, New York or Chicago, ton	125.25	137.25.
Granular decahydrate, 99½ percent, bags, carlots, works, ton.	45.00	Unchanged.
Ton lots, exwarehouse, New York or Chicago, ton	99.25	Do.
Bulk, carlots, works, ton	38.50	Do.
Pentahydrate, 99½ percent, bags, carlots, works, ton	60.00	Do.
Ton lots, exwarehouse, New York or Chicago, ton	114.25	Do.
Powder, 99½ percent, bags, carlots, works, ton	50.00	Do.
Ton lots, exwarehouse, New York or Chicago, ton	104.25	Do.
U. S. P. borax is $15 per ton higher than technical.		
Acid, boric, tech., 99½ percent:		
Crystals, bags, carlots, works	129.00	Do.
Ton lots, exwarehouse, New York or Chicago, ton.	184.25	Do.
Granular, bags, carlots, works, ton	104.00	Do.
Ton lots, exwarehouse, New York or Chicago, ton.	159.25	Do.
Powder, bags, carlots, works, ton	109.00	Do.
Ton lots, exwarehouse, New York or Chicago, ton.	159.25	Do.
U. S. P. boric acid $25 per ton higher.		

FOREIGN TRADE [10]

Boron minerals and compounds were exported from the United States to many countries.

The United States imported 74,000 pounds of boron carbide valued at $123,000 from Canada and West Germany in 1957. Crude boron minerals, imported from Turkey, totaled 5,040 short tons valued at $161,550.

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

TABLE 3.—Boric acid and borates (crude and refined) exported from the United States, 1956–57, by countries of destination

[Bureau of the Census]

Countries	1956		1957	
	Short tons	Value	Short tons	Value
North America:				
Canada	13,637	$1,397,191	12,805	$1,321,831
Costa Rica	123	11,489	273	22,821
Cuba	593	45,977	529	47,410
El Salvador	16	2,760	23	2,009
Mexico	4,157	379,469	4,023	381,325
Nicaragua	12	5,937	36	9,104
Trinidad and Tobago	89	6,975	18	1,328
Other North America	13	2,209	122	13,569
Total	18,640	1,852,007	17,829	1,799,397
South America:				
Brazil	8,188	596,674	4,267	347,839
Colombia	695	58,402	739	73,606
Peru	417	31,776	475	32,233
Uruguay	161	15,001	239	31,404
Venezuela	308	27,905	355	29,531
Other South America	25	3,200	30	3,734
Total	9,794	732,958	6,105	518,347
Europe:				
Austria	3,035	143,184	3,275	161,298
Belgium-Luxembourg	4,013	268,118	3,348	223,508
Denmark	640	44,538	1,178	74,289
Finland	804	51,629	945	65,162
France	28,472	1,894,777	22,377	1,562,266
Germany, West	49,235	3,016,752	42,884	2,859,976
Greece	198	9,878	518	26,766
Ireland	1,237	76,072	1,111	70,617
Italy	17,778	893,391	10,797	632,982
Netherlands	12,605	988,271	12,063	1,015,408
Norway	2,643	215,473	3,495	327,135
Portugal	1,716	128,658	165	16,490
Spain	31	3,378	30	5,468
Sweden	3,532	227,407	3,640	258,865
Switzerland	4,659	310,172	4,834	335,895
United Kingdom	47,156	3,122,600	44,369	3,121,024
Yugoslavia	715	46,963	1,685	127,992
Total	178,469	11,441,261	156,714	10,885,141
Asia:				
Ceylon	185	14,918	39	3,220
Hong Kong	6,138	349,556	2,551	189,581
India	4,612	348,212	4,819	362,579
Indonesia	239	14,373	329	20,261
Iran	283	16,040	156	11,714
Israel	628	40,779	476	35,282
Japan	14,274	973,717	11,862	893,854
Korea	252	17,349	238	16,008
Lebanon	33	4,140	65	4,654
Malaya	134	9,404	45	2,658
Pakistan	314	19,961	497	48,437
Philippines	356	33,633	509	53,491
Syria	28	2,486	66	6,201
Taiwan	1,564	81,835	321	24,664
Thailand	428	26,670	177	14,242
Vietnam, Laos, Cambodia	163	10,455	956	74,828
Other Asia	24	5,420	21	3,860
Total	29,655	1,968,948	23,127	1,765,534
Africa:				
Egypt	206	15,496	119	9,858
Mozambique	56	7,770		
Rhodesia and Nyasaland, Federation of	144	9,829	266	19,298
Union of South Africa	1,452	153,182	2,790	274,961
Other Africa	44	6,338	122	12,448
Total	1,902	192,615	3,297	316,565
Oceania:				
Australia	4,073	318,643	5,155	490,602
New Zealand	1,192	89,658	2,270	199,698
Total	5,265	408,301	7,425	690,300
Grand total	243,725	16,596,090	214,497	15,975,284

WORLD REVIEW

The world's principal supply of boron minerals came from the United States; however, several other countries produced moderate quantities of boron minerals and compounds in 1957.

SOUTH AMERICA

Argentina.—Production of ulexite totaled 22,046 short tons in 1956.[11]

Chile.—A total of 10,122 short tons of boron minerals averaging 33 percent B_2O_3 was produced in 1956.[12]

EUROPE

France.—A system of licensing exports of boron minerals and compounds from France was established.[13]

Italy.—Boric acid production in Italy totaled 4,065 short tons in 1956.[14]

Switzerland.—The Ministry of Economic Affairs announced that exports of borax from Switzerland will require licenses.[15]

United Kingdom.—All aspects of boron chemistry were being investigated in a research program at the new laboratories of Borax Consolidated at Chessington, Surrey.[16] Crystalline elemental boron, 99.0- to 99.5-percent pure, was marketed by Borax Consolidated, Ltd.[17] The Board of Trade changed some licensing controls, effective March 4, 1957, further restricting export of boron minerals, metals, alloys and compounds from the United Kingdom.[18]

ASIA

Turkey.—Production of boron minerals in 1957 totaled 34,879 short tons valued at $1,468,302.[19]

U. S. S. R.—Soviet geologists reported new discoveries of boron deposits in Kazakhstan.[20] A plant for producing borax concentrates was being erected at Indersk, Kazakhstan.[21]

TECHNOLOGY

Boron–10, used in nuclear reactors because of its high absorption for thermal neutrons, was recovered from boron by a complex distillation process at the Hooker Electrochemical Co. plant near Niagara Falls, N. Y.[22] To separate the boron–10 isotope a dimethyl ether-boron trifluoride complex was fed to fractionation towers. Repeated dissociation of the complex in the vapor phase and recombination as

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11 Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 23.
12 U. S. Embassy, Santiago, Chile, State Department Dispatch 430: Oct. 30, 1957, 5 pp.
13 American Metal Market, France Places Export Ban on Boron Items: Vol. 64, No. 66, Apr. 5, 1957, p. 1.
14 U. S. Embassy, Rome, Italy, State Department Dispatch 1505: May 14, 1957, 6 pp.
15 Chemical Age (London), Swiss Borax Exports: Vol. 78, No. 1993, Sept. 21, 1957, p. 454.
16 Chemical Age (London), Intensive Boron-Research Programme for Borax Consolidated: Vol. 78, No. 1993, Sept. 21, 1957, p. 450.
17 Chemical Age (London), Borax Market Cystalline Elemental Boron: Vol. 78, No. 1985, July 27, 1957, p. 148.
18 Chemical Trade Journal and Chemical Engineer (London), Boron Products Exports Control: Vol. 140, No. 3639, Mar. 1, 1957, p. 504.
19 U. S. Embassy, Ankara, Turkey, State Department Dispatch 699: May 5, 1958, 2 pp.
20 Northern Miner (Toronto), Russian Report Find of Lithium and Boron: Vol. 43, No. 38, Dec. 12, 1957, p. 23.
21 Mining Journal (London), vol. 248, No. 6349, Apr. 26, 1957, p. 526.
22 Chemical Engineering, Complex Distillation Separates Isotopes: Vol. 64, No. 5, May 1957, pp. 148–150.

the liquid phase resulted in boron–10 concentrating in the liquid phase and boron–11 in the vapor phase. The B–10-enriched complex was converted to potassium fluoborate, which was electrolyzed in a bath of potassium chloride to obtain the B–10 isotope.

Research workers at Purdue University discovered that the mild reducing power of sodium borohydride can be increased with lithium bromide or aluminum chloride.[23] In addition, the powerful reducing potential of lithium-aluminum hydride can be lowered by adding alkoxy groups. These changes gave a series of reducing agents that could be used to give desired reductions. A new method was also discovered for making trialkylboranes from simple olefins. Polymers of boron and phosphorus were studied at the University of Southern California.[24] One boron-phosphorus compound $[(CH_3)_2PBH_2]_3$ could stand 400° C. temperature without much decomposition.

A report that covered the analysis of organo-boron compounds and the synthesis of alkyl and aryl boron dichlorides used as intermediates for producing boron-substituted borazones and tri–B–N–butylborazole was released for industrial use.[25] The preparation of B-beta-chlorovinylborazole was also discussed.

Polymers of boron and other elements were being studied with a view to incorporating their neutron-absorption ability and heat resistance in atomic reactors and aircraft. Research workers at St. Louis University devised a new way to make borazine and companion syntheses for several substituted borazines.[26]

Small additions of boron to austenitic stainless steels, significantly improved their hot working performance.[27] Extremely small quantities of boron (0.0005 percent increased the ductility of 1 type of steel 50 percent) were needed to produce measurable results in a wide range of steel compositions. Additions to high-manganese, high-nitrogen austenitic alloys were also very effective.

Surface markings known as stretcher strains developed in cold-worked steel during aging, owing to the formation of carbon or nitrogen atmospheres around imperfections in the crystal lattice. According to one report, steels that do not develop stretcher strains may be in mass production within a few years.[28] The addition of 0.007 percent boron is enough to precipitate nitrogen, thereby reducing development of strain during aging.

An alloy steel that can withstand stresses up to 285,000 pounds per square inch, without becoming brittle, has been developed by the National Bureau of Standards.[29] The steel, containing titanium, silicon, and boron, can be made by normal melting and working processes.

A high-temperature steel alloy, intended as a structural material for jet-engine-turbine disks, has been formulated.[30] The alloy contains iron, nickel, chromium, and smaller quantities of molybdenum, titanium, and boron. Test samples withstood a temperature of 1,200° F. and stress of 75,000 p. s. i. for 300 hours without breaking.

[23] Chemical and Engineering News, Versatile Hydroborons: Vol. 35, No. 18, May 6, 1957, p. 28.
[24] Chemical and Engineering News, B-P Polymers for High Temperatures: Vol. 35, No. 21, May 27, 1957, pp. 28, 30.
[25] Ruigh, W. L., and others, Research on Boron Polymers, Pt. 4: Rutgers University, September 1956.
[26] Chemical and Engineering News, Easier Borazine: Vol. 35, No. 37, Sept. 16, 1957, p. 67.
[27] Iron Age, Boron Solves "Hot Shortness" in Stainless Steels: Vol. 179, No. 25, June 20, 1957, pp. 95–97.
[28] Iron Age, Boron Rids Steels of Stretcher Strains: Vol. 180, No. 6, Aug. 8, 1957, p. 79.
[29] Science Newsletter, Super Steel for Planes Developed by Scientists: Vol. 71, No. 26, June 29, 1957, p. 404.
[30] Chemical and Engineering News, W 545 for High Temperatures: Vol. 35, No. 9, Mar. 4, 1957, p. 88.

The effect of boron and nitrogen on the hardenability of low-carbon alloy steels was reported.[31] A base composition containing low values of carbon, nickel, and molybdenum was modified by boron and nitrogen additions. Results of tests showed that small additions of boron in the steels austenitized at 1,550° F. greatly increased hardenability. Nitrogen counteracted the boron contribution to hardenability. Steels containing nitrogen showed lower hardenability than the base composition when quenched from 1,550° F. The hardenability of all steels increased when austenitized at 1,800° F. All steels except 1 containing boron-plus-nitrogen additions showed about the same high hardenability after quenching from 2,000° F. The behavior of the nitrogen-free boron steel indicated that boron was effective, owing to adsorption at grain boundaries. Both steels containing nitrogen responded to heat treatment in a manner that suggested the existence of a second phase in the austenite.

The creation of "borazon," a new material never before observed by man, was announced in 1957. Borazon, the cubic form of boron nitride (BN), was prepared by heating the compound in a metal capsule to 1,800° C., while subjecting it to pressures of 85,000 atmospheres.[32] Borazon is not attacked by any of the usual acids and is only slowly oxidized in air at 2,000° C. It is a good electrical insulator. It is hard enough to scratch diamond, and diamond scratches it. Boron phosphide (BP), another new artificial abrasive, was prepared by the reaction of boron and red phosphorus in an evacuated, sealed silica tube, at 1,100° C.[33] Boron phosphide was expected to be harder than silicon carbide.

High-Energy Boron Fuels.—The reasons for using boron compounds as high-energy fuels were reviewed.[34] Liquid hydrogen was ruled out because its low density would require a large refrigeration system. Beryllium was rejected owing to its toxic compounds and short supply. Compounds of boron and hydrogen yield a lower heat of combustion per pound than liquid hydrogen; however, they give much higher heats of combustion than the hydrocarbon fuels. Two graph charts showed the heating value of the elements and possible fuels.

It was reported that boron hydrides offered gains of 50 percent or more in the performance of airplanes and missiles.[35] The greater energy of boron fuels could extend the range of airplanes, reduce airframe weights, increase payload, or improve performance in speed and climb. In addition, these compounds can be used efficiently at altitudes where ordinary air-mixing fuels will not burn.

Improved forms of high-energy, nontoxic boron fuels were being delivered to the military establishment in engine test quantities.[36] The loss of heating value of boron-based fuels resulting from processes to improve their stability and handling qualities was minimized by a major chemical research effort. Two types of fuels were

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[31] Shyne, J. C., and Morgan, E. R., Effect of Nitrogen on Hardenability in Boron Steels: Jour. Metals, vol. 9, No. 1, January 1957, pp. 116–117.
[32] Wentorf, R. H., Jr. Cubic Form of Boron Nitride: Jour. Chem. Phys., vol. 26, No. 4, April 1957, p. 956.
[33] Chemical Age (London), Boron Phosphide a New High Abrasive: Vol. 77, No. 1978, June 8, 1957, p. 976.
[34] Weilmuenster, E. A., Utilization of High-Energy Fuel Elements: Ind. Eng. Chem., vol. 49, No. 9, September 1957, pp. 1337, 1338.
[35] Fortune, W. C., Bureau of Aeronautics General Representative Western District, Department of the Navy, Excerpts from talk at dedication ceremonies, U. S. Borax & Chemical Corp. Open Pit Mine and Refinery, Boron, Calif., Nov. 13, 1957.
[36] Butz, J. S., Jr., Boron Fuel Stability Improved, Full Production Starts in 1959: Aviation Week, vol. 67, No. 2, July 15, 1957, p. 27.

derived from pentaborane and decaborane. Pentaborane has more heat energy per unit weight than decaborane, but decaborane has more energy per unit volume. Borane fuels could be used in existing rockets, ramjets, and afterburners, but not in conventional turbojets because the solid combustion products would erode turbine blades.

The Federal Geological Survey released results of an exploratory drilling program in the Kramer area of San Bernardino County, Calif.[37] Five test holes were drilled in alluvial and lake sediments. A preliminary examination of drill cores revealed some colemanite, small quantities of realgar, some analcime, and an unusual magnetic iron sulfide mineral.

The process for synthesizing boron fuels was reported to consist of reducing either boron trifluoride or boron trichloride with lithium hydride or sodium borohydride to produce diborane.[38] The diborane was converted to penta or decaborane and then alkylated.

A new process was reported for producing diborane by reacting aluminum trifluoride, sulfuric acid, boron trioxide, and N-trialkyl borazane.[39] A new method for synthesizing alkali metal borohydrides was also described.

A new boron hydride (B_9H_{15}) was isolated by research workers at Iowa State University.[40] It was made by passing diborane through an ozonizer.

The basic process for making sodium borohydride, employed at the Danvers (Mass.), plant of Metal Hydrides, Inc., consisted of reacting sodium hydride with methyl borate in an inert mineral oil.[41] Methanol is recovered and reused to make more methyl borate by reacting it with boric acid. Sodium hydride is obtained from sodium metal and hydrogen. A package unit produces the hydrogen from propane.

The effect on people and laboratory animals of using potentially dangerous boron hydride fuels was reviewed.[42] The paper summarized the effects of diborane, pentaborane, and decaborane on laboratory animals exposed to measured concentrations for a given number of days. Threshold limits for these three compounds of boron, adopted by the American Conference of Governmental Industrial Hygienists, were given. The analytical methods developed for monitoring the atmosphere of places of work and analyzing biological specimens were listed. The report concluded that the boron hydrides were highly toxic compounds, and adequate control measures should be instituted to prevent serious hazards to health. Another article reported that routine safety measures could assure safe handling of toxic boron compounds.[43] Workers at Callery Chemical Co. have handled boron compounds since 1946, with no indication of permanent damage. Two monitoring devices that can detect concentrations of

[37] U. S. Department of the Interior Information Service, Geological Survey Reports on Saline Deposits' Explorations: Mar. 28, 1957, 1 p.; Apr. 17, 1957, 1 p.; May 10, 1957, 1 p.; May 23, 1957, 2 pp.

[38] Chemical Engineering Progress, Olin Mathieson Dedicates New High-Energy Fuel Plant: Vol. 53, No. 8, August 1957, pp. 46, 48.

[39] Chemical Week, Germany Joins the High-Energy Fuels Whirl: Vol. 80, No. 21, May 25, 1957, p. 48.

[40] Chemical and Engineering News, First New Boron Hydride (B_9H_{15}): Vol. 35, No. 38, Sept. 23, 1957, pp. 77, 134.

[41] Chemical Engineering, First Tonnage Sodium Borohydride; Vital Link to High-Energy Fuels: Vol. 64, No. 12, December 1957, pp. 146–148.

[42] Industrial and Engineering Chemistry, Industrial Hygiene of Metals of Recent Industrial Importance: Vol. 49, No. 9, September 1957, Pt. I, pp. 87A–88A.

[43] Chemical and Engineering News, Boron Is a Toxicity Problem: Vol. 35, No. 48, Dec. 2, 1957, pp. 54–55.

boron hydrides as low as 0.005 p. p. m. will soon give an added measure of safety.

A new class of borane derivatives was discovered when a decaborane solution in acetonitrile was heated to reflux.[44]

A stable crystalline diammoniate of tetraborane ($B_4H_{10}.2NH_3$) was isolated.[45] The compound was stable in air and dissolved in cold water slowly yielding hydrogen.

A mixed alkyl borane has been synthesized by use of a cyclic intermediate.[46] N-butyltrihydroxyborane, dehydrated under reduced pressure, yielded tri-n-butylboroxine. This compound reacted with trimethyl aluminum to form n-butyldimethylborane $C_4H_9B(CH_3)_2$. The compound, though spontaneously flammable in air, is one of the more stable boron hydrides.

[44] Schaeffer, R., A New Type of Substituted Borane: Jour. Am. Chem. Soc., vol. 79, No. 4, Feb. 20, 1957, pp. 1006–1007.
[45] Kodama, G., The Diammoniate of Tetraborane: Jour. Am. Chem. Soc., vol. 79, No. 4, Feb. 20, 1957, p. 1007.
[46] Chemical and Engineering News, A Mixed Alkyl Borane: Vol. 35, No. 16, Apr. 22, 1957, p. 113.

Bromine

By Henry E. Stipp[1] and Annie L. Mattila[2]

ALTHOUGH bromine-production capacity increased in 1957, sales of bromine and bromine compounds decreased 2.4 percent from the record sales in 1956. Bromine recovery plants constructed at El Dorado, Ark., and Sodom, Israel, were significant industrial developments.

DOMESTIC PRODUCTION

Bromine production (measured by sales) declined slightly from the high established in 1956. Bromine was recovered from sea water, well brines, and saline-lake brines in the United States during 1957. The greater part of the production was obtained from sea water, an inexhaustible source of bromine.

The Ethyl-Dow Chemical Co. recovered bromine from sea water at Freeport, Tex., and Westvaco Chemical Division of Food Machinery & Chemical Corp. operated a sea-water plant at Newark, Calif. The following firms recovered bromine from well brines in Michigan: The Dow Chemical Co., Midland and Ludington; Great Lakes Chemical Corp., Filer City; Michigan Chemical Corp., East Lake and St. Louis; and Morton Salt Co., Manistee. The Westvaco Chemical Division at South Charleston, W. Va., also treated well brines. American Potash & Chemical Corp. recovered bromine from Searles Lake in California. Michigan Chemical Corp. and Murphy Corp. completed constructing a bromine-recovery plant at El Dorado, Ark. The plant, with a rated capacity of 5 million pounds per year, recovered bromine from waste brine of the Catesville oilfield. Construction of the addition to Great Lakes Oil & Chemical Co. bromine plant at Filer City, Mich., was completed.

TABLE 1.—Total sales of bromine and bromine compounds (bromine content) by primary producers in the United States, 1948–52 (average) and 1953–57

Year	Pounds	Value	Year	Pounds	Value
1948–52 (average)	109,808,042	$21,341,441	1955	184,453,846	$39,855,508
1953	164,143,348	35,372,386	1956	196,730,115	47,433,886
1954	187,399,110	41,312,669	1957	191,971,145	48,038,017

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

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TABLE 2.—Bromine and bromine compounds sold by primary producers in the United States, 1956–57

	Pounds		Value
	Gross weight	Bromine content [1]	
1956			
Elemental bromine	9,490,006	9,490,006	$2,170,056
Sodium bromide	(2)	(2)	(2)
Potassium bromide	2,920,367	1,961,027	878,190
Ammonium bromide	(2)	(2)	(2)
Other, including ethylene dibromide	218,583,248	185,279,082	44,385,640
Total	230,993,621	196,730,115	47,433,886
1957			
Elemental bromine	9,179,027	9,170,957	2,192,884
Sodium bromide	(2)	(2)	(2)
Potassium bromide	3,032,155	2,036,092	971,097
Ammonium bromide	(2)	(2)	(2)
Other, including ethylene dibromide	213,174,731	180,764,096	44,874,036
Total	225,385,913	191,971,145	48,038,017

[1] Calculated as theoretical bromine content present in compound.
[2] Included with "Other, including ethylene dibromide."

CONSUMPTION AND USES

Approximately 94 percent of the total bromine consumed in 1957 was in the form of ethylene dibromide and other compounds. Ethylene dibromide was added to tetraethyl lead for use as an antiknock mixture in gasoline. Other uses for ethylene dibromide were as an intermediate in the synthesis of dyes and pharmaceuticals, as a nonflammable solvent for celluloid, resins, gums, and waxes, and as an anaesthetic, sedative, and antispasmodic agent. It was used in fumigation mixtures for insect control in grain and soil. Methyl bromide and chlorobromopropene were used also as fumigants.

Five percent of the total consumed was elemental bromine, the second largest consumption category in 1957. Elemental bromine was used as a laboratory reagent and as a bleaching and disinfecting agent. It was also used in manufacturing lachrymators, brominated dyes, and bromides for medicinal, photographic, and industrial uses.

Potassium bromide ranked third in quantity of bromide consumed in 1957 (1 percent of the total). Potassium and sodium bromides were used in medical and pharmaceutical preparations, photographic emulsions, and analytical reagents. Ammonium bromide was used in pharmaceutical preparations, photographic films, plates and papers, process engraving, and lithography. It was used also in fire retarding of wood and textiles, in soldering fluxes, and in textile processing.

Potassium bromate was employed as an oxidizing agent in permanent-wave preparations, in soya and high-protein wheat flour to improve baking characteristics, and as an ingredient of yeast foods.

Compounds of bromine were used as catalysts in controlling oxidation of hydrocarbons, as dehumidifying agents in air conditioning, and in the manufacture of hydraulic liquids, fire-extinguishing fluid, and effervescent mineral waters.

PRICES

According to Oil, Paint and Drug Reporter the following prices were quoted for bromine and bromine compounds in 1957: Bromine, purified, cases, carlots, delivered east of the Rocky Mountains, 32 cents a pound from January to mid-February, 33 cents a pound from mid-February to mid-April, and 32 cents a pound for the remainder of the year; less than carlots, same basis, 34 to 39 cents a pound from January to mid-February, 35 to 40 cents a pound from mid-February to mid-April, and 34 to 39 cents a pound for the remainder of the year; drums, lead-lined, carlots, delivered east of the Rocky Mountains, 31 cents a pound from January to mid-February, 32 cents a pound from mid-February to mid-April, and 31 cents a pound for the remainder of the year; potassium bromide, U. S. P., granular, barrels, kegs, 37 to 38 cents a pound from January to mid-February and 39 to 40 cents a pound for the remainder of the year; potassium bromate, drums, 1,000 pounds or more, 50 cents a pound from January through December; sodium bromide, U. S. P., barrels, works, 38 cents a pound from January to mid-February and 40 cents a pound for the remainder of the year; ammonium bromide, N. F., granular, barrels, 43 cents a pound from January to mid-February and 45 cents a pound for the remainder of the year.

FOREIGN TRADE [3]

International trade was a relatively minor factor in the bromine industry. Many of the major industrialized countries supplied their requirements. United States exports of bromine, bromide, and bromates in 1957 totaled 10,510,719 pounds valued at $3,053,172. Exports from the United States went principally to Canada (6,785,333 pounds) and Brazil (2,846,362 pounds). Smaller quantities were shipped to 39 other countries.

United States imports of bromine and bromine compounds in 1957 totaled 1,072 pounds valued at $37,108. United Kingdom and West Germany were the principal sources of supply. Imports of 440 pounds of sodium bromide valued at $968 came from the United Kingdom. No potassium bromide or ethylene dibromide was imported into the United States during the year.

WORLD REVIEW

France.—Production of bromine and bromine compounds in France during 1956 totaled 1,160 metric tons.[4]

Israel.—The Dead Sea Bromine Co. began to operate in January 1957 and made satisfactory progress.[5] Markets were being developed in Great Britain, Netherlands, West Germany, Switzerland, and Poland. The company produced elemental bromine and ethylene dibromide.

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[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.
[4] U. S. Embassy, Paris, France, State Department Dispatch 2418, June 25, 1957, 3 pp.
[5] U. S. Embassy, Tel Aviv, Israel, State Department Dispatch 628, May 31, 1957, 4 pp.

TECHNOLOGY

A new plant for producing bromine was put into operation at Sodom, Israel, in December 1956, by the Dead Sea Bromine Co.[6] The plant was scheduled to produce 1,250 tons of bromine per year, using a patented process that offered savings in equipment and operating costs.[7] End brine from the Dead Sea Bromine Co. potash plant, containing about 10,000 p. p. m. of magnesium bromide, flows to earthen basins, where suspended solids settle. The solution is then clarified and pumped to the top of chlorination towers packed with glass chips. Chlorine gas is introduced at the bottom of the tower and passes upward through the descending brine. Chlorine replaces the bromine in the brine, and the bromine goes into solution. The brine passes down through a stripping tower where 150,000–200,000 cubic feet of air, at a pressure of 190 mm. of mercury and temperature of 95° F., is blown up through the brine for each ton of bromine stripped. The bromine-air stream is dechlorinated by a countercurrent stream of brine and then goes to absorption columns packed with chipped glass. The bromine-air stream enters the bottom of the columns, rising countercurrently through an aqueous solution of 350 grams per liter sodium bromide at about 0° F. Bromine vapor reacts with sodium bromide, producing polybromides. The polybromides are dissociated by steam at 230° F. Steam and bromine vapor are condensed; the water separates from the bromine in a decanter. Recovery is estimated at 90 percent.

Flame and glow resistance of cellulose fabric was improved by the addition of phosphorus and bromine compounds.[8] Early work on cellulose pyrolytic effects indicated the formation of a common intermediate, levoglucosan, at temperatures above 250° C. To prevent formation of levoglucosan a series of reactions was used to introduce various chemical groups. Cellulose was treated with methane-sulfonyl chloride and then phosphorylated with diethyl chlorophosphate. Some of the methane-sulfonyl groups were replaced with bromide or iodide. An aqueous barium carbonate solution was used for this reaction to get good pH control and prevent any acid degradation of the cellulose. Although iodine compounds gave better flame resistance than bromine derivatives, bromine probably would be used on a large scale owing to the difference in cost.

An electrolytic process for the production of potassium or sodium bromate, using a lead peroxide anode, was described.[9] Graphite anodes used previously spalled, forming a mud which discolored bromate with a yellowish tint. Lead peroxide was deposited electrolytically from neutral lead nitrate solution upon the inner surface of an iron cylinder. The lead peroxide was cut into electrodes measuring 350 mm. in length, 50 mm. in width, and 7–9 mm. in thickness. Bromate was produced in a tank containing 10 lead peroxide anodes and 20 stainless steel cathodes. In two experimental runs conducted at constant temperature and anodic density of 20 a. per $dm.^2$, lead peroxide losses averaged 57–60 grams per ton of product. Lead was not detected in the product.

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[6] Chemical Engineering, New Route to Bromine: Vol. 64, No. 9, September 1957, p. 164.
[7] Block, R. M., and Yaron, F., Bromine Production: U. S. Patent 2,784,063, Mar. 5, 1957.
[8] Chemical Engineering News, Cotton Glows, Flames Less: Vol. 35, No. 16, Apr. 22, 1957, pp. 28–29.
[9] Osuga, T., and Kiichiro, S., Electrolytic Production of Bromates: Jour. Electrochem. Soc., vol. 104, No. 7, July 1957, pp. 448–451.

Cadmium

By Arnold M. Lansche[1]

THERE was a surplus of cadmium in 1957. The quoted price for cadmium metal declined in the last month of the year. Industry stocks of metallic cadmium and cadmium (exclusive of consumers' stocks) rose over 1956. The value of negotiated contracts for the purchase of cadmium by the Commodity Credit Corporation in fiscal 1957 declined.

TABLE 1.—Salient statistics of cadmium, 1948–52 (average) and 1953–57, in pounds of contained cadmium

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Primary production	8,414,233	9,767,197	9,551,710	[1] 9,753,699	[2 3] 10,614,356	[2] 10,549,415
Metal imported for consumption	473,191	1,555,140	402,299	927,495	3,115,638	1,585,547
Exports	619,018	65,866	998,959	1,393,915	1,284,248	692,758
Apparent consumption	8,201,478	9,570,063	7,498,719	10,683,705	[3 4] 12,711,015	[4] 10,998,870
Price (average)	$2.20	$1.99	$1.73	$1.70	$1.70	$1.70
World: Production thousand pounds	12,480	15,570	16,100	18,460	19,950	20,430

[1] Primary cadmium metal only.
[2] Primary and secondary cadmium metal.
[3] Revised figure.
[4] Cadmium metal only.

DOMESTIC PRODUCTION

The production of cadmium metal, primary and secondary together, remained relatively high in 1957. Metal production declined about 1 percent from the high mark established in 1956. Production of secondary metal declined more than the output of primary metal.

Cadmium was produced in this country principally as a byproduct of slab-zinc output. Cadmium was also obtained from imported and domestic flue dusts and fumes from plants that processed, by thermal reduction, zinc concentrates and lead and copper concentrates containing zinc and associated cadmium. Other sources of cadmium raw material were cadmium precipitated in purifying zinc electrolyte at electrolytic zinc plants and also when zinc sulfate solutions were purified to make lithopone. A small quantity of secondary cadmium was recovered in 1957 by processing scrap alloys.

Of the 10.6 million pounds of cadmium produced in 1957 an estimated 13 percent was obtained from foreign flue dust; about equal quantities of the remainder came from domestic zinc ore and foreign zinc-ore concentrates and other base-metal concentrates containing zinc and associated cadmium. Mexico, Canada, and Peru were the chief sources of imported zinc concentrates.

[1] Commodity specialist.

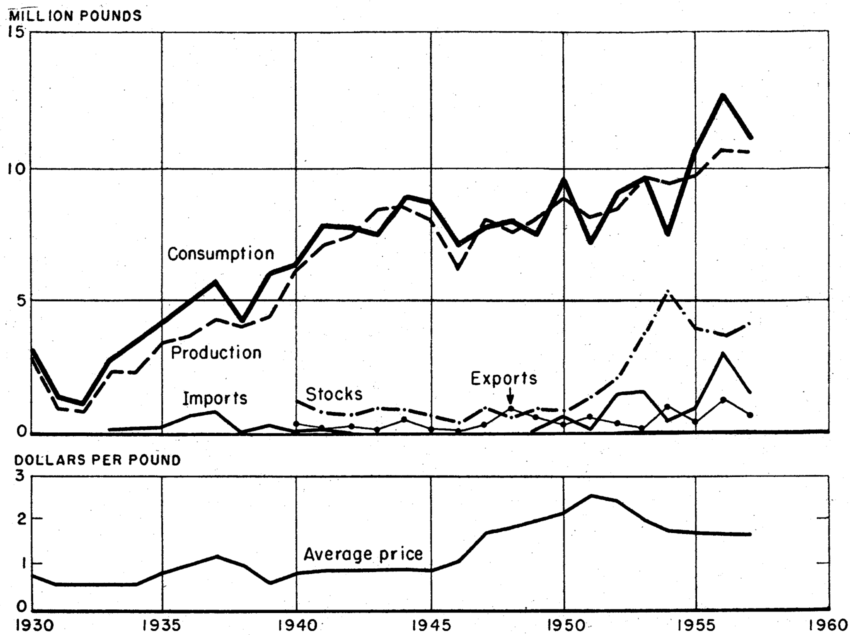

FIGURE 1.—Trends in production, consumption, year-end stocks, imports, exports, and average price of cadmium metal in the United States, 1930–57.

TABLE 2.—Cadmium produced and shipped in the United States, 1948–52 (average) and 1953–57, in pounds of contained cadmium

	1948–52 (average)	1953	1954	1955	1956	1957
Production:						
Primary:						
Metallic cadmium	8,191,666	9,682,197	9,415,710	9,753,699	[1] 10,614,356	[1] 10,549,415
Cadmium compounds [2]	222,567	85,000	136,000	(3)	(3)	(3)
Total primary production	8,414,233	9,767,197	9,551,710	9,753,699	[1] 10,614,356	[1] 10,549,415
Secondary (metal and compounds) [2] [4]	236,113	70,000	138,000	285,800	(3)	(3)
Shipments by producers:						
Primary:						
Metallic cadmium	7,974,370	8,137,045	7,921,741	11,166,830	[1] 10,936,459	[1] 10,091,133
Cadmium compounds [2]	222,567	85,000	136,000	(3)	(3)	(3)
Total primary shipments	8,196,937	8,222,045	8,057,741	11,166,830	[1] 10,936,459	[1] 10,091,133
Secondary (metal and compounds) [2] [4]	228,605	59,636	148,874	285,800	(3)	(3)
Value of primary shipments:						
Metallic cadmium	$16,389,362	$15,229,861	$11,925,068	$15,729,230	[5] $16,283,101	[5] $14,920,946
Cadmium compounds [6]	456,048	158,950	204,000	(3)	(3)	(3)
Total value	16,845,410	15,388,811	12,129,068	15,729,230	16,283,101	14,920,946

[1] Total metallic cadmium, including secondary.
[2] Excludes compounds made from metal.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Bureau of Mines not at liberty to publish figures separately for secondary cadmium compounds.
[5] Value of total metallic shipments, including secondary.
[6] Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

Changes in 1957 included: Cadmium production was begun by the Blackwell Zinc Co. at its Blackwell, Okla., plant; The Bunker Hill Co. transferred production of cadmium at its lead smelter to its zinc smelter on July 1, 1957 (both plants are at Kellogg, Idaho); and the United States Steel Corp. (American Steel & Wire Division) permanently closed its cadmium-production facilities at Donora, Pa.

The production of cadmium sulfide, including cadmium lithopone and cadmium sulfoselenide (cadmium content), declined 17 percent in 1957. Statistics were not available on cadmium-mercury lithopone.

TABLE 3.—Cadmium oxide and cadmium sulfide produced in the United States, 1948–52 (average) and 1953–57, in pounds

Year	Oxide		Sulfide [1]	
	Gross weight	Cd content	Gross weight	Cd content
1948–52 (average)	539,999	470,944	3,187,447	1,104,210
1953	1,094,263	956,100	3,920,402	1,229,282
1954	958,709	838,222	3,470,127	1,045,669
1955	(2)	(2)	4,190,837	1,348,100
1956	(2)	(2)	3,936,629	1,258,446
1957	(2)	(2)	3,198,063	1,040,805

[1] Includes cadmium lithopone and cadmium sulfoselenide.
[2] Figure withheld to avoid disclosing individual company confidential data.

CONSUMPTION AND USES

The apparent consumption of cadmium metal in 1957 was about 11 million pounds—13 percent below that in the peak year, 1956. Reduced barter acquisitions of cadmium by the Commodity Credit Corporation and less production of manufactured goods using cadmium in 1957 were factors that affected cadmium consumption.

Cadmium was consumed in electroplating such items as automobile-engine parts, aircraft parts, radio and television parts, and nuts and bolts. Cadmium was also consumed in bearing alloys, fusible alloys, pigments, dentistry, photography, and dyeing. Nickel-cadmium batteries required up to 7 pounds of cadmium per battery. Cadmium found use in the increased number of nuclear reactors that were built and put into operation in 1957. Otherwise the uses changed little as reviewed in greater detail in the Cadmium chapter, Minerals Yearbook, volume I, 1956.

STOCKS

Stocks of cadmium metal in the hands of metal producers, compound manufacturers, and distributors totaled about 3.68 million pounds, a 14-percent increase over 1956. Stocks of cadmium compounds (cadmium content) held by compound manufacturers and distributors totaled 496,800 pounds, an 11-percent decline from 1956.

The value of cadmium contracted for in fiscal 1957 was $4.1 million according to the Commodity Credit Corporation, or about 2.4 million pounds. This was $1 million less than in 1956.

TABLE 4.—Industry stocks at end of year, 1956–57, in pounds of contained cadmium

	1956			1957		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Metal producers	[1] 2, 847, 123		[1] 2, 847, 123	3, 358, 645		3, 358, 645
Compound manufacturers	128, 808	490, 997	619, 805	98, 497	445, 838	544, 335
Distributors	373, 043	71, 016	444, 059	[2] 349, 854	[2] 69, 511	[2] 419, 365
Total stocks	[1] 3, 348, 974	562, 013	[1] 3, 910, 987	[2] 3, 806, 996	[2] 515, 349	[2] 4, 322, 345
Consumers' stocks	973, 074	168, 226	1, 141, 300	(3)	(3)	[2] 1, 000, 000

[1] Revised figure.
[2] Estimate.
[3] Data not available.

PRICES

Cadmium sticks, bars, and special platers' shapes declined December 23 in quoted price from $1.70 to $1.55 a pound, delivered in 1- to 5-ton lots. Oversupply of the metal and the reduced prices of competitive metals were factors that contributed to the drop in price. Large quantities of cadmium were sold, both in the domestic and export markets, at prices considerably below the quoted price. The London market quotation for cadmium sticks and bars declined from 12s. to 11s. 3d. ($1.68 to $1.57 per pound on the basis of $2.80 per £). The French market price increased in December from 1,400 to 1,500 francs per kilogram ($1.52 to $1.63 per pound on the basis of $0.0024 per franc). The quoted price in Italy for cadmium per kilogram declined during the year, in May it dropped from 2,800 to 2,700 lire, in October it lost a total of 150 lire, and again in November the price fell another 50 lire ending the year at 2,500 lire; in terms of dollars, the decline was from $1.95 to $1.75 per pound on the basis of $0.00154 per lira.

Cadmium-selenium lithopone (sulfoselenide), orange, deepshade, was quoted at $2 a pound, in barrel quantities, in 1957. Cadmium-mercury lithopone, orange, deepshade, was quoted at $1.78 on the same basis into June; in that month the price declined to $1.70, at which it stayed for the remainder of the year.

FOREIGN TRADE [2]

Imports.—General imports of cadmium metal (1.6 million pounds) about equaled imports for consumption in 1957. General imports of the metal dropped 9 percent, and imports for consumption declined 49 percent from those in 1956. General imports of the metal averaged $1.53 a pound in both 1956 and 1957, whereas, imports for consumption averaged $1.49 in 1956 and $1.53 in 1957.

General imports of flue dust (cadmium content) totaled 1.6 million pounds in 1957, down 5 percent; imports for consumption decreased 4 percent from the previous year to 1.4 million pounds. Mexico supplied all of the imported flue dust.

Tariff.—The import duty on cadmium metal remained 3.75 cents per pound in 1957—the rate established January 1, 1948, as a result of action taken at the Geneva Trade Conference of 1947. Cadmium contained in flue dust remained duty free.

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

TABLE 5.—Cadmium metal and flue dust imported[1] into the United States, 1955–57, by countries

[Bureau of the Census]

Country	1955		1956		1957	
	Pounds	Value	Pounds	Value	Pounds	Value
METALLIC CADMIUM						
North America: Canada	665,392	$959,236	809,750	$1,211,159	1,042,359	$1,585,749
South America: Peru	27,826	47,744	28,409	48,295	50,413	81,470
Europe:						
Belgium-Luxembourg	263,344	382,350	287,496	455,990	11,000	18,700
France					2,205	3,729
Germany, West			44,092	67,925		
Italy	760,587	1,070,797	234,800	363,071	55,023	88,528
Netherlands	91,557	131,328	33,075	51,897	22,046	31,526
United Kingdom			2,094	3,078		
Total	1,115,488	1,584,475	601,557	941,961	90,274	142,483
Asia: Japan	247,046	347,480	43,951	66,774	77,133	112,705
Africa: Belgian Congo	220,500	330,750	264,410	407,907	330,218	508,309
Total metallic cadmium	2,276,252	3,269,685	1,748,077	2,676,096	1,590,397	2,430,716
FLUE DUST (CD CONTENT)						
North America:						
Canada	160,774	186,189				
Mexico	1,865,335	1,200,835	1,624,655	1,149,347	1,549,876	1,092,291
Total	2,026,109	1,387,024	1,624,655	1,149,347	1,549,876	1,092,291
South America: Peru	32,562	35,330				
Total flue dust	2,058,671	1,422,354	1,624,655	1,149,347	1,549,876	1,092,291
Grand total	4,334,923	4,692,039	3,372,732	3,825,443	3,140,273	3,523,007

[1] Data are "general imports;" that is, they include cadmium imported for immediate consumption plus material entering the country under bond.

TABLE 6.—Cadmium metal and flue dust imported for consumption in the United States, 1955–57, by countries

[Bureau of the Census]

Country	1955		1956		1957	
	Pounds	Value	Pounds	Value	Pounds	Value
METALLIC CADMIUM						
North America: Canada	565,392	$802,121	932,150	$1,400,474	1,042,359	$1,585,749
South America: Peru	27,826	47,744	28,409	48,295	50,413	81,470
Europe:						
Belgium-Luxembourg	175,829	252,828	386,034	602,047	11,000	18,700
France					2,205	3,729
Germany, West			44,092	67,925		
Italy	66,143	88,082	936,745	1,345,780	55,023	88,528
Netherlands	54,606	77,161	33,075	51,897	17,196	24,590
United Kingdom			2,094	3,078		
Total	296,578	418,071	1,402,040	2,070,727	85,424	135,547
Asia: Japan	37,699	52,025	268,129	382,184	77,133	112,705
Africa: Belgian Congo			484,910	738,657	330,218	508,309
Total metallic cadmium	927,495	1,319,961	3,115,638	4,640,337	1,585,547	2,423,780
FLUE DUST (CD CONTENT)						
North America: Mexico	1,832,827	1,146,253	1,451,889	876,046	1,399,851	837,173
Total flue dust	1,832,827	1,146,253	1,451,889	876,046	1,399,851	837,173
Grand total	2,760,322	2,466,214	4,567,527	5,516,383	2,985,398	3,260,953

Exports.—Exports declined 46 percent in 1957 (cadmium is the metal of chief value in the exports). The United Kingdom received the largest quantity—more than 600,000 pounds.

TABLE 7.—Cadmium metal, alloys, dross, flue dust, residues, and scrap exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Pounds	Value	Year	Pounds	Value
1948–52 (average)	619,018	$1,446,018	1955	1,393,915	$1,938,355
1953	65,866	60,256	1956	1,284,248	1,932,305
1954	998,959	1,422,040	1957	692,758	1,059,569

WORLD REVIEW

World production of cadmium metal continued its record-breaking upward trend begun in 1950. World output of cadmium in 1957 was 20.4 million pounds—2 percent above 1956. The continued increase in world output was attributed to the additional cadmium refineries put into production since World War II.

NORTH AMERICA

The United States contributed 52 percent of total world cadmium-metal production, obtaining its raw materials from both domestic and foreign sources. This contribution is the lowest percentage since 1945, when it was about 76 percent.

Canada.—For the third successive year cadmium production in Canada broke previous records. Consolidated Mining & Smelting Co. produced approximately 2.11 million pounds at its integrated lead-zinc smelting-refining plants at Trail, British Columbia. In 1957 Consolidated Mining & Smelting Co. delivered to consumers in eastern Canada 99.95-percent-pure cadmium, in the form of sticks, bars, and balls at the following prices: 10,000 pounds or more, $1.60 a pound; 5,000–10,000 pounds, $1.75 a pound; 2,000–5,000 pounds, $1.85 a pound; and less than 2,000 pounds, $1.95 a pound.

Hudson Bay Mining & Smelting Co. produced the remainder, about 226,000 pounds, at its Flin Flon, Manitoba, works.

EUROPE

United Kingdom.—The output of cadmium in the United Kingdom was 228,000 pounds in 1957—9 percent below the year before. Consumption increased 5 percent to about 2.16 million pounds. Details of quantities (in pounds) used during the year for various purposes were as follows: Plating anodes, 1,149,100; plating salts, 182,600; cadmium-copper alloy, 102,600; other alloys, 75,900; alkaline batteries, 128,700; dry batteries, 8,400; solder, 81,200; colors, 385,200; miscellaneous uses, 42,200.

TABLE 8.—World production of cadmium, by countries, 1948–52 (average) and 1953–57, in thousand pounds [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	947	1,118	1,087	1,919	2,339	2,340
Guatemala	----	----	----	----	107	84
Mexico [2]	178	2,113	1,130	2,855	1,892	1,678
United States (primary):						
Metallic cadmium	[3] 8,192	[3] 9,682	[3] 9,416	[3] 9,754	[4] 10,604	[4] 10,549
Cadmium compounds (Cd content)	223	85	136	(5)	(5)	(5)
South America: Peru	9	23	66	138	107	[6] 140
Europe:						
Austria [6]	----	----	----	----	[7] 22	22
Belgium [6]	737	1,040	1,100	[7] 1,433	[7] 1,323	1,323
France	156	283	313	397	238	[6] 350
Germany, West	68	227	618	709	645	608
Italy	233	401	458	433	403	485
Netherlands [6]	----	----	[7] 22	[7] 34	[7] 36	36
Norway	170	197	178	255	277	[6] 244
Poland [6]	380	485	500	550	542	556
Spain	11	16	21	22	24	[6] 18
U. S. S. R. [6] [8]	215	440	470	680	795	1,050
United Kingdom	283	380	315	337	251	228
Asia: Japan	197	459	611	757	886	873
Africa:						
Belgian Congo	52	71	139	366	611	660
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	----	----	----	----	117	117
South-West Africa [9]	1,338	1,194	1,620	1,402	2,328	2,838
Oceania: Australia	609	665	645	674	618	[6] 750
World total (estimate)	12,480	15,570	16,100	18,460	19,950	20,430

[1] This table incorporates a number of revisions of data published in previous Cadmium chapters. Data do not add to totals shown, owing to rounding where estimated figures are included in the detail.
[2] 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.
[3] In addition, secondary metal and compounds were as follows: 1948–52 (average), 236,000 pounds; 1953, 70; 1954, 138; and 1955, 286,000 pounds.
[4] Includes secondary.
[5] Bureau of Mines not at liberty to publish figures.
[6] Estimate.
[7] According to the 44th annual issue of Metal Statistics (Metallgesellschaft).
[8] Estimates revised on basis of technologic developments and an assumed average cadmium content of 0.1 percent in zinc concentrates.
[9] Cadmium content of concentrates exported for treatment elsewhere. To avoid duplication of figures, data are not included in the total.

TECHNOLOGY

A clearer picture of the quantitative utilization of cadmium metal to filter out low-energy (thermal) neutrons in nuclear reactors developed in 1957. The Nuclear Products-Erco Division of ACF Industries, Inc., built some reactors using 11 to 28 pounds of cadmium per reactor in the control rods. The rated power of 5 research reactors ranged from 1,000 kilowatts to 30,000 kilowatts and together used 100 pounds of the metal for control rods. These rods are frequently immersed in the stream of water that cools the reactor core. The cadmium is protected from corrosion by aluminum. A layer of cadmium 0.040 to 0.080 inch thick is sprayed onto a sheet of aluminum, and then over that is sprayed a protective layer of aluminum. The quantity of cadmium used as control rods depends largely upon the power produced per unit volume of reactor core. An in-and-out oscillatory motion of some of the control rods holds the number of thermal neutrons available for further reaction with the uranium fuel at a level that controls power production of a reactor and prevents high or rapidly increasing power output.

Cadmium was also used as a lining material of the racks and vaults in which the uranium-bearing fuel elements are kept. In this application, cadmium insures that the number of thermal neutrons is kept low enough so that a nuclear chain reaction cannot develop due to the nearness of adjacent fuel elements.

Atomics International, a division of North American Aviation, Inc., built a laboratory reactor that used about 2.4 pounds of Commercial-grade, unalloyed cadmium-metal sheet as control-rod material.

A prototype nuclear-energy-powered battery was built in 1957. Absorption of beta particle radiation from a promethium (oxide) coating on the phosphor cadmium sulfide or a mixture of cadmium and zinc sulfides caused emanation from the phosphor of red and infrared radiation, which was picked up by adjacent silicon photocells and converted to electricity.

A steel-encased, rechargeable, sintered-plate, alkaline-electrolyte, nickel-cadmium battery was introduced into the United States in 1957. The battery was about the size of a 50-cent coin; hermetically sealed; nongassing upon re-charging; of high-discharge rate because of its low internal resistance; ruggedly constructed; and maintenance-free. The battery has a nominal voltage of 1.2 and operates at normal temperature ranges.

A patent [3] was issued for producing a uniform adherent cadmium coating on irregularly shaped metal surfaces. The metal article to be coated is immersed in a fused-salt bath containing 88 to 99.9 percent of alkali-metal formate and 1 to 12 percent of cadmium compound. The cadmium ionizes and forms the coating.

A patent [4] described the use of cadmium anthranilate to eliminate tapeworm in animals.

TOXICOLOGY

A death due to inhalation of cadmium oxide fumes was reported in 1957.[5] Two 500-gram batches of cadmium propionate were being dried in an electrically heated oven at 100° C. The temperature control was supposedly set for 60° C. for the hour that operating personnel was not attending the oven. During the absence of the attendants the compound exploded, blowing the oven door open and filling the room with a reddish brown smoke. Several people entered the room while it was filled with fumes. Later they became ill; 1 man died from the exposure about 6 days later. Postmortem examination revealed the presence of cadmium oxide in his urine, stomach contents, lungs (15 milligrams), liver (9 milligrams), heart (2 milligrams), and kidneys (1 milligram). Laboratory tests indicated that decomposition of cadmium propionate occurs in the temperature range of 200° to 290° C.

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[3] Couch, Dwight E., Deposition of Cadmium by Chemical Reduction: U. S. Patent 2,790,733, Apr. 30, 1957.

[4] Guthrie, James E., Cadmium Anthranilate Containing Anthelmintics: U. S. Patent 2,797,182, June 25, 1957.

[5] Manley, C. H., and Dalley, R. A., A Fatal Case of Cadmium Poisoning: The Analyst, vol. 82, No. 973, April 1957, pp. 287–289.

Calcium and Calcium Compounds

By C. Meade Patterson[1] and Annie L. Mattila[2]

CALCIUM CHLORIDE production in the United States reached an alltime high in 1957, responding to the recently inaugurated, long-term, multi-billion-dollar, Federal-aid program for construction and improvements of the interstate highway network by 1969. An even greater demand for calcium chloride is anticipated, once the national highway program gets fully under way and the rate of concrete road construction grows.

DOMESTIC PRODUCTION

Calcium for Government requirements was produced by Nelco Metals, Inc., operating the Government-owned plant at Canaan, Conn., during 1957. Lime was reduced by heating with aluminum in vacuum retorts. A small quantity of calcium also was produced from lime by Electro Metallurgical Co., Division of Union Carbide Corp. Calcium for commercial needs was imported from Canada.

Calcium-silicon alloy was produced in the United States during 1957.

The total calcium chloride and calcium-magnesium chloride obtained from natural brines and dry lake deposits and as ammonia-soda byproducts increased to a new high in 1957, but production from natural brines alone decreased 8 percent in 1957 compared with 1956. The output of calcium chloride as an ammonia-soda byproduct constituted about 60 percent of the total domestic production.[3] According to the Bureau of the Census, shipments of solid and flake (calcium chloride and calcium-magnesium chloride 77–80 percent $CaCl_2$) were 535,618 short tons valued at $14,843,000 in 1957 compared with 531,561 short tons valued at $14,099,000 in 1956. Shipments of calcium chloride and calcium-magnesium chloride brine (40–45 percent $CaCl_2$) in 1957 were 181,607 short tons valued at $1,902,000, compared with 183,229 (revised figure) short tons valued at $1,779,000 in 1956.

TABLE 1.—Calcium chloride and calcium-magnesium chloride from natural brines sold by producers in the United States, 1948–52 (average) and 1953–57 (average)

(In terms of 75 percent (Ca,Mg) Cl_2)

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	306,404	$4,100,996	1953–57 (average)	339,342	$6,170,027

[1] Commodity specialist.
[2] Statistical assistant.
[3] Chemical Week, Calcium Chloride Continues Its Climb: Vol. 81, No. 23, Dec. 7, 1957, pp. 109–110, 112.

Calcium chloride and calcium-magnesium chloride were produced from underground saline waters or from a dry lake bed by the following companies:

Company:	*Plant location*
Hill Bros. Chemical Co	Amboy, Calif.
National Chloride Co. of America	Do.
California Salt Co	Do.
Michigan Chemical Corp	St. Louis, Mich.
Morton Salt Co	Manistee, Mich.
Wilkinson Chemical Co	Mayville, Mich.
Dow Chemical Co	Midland, Mich. Ludington, Mich.
Westvaco Chlor-Alkali Div. Food Machinery & Chemical Corp	South Charleston, W. Va.

In California natural chloride brine was produced from the dry bed of Bristol Lake, San Bernardino County, Calif. Two articles described the California dry-lake-bed calcium chloride production and processing.[4] The Michigan and West Virginia companies recovered chlorides of calcium and magnesium from underground formations by evaporation of well brines. Salt, bromine, and magnesium compounds were coproducts. The double salt (calcium-magnesium chloride) and bromine compounds were prepared from well brines obtained near South Charleston, W. Va., by the Westvaco Chlor-Alkali Division of the Food Machinery & Chemical Corp.

Calcium chloride was chemically produced by the Solvay Process Division of Allied Chemical & Dye Corp., New York, N. Y., and Columbia-Southern Chemical Corp., Pittsburgh, Pa., by the ammonia-soda process.

CONSUMPTION AND USES

Calcium was used principally in the metallurgical industries as a reducing agent in 1957. Many uses were made of its affinity for oxygen, nitrogen, sulfur, and carbon in the production of both ferrous and nonferrous metals and alloys. Calcium was a reducing agent in preparing chromium, thorium, titanium, uranium, vanadium, and zirconium and a decarburizer and desulfurizer for ferrous metals and alloys. It was also used to debismuthize lead, to deoxidize iron castings, and to control grain size and inhibit carbide formation in steel production. Calcium is a useful alloying agent for aluminum, copper, lead, magnesium, and bearing metals, to separate argon and nitrogen, to desulfurize petroleum fractions, and to dehydrate alcohol. Calcium-silicon or calcium silicide (calcium 30–33 percent and silicon 60–65 percent) was also used in the metallurgy of steel and alloys by reason of its reducing capacity.

The estimated 1957 United States calcium chloride consumption by uses was as follows: Maintenance of unpaved roads, 30 percent; brine refrigeration and others, 25 percent; industrial processing, 17 percent; winter maintenance of highways, 15 percent; and concrete production, 13 percent. American Concrete Institute approval of

[4] Nordyke, L., California Salt's Mine in the Mojave: Explosives Eng., vol. 35, No. 5, September–October 1957, pp. 134–142. Ver Planck, W. E., Mineral Commodities of California. Calcium Chloride: California Dept. of Nat. Res., Div. of Mines, San Francisco, Calif., Bull. 176, Dec. 1957, pp. 101–104.

its use in concrete further improved calcium chloride's future prospects.[5]

Calcium chloride has assumed importance by virtue of its hygroscopicity and low freezing point (—51° F.) and the relatively high specific gravity of its solutions. As a hygroscopic salt, it was used in dehumidifying air, fireproofing foliage, drying walnuts, and dust-laying roads, coal mines, construction yards, parking lots, and playgrounds. Its low freezing point makes it useful in refrigeration, ice and ice-cream manufacture, deicing roads, and freezeproofing fire barrels and coal and cinder piles. Having a specific gravity up to 40 percent higher than water,[6] calcium chloride solutions are useful as oil-well drilling fluids and as ballast in weighting tires of tractors and earth-moving equipment (hydroflation).[7] Calcium chloride was used in highway construction to stabilize bases, wearing courses, and shoulders. In concrete, calcium chloride provides quicker initial set, higher early strength, greater ultimate strength, uniform curing, increased workability, and cold-weather protection. As an industrial chemical, this readily available, soluble calcium compound was useful in recovering some metals from their ores and in precipitating calcium alginate from seaweed.

PRICES AND SPECIFICATIONS

E&MJ Metal and Mineral Markets quoted the New York City price of calcium, 97–98 percent pure, cast in slabs and small pieces, in ton lots, at $2.05 a pound throughout 1957. This price has not changed, at least as far back as the beginning of 1952. The average value of imported calcium was $1.26 a pound. Calcium silicon prices were not quoted, but the average value of imports in 1957 was 19.5 cents a pound compared with 16.5 cents in 1956. Oil, Paint and Drug Reporter quoted the following prices for calcium chloride in its various commercial forms during 1957:

Grade and form:	*Price, Jan. 1, 1957*	*Price, Dec. 31, 1957*
USP granular	$0.32 per lb. (drums), no change.	$0.32 per lb.
Granular (or crystalline) purified.	$0.27 per lb. (drums), no change.	$0.27 per lb.
Flake, anhydrous, 94–97 percent.	Reported only for period Dec. 2–30, 1957 (paper bags, carlots, at works, frt. equald.), no change.	$37.80 per ton.
Flake, 77–80 percent.	$29.00 per ton through Feb. 18, 1957 (paper bags, carlots, at works frt. equald.), afterward.	$31.00 per ton.
Powdered, 77–80 percent	$35.00 per ton through Feb. 18, 1957 (bags, carlots, at works, frt. equald.), afterward.	$37.00 per ton.
Pellets, 77–80 percent.	$35.40 per ton through Feb. 18, 1957 (bags, carlots, at works, frt. equald.), afterward.	$37.80 per ton.

[5] Work cited in footnote 3.
[6] Calcium Chloride Institute, Properties of Calcium Chloride Solutions: Brief MB-2, Washington, D. C., 1 p.
[7] Columbia-Southern Chemical Corp., Pittsburgh, Pa., The Way to Better Traction; Tire Weighting With Calcium Chloride Solution: March 1957, 6 pp.

Grade and form:	*Price, Jan. 1, 1957*	*Price, Dec. 31, 1957*
Solid, 73–75 percent	$34.00–$71.00 per ton through Feb. 18, 1957 (drums, less than carlots, at works, frt. equald.), afterward.	$36.00–$73.00 per ton.
Solid, 73–75 percent	$27.50 per ton through Feb. 18, 1957 (drums, carlots, at works, frt. equald.), afterward.	$29.50 per ton.
Liquor, 40 percent	$12.35 per ton through Feb. 18, 1957 (tank cars, at works, frt. equald.), afterward.	$12.50 per ton.

In Eastern United States, granular, high-purity calcium chloride was prepared in C. P. (chemically pure) and U. S. P. (United States Pharmacopoeia) grades. Excluding the Commercial-grade anhydrous calcium chloride flake and pellets (94–97 percent), Eastern United States commercial calcium chloride flake, powder, and pellets run 77–80 percent, whereas solid California calcium chloride flake runs 73–75 percent. Much California calcium chloride was sold in solutions of 36° to 40° Be.,[8] 33 to 38 percent calcium chloride at 60° F.[9]

FOREIGN TRADE[10]

Imports.—Calcium imports remained small in 1957. Canada continued as the only foreign supplier.

Calcium-silicon alloy imports in 1957 increased about 160 percent over 1956. Forty-four percent was from Norway, 31 percent from West Germany, 21 percent from France, and 4 percent from Japan.

In 1957, of the 1,989 short tons of calcium chloride worth $77,058 imported, Belgium-Luxembourg supplied 49 percent; West Germany, 44 percent; United Kingdom, 5 percent; and Italy and Canada, each 1 percent.

Exports.—Ninety-seven percent of the exported calcium chloride went to Canada, Cuba, Mexico, and Colombia, in descending order.

TABLE 2.—Calcium metal and calcium-silicon imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Calcium metal		Calcium-silicon	
	Pounds	Value	Pounds	Value
1948–52 (average)	281,183	$296,770	206,626	$15,767
1953	990,017	1,009,934		
1954	685,417	728,379	178,138	22,055
1955	699,799	834,732	689,114	92,366
1956	8,387	10,109	194,869	32,191
1957	24,204	39,411	498,735	97,077

[8] Work cited in footnote 4 p. 6, pt. 2.
[9] Work cited in footnote 6.
[10] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

TABLE 3.—Calcium chloride imported for consumption into and exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Imports		Exports	
	Short tons	Value	Short tons	Value
1948–52 (average)	806	$27,556	17,201	$500,605
1953	2,671	84,594	11,572	370,799
1954	1,547	51,249	10,987	374,332
1955	1,844	57,881	20,743	607,579
1956	1,855	59,635	32,523	1,056,958
1957	1,989	77,058	47,965	1,627,545

Canada alone received 93 percent of the total. The remaining 3 percent was distributed among 20 countries in Latin America, Asia, Europe, and Africa, in descending order.

WORLD REVIEW

NORTH AMERICA

Canada.—Dominion Magnesium, Ltd., Toronto, with a plant at Haley, near Ottawa, continued to be the world's leading calcium producer. Calcium was prepared by thermal reduction of lime with aluminum in vacuum retorts. Most of the metal was supplied as ingots, billets, granules, and powder to consumers in the United Kingdom in 1956,[11] but the United States was Canada's leading calcium consumer in 1957.

Calcium production in 1957 was only 66,341 pounds valued at Can$83,589, or Can$1.26 a pound.[12] By contrast, in 1956 calcium production had been 394,900 pounds valued at Can$515,305 or Can$1.30 a pound.

TABLE 4.—Value of Canadian calcium exports, 1955–57

[Canada Department of Mines]

	1955	1956	1957
United States	Can$762,260	Can$12,560	Can$24,784
United Kingdom	507,706	616,605	7,887
Australia	165		
Belgium	12,030		17,634
France		16,360	20,338
India			54
Italy	788		
Sweden	330	3,243	6,795
West Germany		330	
Total	1,283,279	649,098	77,492

[11] Dominion Bureau of Statistics, Industry and Merchandising Division (Ottawa), Miscellaneous Metal Mining Industry (1956): 1957, p. F–14.
[12] Dominion Bureau of Statistics, Preliminary Estimate of Canada's Mineral Production for 1957 (Ottawa): Jan. 2, 1958, p. 3.

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TABLE 5.—Calcium compounds exported from Canada, 1956–57, by countries of destination

[Canada Department of Mines]

Destination	1956		1957	
	Short tons	Value	Short tons	Value
United States	2,529	Can$161,120	36,709	Can$3,182,982
United Kingdom	8,802	653,753	22,998	1,781,287
Cuba	2,365	221,468	3,575	320,762
Venezuela	2,903	264,039	3,115	294,630
Australia			2,014	243,388
Other countries	8,455	724,989	13,664	1,380,389
Total	25,054	2,025,369	82,075	7,203,438

TABLE 6.—Calcium compounds imported for consumption in Canada, 1956–57

[Canada Department of Mines]

Calcium compound	1956		1957	
	Short tons	Value	Short tons	Value
Calcium arsenate	6	Can$888	41	Can$4,952
Calcium chloride	29,963	853,407	45,413	1,336,776
Chloride of lime	1,658	221,476	1,316	212,437
Other calcium compounds	3,351	727,634	3,215	715,527
Total	34,978	1,803,405	49,985	2,269,692

The only Canadian manufacturer of calcium chloride in 1955 was Brunner Mond Canada, Ltd., Amherstburg, Ontario.[13] Most calcium chloride consumed came from the United States.

Exports of calcium compounds, most of which were shipped to the United States, more than trebled in 1957 over 1956. Canada's imports of calcium compounds in 1957 consisted mainly of calcium chloride from the United States.[14]

EUROPE

United Kingdom.—Calcium metal and its alloys were available in England in 1957 from the following firms: [15] Blackwell's Metallurgical Works, Ltd., Liverpool; Mitcham Smelters, Ltd., Surrey; New Metals & Chemicals, Ltd., and Oakland Metal Co., Ltd., London; and Watsons, Ltd., Sheffield.

TECHNOLOGY

A viscous slurry of calcium chloride, magnesium hydroxide, hydrated lime, and laurylpolyglycol ether was found useful for laying

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[13] Dominion Bureau of Statistics, Industry and Merchandising Division (Ottawa), The Acids, Alkalies and Salts Industry (1955): 1957, p. B-14.

[14] Figures on Canadian exports and imports compiled from data in letters to Bureau of Mines from H. D. Worden, Canada Department of Mines and Technical Surveys, Mines Branch, Ottawa, Mar. 19, 1958, and Apr. 15, 1958.

[15] Metal Industry Handbook and Directory, 1957, Iliffe & Sons, Ltd.: London. 1957, 536 pp.

dust in German coal mines, where it was sprayed on ceilings and coal faces.[16]

A calcium alloy slug in the crankcase may so prolong the lubricating properties of motor oils that automobiles of the future may travel 20,000 miles without an oil change.[17]

The principal hazard in handling calcium is the risk of fire resulting from hydrogen formed by calcium reacting with moisture. Accordingly, it is usually shipped in lump form in an argon atmosphere within special containers.[18]

Calcium chloride played a part in erecting the 60-story Chase Manhattan building in New York City. To provide protection against ground water during excavation, a gel made by mixing solutions of calcium chloride and sodium silicate in the ratio of 4:5 was pumped into the ground constantly by 15-man crews.[19]

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16 Buggisch, H., Müller-Römer, J., and Nees, H. (assigned to Chemische Fabrik Kalk G. m. b. H., Köln-Kalk, Germany), Composition for Binding Coal Dust: U. S. Patent 2,786,815, Mar. 26, 1957.
17 Engineering and Mining Journal, vol. 157, No. 9, September 1956, p. 112.
18 Chemical and Engineering News, Metals' Dangers Listed: Vol. 36, No. 8, Feb. 24, 1958, pp. 64–65.
19 Gillson, J. L., Industrial Minerals: Min. Cong. Jour., vol. 44, No. 2, February 1958, p. 96.

Cement

By D. O. Kennedy [1] and Betty M. Moore [2]

THE PRODUCTION of cement in the United States suffered a setback in 1957. Even the impetus of the President's highway program was unable to offset the effects of strikes in the construction industry on the west coast and a strike in the cement industry in June and July. Of the 162 cement plants in the United States, 68 were shut down in July. As a result, production and shipments decreased 11 percent for the first 7 months of 1957 compared with the first 7 months of 1956. Although production and shipments during the rest of 1957 and 1956 were about equal, the final figures for 1957 were 6 percent below those for 1956. Some contractors and suppliers felt that the highway program was lagging and was partly responsible for the decrease in cement production. The Bureau of Public Roads denied any delay, stating that the program was virtually on schedule and that actual construction always was 21 months behind preliminary engineering and right-of-way acquisitions.[3]

The decrease in cement production in 1957 did not slow down expansion programs of the cement industry. Six companies announced plans for adding more than 5 million barrels to the productive capacity of their plants. Plans for 8 new cement plants were announced by 6 established and 2 new companies. Under the stimulus of plans for constructing dams on the Colorado River, 5 companies announced that they intended to build cement plants in Arizona or New Mexico.

Three classes of cement were produced in the United States in 1957—portland, natural, and slag cements. In addition, prepared masonry cements were produced at many portland cement plants and at all other cement plants.

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[1] Assistant Chief, Branch of Construction and Chemical Materials.
[2] Statistical clerk.
[3] Bell, Joseph N., The Road Program Isn't in Trouble: Rock Products, vol. 60, No. 12, December 1957, pp. 60–65.
Construction Business, Beginning to Build Up Steam: Vol. 39, No. 11, November 1957, pp. 48, 53.
Trauffer, W. E., Highway Program Progressing Satisfactorily: Pit and Quarry, vol. 50, No. 5, November 1957, p. 10.

TABLE 1.—Salient statistics of the cement industry in the United States,[1] 1948–52 (average) and 1953–57

	1948-52 (average)	1953	1954
Production:			
Portland ... thousand barrels	227,296	264,181	272,353
Prepared masonry ... do	(2)	(2)	(2)
Natural, slag, and hydraulic lime ... do	[3] 3,545	[3] 3,488	[3] 3,504
Total ... do	230,841	267,669	275,857
Capacity used at portland-cement mills ... percent	84.4	90.5	91.4
Shipments from mills:			
Portland ... thousand barrels	226,133	260,879	274,872
Prepared masonry ... do	(2)	(2)	(2)
Natural, slag, and hydraulic lime ... do	[3] 3,550	[3] 3,459	[3] 3,513
Total ... do	229,683	264,338	278,385
Value of shipments [4] ... thousand dollars	550,363	707,604	773,076
Average value per barrel	$2.40	$2.68	$2.78
Stocks at mills, Dec. 31 ... thousand barrels	14,760	19,414	16,612
Imports ... do	640	386	450
Exports ... do	3,802	2,551	1,859
Apparent consumption [6] ... do	226,521	262,173	276,977
World: Production (estimated) ... do	776,468	[5] 1,051,902	[5] 1,142,851

	1955	1956	1957
Production:			
Portland ... thousand barrels	297,453	316,438	298,424
Prepared masonry ... do	16,519	15,906	14,701
Natural, slag, and hydraulic lime ... do	941	1,128	631
Total ... do	314,913	333,472	313,756
Capacity used at portland-cement mills ... percent	94.3	90.6	78.5
Shipments from mills:			
Portland ... thousand barrels	292,765	308,678	289,698
Prepared masonry ... do	16,526	15,898	14,381
Natural, slag, and hydraulic lime ... do	954	1,074	662
Total ... do	310,245	325,650	304,741
Value of shipments [4] ... thousand dollars	896,888	1,003,298	978,731
Average value per barrel	$2.89	$3.08	$3.21
Stocks at mills, Dec. 31 ... thousand barrels	17,604	[5] 22,511	28,664
Imports ... do	5,220	4,456	4,426
Exports ... do	1,795	[5] 1,981	1,331
Apparent consumption [6] ... do	313,669	328,133	307,836
World: Production (estimated) ... do	[5] 1,276,589	[5] 1,377,428	1,443,993

[1] Includes Puerto Rico.
[2] Not included in tabulation until 1955.
[3] Includes masonry cement from natural, slag, and hydraulic-lime cement plants.
[4] Value received f. o. b. mill, excluding cost of containers.
[5] Revised figure.
[6] Shipments from domestic mills plus imports minus exports.

PORTLAND CEMENT

PRODUCTION AND SHIPMENTS

Production of portland cement decreased from 316 million barrels in 1956 to 298 million barrels in 1957. Less than one-third of the plants that produced cement in 1956 had larger outputs in 1957 than in 1956. Four new plants began producing in 1957: Lone Star Cement Corp., Lake Charles, La.; Marquette Cement Manufacturing Co., Milwaukee, Wis.; Permanente Cement Co., Cushenbury, Calif.; and Texas Portland Cement Co., Echo, Tex. Although companies with other interests purchased operating cement plants and thus entered the cement industry, the Texas Portland Cement Co. was the

TABLE 2.—Finished portland cement produced, shipped, and in stock in the United States, 1956–57, by districts

District	Active plants		Production			Shipments from mills								Stocks at mills on Dec. 31		
			Thousand barrels		Change from 1956 (percent)	1956			1957					Thousand barrels		Change from 1956 (percent)
						Thousand barrels	Value		Thousand barrels	Value		Change from 1956 (percent) in—				
	1956	1957	1956	1957			Total (thousand dollars)	Average per barrel		Total (thousand dollars)	Average per barrel	Barrels	Average value	1956	1957	
Eastern Pennsylvania, Maryland	21	21	42,720	37,293	−12.7	41,740	129,528	$3.10	35,705	117,585	$3.29	−14.5	+6.1	[1] 3,232	4,456	+37.9
New York, Maine	11	11	19,631	17,836	−9.1	19,412	59,535	3.07	17,259	56,509	3.27	−11.1	+6.5	[1] 1,369	1,753	+28.0
Ohio	10	10	15,723	16,291	+3.6	15,151	46,342	3.06	15,454	49,115	3.18	+2.0	+3.9	[1] 1,228	1,974	+60.7
Western Pennsylvania, West Virginia	7	7	14,070	13,306	−5.4	13,713	41,708	3.04	12,799	41,482	3.24	−6.7	+6.6	[1] 1,019	1,357	+33.2
Michigan	8	8	20,485	21,015	+2.6	20,237	61,749	3.05	20,590	65,996	3.21	+1.7	+5.2	[1] 1,779	2,205	+23.9
Illinois	4	4	8,823	8,794	−.3	8,629	24,866	2.88	8,097	24,560	3.03	−6.2	+5.2	374	875	+134.0
Indiana, Kentucky, Wisconsin	6	7	18,125	17,681	−2.4	17,096	51,845	3.03	16,558	53,611	3.24	−3.1	+6.9	[1] 1,196	1,718	+43.6
Alabama	8	8	12,969	11,965	−7.7	12,311	35,256	2.86	11,382	34,238	3.01	−7.5	+5.2	750	905	+20.7
Tennessee	6	6	8,386	7,181	−14.4	8,050	23,014	2.86	6,776	20,592	3.04	−15.8	+6.3	476	684	+43.7
Virginia, South Carolina	4	4	7,002	7,643	+9.2	6,820	20,996	3.08	7,491	24,173	3.23	+9.8	+4.9	[1] 550	702	+27.6
Georgia, Florida	4	4	7,818	7,167	−8.3	7,675	24,198	3.15	7,079	23,348	3.30	−7.8	+4.8	401	452	+12.7
Louisiana, Mississippi	3	4	6,211	6,784	+9.2	6,096	17,665	2.90	6,599	19,700	2.99	+8.3	+3.1	282	431	+52.8
Iowa	5	5	10,944	10,502	−4.0	10,333	31,158	3.02	10,423	33,219	3.19	+.9	+5.6	1,404	1,380	−1.7
Eastern Missouri, Minnesota, South Dakota	6	6	14,554	12,549	−13.8	13,924	42,787	3.07	12,524	39,926	3.19	−10.1	+3.9	1,373	1,339	−2.5
Kansas	6	6	10,486	8,118	−22.6	10,239	29,371	2.87	7,864	23,593	3.00	−23.2	+4.5	[1] 779	1,006	+29.1
Western Missouri, Nebraska, Oklahoma, Arkansas	6	6	10,627	10,488	−1.3	10,230	30,184	2.95	10,297	31,688	3.08	+.7	+4.4	924	1,083	+17.2
Texas	13	14	25,655	21,845	−14.9	25,234	73,070	2.90	21,547	66,201	3.07	−14.6	+5.9	[1] 1,490	1,788	+20.0
Colorado, Arizona, Utah	6	6	8,435	8,740	+3.6	8,374	27,917	3.33	8,774	29,101	3.32	+4.8	−.3	466	432	−7.3
Wyoming, Montana, Idaho	3	3	3,060	2,802	−8.4	2,988	10,297	3.45	2,788	9,756	3.50	−6.7	+1.4	280	294	+5.0
Northern California	5	5	16,512	16,718	+1.2	16,353	48,150	2.94	16,621	49,993	3.01	+1.6	+2.4	1,187	1,277	+7.6
Southern California	7	8	23,035	21,653	−6.0	22,937	72,361	3.15	21,110	67,859	3.21	−8.0	+2.0	[1] 993	1,535	+54.6
Oregon, Washington	9	9	6,933	6,552	−5.5	6,881	23,958	3.48	6,409	22,482	3.51	−6.9	+.9	[1] 744	886	+19.1
Puerto Rico	2	2	4,234	5,501	+29.9	4,255	14,065	3.31	5,552	17,232	3.10	+30.5	−6.3	99	47	−52.5
Total	160	164	316,438	298,424	−5.7	[2] 308,678	940,020	3.05	[2] 289,698	921,959	3.18	−6.1	+4.3	[1] 22,395	28,579	+27.6
Pennsylvania	24	24	50,358	44,004	−12.6	49,527	153,506	3.10	42,519	140,100	3.29	−14.1	+6.1	[1] 3,851	5,077	+31.8
Missouri	5	5	12,441	10,866	−12.7	12,014	36,888	3.07	10,794	34,307	3.18	−10.1	+3.6	[1] 918	931	+1.4

[1] Revised figure.
[2] Does not include finished cement used in manufacturing prepared masonry cement, as follows: 1956; 2,884,000 barrels, 1957; 2,542,000 barrels.

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States in 1957, by months [1] and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,665	2,673	3,073	3,318	3,672	3,156	95	3,970	4,123	3,970	3,473	3,035
New York, Maine	1,141	1,052	1,438	1,611	1,884	1,842	94	2,001	1,861	1,833	1,654	1,458
Ohio	895	812	1,221	1,051	1,482	1,625	1,369	1,840	1,754	1,744	1,387	1,110
Western Pennsylvania, West Virginia	838	818	995	982	1,159	1,246	1,229	1,418	1,288	1,300	1,045	987
Michigan	946	600	779	1,487	2,068	2,154	2,461	2,548	2,537	2,462	1,712	1,261
Illinois	685	534	643	711	747	766	443	982	926	905	749	702
Indiana, Kentucky, Wisconsin	1,031	909	1,340	1,222	1,713	1,572	1,206	1,949	1,822	1,950	1,470	1,433
Alabama	918	909	1,028	1,050	1,119	1,090	539	1,199	1,104	1,098	1,027	858
Tennessee	601	514	610	662	579	470	400	759	742	726	652	466
Virginia, South Carolina	420	506	610	626	883	773	411	817	783	720	612	482
Georgia, Florida	666	670	671	677	642	391	160	533	687	687	714	668
Louisiana, Mississippi	526	436	543	535	534	605	554	622	709	686	531	504
Iowa	659	695	543	812	992	893	780	1,127	1,157	1,130	910	806
Eastern Missouri, Minnesota, South Dakota	718	652	946	885	1,162	1,044	1,243	1,417	1,314	1,357	997	860
Kansas	546	471	714	606	677	675	506	958	830	867	642	616
Western Missouri, Nebraska, Oklahoma, Arkansas	633	377	624	640	945	945	1,199	1,294	1,096	1,075	834	799
Texas	1,787	1,628	2,081	1,835	1,729	1,886	1,789	2,191	2,171	1,831	1,398	1,539
Colorado, Arizona, Utah	465	387	682	668	787	814	896	904	851	840	755	691
Wyoming, Montana, Idaho	124	101	128	265	262	307	351	301	250	256	273	178
Northern California	1,077	1,027	1,221	1,373	1,464	1,428	1,578	1,624	1,714	1,405	1,411	1,398
Southern California	1,376	1,398	1,823	1,815	1,931	1,738	1,876	1,838	2,025	2,107	1,640	1,586
Oregon, Washington	289	320	538	674	555	602	597	624	626	643	628	444
Puerto Rico	314	338	391	462	499	440	511	490	514	529	500	505
Total: 1957	19,320	17,827	22,642	23,967	27,485	26,462	20,287	31,406	30,884	30,121	25,014	22,386
1956	21,440	19,578	23,386	26,134	29,606	28,771	29,498	30,055	28,643	29,051	25,869	24,429
SHIPMENTS												
Eastern Pennsylvania, Maryland	1,326	1,882	3,278	2,941	4,056	3,743	394	5,403	3,967	4,014	3,012	1,615
New York, Maine	418	679	1,283	1,614	2,222	2,267	241	2,540	2,027	2,005	1,208	754
Ohio	355	619	901	1,002	1,599	1,652	2,207	2,000	1,736	1,732	991	661
Western Pennsylvania, West Virginia	403	564	854	905	1,275	1,340	1,833	1,589	1,245	1,279	927	595
Michigan	390	544	774	1,313	2,156	2,371	3,052	2,673	2,513	2,566	1,411	827
Illinois	137	279	498	523	784	1,085	697	990	1,124	983	514	482
Indiana, Kentucky, Wisconsin	372	703	1,099	1,221	1,799	1,784	1,387	2,175	1,777	1,967	1,297	976
Alabama	730	874	916	1,081	1,227	1,203	588	1,174	855	958	846	902
Tennessee	377	439	547	669	640	533	490	891	583	693	494	422
Virginia, South Carolina	419	447	616	665	811	867	585	836	614	695	489	447
Georgia, Florida	641	627	638	737	678	406	207	534	615	721	621	654
Louisiana, Mississippi	512	443	455	525	586	547	712	650	497	626	494	552

Iowa	142	235	396	850	1,095	1,219	1,437	1,583	1,463	1,213	470	320
Eastern Missouri, Minnesota, South Dakota	197	420	693	819	1,099	1,315	1,659	1,818	1,717	1,539	703	547
Kansas	233	459	560	576	667	858	672	1,014	846	908	525	544
Western Missouri, Nebraska, Oklahoma, Arkansas	260	462	637	706	857	1,006	1,491	1,294	1,222	1,115	619	629
Texas	1,545	1,683	1,848	1,751	1,903	1,893	2,126	2,113	1,866	1,893	1,223	1,702
Colorado, Arizona, Utah	399	525	649	647	788	870	893	913	921	864	661	642
Wyoming, Montana, Idaho	92	116	167	226	289	320	362	282	296	283	198	158
Northern California	1,015	879	1,109	1,389	1,448	1,523	1,649	1,811	1,693	1,596	1,408	1,101
Southern California	1,263	1,638	1,777	1,873	1,853	1,708	1,783	1,854	1,803	1,993	1,642	1,426
Oregon, Washington	241	270	430	647	638	609	685	713	625	641	507	404
Puerto Rico	335	319	426	445	470	426	505	515	506	563	569	474
Total: 1957	11,802	15,106	20,551	23,125	28,940	29,545	25,655	35,365	30,511	30,847	20,829	16,834
1956	13,273	15,929	22,222	27,087	31,787	31,996	31,333	33,324	29,935	31,354	22,705	17,822
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	4,545	5,307	5,063	5,405	4,985	4,371	4,069	2,585	2,708	2,629	3,059	4,460
New York, Maine	2,054	2,409	2,555	2,529	2,170	1,726	1,571	997	816	624	1,057	1,749
Ohio	1,830	2,020	2,331	2,375	2,246	2,211	1,363	1,187	1,202	1,139	1,532	1,974
Western Pennsylvania, West Virginia	1,463	1,707	1,836	1,898	1,763	1,651	1,026	830	860	862	972	1,358
Michigan	2,329	2,385	2,390	2,563	2,475	2,265	1,674	1,549	1,573	1,469	1,771	2,204
Illinois	916	1,165	1,291	1,464	1,407	1,071	802	754	545	445	666	875
Indiana, Kentucky, Wisconsin	1,827	2,000	2,198	2,142	1,995	1,727	1,527	1,210	1,270	1,191	1,315	1,718
Alabama	907	915	1,001	937	789	636	532	503	721	825	978	905
Tennessee	688	752	798	771	693	617	513	353	493	508	651	684
Virginia, South Carolina	551	611	605	566	638	544	370	350	518	543	666	702
Georgia, Florida	425	461	491	428	388	373	322	317	386	352	441	452
Louisiana, Mississippi	294	281	369	373	316	374	212	181	389	446	479	431
Iowa	1,920	2,369	2,507	2,460	2,354	2,018	1,344	880	571	473	901	1,380
Eastern Missouri, Minnesota, South Dakota	1,889	2,113	2,361	2,427	2,482	2,206	1,788	1,382	976	790	1,055	1,339
Kansas	1,092	1,105	1,248	1,278	1,288	1,098	932	870	848	807	923	995
Western Missouri, Nebraska, Oklahoma, Arkansas	1,297	1,212	1,194	1,127	1,199	1,137	845	845	719	671	885	1,055
Texas	1,731	1,677	1,910	1,993	1,819	1,813	1,476	1,554	1,858	1,797	1,972	1,809
Colorado, Arizona, Utah	532	393	426	447	446	389	393	384	313	289	383	432
Wyoming, Montana, Idaho	312	297	258	297	270	258	247	266	220	193	267	287
Northern California	1,249	1,397	1,509	1,491	1,506	1,410	1,338	1,149	1,169	978	981	1,277
Southern California	1,106	866	912	853	931	962	1,055	1,039	1,262	1,375	1,374	1,534
Oregon, Washington	793	843	961	988	906	899	810	723	715	723	843	883
Puerto Rico	78	97	63	81	110	129	136	110	118	84	16	47
Total: 1957	29,828	32,382	34,277	34,893	33,176	29,885	24,345	20,018	20,250	19,213	23,187	28,550
1956	25,454	28,939	29,868	28,679	26,204	22,685	20,598	17,068	15,532	13,007	15,973	[2] 22,018

[1] Difference between monthly and annual reports not adjusted.
[2] Revised figure.

first company in 7 years to build its own plant and become a cement producer without a previously established market for its product.

Descriptions were published of new equipment installed as part of expansion plans at cement plants in Bessemer, Pa., East Fultonham, Ohio, Bunnell, Fla., and Speed, Ind.[4] The equipment installed in new cement plants at Paulding, Ohio, and Echo, Tex., was described.[5]

Several changes in ownership of cement plants occurred in 1957. The Kosmos Portland Cement Co., with 1 plant at Kosmosdale, Ky., was purchased by the Flintkote Co. of New York; the Northwestern Portland Cement Co., with 1 plant at Grotto, Wash., was acquired by the Ideal Cement Co. of Denver; and the Superior Portland Cement, Inc., with 2 plants in Washington, was merged with the Lone Star Cement Corp. of New York. Three companies, the Hercules Cement Corp, of Philadelphia, the Peerless Cement Co. of Detroit, and the Riverside Cement Co. of Los Angeles, were merged at the end of 1957 to become the American Cement Corp.

TYPES OF PORTLAND CEMENT

General-purpose and moderate-heat portland cement (types I–II) constituted 92 percent of all portland cement made in the United States in 1957 and was produced at 163 of the 164 portland-cement plants. High-early-strength portland cement (type III) was produced at 111 plants in 1957; the total quantity was about 4 percent of the portland-cement output.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1948–52 (average) and 1953–57, by types

Type and year	Active plants	Production (thousand barrels)	Shipments		
			Thousand barrels	Value	
				Total (thousand dollars)	Average per barrel
General-use and moderate-heat (types I and II):					
1948–52 (average)	152	192,585	191,499	453,294	$2.37
1953	156	217,555	215,103	569,217	2.65
1954	157	[2] 255,673	258,307	705,963	2.73
1955	157	[2] 276,248	272,064	768,520	2.82
1956	160	[2] 292,598	285,856	858,767	2.99
1957	163	[2] 275,968	268,855	844,962	3.14
High-early-strength (type III):					
1948–52 (average)	91	6,726	6,630	18,448	2.78
1953	99	7,949	7,794	23,743	3.05
1954	102	[3] 10,166	10,172	31,779	3.12
1955	106	[3] 11,744	11,459	37,550	3.28
1956	101	[3] 12,142	11,808	42,596	3.61
1957	111	[3] 12,853	11,867	43,325	3.65

See footnotes at end of table.

[4] Trauffer, W. E., Expansion at Bessemer Limestone: Pit and Quarry, vol. 49, No. 9, March 1957, pp. 136–138, 140, 141–142, 168.
Herod, B. C., Columbia Cement's Latest Expansion: Pit and Quarry, vol. 50, No. 1, July 1957, pp. 129–132, 134, 136, 155.
Avery, Wm. M., Cement Plant Expands Twice Within Five Years: Rock Products, vol. 60, No. 6, June 1957, pp. 91–93, 174, 176, 177.
Herod, B. C., Louisville Cement Doubles Crushing Capacity During General Expansion: Pit and Quarry, vol. 50, No. 1, July 1957, pp. 145, 148, 150, 152, 154.

[5] Meschter, E., Big Equipment Dominates New Cement Plant: Rock Products, vol. 60, No. 11, November 1957, pp. 90–93, 122.
Rock Products, Texas Portland Gets High Rate of Cement Output per Man-Hour: Vol. 60, No. 9, September 1957, pp. 84–87.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1948–52 (average) and 1953–57, by types—Continued

Type and year	Active plants	Production (thousand barrels)	Shipments: Thousand barrels	Shipments: Value: Total (thousand dollars)	Shipments: Value: Average per barrel
Low-heat (type IV):					
1948–52 (average)	4	355	324	947	$2.93
1953	2	193	172	507	2.95
1954	1	84	48	194	4.02
1955	0				
1956	2	14	3	9	3.29
1957	2	21	5	16	3.23
Sulfate-resisting (type V):					
1948–52 (average)	4	83	98	340	3.46
1953	4	79	90	318	3.55
1954	7	142	120	433	3.62
1955	6	65	80	302	3.77
1956	6	93	79	312	3.95
1957	9	191	191	712	3.72
Oil-well:					
1948–52 (average)	16	1,742	1,792	4,789	2.67
1953	17	1,861	1,823	5,464	3.00
1954	16	1,641	1,665	5,059	3.04
1955	16	1,898	1,851	6,429	3.47
1956	16	[4] 1,655	1,705	5,687	3.33
1957	16	1,511	1,482	5,161	3.48
White:					
1948–52 (average)	4	1,100	1,085	5,333	4.91
1953	4	1,114	1,091	6,088	5.58
1954	4	1,110	1,153	6,413	5.56
1955	4	[4] 1,191	1,205	6,580	5.46
1956	3	[4] 1,171	1,133	7,025	6.20
1957	4	[4] 1,087	1,024	6,595	6.44
Portland-pozzolan:					
1948–52	5	1,627	1,654	3,963	2.40
1953	6	2,406	2,449	6,441	2.63
1954	8	[5] 2,413	2,251	6,100	2.71
1955	10	[5] 4,906	4,706	13,183	2.80
1956	12	[5] 6,936	6,817	20,940	3.07
1957	11	[5] 5,219	5,237	17,246	3.29
Air-entrained:					
1948–52 (average)	78	22,218	22,187	51,440	2.32
1953	95	32,131	31,474	82,594	2.62
1954	99	(6)	(6)	(6)	
1955	99	(6)	(6)	(6)	
1956	104	(6)	(6)	(6)	
1957	112	(6)	(6)	(6)	
Miscellaneous:[7]					
1948–52 (average)	23	858	863	2,617	3.03
1953	21	892	883	2,891	3.28
1954	22	1,124	1,156	3,921	3.39
1955	22	1,401	1,400	4,962	3.54
1956	26	1,829	1,277	4,684	3.67
1957	26	[4] 1,574	1,037	3,942	3.80
Grand total:					
1948–52 (average)	152	227,296	226,133	541,172	2.39
1953	156	264,180	260,879	697,263	2.67
1954	157	272,353	274,872	759,862	2.76
1955	157	297,453	292,765	837,526	2.86
1956	160	316,438	308,678	940,020	3.05
1957	164	298,424	289,698	921,959	3.18

[1] Including Puerto Rico.
[2] Includes air-entrained portland cement as follows (in thousand barrels): 1954, 31,204; 1955, 31,858; 1956, 35,458; 1957, 32,791.
[3] Includes air-entrained portland cement as follows (in thousand barrels); (1954, 2,651; 1955, 3,378; 1956, 3,444; 1957, 3,497.
[4] Includes a small quantity of air-entrained portland cement.
[5] Includes air-entrained portland cement as follows (in thousand barrels): 1954, 1,667; 1955, 945; 1956, 1,382; 1957, 2,311.
[6] See footnotes 2, 3, 4, and 5.
[7] Includes hydroplastic, plastic, and waterproofed cements.

Portland-pozzolan cement was produced at 2 plants and portland blast-furnace-slag cement at 7 plants; 8 of these 9 plants produced other types of cement in addition to these special cements.

CAPACITY OF PLANTS

The estimated annual capacity of all portland-cement plants on December 31, 1957, as reported to the Bureau of Mines by producers, was 9 percent greater than that reported on December 31, 1956. The increase was due to expansion of facilities at 32 of the 160 plants operated in 1956 and to 4 new plants completed in 1957.

A comparison of the completion schedule through 1957 with expansion plans of December 1955 showed a lag of less than 2 percent.

Number of portland-cement plants in the United States (including Puerto Rico) in 1957, by size groups

Estimated annual capacity, Dec. 31, million barrels:	*Number of plants*	*Percent of total capacity*
Less than 1	11	2.1
1 to 2	62	24.4
2 to 3	56	34.7
3 to 4	20	17.1
4 to 5	7	7.9
5 to 11	7	13.8
Total	[1] 163	100.0

[1] Does not include clinker-grinding plants.

TABLE 5.—Portland-cement-manufacturing capacity of the United States, 1956–57, by districts

District	Estimated (thousand barrels)		Percent utilized	
	1956	1957	1956	1957
Eastern Pennsylvania, Maryland	45,955	49,473	93.0	75.4
New York, Maine	20,722	22,401	94.7	79.6
Ohio	17,820	18,023	88.2	90.4
Western Pennsylvania, West Virginia	14,911	15,998	94.4	83.2
Michigan	25,370	25,581	80.7	82.2
Illinois	9,121	9,977	96.7	88.2
Indiana, Kentucky, Wisconsin	20,323	24,010	89.2	73.6
Alabama	13,358	15,029	97.1	79.6
Tennessee	8,520	8,520	98.4	84.3
Virginia, South Carolina	8,090	9,270	86.6	82.4
Georgia, Florida	9,382	9,512	83.3	75.3
Louisiana, Mississippi	6,100	8,525	101.8	79.6
Iowa	12,850	13,000	85.2	80.8
Eastern Missouri, Minnesota, South Dakota	14,683	16,514	99.1	76.0
Kansas	11,777	11,750	89.0	69.1
Western Missouri, Nebraska, Oklahoma, Arkansas	12,411	12,865	85.6	81.5
Texas	28,256	32,063	90.8	68.1
Colorado, Arizona, Utah	8,954	8,880	94.2	98.4
Wyoming, Montana, Idaho	3,147	3,150	97.2	89.0
Northern California	18,400	18,335	89.7	91.2
Southern California	24,482	31,815	94.1	68.1
Oregon, Washington	9,510	9,695	72.9	67.6
Puerto Rico	5,300	6,000	79.9	91.7
Total	349,442	380,386	90.6	78.5

TABLE 6.—Capacity of portland-cement plants in the United States,[1] Dec. 31, 1955–57, by processes

Process	Capacity, Dec. 31						Percent of capacity utilized			Percent of total finished cement produced		
	Thousand barrels			Percent of total								
	1955	1956	1957	1955	1956	1957	1955	1956	1957	1955	1956	1957
Wet	179,911	203,522	217,114	57.1	58.2	57.1	94.6	89.3	77.9	57.2	57.4	56.7
Dry	135,388	145,920	163,272	42.9	41.8	42.9	93.9	92.3	79.2	42.8	42.6	43.3
Total	315,299	349,442	380,386	100.0	100.0	100.0	94.3	90.6	78.5	100.0	100.0	100.0

[1] Includes Puerto Rico.

CLINKER PRODUCTION

The production of clinker—the intermediate product between raw materials and finished portland cement—was 5 percent less in 1957 than in 1956. In July 1957, at the peak of the strike in cement plants, clinker production fell to 17 million barrels, the lowest monthly output since February 1951. At the end of 1957 stocks of clinker on hand were 55 percent greater than those reported at the end of 1956.

TABLE 7.—Production and stocks of portland-cement clinker at mills in the United States in 1957, by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	3,278	3,144	3,410	3,576	3,528	3,011	42	3,591	3,732	3,910	3,769	3,471
New York, Maine	1,518	1,464	1,601	1,653	1,580	1,536	42	1,603	1,686	1,723	1,734	1,690
Ohio	1,277	1,107	1,392	1,371	1,421	1,453	1,233	1,583	1,469	1,587	1,532	1,472
Western Pennsylvania, West Virginia	985	951	1,157	1,076	1,112	1,108	957	1,208	1,093	1,108	988	1,103
Michigan	1,702	1,421	1,610	1,700	1,742	1,736	1,962	2,120	2,006	2,255	1,981	1,861
Illinois	716	661	753	740	766	769	348	868	801	849	776	758
Indiana, Kentucky, Wisconsin	1,546	1,323	1,538	1,453	1,559	1,441	1,050	1,571	1,541	1,831	1,576	1,631
Alabama	1,034	915	1,079	1,054	1,077	1,020	535	1,159	1,158	1,202	1,127	987
Tennessee	716	620	730	715	595	385	386	691	698	741	706	545
Virginia, South Carolina	642	550	648	708	797	733	329	675	762	776	703	617
Georgia, Florida	711	679	748	754	650	400	166	459	728	731	750	775
Louisiana, Mississippi	497	493	566	534	560	548	510	522	670	636	601	524
Iowa	813	884	801	865	964	783	592	1,021	1,059	1,101	988	836
Eastern Missouri, Minnesota, South Dakota	1,108	953	1,071	1,124	1,220	1,097	909	1,136	1,136	1,281	1,151	1,034
Kansas	677	667	787	672	711	680	461	723	748	742	645	670
Western Missouri, Nebraska, Oklahoma, Arkansas	940	679	772	843	958	940	986	1,078	1,021	1,045	879	997
Texas	1,864	1,697	2,058	2,011	1,901	1,893	1,716	2,052	2,288	1,918	1,882	1,658
Colorado, Arizona, Utah	587	496	664	756	781	712	747	783	807	786	797	784
Wyoming, Montana, Idaho	213	181	195	216	245	284	290	281	271	226	301	245
Northern California	1,412	1,325	1,271	1,420	1,488	1,364	1,492	1,502	1,433	1,245	1,236	1,654
Southern California	1,406	1,272	1,637	1,703	1,761	1,827	1,789	1,775	2,028	2,081	1,873	1,691
Oregon, Washington	389	419	675	722	500	422	438	543	537	501	726	547
Puerto Rico	381	378	454	448	481	444	477	451	440	483	472	458
Total: 1957	24,412	22,279	25,617	26,114	26,397	24,586	17,457	27,395	28,112	28,758	27,193	26,008
1956	25,153	23,131	25,811	26,047	27,853	27,053	28,230	28,334	27,324	27,940	26,607	26,450
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	1,448	1,853	2,149	2,355	2,154	1,965	1,955	1,487	1,003	891	1,147	1,514
New York, Maine	1,177	1,573	1,724	1,767	1,466	1,161	1,111	705	523	404	478	685
Ohio	518	821	982	1,299	1,218	1,049	940	683	403	242	360	735
Western Pennsylvania, West Virginia	450	612	811	915	900	801	583	415	281	147	130	278
Michigan	1,476	2,249	3,072	3,230	2,886	2,437	1,909	1,478	923	624	691	1,218
Illinois	176	291	401	424	435	438	343	224	95	39	61	113
Indiana, Kentucky, Wisconsin	986	1,381	1,685	1,921	1,871	1,765	1,700	1,294	1,032	812	913	1,124
Alabama	337	407	430	408	328	236	233	174	176	249	331	439
Tennessee	196	299	410	454	459	361	330	243	194	198	251	320
Virginia, South Carolina	482	519	538	604	501	446	342	213	182	215	293	398
Georgia, Florida	141	121	155	203	179	154	152	60	69	84	80	150
Louisiana, Mississippi	62	133	186	202	258	246	218	136	118	63	126	145

Iowa	310	506	764	814	784	676	496	387	293	225	305	331
Eastern Missouri, Minnesota, South Dakota	805	1,109	1,231	1,464	1,528	1,494	1,162	862	695	738	871	1,036
Kansas	324	507	582	652	677	688	650	416	324	200	197	253
Western Missouri, Nebraska, Oklahoma, Arkansas	558	847	991	1,195	1,222	1,218	1,022	820	731	658	679	796
Texas	569	625	560	689	841	828	706	560	626	650	1,112	1,208
Colorado, Arizona, Utah	482	591	576	665	654	537	381	251	232	213	280	371
Wyoming, Montana, Idaho	208	288	354	302	288	263	201	182	199	169	193	258
Northern California	811	1,120	1,184	1,244	1,281	1,228	1,162	1,058	794	651	508	762
Southern California	1,944	1,800	1,641	1,562	1,405	1,515	1,513	1,474	1,510	1,526	1,787	1,890
Oregon, Washington	721	819	957	1,005	950	768	609	520	429	285	379	475
Puerto Rico	156	154	238	246	254	276	261	239	184	161	154	127
Total: 1957	14,337	18,625	21,621	23,620	22,539	20,550	17,979	13,881	11,016	9,444	11,326	14,626
1956	10,460	13,873	16,151	15,951	14,222	12,537	11,059	9,264	7,969	6,874	7,476	[1] 9,443

[1] Revised figure.

TABLE 8.—Portland-cement clinker produced and in stock at mills in the United States,[1] 1956–57, by processes, in thousand barrels [2]

Process	Plants		Production		Stocks on Dec. 31—	
	1956	1957	1956	1957	1956 [3]	1957 [4]
Wet	95	98	183,002	175,062	4,059	7,785
Dry	65	66	136,931	129,266	5,384	6,841
Total	160	164	319,933	304,328	9,443	14,626

[1] Including Puerto Rico.
[2] Compiled from monthly estimates of producers.
[3] Revised figures.
[4] Preliminary figures.

RAW MATERIALS

The principal raw materials used in the United States for manufacturing portland cement in 1957 were limestone and clay or shale. Since 1943 approximately 70 percent of the output has been made from these materials. Argillaceous limestone (cement rock) or a mixture of cement rock and pure limestone was used for 26 percent of the portland cement made in 1957. Nine portland-cement plants used shell in place of limestone.

Blast-furnace slag was used as an ingredient of portland cement at 15 plants, 7 of which used approximately 350,000 tons of blast-furnace slag to produce portland slag cement.

TABLE 9.—Production and percentage of total output of portland cement in the United States,[1] 1909–14, 1926, 1929, 1933, 1935, and 1941–57, by raw materials used

Year	Cement rock and pure limestone		Limestone and clay or shale [2]		Marl and clay		Blast-furnace slag and limestone	
	Thousand barrels	Percent	Thousand barrels	Percent	Thousand barrels	Percent	Thousand barrels	Percent
1909	24,274	37.3	32,219	49.6	2,711	4.2	5,787	8.9
1910	26,521	34.6	39,720	51.9	3,307	4.3	7,002	9.2
1911	26,812	34.1	40,666	51.8	3,314	4.2	7,737	9.9
1912	24,713	30.0	44,608	54.1	2,467	3.0	10,650	12.9
1913	29,333	31.8	47,832	51.9	3,735	4.1	11,197	12.2
1914	24,907	28.2	50,169	56.9	4,038	4.6	9,116	10.3
1926	44,091	26.8	101,638	61.8	3,324	2.0	15,477	9.4
1929	51,077	29.9	97,623	57.2	4,833	2.9	17,113	10.0
1933	14,135	22.3	43,638	68.7	1,403	2.2	4,297	6.8
1935	23,812	31.0	45,073	58.8	1,479	1.9	6,378	8.3
1941	46,534	28.4	102,286	62.3	3,142	1.9	12,069	7.4
1942	49,479	27.0	115,948	63.4	3,010	1.7	14,344	7.9
1943	29,915	22.4	92,310	69.2	2,301	1.7	8,898	6.7
1944	17,609	19.4	65,478	72.0	2,079	2.3	5,740	6.3
1945	20,384	19.8	73,410	71.4	2,035	2.0	6,976	6.8
1946	39,071	23.8	112,142	68.3	2,720	1.7	10,131	6.2
1947	43,428	23.3	129,338	69.3	2,409	1.3	11,344	6.1
1948	47,560	23.1	144,855	70.5	2,620	1.3	10,413	5.1
1949	45,655	21.8	150,436	71.7	3,310	1.6	10,326	4.9
1950	47,120	20.8	164,812	73.0	2,597	1.1	11,497	5.1
1951	50,328	20.4	169,204	68.8	2,653	1.1	23,837	9.7
1952	48,563	19.5	177,901	71.4	4,038	1.6	18,754	7.5
1953	54,029	20.5	184,182	69.7	5,097	1.9	20,873	7.9
1954	57,173	21.0	190,611	69.9	5,082	1.9	19,487	7.2
1955	71,764	24.1	201,412	67.7	5,351	1.8	18,926	6.4
1956	72,722	23.0	216,601	68.4	5,347	1.7	21,768	6.9
1957	64,776	21.7	206,419	69.2	5,324	1.8	21,905	7.3

[1] Includes Puerto Rico, 1941–57; Hawaii, 1945–46. There has been no production in Hawaii since 1946.
[2] Includes output of 2 plants using oystershell and clay in 1926; 3 plants in 1929, 1933, and 1935; 4 plants in 1941–45; 5 plants in 1946–49; 6 plants in 1950; 7 plants in 1951; 8 plants in 1952–56; and 9 plants in 1957.

TABLE 10.—Raw materials used in producing portland cement in the United States,[1] 1955–57

Raw material	1955	1956	1957
Cement rock .... thousand short tons..	19,120	19,463	17,152
Limestone (including oystershell) .... do....	61,117	66,117	63,903
Marl .... do....	1,332	1,421	1,565
Clay and shale [2] .... do....	8,692	9,095	9,044
Blast-furnace slag .... do....	1,659	1,706	1,455
Gypsum .... do....	2,319	2,449	2,366
Sand and sandstone (including silica and quartz) .... do....	923	1,011	973
Iron materials [3] .... do....	327	494	516
Miscellaneous [4] .... do....	311	220	222
Total	95,800	101,976	97,196
Average total weight required per barrel (376 pounds) of finished cement .... pounds..	644	645	651

[1] Includes Puerto Rico.
[2] Includes fuller's earth, diaspore, and kaolin for making white cement.
[3] Includes iron ore, pyrite cinder and ore, and mill scale.
[4] Includes fluorspar, pumicite, pitch, red mud and rock, hydrated lime, tufa, calcium chloride, sludge, air-entraining compounds, and grinding aids.

FUEL AND POWER

The decrease in cement production in 1957 was accompanied by decreases of 4 and 32 percent, respectively, in coal and oil used in the production of cement compared with 1956. The quantity of natural gas utilized in cement plants increased 1 percent. The 164 plants used an average of 1.3 million B. t. u. per barrel of cement produced.

TABLE 11.—Finished portland cement produced and fuel consumed by the portland-cement industry in the United States,[1] 1956–57, by processes

	Finished cement produced			Fuel consumed [2]		
	Plants	Thousand barrels	Percent of total	Coal (short tons)	Oil (barrels of 42 gallons)	Natural gas (M cubic feet)
1956						
Wet	95	181,686	57.4	4,482,581	5,938,246	100,386,160
Dry	65	134,752	42.6	4,787,051	1,987,413	43,805,360
Total	160	316,438	100.0	[3] 9,269,632	7,925,659	[4] 144,191,520
1957						
Wet	97	169,109	56.7	4,340,542	4,319,726	103,852,885
Dry	67	129,315	43.3	4,512,623	1,095,333	42,312,794
Total	164	298,424	100.0	[5] 8,853,165	5,415,059	[6] 146,165,679

[1] Includes Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Comprises 243,642 tons of anthracite and 9,070,661 tons of bituminous coal.
[4] Includes 101,545 M cubic feet of byproduct gas and 2,642,278 M cubic feet of coke-oven gas.
[5] Comprises 221,075 tons of anthracite and 8,632,090 tons of bituminous coal.
Includes 55,606 M cubic feet of byproduct gas and 2,502,631 M cubic feet of coke-oven gas.

TABLE 12.—Portland cement produced in the United States,[1] 1956–57, by kinds of fuel

Fuel	Finished cement produced			Fuel consumed [2]		
	Plants	Thousand barrels	Percent of total	Coal (short tons)	Oil (barrels of 42 gallons)	Natural gas (M cubic feet)
1956						
Coal	62	[3] 119,713	37.8	6,544,780	-	-
Oil	11	[3] 25,575	8.1	-	5,330,254	-
Natural gas	19	[3] 39,161	12.4	-	-	[4] 51,131,030
Coal and oil	20	39,173	12.4	1,737,232	1,025,827	-
Coal and natural gas	23	42,256	13.3	882,337	-	[5] 35,991,411
Oil and natural gas	17	39,459	12.5	-	1,530,096	43,082,237
Coal, oil, and natural gas	8	11,101	3.5	105,283	39,482	13,986,842
Total	160	316,438	100.0	[6] 9,269,632	7,925,659	144,191,520
1957						
Coal	63	[3] 113,221	37.9	6,149,964	-	-
Oil	8	[3] 14,543	4.9	-	2,705,918	-
Natural gas	22	[3] 36,626	12.2	-	-	[7] 47,915,347
Coal and oil	20	39,728	13.3	1,686,864	1,205,471	-
Coal and natural gas	23	35,440	11.9	837,668	-	[8] 29,871,334
Oil and natural gas	20	47,603	16.0	-	1,460,651	55,931,343
Coal, oil, and natural gas	8	11,263	3.8	178,669	43,019	12,447,655
Total	164	298,424	100.0	[9] 8,853,165	5,415,059	146,165,679

[1] Includes Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Average consumption of fuel per barrel of cement produced as follows: 1956—coal, 109.3 pounds; oil, 0.2084 barrel; natural gas, 1,306 cubic feet. 1957—coal, 108.6 pounds; oil, 0.1861 barrel; natural gas, 1,308 cubic feet.
[4] Includes 2,642,278 M cubic feet of coke-oven gas.
[5] Includes 101,545 M cubic feet of byproduct gas.
[6] Comprises 243,642 tons of anthracite and 9,070,661 tons of bituminous coal.
[7] Includes 2,502,631 M cubic feet of coke-oven gas.
[8] Includes 55,606 M cubic feet of byproduct gas.
[9] Comprises 221,075 tons of anthracite and 8,632,090 tons of bituminous coal.

TABLE 13.—Electric energy used at portland-cement-producing plants in the United States,[1] 1956–57, by processes

Process	Electric energy used						Finished cement produced (thousand barrels)	Average electric energy used per barrel of cement produced (kilowatt hours)
	Generated at portland-cement plants		Purchased		Total			
	Active plants	Million kilowatt hours	Active plants	Million kilowatt hours	Million kilowatt hours	Percent		
1956								
Wet	26	757	89	3,049	3,806	55.5	181,686	20.9
Dry	33	1,569	60	1,478	3,047	44.5	134,752	22.6
Total	59	2,326	149	4,527	6,853	100.0	316,438	21.7
Percent of total electric energy used	-	33.9	-	66.1	100.0	-	-	-
1957								
Wet	26	705	91	3,009	3,714	54.9	169,109	17.6
Dry	37	1,538	62	1,515	3,053	45.1	129,315	23.1
Total	63	2,243	153	4,524	6,767	100.0	298,424	22.7
Percent of total electric energy used	-	33.1	-	66.9	100.0	-	-	-

[1] Includes Puerto Rico.

TRANSPORTATION

The trend toward shipping cement in bulk rather than in bags continued. Originally cement had been shipped in barrels, but later these were replaced by bags. By 1947 nearly two-thirds of all cement was shipped in bags. In 1957 less than one-fourth of the total was shipped in bags, and three-fourths was shipped in bulk. The quantity of cement shipped by truck has increased from 16 percent in 1947 to 34 percent in 1957. Shipments by boat were confined almost entirely to Puerto Rico, Kentucky, Louisiana, northern California, and Alabama, where 41, 40, 32, 19, and 10 percent, respectively, of the total shipments were by boat. The few shipments by boat in other localities were insignificant. Shipments between producing plants or from plants to distribution centers are not included in these tabulations, which represent only shipments from producing companies to consumers.

TABLE 14.—Shipments of portland cement from mills in the United States,[1] 1955–57, in bulk and in containers, by types of carriers

Type of carrier	In bulk		In containers				Total shipments	
			Bags		Other containers [2] (thousand barrels)	Total (thousand barrels)		
	Thousand barrels	Percent	Paper (thousand barrels)	Cloth (thousand barrels)			Thousand barrels	Percent
1955								
Truck	65,714	31.3	21,284	121	----------	21,405	87,119	29.7
Railroad	137,328	65.4	59,900	301	19	60,220	197,548	67.5
Boat	6,788	3.2	797	32	----------	829	7,617	2.6
Used at plant	256	.1	217	1	7	225	481	.2
Total	210,086	100.0	82,198	455	26	82,679	292,765	100.0
Percent of total	71.8	--------	28.1	0.1	(3)	28.2	100.0	--------
1956								
Truck	75,374	32.4	22,993	187	----------	23,181	98,554	31.9
Railroad	150,570	64.8	52,453	65	13	52,531	203,101	65.8
Boat	5,868	2.5	416	22	----------	438	6,307	2.1
Used at plant	601	.3	111	1	4	115	716	.2
Total	232,413	100.0	75,973	275	17	76,265	308,678	100.0
Percent of total	75.3	--------	24.6	0.1	(3)	24.7	100.0	--------
1957								
Truck	78,220	35.2	21,213	163	----------	21,376	99,596	34.4
Railroad	137,043	61.7	45,472	60	9	45,541	182,584	63.0
Boat	6,342	2.9	580	16	----------	596	6,938	2.4
Used at plant	495	.2	84	----------	1	85	580	.2
Total	222,100	100.0	67,349	239	10	67,598	289,698	100.0
Percent of total	76.7	--------	23.2	0.1	(3)	23.3	100.0	--------

1 Includes Puerto Rico.
2 Includes steel drums and iron and wood barrels.
3 Less than 0.05 percent.

CONSUMPTION

Although shipments of cement into a State do not equal consumption in that State for a particular year, they afford a fair index of consumption. Shipments were higher in 14 States and lower in 34 States and the District of Columbia in 1957 than in 1956.

Shipments of high-early-strength cement were greatest to Michigan, New York, New Jersey, and Pennsylvania.

As indicated in figure 1, regional consumption of portland cement in 1957 followed the upward trends held since 1945.

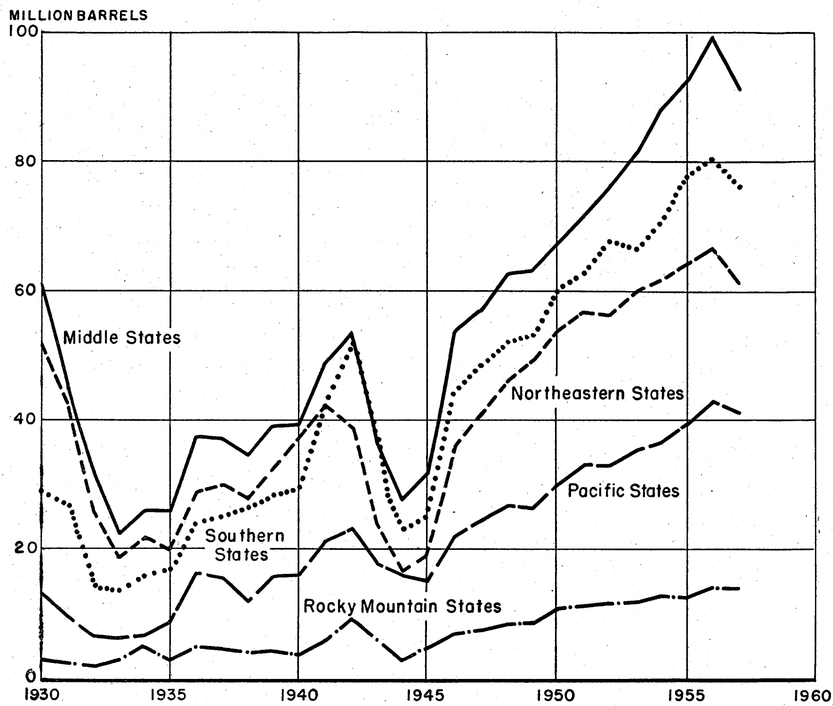

FIGURE 1.—Indicated consumption of portland cement in continental United States, 1930–57, by regions.

TABLE 15.—Destination of shipments of finished portland cement from mills in the United States, 1955–57, by States

Destination	1955 (thousand barrels)	1956 (thousand barrels)	1957	
			Thousand barrels	Change from 1956 (percent)
Continental United States:				
Alabama	3,940	4,766	4,665	−2
Arizona	2,337	2,624	2,773	+6
Arkansas	2,519	1,843	1,694	−8
California	31,643	35,872	33,388	−7
Colorado	3,486	3,704	4,026	+9
Connecticut [1]	3,385	4,321	5,185	+20
Delaware [1]	1,096	1,085	904	−17
District of Columbia [1]	1,391	1,327	1,171	−12
Florida	8,946	9,499	9,950	+5
Georgia	5,201	5,382	4,676	−13
Idaho	923	1,073	956	−11
Illinois	14,670	16,716	16,236	−3
Indiana	7,984	9,064	7,044	−22
Iowa	5,974	6,771	5,813	−14
Kansas	7,248	6,963	4,981	−28
Kentucky	3,640	3,510	3,281	−7
Louisiana	7,340	8,507	7,585	−11
Maine	951	975	965	−1
Maryland	4,882	5,772	5,127	−11
Massachusetts [1]	5,239	5,847	4,922	−16
Michigan	13,893	16,237	14,871	−8
Minnesota	5,827	5,518	5,480	−.7
Mississippi	1,887	1,977	1,816	−8
Missouri	7,919	7,643	6,851	−10
Montana	951	1,409	1,378	−2
Nebraska	3,485	3,351	2,649	−21
Nevada [1]	740	619	568	−8
New Hampshire [1]	1,157	924	635	−31
New Jersey [1]	9,335	9,427	7,943	−16
New Mexico [1]	1,995	2,086	2,207	+6
New York	19,400	20,395	19,182	−6
North Carolina [1]	4,415	4,385	4,646	+6
North Dakota [1]	1,057	1,290	1,930	+50
Ohio	17,475	17,552	17,338	−1
Oklahoma	4,789	4,814	4,886	+1
Oregon	2,392	2,550	2,533	−.7
Pennsylvania	16,083	15,540	14,354	−8
Rhode Island	830	747	727	−3
South Carolina	2,461	2,358	2,011	−15
South Dakota	1,221	1,376	1,072	−22
Tennessee	5,088	4,845	4,156	−14
Texas	20,782	20,954	18,891	−10
Utah	1,835	2,009	1,790	−11
Vermont [1]	294	325	302	−7
Virginia	4,802	5,421	5,435	+.3
Washington	5,595	4,683	5,088	+9
West Virginia	1,849	1,938	2,325	+20
Wisconsin	6,186	6,745	6,758	+.2
Wyoming	579	654	688	+5
Unspecified	18	6	24	+300
Total continental United States	287,135	303,399	283,876	−6
Outside continental United States [2]	5,630	5,279	5,822	+10
Total shipped from cement plants	292,765	308,678	289,698	−6

[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 16.—Destination of shipments of finished portland cement from mills in the United States in 1957, by months, in thousand barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Continental United States:												
Alabama	297	344	366	459	469	451	255	555	353	411	330	339
Arizona	183	227	237	231	231	221	222	226	245	262	232	262
Arkansas	53	88	124	116	159	166	227	176	179	199	104	94
California	2,097	2,310	2,588	2,891	2,873	2,812	2,917	3,251	3,081	3,160	2,683	2,247
Colorado	149	229	281	235	361	446	475	447	452	412	269	271
Connecticut	138	227	407	491	610	655	107	755	611	607	383	195
Delaware	21	45	84	90	103	87	37	136	92	104	73	31
District of Columbia	58	79	115	129	75	121	59	137	119	116	104	59
Florida	860	814	850	980	968	773	476	750	839	820	959	895
Georgia	257	343	339	457	510	491	267	565	354	398	343	351
Idaho	24	26	68	96	94	97	131	96	112	106	75	35
Illinois	281	633	997	1,106	1,531	1,782	1,543	2,075	2,147	2,069	1,130	944
Indiana	145	292	481	489	681	729	700	893	833	870	546	384
Iowa	56	109	196	500	633	735	817	845	818	666	256	179
Kansas	137	279	341	378	424	523	487	598	542	520	369	383
Kentucky	71	133	197	236	360	375	383	447	337	373	223	146
Louisiana	615	555	604	681	715	633	699	681	573	603	551	674
Maine	16	18	44	54	92	136	14	191	200	127	48	26
Maryland	219	309	449	427	562	586	328	718	486	517	388	187
Massachusetts	118	248	460	438	597	545	109	639	520	560	391	296
Michigan	289	416	611	978	1,577	1,707	1,789	1,922	1,798	1,823	997	591
Minnesota	97	135	228	388	617	666	790	801	730	623	252	154
Mississippi	105	128	141	172	171	209	196	267	195	245	170	190
Missouri	145	348	498	501	611	755	652	879	822	799	456	383
Montana	28	33	62	125	149	157	174	138	160	155	109	88
Nebraska	53	97	137	217	243	259	343	317	343	345	155	141
Nevada	28	34	55	62	60	45	49	58	49	41	40	36
New Hampshire	19	25	55	55	71	71	10	105	68	82	47	28
New Jersey	329	470	751	660	912	833	201	1,081	824	861	667	362
New Mexico	143	148	162	199	190	204	208	236	225	177	159	155
New York	525	769	1,455	1,603	2,372	2,321	669	2,803	2,157	2,209	1,441	852
North Carolina	282	278	346	406	462	426	379	590	404	473	316	285
North Dakota	11	17	32	67	117	185	449	479	317	198	37	22
Ohio	420	653	993	1,115	1,794	1,782	2,220	2,389	1,956	2,002	1,196	786
Oklahoma	186	298	391	312	372	455	531	570	567	497	336	401
Oregon	135	118	148	221	226	245	287	272	258	249	206	168
Pennsylvania	478	643	1,092	1,051	1,603	1,551	954	2,084	1,570	1,530	1,113	618
Rhode Island	15	33	68	60	79	99	18	120	81	86	62	42
South Carolina	132	151	161	173	195	178	115	219	162	197	153	174
South Dakota	22	35	56	81	121	129	154	138	127	110	62	37
Tennessee	156	226	324	387	435	422	363	480	401	456	269	237
Texas	1,317	1,460	1,608	1,470	1,682	1,653	1,936	1,917	1,571	1,718	1,054	1,507
Utah	75	76	132	163	181	187	187	197	184	186	130	93
Vermont	6	8	22	33	32	41	8	51	33	39	20	8

Virginia	253	299	489	520	599	573	451	639	466	527	368	252
Washington	140	201	331	456	498	501	583	564	499	525	423	357
West Virginia	67	99	157	177	226	222	232	294	231	244	174	145
Wisconsin	135	187	295	457	712	765	855	1,006	852	835	388	282
Wyoming	23	26	39	51	66	79	78	81	97	72	41	35
Unspecified					4					1		
Total, continental United States	11,409	14,719	20,067	22,644	28,425	29,084	25,134	34,878	30,040	30,205	20,298	16,427
Outside continental United States [1]	393	387	484	481	515	461	521	487	471	642	531	407
Total	11,802	15,106	20,551	23,125	28,940	29,545	25,655	35,365	30,511	30,847	20,829	16,834

[1] Shipments by producers to foreign countries and to noncontiguous Territories of the United States (Alaska, Hawaii, and Puerto Rico), including distribution from Puerto Rican mills.

TABLE 17.—Destination of shipments of high-early-strength cement from mills in the United States,[1] 1956–57, by States

Destination	1956 (thousand barrels)	1957 Thousand barrels	1957 Change from 1956 (percent)
Continental United States:			
Alabama	428	535	+25
Arizona	1	2	+100
Arkansas	18	16	−11
California	132	92	−30
Colorado	13	18	+38
Connecticut [2]	355	348	−2
Delaware [2]	75	67	−11
District of Columbia [2]	75	74	−1
Florida	581	786	+35
Georgia	221	226	+2
Idaho	6	3	−50
Illinois	582	569	−2
Indiana	360	409	+14
Iowa	161	142	−12
Kansas	164	116	−29
Kentucky	43	54	+26
Louisiana	72	83	+15
Maine	63	62	−2
Maryland	145	136	−6
Massachusetts [2]	507	440	−13
Michigan	1,647	1,296	−21
Minnesota	218	285	+31
Mississippi	20	15	−25
Missouri	146	135	−8
Montana	6	10	+67
Nebraska	10	35	+250
Nevada [2]	2	10	+400
New Hampshire [2]	63	52	−17
New Jersey [2]	1,388	1,257	−9
New Mexico [2]	60	72	+20
New York	1,097	1,292	+18
North Carolina [2]	194	162	−16
North Dakota [2]	3	1	−67
Ohio	429	392	−9
Oklahoma	40	57	+43
Oregon	3	3	-------
Pennsylvania	934	955	+2
Rhode Island [2]	79	62	−22
South Carolina	159	75	−53
South Dakota	30	13	−57
Tennessee	45	77	+71
Texas	431	600	+39
Utah	17	20	+18
Vermont [2]	25	21	−16
Virginia	313	313	-------
Washington	333	315	−6
West Virginia	11	7	−36
Wisconsin	46	40	−13
Wyoming	3	24	+700
Unspecified	0	1	-------
Total, continental United States	11,754	11,775	+0.2
Outside continental United States [3]	54	92	+70
Total shipped from cement plants	11,808	11,867	+.5

[1] Included in figures of finished portland cement, table 15.
[2] Non-cement producing State.
[3] Direct shipments by producers to foreign countries and to noncontiguous Territories (Alaska and Hawaii).

TABLE 18.—Destination of shipments of high-early-strength cement from mills in the United States in 1957, by months, in thousand barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Continental United States:												
Alabama	38	43	46	51	52	62	18	59	43	46	40	38
Arizona	—	—	—	1	1	—	—	—	—	—	—	—
Arkansas	1	1	1	2	1	1	1	2	2	2	1	1
California	7	8	9	8	7	6	7	9	8	8	8	6
Colorado	2	3	1	2	3	2	1	1	1	1	2	1
Connecticut	20	22	34	28	32	32	8	37	38	39	34	24
Delaware	4	6	7	5	6	6	1	9	7	7	6	3
District of Columbia	5	1	4	8	9	8	1	9	9	7	8	5
Florida	65	65	71	80	82	62	1	73	66	75	75	71
Georgia	15	18	19	18	22	19	2	26	21	22	20	23
Idaho	—	1	—	—	—	—	—	—	—	1	—	—
Illinois	30	33	39	39	46	49	48	53	58	60	52	63
Indiana	22	25	40	41	40	38	34	35	33	44	32	27
Iowa	5	7	11	13	14	12	12	15	13	13	12	13
Kansas	6	10	9	10	9	8	10	16	9	7	9	11
Kentucky	2	2	2	2	4	7	5	7	7	8	4	5
Louisiana	6	5	12	7	6	3	5	12	5	9	7	5
Maine	3	2	3	6	8	8	1	8	7	7	5	4
Maryland	5	8	12	11	13	14	5	14	11	16	16	11
Massachusetts	23	31	45	39	42	45	6	52	42	48	36	31
Michigan	58	85	100	123	122	114	116	120	116	133	110	93
Minnesota	11	15	23	27	32	31	17	32	27	30	22	17
Mississippi	2	2	3	2	2	2	1	2	1	1	1	1
Missouri	9	14	16	12	10	11	6	13	9	14	10	13
Montana	1	1	1	—	—	—	1	—	2	1	1	1
Nebraska	1	—	1	1	8	3	5	2	4	6	3	3
Nevada	—	6	2	—	—	—	1	—	—	—	1	—
New Hampshire	2	4	6	5	6	5	1	6	4	6	3	3
New Jersey	82	92	131	102	132	112	18	143	121	128	115	81
New Mexico	4	4	6	5	4	6	10	7	6	5	7	7
New York	83	87	115	102	117	104	38	132	127	140	137	108
North Carolina	17	13	16	14	15	13	13	15	11	12	11	13
North Dakota	—	—	—	—	—	—	—	—	—	—	—	—
Ohio	27	28	30	28	34	35	40	40	38	42	29	31
Oklahoma	2	3	4	3	5	6	5	8	8	7	3	3
Oregon	1	—	—	—	—	—	—	—	—	—	—	—
Pennsylvania	49	60	89	73	104	102	33	120	93	91	83	64
Rhode Island	4	5	7	6	8	7	1	6	5	6	4	5
South Carolina	11	10	12	8	6	5	—	3	4	7	5	5
South Dakota	1	1	1	2	2	1	1	1	1	1	2	1
Tennessee	5	5	7	7	8	11	3	6	4	9	7	4
Texas	44	46	50	63	48	57	63	54	36	44	47	48
Utah	1	1	2	1	2	2	2	3	2	1	1	2

TABLE 18.—Destination of shipments of high-early-strength cement from mills in the United States in 1957, by months in thousand barrels—Continued

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Continental United States—Continued												
Vermont	3	1	3	2	2	2	1	3	2	2	2	1
Virginia	24	19	31	30	30	31	27	30	23	26	21	18
Washington	18	21	34	37	24	19	18	26	27	30	38	21
West Virginia	-------	1	-------	1	-------	-------	1	-------	1	1	1	-------
Wisconsin	1	1	3	5	5	5	2	3	4	5	3	3
Wyoming	1	2	2	1	1	1	1	4	6	3	1	2
Unspecified	-------	-------	-------	-------	2	-------	-------	1	-------	-------	-------	-------
Total continental United States	721	818	1,060	1,031	1,126	1,067	591	1,217	1,062	1,171	1,035	890
Outside continental United States [1]	5	11	7	15	10	11	5	6	7	10	4	1
Total	726	829	1,067	1,046	1,136	1,078	596	1,223	1,069	1,181	1,039	891

[1] Shipments by producers to foreign countries and to noncontiguous Territories of the United States (Alaska and Hawaii).

STOCKS

Stocks of finished portland cement and clinker at portland-cement plants on December 31, 1957, were 27 and 55 percent higher, respectively, than on December 31, 1956.

Changes in stocks during the period 1950–57 are shown in figure 2.

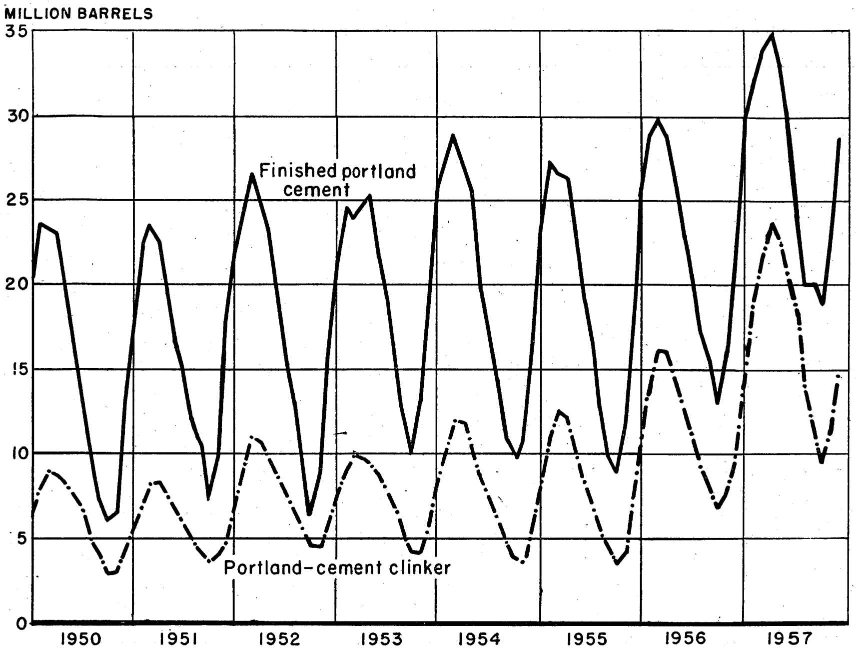

FIGURE 2.—End-of-month stocks of finished portland cement and portland-cement clinker, 1950–57.

TABLE 19.—Stocks of finished portland cement and portland-cement clinker at mills in the United States [1] on December 31 and yearly range in end-of-month stocks, 1953–57

		Dec. 31 (thousand barrels)	Range			
			Low		High	
			Month	Thousand barrels	Month	Thousand barrels
1953	Cement	19,272	October	10,049	May	25,247
	Clinker	5,349	November	4,022	March	9,895
1954	Cement	16,533	October	9,667	do	28,905
	Clinker	5,294	November	3,634	do	11,947
1955	Cement	17,539	October	8,754	February	27,087
	Clinker	7,001	do	3,514	March	12,629
1956	Cement	[2] 22,395	do	13,007	do	29,868
	Clinker	[2] 9,443	do	6,874	do	16,151
1957	Cement	28,579	do	19,213	April	34,893
	Clinker	14,626	do	9,444	do	23,620

[1] Includes Puerto Rico.
[2] Revised figure.

PREPARED MASONRY CEMENTS

PRODUCTION AND SHIPMENTS

Prepared masonry cements were produced at 118 portland-cement plants, 4 natural-cement plants, 2 slag-cement plants, and 1 hydraulic lime plant in 1957.

Prepared masonry cements vary considerably in the proportions of their constituents; consequently, they vary in weight per cubic foot and per barrel. Statistics on prepared masonry cements were converted to equivalent 376-pound barrels for uniformity in the tabulations.

The prepared masonry-cement tabulations in this chapter cover only production from cement-producing companies and do not include statistics on masonry cements made by nonproducing companies that purchased portland cement for reprocessing.

TABLE 20.—Prepared masonry cement produced and shipped in the United States, 1956–57, by districts

District	Active plants		Production (thousand barrels)		Shipments from mills					
					1956			1957		
	1956	1957	1956	1957	Thousand barrels	Value (thousand dollars)	Average	Thousand barrels	Value (thousand dollars)	Average
Eastern Pennsylvania, Maryland	17	18	2,006	1,791	2,059	7,285	$3.54	1,724	6,093	$3.53
New York, Maine	12	12	1,042	1,037	1,150	3,960	3.44	997	3,599	3.61
Ohio	9	9	904	815	914	3,452	3.78	784	3,069	3.91
Western Pennsylvania, West Virginia	7	6	971	960	961	3,615	3.76	935	3,641	3.89
Michigan	5	5	1,632	1,529	1,643	6,049	3.68	1,455	5,610	3.85
Illinois	4	4	692	485	672	2,397	3.57	478	1,796	3.76
Indiana, Kentucky, Wisconsin	5	6	2,062	1,692	2,032	8,621	4.24	1,703	6,804	4.00
Alabama	7	7	1,783	1,643	1,753	6,585	3.76	1,618	6,041	3.73
Tennessee	5	5	704	643	705	2,421	3.43	639	2,214	3.47
Virginia, South Carolina	3	5	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Georgia, Florida	3	3	786	799	787	3,139	3.99	787	3,239	4.12
Louisiana, Mississippi	3	3	135	180	135	486	3.61	173	611	3.53
Iowa	4	4	461	361	427	1,664	3.90	400	1,662	4.16
Eastern Missouri, Minnesota, South Dakota	6	6	539	470	501	2,001	3.99	436	1,798	4.12
Kansas	6	7	381	305	359	1,325	3.69	314	1,221	3.89
Western Missouri, Nebraska, Oklahoma, Arkansas	6	6	276	291	281	1,064	3.79	284	1,159	4.08
Texas	10	10	731	622	732	2,625	3.59	597	2,340	3.92
Colorado, Arizona, Utah	3	2	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Wyoming, Montana, Idaho	2	2	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Northern California	1	1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Southern California	0	0								
Oregon, Washington	4	4	50	46	47	207	4.37	37	160	4.33
Puerto Rico	0	0								
Undistributed			751	1,032	740	2,793	3.77	1,020	3,688	3.61
Total	122	125	15,906	14,701	15,898	59,689	3.75	14,381	54,745	3.81
Pennsylvania	21	21	2,406	2,231	2,437	8,882	3.64	2,161	8,030	3.72
Missouri	5	5	346	335	337	1,364	4.05	308	1,269	4.12

1 Included with "Undistributed" to avoid disclosing individual company operations.

TABLE 21.—Production and shipments of prepared masonry cement from mills in the United States in 1957, by months [1] and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	144	115	147	186	181	147	3	290	125	161	153	139
New York, Maine	43	89	114	96	91	88	19	136	95	92	67	104
Ohio	100	12	68	45	106	69	60	107	66	77	70	36
Western Pennsylvania, West Virginia	49	57	50	111	102	100	97	116	86	69	80	37
Michigan	43	123	63	132	129	148	141	151	136	192	99	171
Illinois	10	39	41	42	62	44	20	94	35	23	41	20
Indiana, Kentucky, Wisconsin	146	150	140	177	146	165	38	215	235	126	135	114
Alabama	77	20	63	39	76	31	30	77	71	34	51	57
Tennessee	58	29	54	59	56	55	60	83	50	58	37	44
Virginia, South Carolina	59	13	37	32	36	32	47	57	23	53	23	33
Georgia, Florida	65	78	88	66	75	49	21	65	68	57	86	84
Louisiana, Mississippi	6	27	13	21	31	---	16	17	9	13	27	---
Iowa	5	18	22	40	35	41	35	45	21	22	38	36
Eastern Missouri, Minnesota, South Dakota	46	25	45	19	28	32	18	28	20	9	126	83
Kansas	29	43	29	---	32	12	---	26	47	12	24	7
Western Missouri, Nebraska, Oklahoma, Arkansas	31	14	22	20	34	25	7	11	24	52	34	17
Texas	41	53	54	48	59	63	36	49	77	56	42	45
Colorado, Arizona, Utah	10	14	14	14	24	21	27	21	24	23	22	23
Wyoming, Montana, Idaho	---	---	---	5	1	2	3	---	7	---	8	6
Northern California	---	---	---	2	---	1	2	2	1	1	---	---
Southern California	---	---	---	---	---	---	---	---	---	---	---	---
Oregon, Washington	---	---	---	---	---	7	---	19	---	2	7	11
Puerto Rico	---	---	---	---	---	---	---	---	---	---	---	---
Total: 1957	962	919	1,064	1,154	1,304	1,132	680	1,609	1,220	1,132	1,170	1,067
1956	1,048	947	1,354	1,293	1,384	1,401	1,326	1,359	1,297	1,204	1,228	998
SHIPMENTS												
Eastern Pennsylvania, Maryland	57	102	168	166	206	180	22	281	140	162	128	64
New York, Maine	26	48	85	96	119	132	20	159	88	102	75	47
Ohio	16	38	59	62	91	83	114	89	70	75	47	38
Western Pennsylvania, West Virginia	18	39	66	76	107	101	133	124	90	89	63	35
Michigan	40	69	98	125	148	147	188	168	150	149	99	75
Illinois	12	24	49	46	56	57	37	59	43	42	25	29
Indiana, Kentucky, Wisconsin	61	106	145	165	195	182	85	223	144	170	119	107
Alabama	44	46	44	51	57	59	37	85	44	42	37	38
Tennessee	34	40	53	62	64	60	55	86	50	62	38	35
Virginia, South Carolina	21	23	36	40	41	47	45	57	31	42	25	24
Georgia, Florida	63	72	73	74	73	56	23	55	70	77	75	76

Louisiana, Mississippi	8	11	19	13	13	12	22	25	11	14	12	12
Iowa	8	16	29	43	47	49	44	45	37	40	22	20
Eastern Missouri, Minnesota, South Dakota	11	18	30	36	45	54	52	50	42	44	27	26
Kansas	8	20	23	24	26	29	23	27	24	27	17	22
Western Missouri, Nebraska, Oklahoma, Arkansas	10	17	22	23	25	26	38	28	30	28	17	20
Texas	38	44	54	52	55	55	60	64	48	50	34	44
Colorado, Arizona, Utah	8	16	18	16	20	25	26	25	25	22	16	22
Wyoming, Montana, Idaho	1	1	2	3	3	3	4	3	3	3	2	2
Northern California						1	1	1	1	1	1	
Southern California												
Oregon, Washington	1	2	3	5	4	4	4	4	3	3	2	2
Puerto Rico												
Total: 1957	485	752	1,076	1,178	1,395	1,362	1,033	1,658	1,144	1,244	881	738
1956	636	823	1,156	1,449	1,577	1,545	1,457	1,524	1,389	1,327	1,020	855

[1] Difference between monthly and annual reports not adjusted.

TABLE 22.—Destination of shipments of prepared masonry cement from mills in the United States, 1956–57, by States

Destination	1956 (thousand barrels)	1957 Thousand barrels	1957 Change from 1956 (percent)
Continental United States:			
Alabama	1,234	1,151	−7
Arizona	7	7	
Arkansas	132	119	−10
California	1		
Colorado	195	185	−5
Connecticut [1]	97	93	−4
Delaware [1]	22	21	−5
District of Columbia [1]	191	205	+7
Florida	887	921	+4
Georgia	290	266	−8
Idaho	12	11	−8
Illinois	799	685	−14
Indiana	573	491	−14
Iowa	171	144	−16
Kansas	170	186	+9
Kentucky	315	309	−2
Louisiana	107	106	−1
Maine	54	49	−9
Maryland	381	332	−13
Massachusetts [1]	238	203	−15
Michigan	1,296	1,070	−17
Minnesota	328	286	−13
Mississippi	107	104	−3
Missouri	169	143	−15
Montana	30	24	−20
Nebraska	71	55	−23
Nevada [1]	1		
New Hampshire [1]	46	45	−2
New Jersey [1]	480	443	−8
Continental United States—Continued			
New Mexico [1]	79	72	−9
New York	1,041	903	−13
North Carolina [1]	754	704	−7
North Dakota [1]	44	38	−14
Ohio	1,285	1,084	−16
Oklahoma	179	151	−16
Oregon	2	2	
Pennsylvania	1,081	1,019	−6
Rhode Island [1]	22	21	−5
South Carolina	330	265	−20
South Dakota	45	38	−16
Tennessee	499	466	−7
Texas	657	553	−16
Utah	19	17	−11
Vermont [1]	31	29	−6
Virginia	617	694	+12
Washington	38	34	−11
West Virginia	168	174	+4
Wisconsin	531	439	−17
Wyoming	8	6	−25
Unspecified	42	2	−95
Total continental United States	15,876	14,365	−10
Outside continental United States [2]	22	16	−27
Total shipped from cement plants	15,898	14,381	−10

[1] Non-cement-producing State.
[2] Direct shipments by producers to foreign countries and to Alaska.

TABLE 23.—Destination of shipments of prepared masonry cement from mills in the United States in 1957, by months, in thousand barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Continental United States:												
Alabama	7	7	9	10	10	13	9	14	9	9	9	9
Arizona	1	1	1	1	1	1	1	1	1	1	—	—
Arkansas	4	8	10	9	10	14	12	12	11	13	7	8
California	—	—	—	—	—	—	—	—	—	—	—	—
Colorado	5	13	14	12	15	18	19	19	19	17	13	19
Connecticut	2	5	9	9	10	12	2	16	8	8	7	5
Delaware	—	2	2	1	3	1	1	4	2	2	2	1
District of Columbia	5	10	15	16	20	13	4	18	10	13	10	4
Florida	77	82	80	81	85	71	32	88	79	81	81	84
Georgia	18	22	22	25	26	24	19	31	20	23	20	17
Idaho	—	—	1	1	1	1	2	1	1	2	1	—
Illinois	15	39	63	59	70	77	60	85	62	65	42	46
Indiana	12	27	39	39	52	49	53	63	48	47	30	32
Iowa	3	6	12	19	16	16	15	16	13	12	7	6
Kansas	5	10	11	12	15	15	15	13	11	14	10	13
Kentucky	8	17	22	28	31	35	33	37	29	33	20	17
Louisiana	6	7	16	7	7	7	9	16	8	9	6	8
Maine	2	2	3	5	5	7	—	9	5	6	3	2
Maryland	13	20	31	32	39	37	14	49	26	34	28	13
Massachusetts	3	11	17	20	24	25	3	38	18	20	13	10
Michigan	31	53	76	97	114	107	117	125	112	110	71	55
Minnesota	7	11	18	25	36	37	31	33	27	30	17	15
Mississippi	6	7	9	9	11	9	9	14	8	9	8	7
Missouri	3	8	13	13	16	15	13	18	14	15	10	8
Montana	1	1	1	2	1	2	3	3	3	2	2	1
Nebraska	2	3	4	5	6	5	6	6	6	5	3	3
Nevada	—	—	—	—	—	—	—	—	—	—	—	—
New Hampshire	1	2	4	4	5	7	1	8	4	5	3	2
New Jersey	14	24	38	42	51	46	7	73	36	39	33	15
New Mexico	4	5	6	7	6	8	6	7	7	10	4	5
New York	25	44	74	83	107	109	40	139	78	90	66	44
North Carolina	43	42	57	69	70	60	45	93	39	58	39	35
North Dakota	1	1	2	4	6	5	4	5	4	4	2	1
Ohio	25	54	83	86	127	114	133	122	103	108	75	54
Oklahoma	5	11	13	12	12	15	17	13	16	15	9	12
Oregon	—	—	—	—	—	—	—	—	—	1	—	—
Pennsylvania	19	44	78	86	119	112	83	144	91	90	68	32
Rhode Island	—	2	2	2	2	2	—	4	2	1	2	1
South Carolina	18	22	22	28	25	25	15	33	17	25	17	18
South Dakota	1	1	3	4	4	4	5	4	4	4	2	3
Tennessee	20	27	38	46	50	52	35	58	37	43	29	30
Texas	34	41	49	46	50	50	58	61	44	47	33	40
Utah	1	1	1	2	2	2	2	2	2	1	1	1

TABLE 23.—Destination of shipments of prepared masonry cement from mills in the United States in 1957, by months, in thousand barrels—Continued

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Continental United States—Continued												
Vermont	1	1	3	4	3	3	1	6	3	3	2	1
Virginia	23	32	50	57	60	57	30	74	42	51	34	25
Washington	1	1	3	4	3	4	4	4	2	3	3	2
West Virginia	4	6	14	15	20	22	17	25	15	17	12	7
Wisconsin	8	17	32	39	48	52	46	51	46	45	26	27
Wyoming	----	----	1	----	----	1	1	1	1	1	----	----
Unspecified	----	----	4	----	----	----	----	----	----	----	----	----
Total continental United States	484	750	1,075	1,177	1,394	1,361	1,032	1,656	1,143	1,241	880	738
Outside continental United States [1]	1	2	1	1	1	1	1	2	1	3	1	----
Total	485	752	1,076	1,178	1,395	1,362	1,033	1,658	1,144	1,244	881	738

[1] Shipments by producers to foreign countries.

NATURAL, SLAG, AND HYDRAULIC-LIME CEMENTS

Natural cement was produced for sale at 3 plants in the United States and slag cement at 2 in 1957. The output of these cements was small, as the 5 plants used most of their productive capacity to produce prepared masonry cements. Another natural-cement plant and a hydraulic-lime cement plant produced only prepared masonry cements in 1957. As all of these prepared masonry cements contained some portland cement, they were included in the tabulations of masonry cements prepared at portland-cement plants (tables 20-23).

Figures on production of natural and slag cements in 1957 are not entirely comparable with figures for former years because of changes in method of reporting by some producers. Producers of these cements reported consumption of 19,000 short tons of coal and 147 million cubic feet of natural gas.

The 7 plants reported an estimated annual capacity of 1.3 million barrels. During 1957 they used 142,000 short tons of limestone, 133,000 tons of slag, and 44,000 tons of lime.

TABLE 24.—Natural, slag, and hydraulic-lime cements produced, shipped, and in stock at mills in the United States,[1] 1948–52 (average) and 1953–57

Year	Production		Shipments		Stocks on Dec. 31 (thousand barrels)
	Active plants	Thousand barrels	Thousand barrels	Value (thousand dollars)	
1948–52 (average)	9	3,545	3,550	9,191	167
1953	8	3,488	3,459	10,341	142
1954	8	3,504	3,513	13,215	79
1955	6	941	954	3,019	66
1956	6	1,128	1,074	3,589	[2] 116
1957	5	631	662	2,027	85

[1] Includes natural masonry cements through 1954.
[2] Revised.

PRICES

The average net realization of all shipments from cement plants in 1957 was $3.21 per barrel compared with $3.08 in 1956.

Portland-cement prices at the cement plants increased from $3.08 per barrel in the fourth quarter of 1956 to $3.16, $3.18, and $3.19 in the first three quarters of 1957, respectively. The average price in the fourth quarter dropped slightly to $3.18, the average for the year.

Average prices of high-early-strength cement rose from $3.61 per barrel in the first and second quarters of 1957 to $3.70 in the third quarter and dropped slightly to $3.68 in the fourth quarter, resulting in an average for 1957 of $3.65 per barrel.

Prepared masonry cements increased in price from $3.69 per barrel of 376 pounds in the first quarter to $3.79 in the third quarter and dropped to $3.74 in the last quarter.

The composite wholesale price index of portland cement, f. o. b. destination, according to the Bureau of Labor Statistics index (1947–49=100), was 146.9 in 1957 compared with 139.7 in 1956.

TABLE 25.—Average mill value per barrel, in bulk, of cement in the United States,[1] 1948–52 (average) and 1953–57

Year	Portland cement	Natural, slag, and hydraulic-lime cements	Prepared masonry cement [2]	All classes of cement [3]
1948–52 (average)	$2.39	$2.47	$2.82	$2.40
1953	2.67	2.93	3.22	2.68
1954	2.76	3.18	3.50	2.78
1955	2.86	3.16	3.41	2.89
1956	3.05	3.34	3.75	3.08
1957	3.18	3.06	3.81	3.21

[1] Includes Puerto Rico.
[2] Includes masonry cements made at portland-, natural-, and slag-cement plants.
[3] Includes shipments of masonry or 1955, 1956, and 1957.

FOREIGN TRADE [6]

Imports.—Imports of hydraulic cement in 1957 were virtually the same as in 1956—almost 4½ million barrels. Imports from Canada, mainly into New York and the New England States, from July through October nearly doubled in 1957. Approximately 60 percent of the total 1957 imports entered through Florida and came mainly from Belgium-Luxembourg and West Germany. Imports from Yugoslavia and Israel decreased substantially in 1957 from the high quantities imported in 1956 to nearly the 1955 level.

Imports of white portland cement in 1957 amounted to 448,200 barrels—mainly from France, Belgium-Luxembourg, and West Germany; nearly 80 percent of all white portland cement entered through Florida.

Exports.—Exports of hydraulic cement in 1957 decreased to 1⅓ million barrels, the lowest figure since 1942.

TABLE 26.—Hydraulic cement imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Roman, portland, and other hydraulic cement		Hydraulic-cement clinker		White, nonstaining portland cement		Total	
	Barrels	Value	Barrels	Value	Barrels	Value	Barrels	Value
1948–52 (average)	635,473	$1,833,278	503	$2,323	4,121	$21,468	640,097	$1,857,069
1953	337,078	1,004,608	3,298	22,794	45,675	238,419	386,051	1,265,821
1954	371,558	[1] 1,307,876	47	280	78,643	454,552	450,248	[1] 1,762,708
1955	4,559,953	[1] 12,712,524	466,962	589,061	192,785	1,052,827	5,219,700	[1] 14,354,412
1956	3,672,527	[1] 11,362,209	483,423	1,068,949	300,170	[1] 1,757,417	4,456,120	[1] 14,188,575
1957	3,856,435	[1] 11,887,440	121,663	221,249	448,199	[1] 2,710,781	4,426,297	[1] 14,819,470

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable with years before 1954.

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

TABLE 27.—Hydraulic cement imported for consumption in the United States, 1955–57, by countries

[Bureau of the Census]

Country	1955		1956		1957	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Canada	738,741	$2,708,887	568,719	$1,666,738	1,061,317	$3,845,601
Cuba			12,566	54,000		
Dominican Republic	149,364	347,498	149,801	358,605	134,722	323,622
Mexico	281,858	641,675	58,337	154,677	21,164	65,046
Total	1,169,963	3,698,060	789,423	2,234,020	1,217,203	4,234,269
South America: Colombia	56,331	208,016	194,997	533,613	134,642	377,168
Europe:						
Belgium-Luxembourg	1,537,427	4,496,875	650,573	2,495,741	1,157,882	4,016,358
Denmark	504,394	710,199	325,630	1,048,714	37,304	176,474
Finland	12,899	49,500				
France	20,094	137,150	97,227	637,720	173,539	1,175,374
Germany, West	1,248,112	3,306,407	903,751	2,604,169	982,729	2,767,130
Italy					1,512	12,037
Netherlands	1,759	7,642	500	2,800	1,001	5,597
Norway					95,190	269,621
Poland and Danzig			12,065	21,931		
Portugal	2,990	6,273	176,379	452,817		
Sweden	440,595	917,300	283,252	1,063,974	346,574	837,859
Switzerland					30,000	81,600
United Kingdom	61,947	337,281	116,030	474,028	90,311	336,292
Yugoslavia	109,506	328,551	387,533	1,033,862	43,953	165,169
Total	3,939,723	10,297,178	2,952,940	9,835,756	2,959,995	9,843,511
Asia:						
Israel	52,497	148,574	453,414	1,368,681	108,205	333,395
Japan	1,186	2,584	4,454	18,741	6,252	31,127
Total	53,683	151,158	457,868	1,387,422	114,457	364,522
Africa: Tunisia			60,892	197,764		
Grand total	5,219,700	[1] 14,354,412	4,456,120	[1] 14,188,575	4,426,297	[1] 14,819,470

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable with years before 1954.

TABLE 28.—Hydraulic cement exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Barrels	Value	Percent of total shipments from mills
1948–52 (average)	3,801,938	$13,052,990	1.7
1953	2,550,788	9,347,169	1.0
1954	1,859,012	6,651,790	1.0
1955	1,795,448	7,066,918	1.0
1956	[1] 1,980,804	[1] 7,291,867	1.0
1957	1,330,520	5,321,525	.5

[1] Revised figure.

TABLE 29.—Hydraulic cement exported from the United States, 1955–57, by countries of destination

[Bureau of the Census]

Country	1955		1956		1957	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Bermuda	425	$2,210			1,355	$5,474
Canada	743,671	3,032,905	628,049	$2,649,101	294,969	1,322,117
Central America:						
British Honduras	2,382	9,527	750	2,805	1,133	5,780
Canal Zone	1,582	7,042	2,622	13,146	2,382	9,756
Costa Rica	4,125	34,213	11,775	37,841	15,250	49,796
El Salvador	760	4,880	725	3,557	200	2,061
Guatemala	926	7,714	7,419	32,817	1,600	6,357
Honduras	11,461	38,191	9,297	33,337	16,776	62,806
Nicaragua	5,906	31,911	4,417	28,308	10,350	45,409
Panama	1,785	9,791	396	3,428	264	1,832
Mexico	213,438	985,760	345,086	1,539,987	312,830	1,346,547
West Indies:						
British:						
Bahamas	14,774	64,926	6,225	36,667	13,092	64,246
Barbados	1,380	7,038	1,000	16,833		
Jamaica	1,847	13,241	50	1,109	6,623	27,333
Leeward and Windward Islands	5,149	17,188	5,600	19,130	11,407	38,112
Trinidad and Tobago	5,347	25,917	464	2,421	1,472	8,146
Cuba	216,349	574,153	540,352	900,449	145,489	267,323
Dominican Republic					613	3,448
French West Indies	15,203	43,353	10,025	27,769	6,553	16,856
Haiti	269,068	775,060	96,266	263,620	50	1,180
Netherlands Antilles	3,550	9,685	842	3,145	989	3,109
Total	1,519,128	5,694,705	1,671,360	5,615,470	843,397	3,287,688
South America:						
Argentina					3,476	28,796
Bolivia	725	4,083			1,995	11,403
Brazil	18,388	85,265	21,230	93,195	20,059	89,569
British Guiana			1,958	10,016	1,056	4,776
Chile	1,359	17,804	[1] 3,894	[1] 34,199	6,013	41,460
Colombia	13,060	85,606	20,193	129,376	16,120	110,074
Ecuador	625	2,817	3,058	13,335	48	596
Peru	13,422	42,085	5,247	19,703	943	6,478
Surinam	201	1,481	132	1,494	1,264	5,113
Venezuela	163,752	745,475	126,727	596,590	353,106	1,055,444
Total	211,532	984,616	[1] 182,439	[1] 897,908	404,080	1,353,709
Europe:						
Belgium-Luxembourg	1,416	19,809	995	11,970	953	17,751
Denmark			100	3,670	427	10,041
France	821	7,591	1,442	8,831	1,893	12,544
Germany, West			473	7,442	1,003	25,617
Iceland					626	3,562
Italy			140	6,694	252	6,436
Netherlands					367	10,854
Norway	100	500	774	12,978	795	26,928
Spain	884	4,432	288	8,843	258	9,013
Sweden			2,005	27,511	722	27,261
United Kingdom			369	9,697	300	7,400
Other Europe	144	1,553	375	1,923	214	7,633
Total	3,365	33,885	6,961	99,559	7,810	165,040

See footnote at end of table.

TABLE 29.—Hydraulic cement exported from the United States, 1955–57, by countries of destination—Continued

[Bureau of the Census]

Country	1955		1956		1957	
	Barrels	Value	Barrels	Value	Barrels	Value
Asia:						
Aden	894	$5,275	894	$6,535		
Arabia Peninsula States n. e. c.			250	1,320	2,300	$12,157
India			257	1,285	2,883	14,808
Indonesia	18,635	92,097	[1] 44,187	[1] 199,548	3,272	13,253
Iran			1,174	8,524		
Iraq	3,434	17,136	4,490	23,728	1,100	6,314
Japan	1,990	46,832	3,442	98,970	6,281	144,039
Korea, Republic of	6,692	35,942	6,175	29,265		
Kuwait	5,506	20,219	[1] 15,999	[1] 73,735	8,595	49,614
Malaya	2,000	9,992	2,132	11,400	750	3,871
Pakistan			3,749	13,892	4,008	18,263
Philippines	1,863	18,596	2,000	22,310	2,924	23,579
Saudi Arabia	1,000	4,230	1,004	18,923	856	11,304
Turkey			1,000	6,019	2,600	10,348
Other Asia	1,724	12,425	233	6,480	783	4,155
Total	43,738	262,744	[1] 86,986	[1] 521,934	36,352	311,705
Africa:						
British East Africa	796	3,744	1,198	6,908		
Liberia	8,953	38,569	13,111	51,172	13,156	53,342
Libya			894	4,685	1,250	6,905
Mozambique	132	1,490	632	3,940		
Nigeria	250	1,225				
Somaliland			1,575	7,409	1,813	8,257
Other Africa	360	3,181	232	1,302	465	5,628
Total	10,491	48,209	17,642	75,416	16,684	74,132
Oceania:						
Australia	1,330	15,854	507	4,546		
British Western Pacific Islands			3,440	13,968	5,444	23,025
New Guinea	532	6,038	[1] 5,564	[1] 38,942	4,648	55,263
New Zealand	5,332	20,867	5,405	22,083	7,830	32,538
Trust Territory of the Pacific Islands					4,275	18,425
Other Oceania			500	2,041		
Total	7,194	42,759	[1] 15,416	[1] 81,580	22,197	129,251
Grand total	1,795,448	7,066,918	[1] 1,980,804	[1] 7,291,867	1,330,520	5,321,525

[1] Revised figure.

WORLD REVIEW

NORTH AMERICA

Canada.—With completion of a new plant at Picton, Ontario, and enlargement of capacity at 5 other plants, shipments of cement in Canada in 1957 increased 5.5 million barrels over 1956. The new St. Lawrence Waterway was a large consumer.

An additional 350-foot kiln, which began operation in July 1957 at the British Columbia Cement Co., Ltd., plant at Barberton, Vancouver Island, increased productive capacity from 2.1 to 3.1 million barrels annually. A new plant of Lafarge Cement of North America, Ltd., on Lulu Island, 10 miles from Vancouver, was expected to begin operation in December 1957. It has an initial capacity of 1.1 million barrels annually.[7]

[7] Utley, H. F., Doubling of Cement Output in British Columbia This Year: Pit and Quarry, vol. 50, No. 3, September 1957, pp. 102–103, 104, 112.

TABLE 30.—World production of hydraulic cement, by countries, 1948–52 (average) and 1953–57, in thousand barrels [1]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada (sold or used by producers)	15,327	20,697	20,885	23,430	26,713	32,178
Cuba	2,011	2,386	2,468	2,492	2,445	3,917
Dominican Republic	481	762	938	1,372	1,448	1,642
Guatemala	270	334	364	463	469	575
Jamaica	[2] 440	592	575	639	780	657
Mexico	7,792	9,774	10,261	11,815	13,351	15,010
Nicaragua	106	141	141	170	246	252
Panama	369	469	451	428	410	463
Salvador	----------	211	287	334	405	498
Trinidad	----------	----------	141	709	815	780
United States	230,841	267,669	275,857	314,913	333,472	313,756
Total	257,637	303,035	312,368	356,765	380,554	369,728
South America:						
Argentina	8,678	9,710	9,850	10,835	11,961	13,861
Bolivia	229	199	193	223	188	141
Brazil	8,039	11,902	14,658	16,247	19,308	19,795
Chile	3,594	4,468	4,544	4,714	4,521	[3] 4,515
Colombia	3,231	5,119	5,640	6,133	7,153	7,100
Ecuador	375	534	557	856	891	909
Paraguay	[2] 23	18	41	70	82	70
Peru	1,917	2,632	2,832	3,195	3,237	3,201
Uruguay	1,741	1,741	1,741	1,560	1,988	2,445
Venezuela	2,902	5,758	7,112	7,517	8,508	10,243
Total	30,729	42,081	47,168	51,350	57,837	62,280
Europe:						
Albania	59	76	88	252	[3] 440	410
Austria	7,007	8,173	9,510	10,900	11,351	12,483
Belgium	21,483	27,124	25,652	27,493	27,346	27,587
Bulgaria	3,266	4,110	4,573	4,761	5,037	5,160
Czechoslovakia	11,328	13,603	15,022	16,957	18,458	21,530
Denmark	5,482	7,388	7,165	7,382	6,954	6,831
Finland	4,175	5,494	6,098	6,192	5,629	5,547
France	41,981	54,593	57,144	62,303	65,581	73,151
Germany:						
East	[3] 7,945	14,353	15,450	17,420	19,167	20,287
West	58,656	90,166	95,443	110,048	115,267	112,880
Greece	2,386	4,374	5,007	6,620	7,259	7,183
Hungary	4,304	6,215	5,553	6,889	5,834	5,799
Ireland	2,533	2,767	3,471	3,940	3,682	2,650
Italy	29,193	45,910	51,368	62,075	63,259	69,808
Luxembourg	704	862	885	921	956	[3] 956
Netherlands	3,811	5,048	5,699	6,455	7,364	7,740
Norway	3,647	4,427	4,515	4,691	5,371	5,799
Poland	14,113	19,314	19,953	22,357	23,658	26,314
Portugal	3,471	4,509	4,591	4,568	6,004	5,576
Rumania	5,042	11,117	9,381	11,674	12,817	14,195
Saar	1,225	1,671	1,618	1,659	1,929	2,058
Spain	15,016	19,091	22,351	25,400	25,828	28,701
Sweden	10,888	13,790	14,453	14,951	14,629	14,342
Switzerland	6,772	9,270	10,654	12,413	13,955	13,931
U. S. S. R	59,542	93,584	111,356	131,924	145,996	170,036
United Kingdom	58,211	66,842	71,274	74,581	76,059	71,274
Yugoslavia	7,229	7,511	8,168	9,164	9,117	11,627
Total	389,469	541,382	586,442	663,990	698,947	743,855

See footnotes at end of table.

TABLE 30.—World production of hydraulic cement, by countries, 1948–52 (average) and 1953–57, in thousand barrels [1]—Continued

Country	1948–52 (average)	1953	1954	1955	1956	1957
Asia:						
Burma	[4] 76	240	358	352	229	205
Ceylon	[5] 264	375	493	446	498	287
China	[3] 6,579	22,750	26,971	26,385	37,654	39,911
Hong Kong	375	375	586	686	709	610
India	15,491	22,515	26,203	26,309	29,358	33,362
Indonesia	516	874	862	874	616	879
Iran	358	381	364	469	915	815
Iraq	[4] 369	1,038	1,161	1,859	[3] 2,873	3,541
Israel	1,952	2,726	3,301	4,104	3,594	4,216
Japan	27,282	51,409	62,591	61,934	76,364	88,981
Jordan	----------	----------	369	[3] 498	528	627
Korea:						
North [3]	1,231	1,759	2,932	2,111	3,518	3,518
Republic of	111	258	364	328	270	539
Lebanon	1,519	1,788	1,964	2,463	2,861	3,283
Malaya	----------	188	504	639	610	668
Pakistan	2,609	3,553	4,010	4,063	4,609	6,420
Philippines	1,442	1,706	1,818	2,345	2,562	2,996
Syria	463	1,313	1,460	1,548	1,911	1,841
Taiwan	1,988	3,049	3,143	3,459	3,459	3,541
Thailand	1,096	1,689	2,252	2,263	2,334	2,357
Turkey	2,304	3,096	4,151	4,814	5,687	7,394
Vietnam	973	1,706	1,489	[3] 1,759	[3] 2,052	[3] 2,052
Total	66,998	122,788	147,346	149,708	183,211	208,043
Africa:						
Algeria	1,777	3,037	3,864	3,958	3,923	4,169
Angola	----------	170	246	410	510	[3] 510
Belgian Congo	1 044	1,454	2,029	2,375	2,691	[3] 2,697
Egypt	5,576	6,432	7,828	8,039	7,921	8,596
Ethiopia	[3] 41	59	164	[3] 188	158	[3] 188
French West Africa	[4] 352	352	487	756	850	[3] 727
Kenya	141	211	416	768	1,091	1,208
Madagascar	23	----------	----------	----------	----------	----------
Morocco:						
Northern zone	----------	----------	29	258	[3] 293	[3] 293
Southern zone	1,947	3,577	3,835	4,016	3,436	2,556
Mozambique	346	510	598	803	885	973
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	[6] 246	375	393	534	663	} 4,257
Southern Rhodesia	733	1,519	1,935	2,363	[3] 2,345	
Tunisia	1,050	1,325	1,665	2,246	2,111	2,351
Uganda	----------	135	246	293	358	504
Union of South Africa	9,962	12,448	12,676	13,697	14,482	14,805
Total	23,238	31,604	36,411	40,704	41,717	43,834
Oceania:						
Australia	7,007	9,370	11,222	11,674	12,518	13,615
New Zealand	1,390	1,642	1,894	2,398	2,644	[3] 2,638
Total	8,397	11,012	13,116	14,072	15,162	16,253
World total (estimate) [1]	776,468	1,051,902	1,142,851	1,276,589	1,377,428	1,443,993

[1] This table incorporates a number of revisions of data published in previous Cement chapters.
[2] Average for 1 year only, as 1952 was first year of commercial production.
[3] Estimate.
[4] Average for 1949–52.
[5] Average for 1950–52.
[6] Average for 1951–52.

Cement plants at Woodstock, Ontario, and Regina, Alberta, and a new clinker grinding mill at Montreal East, Quebec, were described.[8]

Imperial Cement, Ltd., made plans for a new $12-million cement plant, using marl as raw material, to be constructed near Edmonton, Alberta, in 1958.[9]

A review of the Canadian cement industry was published.[10]

Cuba.—In mid-1956 the Compañía Cubana de Cement Portland S. A., a subsidiary of the Lone Star Cement Co., announced plans for constructing a new cement plant near Jaruco, 40 miles southeast of Havana. The plant was scheduled for completion late in 1957. Cuba imported large quantities of cement clinker, which was ground in a plant built in 1956 at Santiago de Cuba. It was expected that the new plant near Havana would alleviate the need for importing cement from abroad. To stimulate cement production, the Cuban Government granted a 1-year exemption from the 2.75-percent gross sales tax on all machinery and building materials imported for constructing or expanding cement plants.[11]

Preliminary plans were made to construct a $4-million cement plant on the Isle of Pines.[12]

Jamaica.—Addition of a kiln to the plant of the Caribbean Cement Co. increased its capacity to 1.1 million barrels of cement per year. Addition of a third kiln was planned to increase capacity to 1.6 million barrels per year. Rapid industrialization in Jamaica has increased greatly the demand for cement.[13]

CENTRAL AMERICA

Costa Rica.—According to press reports, plans were approved for building a cement plant on the Pacific coast just south of Puntarenas.[14]

Guatemala.—Completion of a $2½-million expansion program at Guatemala's cement plant, Cementos Novella, was expected to double plant capacity.[15]

Honduras.—No cement was produced in Honduras; however, according to a press report, equipment was to be supplied by a United States firm to Cementos de Honduras to build a 900-barrel-per-day wet-process plant in that country.[16]

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[8] Howe, H. B., New 2,000 Hp. Clinker Mill Installed in Montreal East Plant of Canada Cement Company: Pit and Quarry, vol. 50, No. 6, December 1957, pp. 84–86, 88–92, 95, 100, 136.
Trasler, F. M., Saskatchewan's New Cement Plant: Canadian Min. Met. Bull., vol. 50, No. 537, January 1957, pp. 14–20.
Trauffer, W. E., Canada Cement Company Builds 3,200,000-Bbl. Plant: Pit and Quarry, vol. 50, No. 1, July 1957, pp. 72–76, 80–83, 86, 160, 163.

[9] Western Miner and Oil Review, New Cement Plant: Vol. 30, No. 11, November 1957, p. 65.

[10] Trauffer, W. E., Review and Forecast of the Canadian Cement Industry: Pit and Quarry, vol. 49, No. 9, March 1957, pp. 106–108, 110, 160–161.

[11] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, pp. 21–22.

[12] Foreign Commerce Weekly, Cuban Income to Rise as Result of Higher Sugar Prices, Larger Crop. Vol. 57, No. 12, March 1957, pp. 2, 22.

[13] Pit and Quarry, Expansion to Triple Output of Caribbean Cement Co. to 300,000 Tons per Year: Vol. 50, No. 2, August 1957, p. 120.

[14] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 21.

[15] Thomson, G. F., Guatemala Cement Plant Provides a Real Lesson in Kiln Efficiency: Rock Products, vol. 60, No. 12, December 1957, pp. 73–76.

[16] Pit and Quarry, Latin American Concerns Order U. S. Equipment For Two Cement Plants: Vol. 49, No. 11, May 1957, p. 48.

SOUTH AMERICA

Brazil.—Leaders of the Japanese cement industry considered the construction of a joint Japanese-Brazilian cement plant at Sao Paulo. Two Japanese survey teams were sent to Brazil.[17]

Colombia.—According to a press report, a United States firm was supplying equipment for a new cement plant to be constructed by Cementos del Sinu S. A. at Planeta Rica in the interior of Colombia.[18]

Peru.—Two new cement plants in northern Peru were completed, one at Pacasmayo and the other at Chiclayo. Plans were made by Chanchamina S. A. and Cía. Cemento Andino S. A. to build cement plants in the central plateau area. According to press reports, plans were completed early in 1957 by Compañía de Cemento del Sur del Peru S. A. with a London firm to finance a $4.3-million cement plant at Juliaca, southern Peru. The plant was expected to begin production late in 1958.[19]

As a result of increased domestic production, the temporary import-duty exemptions through the ports of Paita and Talera were withdrawn but were still in effect at the ports of Mollendo and Matarani.[20]

EUROPE

Denmark.—About mid-1957 the Alborg Portland Cement Works began constructing a cement plant near Karlstrup, about 20 miles south of Copenhagen. The plant was to have an annual capacity of 0.9 million barrels and was to be in operation before the end of 1958. Enough limestone, chalk, and clay for 50 years' operations were said to be available on a 660-acre tract acquired by the company.[21]

Italy.—Approximately 50 companies (operating about 100 plants) produced cement in Italy. About half of the total was produced by one company, Italcementi of Bergamo. Production was increasing because of building activity in all parts of the country.[22]

Netherlands.—Cement production in the Netherlands in 1957 was approximately three times the annual output before World War II. Even that quantity supplied only about 50 percent of domestic requirements.[23]

Spain.—Large expansion was planned for the Spanish cement industry. Plans were formulated for new cement plants at Yanguas, Segovia; La Magdalena, Castellon; Ribas de Jarama, Madrid; Maco, Madrid; and Pedera, Seville. Additional productive capacity was planned for the plant operated by Cementos y Cales Freixa S. A. at Los Monjos, Barcelona.[24] An increase of 50 percent was forecast in Spanish productive capacity within the next 4 years.

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17 Pit and Quarry, Brazilians Seek Japanese Aid to Erect Joint Cement Plant: Vol. 49, No. 9, March 1957, p. 26.

18 Work cited in footnote 16.

19 Bureau of Mines, Mineral Trade Notes Vol. 44, No. 6, June 1957, pp. 22–23.

20 Foreign Commerce Weekly, Peru Withdraws Exemption of Import Duty on Cement: Vol. 58, No. 22, Nov. 25, 1957, p. 9.

21 Work cited in footnote 14, p. 21.

22 Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, pp. 21–22.

23 Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 3, March 1957, pp. 19–20.

24 Chemical Trade Journal and Chemical Engineer (London), Cement Manufacture Expansion Plans: Vol. 140, No. 3644, Apr. 5, 1957, p. 799.

United Kingdom.—In 1957, for the first time since the end of World War II, domestic demand for cement in Great Britain decreased. Deliveries were 56.9 million barrels compared with 60.1 million barrels in 1956. The decline was reported to have been caused by smaller defense demands.[25]

A new cement plant having an annual capacity of 1 million barrels began operation at the end of April 1957 at Cauldon Low near Stoke-on-Trent, Staffordshire. It was the 28th plant of the Blue Circle group operating in Great Britain. The plant was described in detail in a recent article.[26]

Work was in progress in 1957 to increase productive capacity of the plant of Chinnor Cement and Lime Co., Ltd., by 1,600 barrels per day.[27]

ASIA

India.—A large increase in cement production in India was anticipated. Estimated output was 26 million barrels in 1956 and 35 million barrels in 1957. Production of 42 million barrels for 1958 was forecast. According to the Second Five-Year Plan, which began April 1, 1956, a goal of 85 million barrels was established. Twenty-nine new plants and expansion of several existing units were licensed. To facilitate construction of new plants the Government tentatively approved the establishment of a cement-machinery manufacturing plant in India. Because of a serious decline in foreign-exchange reserves, importations of cement were greatly restricted during the first half of 1957, and steps were taken to economize in its use.[28] According to a later report,[29] more than ½ million barrels of cement was imported from July 1, 1956, to January 31, 1957, and the State Trading Corporation expected to import another million barrels by August 31, 1957, to relieve the acute shortage.

Indonesia.—A modern new plant with a capacity of 1.3 million barrels of cement a year was formally dedicated on August 7, 1957. It was expected that the plant would strengthen Indonesia's economy and spur new industries.[30]

Iran.—Orders were placed with a British firm to supply equipment for a new wet-process cement plant to be constructed in Iran, midway between the Persian Gulf and the Caspian Sea, where water was ample and limestone, clay, and gypsum were readily available.[31]

Iraq.—The Government-owned Sarchinar cement plant began producing in July 1957. This new plant, the fourth in the country, increased the total national output to 13,000 barrels a day.[32]

Japan.—A new cement plant on Hokkaido Island, operated by Fuji Cement Co., was the first closed-circuit-grinding, wet-process plant in Japan.[33]

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[25] U. S. Embassy, London, England, State Department Dispatch 2490: Jan. 20, 1958, p. 10.
[26] Pit and Quarry, Interesting Features Observed at Cauldon Works of Blue Circle Group: Vol. 50, No. 6, December 1957, pp. 119-120, 122-126, 129-130.
[27] Chemical Trade Journal and Chemical Engineer (London), Chinnor Cement and Lime: Vol. 141, No. 3660, July 26, 1957, p. 208.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, pp. 20-21.
[29] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 33.
[30] Rock Products, New Cement Plant Opens in Indonesia: Vol. 60, No. 10, October 1957, p. 68.
[31] Pit and Quarry, New Iranian Cement Plant To Use British Equipment: Vol. 50, No. 1, July 1957, p. 155.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, pp. 20-21.
[33] Rock Products, Japan's New Wet-Process Plant Starts Operation: Vol. 60, No. 3, March 1957, p. 52.

Korea.—A new cement plant financed by the United Nations Korean Reconstruction Agency was under construction at Mungyong, about 90 miles from Seoul. It will have a capacity of 1 million barrels of cement a year, and initial operation was scheduled for January 1958.[34]

Malaya.—Plans were made to construct a new cement plant near Ipoh, Perak, to supply the area in northern Malaya, which imported cement through the port of Penang.[35]

Pakistan.—The Pakistan Industrial Development Corporation invited quotations for equipment to almost double the capacity of the cement plants at Daukhel and Hyderabad.[36]

Philippines.—The Republic Cement Corp. plant at Norzagary, near Manila, which began operation in July 1957, increased Philippine output about 30 percent. Its capacity is 750,000 barrels per year. It became the fifth producer in the Philippines and was the only dry-process plant in the country. Plans were already under way to double its capacity.[37]

Taiwan (Formosa).—A company known as the Chia Hsin Cement Corp., Ltd., was organized to raise capital and formulate plans for building a new cement plant.[38]

Thailand.—A third kiln was added to the Ta Luang cement plant operated by the Siam Cement Co. The 395-foot rotary kiln was floated 60 miles up the river from Bankok harbor in 7 sealed sections. The new kiln will increase clinker capacity from 2.2 to 3.2 million barrels per year.[39]

The Jalaprathan Cement Co. was building a new cement plant of 0.5 million barrels per year capacity at Takli, 190 km. north of Bankok. Construction was expected to be completed early in 1958.

Turkey.—The new Adana cement plant, the eighth operation in Turkey, was officially opened in May 1957. Its capacity of 0.9 million barrels of cement a year increased the national capacity to 8.8 million barrels. A trend from stucco and brick to concrete structures in Turkey increased greatly the domestic demand for cement.[40]

AFRICA

Angola.—Authorization was obtained to increase the annual cement production of the Companhia de Cimentos de Angola plant at Lobito to 0.8 million barrels per year. The Companhia de Cimento Secil do Ultramar had already applied for authority to increase production of its new plant at Luanda from 0.5 to 1.2 million barrels annually, although the plant was not expected to produce until May 1957.[41]

[34] Pit and Quarry, UNKRA Finances Korean Cement Plant Costing $9,000,000: Vol. 50, No. 5, November 1957, pp. 74–75.
[35] Foreign Commerce Weekly, New Malay Cement Works Planned: Vol. 53, No. 3, Jan. 21, 1957, p. 12.
[36] Foreign Commerce Weekly, Pakistan To Expand Cement Plants: Quotations Wanted: Vol. 57, No. 23, June 10, 1957, p. 20.
[37] Foreign Commerce Weekly, New Cement Factory in the Philippines: Vol. 58, No. 17, Oct. 21, 1957, p. 124.
[38] Foreign Commerce Weekly, New Cement Factory Planned for Taiwan: Vol. 58, No. 26, Dec. 23, 1957, p. 18.
[39] Rock Products, Float Kiln Upriver to Plant: Vol. 60, No. 6, June 1957, p. 80.
[40] Pit and Quarry, New Adana Cement Plant Increases Turkey's Output to 1,530,000 Tons Annually: Vol. 50, No. 3, September 1957, p. 101.
Rock Products, Turkey Switches to Concrete: Vol. 60, No. 10, October 1957, p. 57.
[41] U. S. Embassy, Luanda, Angola, State Department Dispatch 150: Apr. 29, 1957.

Kenya.—Cement became the most important mineral product of Kenya. Production in 1957 showed a gain of 20 percent over 1956 and was nearly twice as large as in 1955. The East African Portland Cement, Ltd., plant at the Athi River began producing in 1957. The British Standard Portland Cement Co. plant at Bamburi was enlarged by the addition of a third kiln early in 1957. These two plants probably were large enough to supply the needs of the Colony.[42]

Mozambique.—Companhia de Cimentos de Mozambique, the sole producer of cement in the country, operated 2 plants, 1 at Dondo near Beira, and 1 in Laurenco Marques. Both plants were being enlarged in 1957, and completion of a third plant was expected by 1960. Production of cement increased greatly after 1953 to furnish concrete for the Limpopo Irrigation Dam.[43]

Nigeria.—A cement plant was being built at Nkalagu, Ogaja Province. A limestone mining lease was obtained, covering 7,000 acres.[44]

Rhodesia and Nyasaland, Federation of.—The new plant of the Salisbury Portland Cement Co., Ltd., at Manresa near Salisbury began producing in 1957. It was said to be the most modern cement plant in southern Africa.[45] The company was planning to construct another plant of 0.7 million barrels yearly capacity at Sternblick, 13 miles from Salisbury. Limestone and clay deposits had been obtained.[46]

It was reported that plans were being made to construct a cement plant at Changalumi, Nyasaland. The clinker would be ground in a mill that was under construction at Blantyre.[47]

Uganda.—Expansion of productive capacity of the Uganda cement industry to 0.9 million barrels a year was nearly completed at the end of 1956. With the new facilities in operation, it was expected that all the needs of Uganda would be met and that a surplus of cement would be available for export.[48]

Union of South Africa.—Pretoria Portland Cement Co. planned an additional kiln to increase its annual capacity to 1 million barrels. The Cape Cement Co. was considering the construction of a new plant in an area where it had extensive limestone deposits.[49]

OCEANIA

Australia.—Australian Cement, Ltd., was adding a new rotary kiln to its plant at Geelong, Victoria, to increase plant capacity about 0.8 million barrels per year. It was not expected to be in operation before the end of 1958. The present plant was operating beyond its rated capacity to supply the heavy demands of the Melbourne area.[50]

New Zealand.—Two new cement plants were under construction in New Zealand, one for Waitomo Cement, Ltd., at Te Kuiti, and the

[42] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, pp. 33–34.
U. S. Embassy, Nairobi, Kenya, State Department Dispatch 259: Jan. 27, 1958, p. 17.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 3, March 1957, pp. 1, 9.
[44] Rock Products, New Nigerian Plant: Vol. 60, No. 6, June 1957, p. 183.
[45] South African Mining and Engineering Journal, New Works: Vol. 68, No. 3368 (pt. II), Aug. 30, 1957, p. 55.
[46] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, p. 22.
[47] Rhodesian Mining and Engineering Review (London), Vol. 21, No. 11, November 1956, p. 19.
[48] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 34.
[49] Rock Products, African Industry Expands: Vol. 60, No. 6, June 1957, p. 72.
[50] Chemical Engineering and Mining Review, Geelong Cement to Increase Capacity: Vol. 50, No. 1, Oct. 15, 1957, p. 75.

other for Southland Cement, Ltd., at Orawia. Both were of the vertical-kiln type.[51]

TECHNOLOGY

Research.—The laboratories of the Portland Cement Association at Skokie, a suburb of Chicago, were described as the largest in the world devoted to cement research. The value of the buildings and equipment was stated to be $3,500,000, and two buildings were under construction at a cost of $2,750,000. The work was conducted under three main departments—Research, Development, and Manufacturing Processes.[52]

Dewatering.—Cement slurry has been dewatered by filtering, but a newer method was described, using a slurry additive of peat or boggy soil with alkali. The water content was reduced to 25 percent. The additive also acted as a grinding aid and reduced dust concentrations in kiln gases.[53]

Liquid cyclones were used successfully at a California plant to dewater slurry and thus decrease the volume of material handled by existing equipment.[54]

A process was patented to facilitate filtering of a slurry by addition of an alkaline-earth metal halide.[55]

According to a recent patent, the viscosity of a slurry was reduced by adding enough CO_2 to lower the pH to 6 or 7.[56]

A new type of classifier for treating wet-process cement-plant slurries was patented.[57]

Grinding.—It was found that only about 10 percent of the energy consumed in dry grinding clinker in ball mills created new surfaces in the ground product and that most of the energy was converted to heat that might increase the temperature high enough to damage the finished cement. One investigator claimed that 45 percent of the heat generated in grinding was contained in the charge of grinding balls; he proposed a method of reducing the heat by discharging the balls with the ground product, separating them by screening, cooling the grinding charge, and returning it to the circuit.[58]

A method of drying and grinding raw materials in a single operation, rather than as separate and independent steps, was employed successfully at several plants.[59]

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[51] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, p. 22.

[52] Persons, Hubert C., A Tour of World's Largest Cement Research Lab: Rock Products, Vol. 60, No. 9, September 1957, pp. 76–79, 117–118; Vol. 60, No. 10, October 1957, pp. 120–121, 124, 128, 132, 190, 192; Vol. 60, No. 11, November 1957, pp. 100–103, 127; Vol. 60, No. 12, December 1957, pp. 66–69, 105.

Thaulow, Sven, The Portland Cement Association in the U. S. A. and Canada, Seen from the European Viewpoint: Pit and Quarry, Vol. 50, No. 4, October 1957, pp. 112–114, 116–118, 120.

[53] Rutle, Johs, Reducing Water Content of Slurry in Wet-Process Cement Manufacture: Pit and Quarry, Vol. 49, No. 8, February 1957, pp. 78–79, 82–83, 89.

[54] Curry, James, J., Operation of Liquid Cyclones at Calaveras Cement Co.: Min. Eng., Vol. 9, No. 10, October 1957, pp. 1109–1111.

[55] Geary, Eugene W., and Kreager, Edgar, C. (assigned to Pittsburgh Plate Glass Co., Pittsburgh, Pa.), Cement Slurry Filtration: U. S. Patent 2,792,312, May 14, 1957.

[56] Williams, Duncan R. (assigned to Monolith Portland Midwest Co., Los Angeles, Calif), Lowering the Viscosity of Cement Slurry by Addition of CO_2 Gas: U. S. Patent 2,790,725, Apr. 30, 1957.

[57] Krebs, K. (assigned to Centricolne Corp., San Francisco, Calif.), Centrifugal Classifier: U. S. Patent 2,787,374, Apr. 2, 1957.

[58] Clausen, C. F., Here's a New Way to Make Cool Cement: Rock Products, Vol. 60, No. 2, February 1957, pp. 104–105, 108–109, 112–114, 162.

[59] Tonry, J. R., Raw Mix Drying and Grinding Systems: Pit and Quarry, pt. I, vol. 50, No. 1, July 1957, pp. 96, 98, 100, 105, 128, 156; pt. II, vol. 50, No. 2, August 1957, pp. 102–103, 106–108, 115.

The widely known process for wet-grinding portland-cement raw materials in a nonaqueous liquid medium (U. S. Patent 2,611,714) was improved by a process for recovering the used liquid.[60]

Equipment and methods used in both raw-material and clinker grinding were described in detail with illustrations.[61]

As a result of a questionnaire sent to 16 cement companies, it was found that good-quality, high-early-strength cement can be ground in single-stage ball mills with comparable or better results than in compartment mills or multistage circuits.[62]

The ends of hammers used in hammer-mill grinding were subject to rapid wear, and their repair was costly and time consuming. A cement company saved considerable on repair work by using a trunnioned fixture into which the hammers are clamped for treatment with a semiautomatic welder. Alloy flux permitted the use of mild-steel electrode wire.[63] A similar problem confronted cement-plant operators seeking to improve die-ring wear resistance in clinker-grinding mills. One investigator found that the best results were obtained by applying alloy-rod and paste-type hardfacing materials to a die-ring base of carbon steel.[64]

Calcination.—Research on cement-kiln thermal efficiency by various individuals, companies, and organizations followed three lines of approach in 1957: (1) Utilization of heat that normally escapes with waste kiln gases, (2) reduction of heat that escapes in the calcined product, and (3) improvement of heat transfer within the kiln.[65]

A new type of slurry preheater was introduced by the National Portland Cement Co. at Broadhead, Pa. It was designed to reduce heat losses, particularly in gases leaving the kiln. Heat consumption was reduced to 900,000 B. t. u. per barrel at a daily output of 2,000 barrels.[66] A system of preheating with coils, developed by the Coplay Cement Co., is said to have reduced fuel consumption 40 percent.[67]

It was found at Kenya, Africa, that cement could be made more advantageously in shaft than in rotary kilns. One advantage of the shaft kiln was the low investment cost. Another was the successful use of anthracite screenings, which are unsuited to rotary kilns. Low heat and power consumption also were claimed.[68]

To reduce the time lost while rotary kilns were shut down for relining, a new method of placing firebrick was devised. Instead of inserting separate cardboard and steel shims between the bricks to provide space for expansion, the shims were bonded to each brick, thus permitting rapid setting and uniform spacing.[69]

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60 Witt, J. C., Method of and Apparatus for the Wet Grinding of Solids: U. S. Patent 2,801,932, Aug. 6, 1957.

61 Bendy, W. R., Modern Grinding Plant Design in the Cement Industry: Min. Eng., vol. 9, No. 10, October 1957, pp. 1145–1149.

62 Rowland, C. A., Production of High Early Strength Cement in Single-Stage Ball Mills: Min. Cong. Jour., vol. 43, No. 10, October 1957, pp. 110–111, 113.

63 Bavaria, Albert J., Welding Time Cut Two-Thirds: Pit and Quarry, vol. 50, No. 3, September 1957, pp. 113–115.

64 Rock Products, Unusual Technique Reduces Abrasive Wear: Vol. 60, No. 7, July 1957, pp. 94, 96.

65 Rock Products, Mining Engineers Discuss New Tools and Techniques: Vol. 60, No. 12, December 1957, pp. 124–126, 132, 134.

66 Peck, Roy L., National's New Slurry Preheater: Pit and Quarry, vol. 49, No. 8, February 1957, pp. 102–103, 106–107, 110.

67 Bell, Joseph N., Radical Preheater Design Proves Practical: Rock Products, vol. 60, No. 9, September 1957, pp. 90–92.

68 White, C. A., African Cement Firm Took a Look—Then Went to Vertical Kilns: Rock Products, vol. 60, No. 10, October 1957, pp. 108–111, 187–188.

69 Rock Products, New Kiln Liner Cuts Down Time, Offers Savings: Vol. 60, No. 9, September 1957, pp. 106, 118, 120.

Several patents issued in 1957 covered kiln operation and calcination processes. One pertained to accurately controlled flow of fluidized raw materials.[70] Another patent covered a method and apparatus for preheating raw materials.[71] A patented heat-exchange apparatus designed to reduce heat loss comprises cyclones arranged in series.[72] A method was devised for feeding shaft kilns by dumping successively buckets of different raw materials.[73]

Equipment was designed for furnishing a uniform flow of heated secondary air to the firing hood of a kiln.[74] Cooling after calcination also received attention. A mechanism was invented for rapidly cooling cement clinker and similar calcined products on a rotating platform.[75]

A fluidized-solids process for making portland cement was carried successfully through a small pilot-plant stage. Powdered raw material entered from the bottom of the reactor into a fluidized bed where calcination took place. The clinker was discharged near the top of the reactor.[76]

A process has been developed to the pilot-plant stage for making cement clinker in a mere fraction of the time required in the rotary kiln. The raw materials were discharged into a chamber where they were brought into immediate contact with a countercurrent of burning fuel.[77]

Slag Cements.—Exhaustive tests proved that portland blast-furnace slag cements made in accordance with ASTM specifications performed as well as Type I portland cement but did not meet all the requirements of Type II portland cement.[78]

The strength and surface hardness of blast-furnace slag cements of various compositions were tested in Japan.[79]

Oil-Well Cements.—Several patents were issued on oil-well cements having retarded setting time or other special properties.[80]

[70] Krauss, W. (assigned to Fuller Co., Catasauqua, Pa.), Material Feed Regulator: U. S. Patent 2,802,698, Aug. 13, 1957.

[71] Muller, F. (assigned to Klockner-Humboldt-Deutz Aktiengesellschaft, Kaln-Deutz, Germany), Method and Apparatus for Preheating Cement Raw Material by Kiln Exit Gases: U. S. Patent 2,785,886, Mar. 19, 1957.

[72] Sylvest, K. J. (assigned to F. L. Smidth & Co., New York, N. Y.), Heat Exchange Apparatus Including Cyclone Separators: U. S. Patent 2,802,280, Aug. 13, 1957.

[73] Beckenbach, K., Kiln Charging Apparatus: U. S. Patent 2,784,025, Mar. 5, 1957.

[74] Puerner, B. H. (assigned to Allis Chalmers Mfg. Co., Milwaukee, Wis.), Method and Apparatus for Supplying a Kiln With a Uniform Flow of Secondary Combustion Air at a Constant Temperature: U. S. Patent 2,793,020, May 21, 1957.

[75] Vreeland, G. W. (assigned to Kaiser Steel Corp., Oakland, Calif.), Cooling Device: U. S. Patent 2,792,924, May 21, 1957.

[76] Chemical Week, Pyzel Fluid-Bed Cement Process: Vol. 80, No. 7, Feb. 16, 1957, pp. 108, 110.

[77] Witt, J. C., Counter-Cyclone Unit Designed to Produce Clinker in Minutes: Pit and Quarry, vol. 50, No. 6, December 1957, pp. 94, 136.

[78] Mather, Bryant, Laboratory Tests of Portland Blast-Furnace Slag Cements: Jour. Am. Concrete Inst., vol. 29, No. 3, September 1957, pp. 205–212.

[79] Tanaka, Jaro, From Blast Furnace Slag to Cement: Rock Products, vol. 60, No. 3, March 1957, pp. 100, 102, 104, 106; vol. 60, No. 4, April 1957, pp. 107, 111, 114, 117; vol. 60, No. 10, October 1957, pp. 163, 164, 166, 196.

[80] Anderson, F. M. (assigned to Halliburton Oil Well Cementing Co., Duncan, Okla.), High Temperature Well Cementing: U. S. Patent 2,805,719, Sept. 10, 1957.

Bergman, W. E. (assigned to Phillips Petroleum Co., of Delaware), Hydraulic Natural Cements Having an Extended Thickening Time: U. S. Patent 2,790,724, Apr. 30, 1957.

Clark, Roscoe, C., Jr., Coffer, Henry F., and Shock D'Arcy, A. (assigned to Continental Oil Co., Ponca City, Okla., of Delaware), Light Weight Well Cement: U. S. Patent 2,803,555, Aug. 20, 1957.

Jones, R. V. (assigned to Phillips Petroleum Co., of Delaware), Well Cementing Materials and Their Application: U. S. Patent 2,782,465, Feb. 26, 1957.

Morgan, Bryan, and Dumbauld, George K. (assigned to Esso Research & Engineering Co., Elizabeth, N. J., of Delaware), Well Cementing Composition: U. S. Patent 2,798,003, July 2, 1957.

Van Heiningen, Jan, and Harmsen, Gerrit, J. (assigned to Shell Development Co., New York, N. Y., of Delaware), Hydraulic Cement With Retarded Setting Action: U. S. Patent 2,816,043, Dec. 10, 1957.

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Prestressed Concrete.—The manufacture of prestressed concrete units has grown from an infant industry to "big business" since 1950. In 1957 an estimated 220 factories in the United States were making prestressed girders, beams, piling, and other structural units.[81] The worldwide interest in this new type of construction material was emphasized by the weeklong World Conference on Prestressed Concrete, held in San Francisco, Calif., in August 1957 and attended by 1,200 persons from 31 countries and more than 40 States.[82] The Prestressed Concrete Institute devoted study to current problems in the industry. In cooperation with the University of Florida, the institute sponsored a second prestressed concrete short course scheduled for February 1958.[83] A special application of the product was publicized, and testing methods were described.[84]

Tests and Specifications.—ASTM issued a new edition of Standards on Cement covering tests and specifications to February 1957.

Control of the magnesium content of cement raw materials required frequent analyses that were tedious and lengthy by standard methods. A new method of analyzing for magnesium was developed, whereby a determination could be made in 20 minutes.[85]

Tests conducted at the Portland Cement Association laboratories indicated that a P_2O_5 content of 2 percent or more in cement clinker was not detrimental.[86]

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81 Wall Street Journal, Stress on Prestress: Vol. 150, No. 29, Aug. 9, 1957, pp. 1, 12.
82 Engineering News Record, Spotlight on Presstressed Concrete: Vol. 159, No. 6, Aug. 8, 1957, pp. 23–25.
83 Concrete, Second Course Scheduled on Prestressed Concrete: Vol. 65, No. 11, November 1957, p. 22.
84 Concrete, Prestress Roof's 9,000 Precast Slabs: Vol. 65, No. 8, August 1957, p. 22. Prestressed Testing: Vol. 65, No. 4, April 1957, pp. 23, 34.
85 Gerhard, Henry E., Quick, Accurate Method for Magnesia Determination: Rock Products, vol. 60, No. 2, February 1957, pp. 117–118, 120.
86 Steinour, Harold H., The Effect of Phosphate in Portland Cement Clinker: Pit and Quarry, vol. 50, No. 3, September 1957, pp. 93–98, 100–101; vol. 50, No. 4, October 1957, pp. 80–85, 101.

Chromium

By Wilmer McInnis[1] and Hilda V. Heidrich[2]

BOTH DOMESTIC mine production and imports of chromite in 1957 were higher than in any previous year. Consumption, following the lowered industrial activity, decreased compared with 1956, and industry stocks reached a new peak by the year end. The use of chromite by the refractory industry decreased most, but the quantities used by the chemical and metallurgical industries were also less. Consumption of chromium ferroalloys and chromium metal decreased 17 percent compared with 1956. Research included studies on the beneficiation and use of offgrade domestic ores, high-purity chromium, chromium-base alloys, and chromium plating. Prices quoted for foreign produced ores decreased during 1957.

The Defense Minerals Exploration Administration (DMEA) continued to encourage exploration of domestic chromite deposits but received only one application for assistance during the year.

TABLE 1.—Salient statistics of chromite in the United States,[1] 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Domestic production (shipments)	6,563	58,817	163,365	153,253	[2] 207,662	166,157
Imports for consumption	1,437,536	2,226,631	1,471,037	1,833,999	2,175,056	2,281,591
Total new supply	1,444,099	2,285,448	1,634,402	1,987,252	[2] 2,382,718	2,447,748
Exports	2,176	1,166	864	1,341	1,727	837
Stocks Dec. 31 (consumers')	671,502	1,015,878	1,267,817	1,109,924	1,226,578	1,619,113
Consumption	985,223	1,335,755	913,973	1,583,983	1,846,600	1,760,469
World production	2,800,000	4,300,000	3,600,000	3,800,000	[3] 4,400,000	4,500,000

[1] Includes Alaska.
[2] Includes 45,710 short tons of concentrate produced in 1955 and 1956 from low-grade ore and concentrate stockpiled near Coquille, Oreg., during World War II.
[3] Revised figure.

DOMESTIC PRODUCTION

Production (shipments) of chromite from newly mined ores in 1957 was higher than in any preceding year, but it comprised less than 7 percent of the total domestic supply. Approximately 22 percent of the output contained 42 percent or more Cr_2O_3; the Cr : Fe ratio was at least 2 : 1; the rest averaged 38.3 percent Cr_2O_3 and

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

its Cr : Fe ratio was less than 2 : 1. Virtually all production was sold to the Government at incentive prices. According to General Services Administration, 175,028 long dry tons of chromite ore and concentrate had been accepted under the Domestic Purchase Program for Chromite Ores and Concentrates on December 31, 1957.

Chromite was produced from 174 mines and mills in California (120), Montana (1), Oregon (51), and Alaska (2). The 158,800 short dry tons shipped averaged 40.7 percent Cr_2O_3. Of this quantity, 12,700 short dry tons was lumpy ore that averaged 46.8 percent Cr_2O_3; 2,700 tons, fines, averaging 47.6 percent Cr_2O_3; and 143,400 tons, concentrate, averaging 40.1 percent Cr_2O_3. Production in California was largely from small deposits. The principal mines and history of chromite production in California were published.[3] All output in Montana came from the Mouat mine in the Stillwater complex, where the grade of ore is sub-Metallurgical in respect to both chromic oxide content and Cr : Fe ratio. Chromite production in Oregon decreased 11 percent compared with 1956. The operator of the Oregon Chrome mine, which has been the major chromite-producing mine in the State, discontinued exploration work and reduced mining activity.[4] A study of chromite deposits in southwestern Oregon indicated that they occur along definite zones or horizons in sill-like ultramafic intrusions.[5]

Chromite was produced from two mines in Alaska during 1957. Kenai Chrome Co. shipped over 3,700 long tons of Metallurgical-grade ore from its Star Four mine in Kenai Peninsula and stockpiled low-grade ore at its concentrating plant for beneficiation during the winter months. The firm was building a compressor shack and making other improvements at the Queen mine in anticipation of mining additional low-grade ore for beneficiation in the plant.

TABLE 2.—Chromite production (mine shipments) in the United States, 1953–57, by States, in short tons, wet weight

State	1953	1954	1955	1956		1957	
				Shipments	Value	Shipments	Value
Alaska		2,953	7,082	7,193	$711,481	4,207	$431,373
California	26,512	30,661	22,105	27,082	2,191,956	34,901	2,788,490
Montana	26,089	123,096	118,703	118,780	3,806,926	119,149	3,921,439
Oregon	6,216	6,655	5,341	[1] 54,577	[1] 2,001,083	7,900	674,631
Washington			22	30	3,330		
Total	58,817	163,365	153,253	[1] 207,662	[1] 8,714,776	166,157	7,815,933

[1] Includes 45,710 short tons of concentrate produced in 1955 and 1956 from low-grade ore and concentrate stockpiled near Coquille, Oreg., during World War II.

CONSUMPTION AND USES

Domestic consumption of chromite ore and concentrate for all purposes during 1957 was 5 percent below the record quantity used in 1956. By industries, metallurgical consumption was off 3 percent, refractory 8 percent, and chemical 7 percent.

[3] Rice, Salem J., Chromite: State of California, Dept. of Nat. Resources, Bull. 176, 1957, pp. 121–129.
[4] Ore.-Bin, State of Oregon, Dept. of Geol. and Min. Ind., vol. 20, No. 1, January 1958, p. 4.
[5] Ramp, Len, Geology of the Lower Illinois River Chromite District: Ore.-Bin, State of Oregon, Dept. of Min. Ind., vol. 19, No. 4, April 1957, pp. 29–34. Nature and Origin of Southwestern Oregon Chromite Deposits: Min. Eng., vol. 9, No. 8, August 1957, pp. 894–897.

The metallurgical industry consumed 1,177,000 tons of ore and concentrate, which averaged 47.1 percent Cr_2O_3. Of this quantity, 1,155,000 tons was used to produce 496,893 short tons of chromium ferroalloys and chromium metal; 22,000 tons was added direct to steel. Of the 1,155,000 tons of ore used to produce chromium ferroalloys and chromium metal, 84 percent was Metallurgical grade (48 percent Cr_2O_3), 11 percent Chemical grade (44 percent Cr_2O_3), and 5 percent Refractory-grade (34.9 percent Cr_2O_3) ore. The ratio of Cr : Fe in 71 percent of the Metallurgical-grade ore was at least 3 : 1; 27 percent was less than 3 : 1, but at least 2 : 1; and 2 percent was less than 2 : 1 Cr : Fe ratio.

The refractory industry consumed 428,000 tons of chromite ore that averaged 34.8 percent Cr_2O_3 in manufacturing chrome brick and other refractory products, and 7,000 tons of ore was used direct in furnace repairs.

Manufacturers of chromium chemicals used 148,000 tons of chromite ore that averaged 45 percent Cr_2O_3 in producing 106,337 short tons of chromium chemicals (sodium bichromate equivalent)—1.4 tons of chromite ore per ton of sodium bichromate produced.

Metallurgical Uses.—Chromium used to produce chromium ferroalloys and metal comprised 65 percent of all the chromium contained in ore and concentrate consumed in the United States during 1957. The metallurgical products produced were high- and low-carbon ferrochromium (82 percent), ferrochromium silicon (13 percent), exothermic chromium alloys and chromium metal (4 percent), and miscellaneous chromium alloys (1 percent).

Vanadium Corporation of America opened a new ferroalloy plant at Vancoram, Ohio, in October 1957, for producing both high- and low-carbon ferrochromium. It was reported that the firm contemplated the addition of another unit to the plant for producing manganese products.[6]

Domestic consumption of chromium ferroalloys and metal reported during 1957 totaled 246,000 short tons, which is estimated to be 85 percent of actual consumption; many users of small quantities were not canvassed. This tonnage reflected lowered industrial use and was 17 percent less than the quantity consumed in 1956. Consumption declined throughout 1957, dropping from 78,000 short tons in the first quarter to 64,000, 53,000, and 51,000 tons in the second, third, and fourth quarters, respectively. The chromium content of all the alloys and metal used totaled 146,000 tons compared with 178,000 tons in 1956.

The major metallurgical applications of chromium were for improving the properties of alloy steels such as hardness and resistance to corrosion, elevated temperatures, creep, impact, and wear. Smaller but important quantities were used in cast iron, high-temperature alloys, electrical-resistance alloys, and aluminum, copper, and titanium alloys. A new titanium-base alloy containing 5 percent aluminum, 1.5 percent iron, 1.4 percent chromium, and 1.2 percent molybdenum developed by Titanium Metals Corporation of America was reported to have the highest strength of any commercial available

[6] American Metal Market, Vanadium's New Ferroalloy Plant Formally Opened in Ohio: Vol. 64, No. 204, Oct. 22, 1957, pp. 1, 13.

titanium alloy.[7] A new iron-chromium alloy suitable for continuous resistance heating at temperatures up to 2,150° F. was reported developed by Hoskins Manufacturing Co.[8]

Refractory Uses.—Chromite ore used to produce refractories comprised 25 percent of the total consumed in the United States during 1957 and in terms of contained chromium was 19 percent of the total. The major uses of the chromite refractories were in lining basic open-hearth and electric steel furnaces. Some steel producers prefer burned chrome brick in the subhearths of the basic open-hearth furnace, because of its resistance to hydration. In furnaces that have basic hearths and acid roofs, chrome brick is preferred at the juncture of the two because of its neutral chemical qualities. Chromite refractory products were used also in lining reverberatory and other types of furnaces used in smelting metals such as aluminum, copper, and nickel.

Chemical Uses.—The domestic chemical industry consumed approximately 46,000 tons of chromium in ore and concentrate in producing chromium chemicals during 1957. Major uses of the chemicals were in pigments and allied products, tanning leather, treating and cleaning the surface of metals, and electroplating. The chemicals also were

TABLE 3.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States, 1948–52 (average) and 1953–57, in short tons

	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)
1948–52 (average)	485,064	47.8	355,643	34.0	144,516	44.6	985,223	42.4
1953	742,822	46.3	441,155	33.6	151,778	44.5	1,335,755	42.7
1954	502,278	46.3	278,324	34.3	133,371	44.6	913,973	42.4
1955	993,653	46.5	431,407	34.4	158,923	44.8	1,583,983	43.0
1956	1,211,914	46.8	474,562	34.4	160,124	45.4	1,846,600	43.5
1957	1,177,073	47.1	434,922	34.8	148,474	45.0	1,760,469	43.9

TABLE 4.—Consumption of chromium ferroalloys and metal in the United States in 1957, by major end uses

Alloy	Short tons		Percent consumed in (gross weight)—				
	Gross weight	Cr content	Stainless steel	High-speed steel	Other alloy steels	High temperature alloys	Other uses
Low-carbon ferrochromium	115,933	77,883	78.9	0.3	14.1	6.3	0.4
High-carbon ferrochromium	56,464	35,737	49.8	1.5	42.8	2.7	3.2
Low-carbon ferrochromium-silicon	36,780	14,987	88.8	.0	10.1	.7	.4
Other [1]	36,414	17,365	11.4	.0	78.8	4.3	5.5
Total	245,591	145,972	63.7	.5	29.7	4.3	1.8

[1] Includes chromium briquets, exothermic chromium additives, chromium metal, and other chromium alloys.

[7] American Metal Market, Strong Alloy of Titanium Now Made by T. M. C.: Vol. 64, No. 187, Sept. 27, 1957, p. 1.

[8] Daily Metal Reporter, Development of New Alloy Announced by Hoskins: Vol. 57, No. 214, Nov. 5, 1957, p. 11.

TABLE 5.—End use of individual chromium ferroalloys and chromium metal in the United States, 1957, in percent

Alloy	Stainless steel	High-speed steel	Other alloy steel	High-temperature alloys	Other uses
Low-carbon ferrochromium	78.9	0.3	14.1	6.3	0.4
High-carbon ferrochromium	49.8	1.5	42.8	2.7	3.2
Chromium briquets	92.2		.3	1.2	6.3
Chromium metal	4.0		3.1	77.9	15.0
Exothermic ferrochromium-silicon	.8		96.6	.5	2.1
Exothermic ferrochromium (low- and high-carbon)			97.7	.4	1.9
Low-carbon ferrochromium-silicon	88.8		10.1	.7	.4
Other chromium alloys [1]			43.3		56.7

[1] Includes V-5 alloy, chrome-silicon alloy, and other miscellaneous chromium alloys.

used in various other applications, such as catalysts and chemical reagents and in dry-cell batteries and matches. Chromate conversion coatings were used in an atomic reactor to prevent water corrosion of aluminum parts and to retard galvanic action where dissimilar metals met.[9] Another use of chromium was the coating of small cutting tools, such as files, bits, and bandsaw blades. It was claimed that the chromium extended the shop life of such tools.[10]

STOCKS

Industry stocks of chromite ore and concentrate increased 32 percent to a record high at the close of the year. Of the 1.6 million short tons that averaged 41.6 percent Cr_2O_3, 52 percent (45.9 percent Cr_2O_3) was at metallurgical plants, 38 percent (34.7 percent Cr_2O_3) at refractory plants, and 10 percent (45.2 percent Cr_2O_3) was at chemical plants.

Producers' and consumers' stocks of chromium ferroalloys and chromium metal on December 31, 1957, totaled 74,000 and 24,000 short tons, respectively, compared with 56,000 and 37,000 short tons, respectively, at the end of 1956.

Stocks of chromium chemicals at producers' plants totaled 14,000 short tons, sodium bichromate equivalent, at the close of 1957.

PRICES AND SPECIFICATIONS

Prices of foreign chromite declined during 1957 and on December 31 were $1 to $10 a ton lower than at the beginning of the year, according to E&MJ Metal and Mineral Markets. Domestically produced chromite was sold to the Federal Government at incentive prices. Base prices under the Purchase Program for Ore and Concentrate were: Lump ore, $115 a long dry ton; and fines and concentrate, $110 a ton.

E&MJ Metal and Mineral Markets quoted prices at the close of 1957 for ferrochromium in carload lots, f. o. b. destination continental United States were: High-carbon ferrochromium (4–9 percent carbon, 65–70 percent chromium) 28.75 cents a pound of contained chromium; low-carbon ferrochromium (0.10 percent carbon, 67–72 percent chro-

[9] Iron Age, Keep Corrosion at Bay With Chromates: Vol. 179, No. 15, Apr. 11, 1957, p. 115.
[10] Iron Age, Chrome-Coated Bench Tools Last Longer: Vol. 179, No. 11, Mar. 14, 1957, pp. 132–133.

TABLE 6.—Stocks of chromite at consumers' plants, December 31, 1953–57, in short tons

Grade	1953	1954	1955	1956	1957
Metallurgical	607,724	803,889	628,244	640,277	848,759
Refractory	259,896	257,451	313,189	431,285	610,477
Chemical	148,258	206,477	168,491	155,016	159,877
Total	1,015,878	1,267,817	1,109,924	1,226,578	1,619,113

mium) 38.50 cents a pound of contained chromium; and special ferrochromium (0.01 percent carbon, 63–66 percent chromium) 37.75 cents a pound of contained chromium. Prices quoted for the various grades of chromium metal were unchanged in 1957. Commercial-grade electrolytic chromium (99 percent minimum) and 97-percent-grade chromium were $1.29 a pound delivered, and chromium containing 9 to 11 percent carbon was $1.38 a pound delivered.

Revised National Stockpile Purchase Specifications issued during 1957 were: P–96–R-Chromium Metal dated January 7, 1957; P–11a–R-Low-Carbon Ferrochromium dated December 26, 1957; and P–11c–R2-Ferrochromium Silicon dated December 23, 1957. Chemical requirements of the specification covering chromium metal were not changed, but the phosphorus content of low-carbon ferrochromium and ferrochromium-silicon was increased to 0.04 and 0.05 percent, respectively. The only change in the specification covering chromium metal pertained to the labeling of the containers.

TABLE 7.—Price quotations for various grades of foreign chromite in 1957

[E&MJ Metal and Mineral Markets]

Source	Cr_2O_3 (percent)	Cr : Fe ratio	Price per long ton [1]	
			January 1	December 31
Pakistan	48	3:1	[2] $52–$53	[2] $52–53
Rhodesia	48	3:1	55–58.50	[2] 47–49
Do	48	2.8:1	52–56	[2] 44–46
Do	48		46–49.75	[2] 37–39
South Africa, Union of (Transvaal)	48		38–39	36–37
Do	44		26.50–27.50	26–26.50
Turkey	48	3:1	59–61	[2] 55–57
Do	46	3:1	56–58	[2] 52–54

[1] Quotations are on a dry basis, subject to penalties if guarantees are not met, f. o. b. cars, East coast ports.
[2] Nominal.

FOREIGN TRADE [11]

Imports.—Domestic imports of 2.3 million short tons of chromite ore and concentrate during 1957 were higher than in any preceding year. Imports of ore and concentrate were reported from 10 coun-

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

tries, but 91 percent came from the 4 major producing countries: Federation of Rhodesia and Nyasaland, Philippines, Turkey, and the Union of South Africa. Metallurgical-grade chromite (46.7 percent Cr_2O_3) comprised 62 percent of the total, Refractory-grade (33.9 percent Cr_2O_3) 26 percent, and Chemical-grade (43.9 percent Cr_2O_3) 12 percent.

Imports of chromium metal during 1957 totaled 1,354 short tons valued at $2,747,923; West Germany supplied 41 percent, United Kingdom 35 percent, France 15 percent, and Japan 9 percent. A total of 1,101 short tons of chromate and bichromate valued at $210,051 was imported from Canada, West Germany, and the Union of South Africa during 1957.

Exports.—United States exports of chromic acid totaled 674 short tons valued at $387,586. Sodium bichromate and chromate exports totaled 3,438 short tons valued at $869,032. Exports of other chromium products included 5 tons of chromium metal and alloys in crude form and scrap valued at $13,989 and 5 tons of semifabricated forms valued at $23,444.

Tariff.—No import duty was imposed on chromite ores. Pursuant to concessions granted in the General Agreement on Tariffs and Trade in 1956, the duties on some chromium products imported from countries other than Soviet Russia and other designated Communist countries and areas were reduced in 1957. The import duties on chromium metal and ferrochromium containing under 3 percent carbon were reduced from 11½ percent ad valorem to 11 percent ad valorem effective June 30, 1957. Import duties on other chromium products from Free World countries were: Ferrochromium, containing 3 percent or more carbon, ⅝ cent a pound of contained chromium; chromium carbide, chromium-nickel, chromium-silicon, and chromium-vanadium, 12½ percent ad valorem; chromium-cobalt-tungsten, chromium-tungsten, and ferrochromium-tungsten, 42 cents a pound of contained tungsten plus 12½ percent ad valorem; and chromic acid and chrome green and other colors containing chromium, 12½ percent ad valorem.

Tariffs on chromium products from Soviet Russia and other designated Communist countries and areas were: Chromium metal, and ferrochromium containing less than 3 percent carbon, 30 percent ad valorem; ferrochromium containing 3 percent or more carbon, 2½ cents per pound of contained chromium; chromium-cobalt-tungsten, chromium-tungsten, and ferrochromium-tungsten, 60 cents a pound of contained tungsten plus 25 percent ad valorem; chromium carbide, chromium-nickel, chromium-silicon, chromium-vanadium, chrome green and other colors containing chromium, 25 percent ad valorem.

Duties on imports from all countries: Chrome brick and shapes, 25 percent ad valorem; sodium chromate and bichromate 1¾ cents a pound; and potassium chromate and bichromate, 2¼ cents a pound.

TABLE 8.—Chromite imported for consumption in the United States, 1956–57, by countries and grades

[Bureau of the Census]

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		Gross weight	Cr_2O_3		Gross weight	Cr_2O_3		Gross Weight	Cr_2O_3	
1956												
North America:												
Cuba				5, 663	2, 557	$143, 601	46, 154	16, 176	$1, 024, 766	51, 817	18, 733	$1, 168, 367
Guatemala				979	551	38, 420				979	551	38, 420
Total				6, 642	3, 108	182, 021	46, 154	16, 176	1, 024, 766	52, 796	19, 284	1, 206, 787
South America: Brazil				1, 120	560	30, 500				1, 120	560	30, 500
Europe:												
Greece				1, 680	756	73, 500				1, 680	756	73, 500
Yugoslavia				16, 421	7, 869	487, 136				16, 421	7, 869	487, 136
Total				18, 101	8, 625	560, 636				18, 101	8, 625	560, 636
Asia:												
India				19, 149	9, 247	470, 031	12, 103	4, 871	167, 326	31, 252	14, 118	637, 357
Japan				120	56	3, 979				120	56	3, 979
Pakistan				7, 307	3, 216	88, 086				7, 307	3, 216	88, 086
Philippines				89, 295	44, 071	2, 006, 971	588, 259	190, 996	8, 574, 575	677, 554	235, 067	10, 581, 546
Turkey				528, 266	247, 254	17, 798, 605				528, 266	247, 254	17, 798, 605
Total				644, 137	303, 844	20, 367, 672	600, 362	195, 867	8, 741, 901	1, 244, 499	499, 711	29, 109, 573
Africa:												
British East Africa				1, 683	724	24, 658				1, 683	724	24, 658
Rhodesia and Nyasaland, Federation of				342, 846	160, 722	10, 367, 134	15, 961	6, 961	365, 411	358, 807	167, 683	10, 732, 545
Union of South Africa	269, 447	118, 138	$3, 432, 427	162, 524	72, 661	2, 649, 360	16, 759	6, 875	222, 205	448, 730	197, 674	6, 303, 992
Total	269, 447	118, 138	3, 432, 427	507, 053	234, 107	13, 041, 152	32, 720	13, 836	587, 616	809, 220	366, 081	17, 061, 195
Oceania: New Caledonia [1]				49, 320	24, 994	1, 381, 341				49, 320	24, 994	1, 381, 341
Grand total, 1956	269, 447	118, 138	3, 432, 427	1, 226, 373	575, 238	35, 563, 322	679, 236	225, 879	10, 354, 283	2, 175, 056	919, 255	49, 350, 032

1957												
North America:												
Cuba				8,282	3,781	335,096	92,239	30,702	1,655,110	100,521	34,483	1,990,206
Guatemala				802	385	42,502				802	385	42,502
Total				9,084	4,166	377,598	92,239	30,702	1,655,110	101,323	34,868	2,032,708
Europe:												
Greece				6,269	3,047	273,196				6,269	3,047	273,196
Yugoslavia				4,739	2,042	171,419				4,739	2,042	171,419
Total				11,008	5,089	444,615				11,008	5,089	444,615
Asia:												
India				20,360	9,251	478,754	560	213	7,620	20,920	9,464	486,374
Philippines				147,290	71,305	3,726,248	426,438	141,403	7,428,221	573,728	212,708	11,154,469
Turkey				412,664	192,395	14,618,561				412,664	192,395	14,618,561
Total				580,314	272,951	18,823,563	426,998	141,616	7,435,841	1,007,312	414,567	26,259,404
Africa:												
Rhodesia and Nyasaland, Federation of				504,821	233,678	15,923,334	18,820	7,381	457,674	523,641	241,059	16,381,008
Union of South Africa	289,491	127,261	3,535,182	238,471	107,610	4,321,555	47,575	18,990	573,570	575,537	253,861	8,430,307
Total	289,491	127,261	3,535,182	743,292	341,288	20,244,889	66,395	26,371	1,031,244	1,099,178	494,920	24,811,315
Oceania: New Caledonia [1]				62,770	33,445	2,112,929				62,770	33,445	2,112,929
Grand total	289,491	127,261	3,535,182	1,406,468	656,939	42,003,594	585,632	198,689	10,122,195	2,281,591	982,889	55,660,971

[1] Assumed source; classified in import statistics under "French Pacific Islands."

TABLE 9.—Ferrochromium imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	Low-carbon ferrochromium (less than 3 percent carbon)			High-carbon ferrochromium (3 percent or more carbon)		
	Short tons		Value	Short tons		Value
	Gross weight	Chromium content		Gross weight	Chromium content	
1956						
North America: Canada				8,998	4,839	$1,901,147
Europe:						
France	4,728	3,503	$2,041,894	156	110	39,509
Germany, West	16	11	11,447	55	38	16,538
Italy				1,580	1,060	474,712
Norway	1,121	793	416,719			
Sweden	641	455	255,089	1,129	735	266,677
Yugoslavia	1,899	[1] 1,304	733,355			
Total	8,405	6,066	3,458,504	2,920	1,943	797,436
Asia: Japan	[1] 1,025	623	[1] 396,444	2,102	[1] 1,418	562,806
Africa:						
Rhodesia and Nyasaland, Federation of	3,300	2,368	1,225,549			
Union of South Africa				[1] 13,132	[1] 8,721	3,061,648
Total	3,300	2,368	1,225,549	13,132	8,721	3,061,648
Grand total, 1956	[1] 12,730	[1] 9,057	[1] 5,080,497	[1] 27,152	[1] 16,921	6,323,037
1957						
North America: Canada				8,238	4,177	1,709,224
Europe:						
France	3,813	2,716	1,661,044	228	165	60,015
Germany, West	6,686	4,610	2,383,184	3,845	2,737	1,089,148
Italy				4,034	2,658	1,223,147
Netherlands	112	80	47,689			
Sweden	869	596	370,810	99	67	29,760
Yugoslavia	1,757	1,223	704,335			
Total	13,237	9,225	5,167,062	8,206	5,627	2,402,070
Asia: Japan	296	196	115,326	5,567	3,751	1,637,798
Africa:						
Rhodesia and Nyasaland, Federation of	1,282	907	564,541	242	165	111,402
Union of South Africa	1,538	1,039	457,983	9,063	5,823	2,294,999
Total	2,820	1,946	1,022,524	9,305	5,988	2,406,401
Grand total, 1957	16,353	11,367	6,304,912	31,316	19,543	8,155,493

[1] Revised figure.

TABLE 10.—Chromite ore and concentrates exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

	Domestic [1]		Foreign [2]	
	Short tons	Value	Short tons	Value
1948–52 (average)	2,176	$87,300	12,583	$519,693
1953	1,166	56,393	6,071	251,525
1954	864	50,371	427	7,611
1955	1,341	75,656	2,950	86,986
1956	1,727	99,169	12,990	501,938
1957	837	52,579	4,872	193,546

[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 later exported without change of form.

WORLD REVIEW

World production of chromite during 1957 was estimated as higher than in any previous year. The Philippines, Federation of Rhodesia and Nyasaland, Turkey, and the Union of South Africa, combined, produced approximately 65 percent of the total estimated output. U. S. S. R. also was a major producer.

TABLE 11.—World production of chromite, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	415					
Cuba	92,745	77,205	80,011	85,107	[3] 59,248	127,126
Guatemala	477	441	146	320	979	[4] 1,200
United States	6,563	58,817	163,365	153,253	[5] 207,662	166,157
Total	100,200	136,463	243,522	238,680	267,889	294,483
South America: Brazil	2,187	3,942	2,108	4,546	4,536	[4] 4,000
Europe:						
Albania	48,600	51,800	110,200	135,000	[4] 147,000	184,400
Greece	16,612	40,520	29,508	27,902	53,581	[3] 49,135
Portugal	99	6	23			
U. S. S. R.[4] [6]	580,000	600,000	600,000	600,000	600,000	600,000
Yugoslavia	108,760	139,950	137,216	139,119	130,913	132,570
Total [1] [4]	765,000	900,000	900,000	900,000	1,000,000	1,000,000
Asia:						
Afghanistan	[7] 448					
Cyprus (exports)	14,629	9,115	10,080	9,599	6,526	5,678
India	24,996	72,543	50,968	100,071	59,009	87,968
Iran [8]	6,355	23,657	23,406	38,504	29,700	[4] 27,600
Japan	34,767	41,418	36,138	29,269	43,947	51,050
Pakistan	19,756	26,255	24,527	31,808	25,487	[4] 20,000
Philippines	359,837	614,086	442,230	655,882	781,598	799,744
Turkey	566,038	1,005,883	619,001	710,253	918,308	772,368
Total [6]	1,026,826	1,792,957	1,206,350	1,575,386	1,864,575	1,764,408
Africa:						
Egypt	61	231	584	926	281	
Sierra Leone	17,159	27,277	21,011	23,231	21,900	[3] 18,344
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	306,149	463,028	442,506	449,202	448,965	654,072
Union of South Africa	537,593	798,562	706,935	597,368	690,851	722,588
Total	860,962	1,289,098	1,171,036	1,070,727	1,161,997	1,395,004
Oceania:						
Australia	1,088	3,070	5,536		6,828	3,650
New Caledonia	98,175	134,032	93,645	50,790	53,932	[4] 71,100
Total	99,263	137,102	99,181	50,790	60,760	[4] 74,750
World total (estimate) [1]	2,855,000	4,300,000	3,600,000	3,800,000	4,400,000	4,500,000

[1] In addition to countries listed, Bulgaria and Rumania produce chromite, but data on output are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Chromite chapters. Data do not add to totals shown because of rounding where estimated figures are included in the detail.
[3] Exports.
[4] Estimate.
[5] Includes 45,710 short tons of concentrates produced in 1955–56 from low-grade ores and concentrates stockpiled near Coquille, Oreg., during World War II.
[6] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[7] Average for 1949–52.
[8] Year ended March 20 of year following that stated.

Canada.—Steps were taken during 1957 to develop the large low-grade chromite deposits in the Cat Lake-Bird River area of southeastern Manitoba. Strannar Mines, Ltd., was reported formed by Strategic Materials Corp. and Gunnar Mines, Ltd., to develop the chromite claims in this area owned by Gunnar Mines, and Chromite Mining Corp., Ltd.[12] Goldmont Porcupine Mines planned to resume exploration of chromite prospects in the Ashcroft area of British Columbia.[13]

Cuba.—One of the most productive chromite mines (Cayoguan) in Cuba was nearly worked out.[14] The mine is in Oriente Province, about 10 miles from Moa, and has been the source of over 1 million tons of Refractory-grade ore.

Cyprus.—The Cyprus Chrome Co., the only producer of chromite in Cyprus during 1957, increased production 17 percent compared with 1956. The firm exported 6,525 short tons of ore and concentrate during 1957, and at the year end its stocks at the mine were about 6,900 tons.[15]

India.—Exports of chromite from India during 1957 were controlled by the Government. The mine owners and shippers were given quotas equal to the allotments given them in 1956.[16] The Indian Government also permitted the State Trading Corporation of India to export chromite.

Iran.—Chromite deposits in Iran attracted the attention of representatives from several countries during 1957. German geologists examined chromite deposits in Northeast Iran. A private British company was negotiating with the Plan Organization for joint exploitation of chromite mines near Esfandaqeh, 180 kilometers south of Kerman, and one American company was investigating other chromite deposits.

Pakistan.—Chromite deposits were discovered in the Ras Koh range in former Baluchistan Province by the Geological Survey of Pakistan.[17] A summary of chromite resources in Pakistan contained data on historical production, mining problems, and deposits.[18]

Philippines.—Chromite production in the Philippines during 1957 was higher than in any preceding year. Refractory-grade ore from the Masinloc mine of Consolidated Mines, Inc., comprised 84 percent of the output; the remainder was Metallurgical-grade ore from several mines.

Chromite ore reserve of the Masinloc deposit was reported at 4.7 million short tons at the beginning of 1957.[19] Exploration of these deposits was continued during 1957 to further increase ore reserves.

Consolidated Mines, Inc., sold Nanyo Busson Co., Ltd., of Tokyo, Japan, 550,000 tons of ore fines previously considered unmarketable because of the high silica content.[20] The firm shipped its Refractory-grade ore principally to the United States, but sizable quantities were also shipped to Japan and several Western European countries.

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[12] Mining World, Strategic, Gunnar Join to Produce Chromite: Vol. 20, No. 1, January 1958, p. 89.
[13] Northern Miner (Toronto), Goldmont to Resume Chromium Search: Vol. 43, No. 27, Sept. 26, 1957, p. 40.
[14] Engineering and Mining Journal, Cuba and Its Stake in Mining: Vol. 158, No. 9, September 1957, p. 76.
[15] U. S. Consulate, Nicosia, Cyprus, State Department Dispatch 62: Feb. 6, 1958.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 6.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, Special supplement 50, July 1957, p. 8.
[18] Bureau of Mines, Mineral Trade Notes, Vol. 45, No. 6, December 1957, pp. 7–9.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, pp. 5–9.
[20] Mining Journal (London), Chrome for Japan: Vol. 249, No. 6362, July 26, 1957, p. 113.

Rhodesia and Nyasaland, Federation of.—Owing to a vast improvement in the railroad haulage in Southern Rhodesia since the Lourenco Marques Railway was completed in 1955, both production and shipments of chromite reached new peaks in 1957. Production increased 46 percent compared with output in 1956. The large stockpile of ore at mines was reported to have been eliminated by the end of 1957.

Chromite deposits covering an area of about 15 square miles were discovered in the Belingwe Reserve, 40 miles south of Shabani.[21] Reserves of chromite in the Great Dyke were estimated roughly at 369 million tons down to a depth of 100 feet on the incline.[22] The Great Dyke was described as a narrow belt of ultrabasic rocks up to 4 miles wide and extending some 330 miles from south of Belingwe to the Zambesi Valley beyond Sipolilo. The report also described the types of chromite deposits and the mining methods employed.

Turkey.—Production of chromite in Turkey during 1957 decreased slightly, compared with production in 1956. About one-third of the output came from the State-owned Guleman and Sori mines controlled by Etibank, and the rest came from many privately operated mines of which the majority are small. The principal chromite producing Provinces of Turkey were Bursa, Elazig, Eskisehir, Burdur, Mugla, Kütahya, Gaziantep, Hatay, and Antalyá. Chromite-ore reserves in Turkey were estimated at 3 to 4 million tons.[23]

The Turkish press announced that an agreement was signed by representatives of Etibank and two French firms for the construction of a ferrochromium plant near Antalyá capable of producing 8,000 tons of ferrochromium and 4,000 tons of calcium carbide annually.

TABLE 12.—Exports of chromite from Turkey, 1953–57, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957 [2]
North America:					
Canada	----------	----------	1,120	2,240	3,360
United States	516,577	224,037	434,014	490,982	297,272
Europe:					
Austria	38,455	31,281	35,842	34,395	30,503
Belgium	----------	----------	667	772	----------
France	20,286	20,224	27,476	37,883	39,939
Germany, West	25,374	69,568	72,410	72,018	41,549
Italy	2,470	5,897	5,077	9,737	7,712
Netherlands	4,700	7,883	3,797	2,240	6,720
Norway	23,830	8,063	----------	4,445	9,172
Spain	1,764	661	8,257	5,197	1,102
Sweden	24,413	12,125	2,205	8,960	4,572
Switzerland	9,060	----------	----------	6.599	4,256
United Kingdom	14,807	12,419	25,264	22,015	23,068
Yugoslavia	----------	882	551	----------	----------
Asia:					
Japan	----------	----------	----------	8,623	----------
Other countries	1,102	----------	154	1,587	----------
Total	682,838	393,040	616,834	707,693	469,225

[1] Compiled from Customs Returns of Turkey.
[2] January thru September inclusive.

[21] Mining World, Africa: Vol. 19, No. 6, May 1957, p. 100.
[22] Stanley, R., Chrome Ore Mines' Output Expansion, Rhodesia: Financial Times (London), Oct. 21, 1957, p. 28.
[23] Mining World, Turkey: Vol. 19, No. 5, April 1957, p. 148.

Union of South Africa.—Chromite production in the Union of South Africa during 1957 increased 6 percent compared with that in 1956. The Marble Lime and Associated Industries, Ltd., reportedly purchased the Kroondal chromite property in Western Transvaal and built a plant for concentrating the ore.[24] Chromite valued at nearly $168,000 was salvaged by a British crew from the wreck of an American steamer 10 miles off South Africa's Cape Agulhas.[25]

RESERVES

In 1957 the Geological Survey estimated the measured, indicated, and inferred reserves of chromite in the United States and Alaska at 3.5 million long tons of chromic oxide. Over 90 percent of the reserve is in layered deposits in the Stillwater complex in Montana and in old beach sands along the coast of Oregon.

TECHNOLOGY

Bureau of Mines conducted research on the development of economical methods of beneficiating and using subgrade domestic chromite ores, recovering chromium from laterites, and producing ultrapure chromium and its alloys. Flotation studies were made on low-grade ores from the Seiad Creek area in California. Concentrates produced from ores in the Stillwater complex in Montana were smelted to usable ferrochromium and other chromium-bearing alloys. Other studies on the beneficiation of low-grade ores included roasting and leaching, direct smelting and flotation of laterites and serpentines. Ultrapure ductile chromium produced incident to the Bureau's research was made available to outside laboratories for special studies, including a laboratory that used the metal in the experimental treatment of cancer. Results of the Bureau's research in developing processes for producing both Commercial grade and ultrapure electrolytic chromium were published.[26] Another report gave results of the Bureau's laboratory-scale work on the concentration of chromite ores from the Red Mountain district in Alaska.[27]

Results of worldwide research on ductile chromium and its alloys were published.[28] A process for producing electrolytic chromium direct from disseminated chromite ores was patented.[29] The process involves the leaching of the ore with sulfuric acid, the reduction of trivalent chromic sulfate with titanous sulfate, and electrolyzing to produce metallic chromium. A method for increasing the iron to chromium ratio of chromium-bearing iron ores was patented.[30] The method consists of oxidizing a solution containing iron and chromium sulfates to convert a substantial part of the chromium to the hexavalent

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[24] Mining World, Africa: Vol. 19, No. 2, February 1957, p. 116.
[25] Mining Congress Journal, British Salvage Chrome Ore: Vol. 43, No. 6, June 1957, p. 118.
[26] Gruzensky, P. M., and Block, F. E., Preparation of High-Purity Electrolytic Chromium: Bureau of Mines Rept. of Investigations 5305, 1957, 11 pp.
Rosenbaum, J. B., Lloyd, R. R., and Merrill, C. C., Electrowinning Chromium Metal: Bureau of Mines Rept. of Investigations 5322, 1957, 58 pp.
[27] Wells, R. R., Sterling, F. T., Erspamer, E. G., and Stickney, W. A., Laboratory Concentration of Chromite Ores, Red Mountain District, Kenai Peninsula, Alaska: Bureau of Mines Rept. of Investigations 5377, 1957, 22 pp.
[28] American Society for Metals, Ductile Chromium: 1957, 376 pp.
[29] Westby, George C. (assigned to Key Metals Corp., Seattle, Wash.), Chemical and Electrochemical Extraction of Chromium From Its Ores: U. S. Patent 2,803,594, Aug. 20, 1957.
[30] Mancke, Edgar B. (assigned to Bethlehem Steel Co.), Treatment of Iron Ores: U. S. Patent 2,776,207, Jan. 1, 1957.

state and autoclaving the oxidized solution at about 390° F. to precipitate the iron compound.

Government-sponsored research on chromium-base alloys for high-temperature use included studies on brittle to ductile transition temperature of binary chromium alloys, oxidation resistance of binary chromium-base alloys, and transition temperatures of chromium and chromium-base alloys. Initial studies under a contract (NOas 56–1090–d) between the Department of the Navy, Bureau of Aeronautics, and the Massachusetts Institute of Technology indicated: Room-temperature, ductile, chromium-base alloys in the 60- to 90-percent-chromium range can be achieved if the transition temperature of the starting chromium is low enough; chromium-palladium alloys have very good oxidation resistance in flowing air at 1,800° F.; and cost of producing low-transition-temperature chromium by deoxidation and denitrogenation is more favorable than other methods.

The use of the ion-exchange system for purifying and recovering chromium-plating waste solutions was discussed.[31] A chromium-plating process developed by Heintz Manufacturing Co., Philadelphia, Pa., was reported to have been used for chromium-plating blackplate for use in manufacturing detergent containers.[32] The process was said to be applicable to high-speed operation and to produce a scratch-resistant coating capable of taking a high luster. A method for chromium-plating objects by using chromium-bearing gas was patented.[33]

A modified alkaline chromate method for determining chromium in soils was described as useful in geochemical prospecting.[34]

[31] Young, M. K., Chrome Waste Treatment: Metal Industry, vol. 90, No. 4, Jan. 25, 1957, pp. 67–68.
[32] Metal Bulletin (London), On the Technical Side: No. 4203, June 18, 1957, p. 19.
[33] Ostrofsky, Bernard, and Ballard, James W. (assigned to The Commonwealth Engineering Co., Dayton, Ohio), Method of Gas Plating With Chromium Compound and Products of the Method: U. S. Patent 2,793,140, May 21, 1957.
[34] Wood, G. A., and Stanton, R. E., A Rapid Method for the Determination of Chromium in Soils for Use in Geochemical Prospecting: Inst. Min. and Met. (London), vol. 66, pt. 7, No. 605, April 1957, pp. 321–340.

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Clays

By Brooke L. Gunsallus[1] and Betty Ann Brett[2]

TOTAL CLAYS sold or used by producers in 1957 decreased 10 percent in tonnage compared with 1956. All six major classifications of clay—china clay or kaolin, ball clay, fire clay, bentonite, fuller's earth, and miscellaneous clay—reported quantity decreases in 1957 compared with 1956 and all except kaolin decreased in value.

Kaolin sold or used by producers decreased 3 percent in tonnage and increased 3 percent in value; ball clay decreased 11 and 9 percent; bentonite, 8 and 3 percent; fire clay, 8 and 5 percent; fuller's earth, 12 and 9 percent; and miscellaneous, 11 and 9 percent.

Prices for most clays and clay products in 1957, as shown in trade papers, remained steady.

Imports of kaolin for 1957 decreased 7 percent over 1956 and were 6 percent of the total domestic consumption of kaolin. Imports of common blue and ball clay in 1957 decreased 16 percent in tonnage and value compared with 1956.

Exports of kaolin or china clay in 1957 decreased 7 percent over 1956; 73 percent was shipped to Canada and 7 percent to Mexico. Exports of fire clay in 1957 decreased 10 percent in tonnage but increased 15 percent in value compared with 1956. Canada received 65 percent and Mexico 21 percent of the fire-clay exports.

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

TABLE 1.—Salient statistics of clays in the United States, 1948–52 (average) and 1953–57, thousand short tons and thousand dollars

		1948–52 (average)	1953	1954	1955	1956	1957
Domestic clays sold or used by producers:							
Kaolin or china clay	Quantity	1,686	1,884	1,873	2,166	2,250	2,184
	Value	$22,648	$27,092	$28,019	$31,883	$34,504	$35,598
Ball clay	Quantity	304	301	328	411	459	409
	Value	$3,614	$3,389	$4,168	$5,387	$6,081	$5,521
Fire clay, including stoneware clay	Quantity	10,219	10,267	8,797	10,840	11,803	10,805
	Value	$36,185	$38,451	$33,327	$42,119	$53,750	$51,311
Bentonite	Quantity	1,060	1,270	1,278	1,480	1,570	1,451
	Value	$10,086	$16,180	$14,723	$17,219	$18,415	$17,830
Fuller's earth	Quantity	393	436	376	370	418	366
	Value	$6,397	$7,615	$6,862	$7,620	$8,879	$8,057
Miscellaneous clay	Quantity	25,806	28,268	29,853	32,975	34,385	30,495
	Value	$24,830	$32,407	$36,185	$35,433	$41,516	$37,580
Total sold or used by producers	Quantity	39,468	42,426	42,505	48,242	50,885	45,710
	Value	$103,760	$125,134	$123,284	$139,661	$163,145	$155,897
Imports:							
Kaolin or china clay	Quantity	103	119	134	152	145	134
	Value	$1,506	$1,854	[1] $2,158	$2,445	$2,479	$2,371
Common blue and ball clay	Quantity	[2] 31	[2 3] 26	26	34	26	22
	Value	[2] $353	[2 3] $297	$272	[1] $359	$293	$248
Other clays [4]	Quantity	5	[3] 4	5	6	5	6
	Value	$53	[3] $44	$55	[1] $137	$197	$321
Total imports	Quantity	139	149	165	192	176	162
	Value	$1,912	$2,195	$2,485	$2,941	$2,969	$2,940
Exports:							
Kaolin or china clay	Quantity	29	43	49	50	59	55
	Value	$514	$795	$946	$1,017	$1,298	$1,327
Fire clay	Quantity	89	91	78	109	152	137
	Value	$870	$920	$815	$1,358	[5] $1,573	$1,794
Other clays	Quantity	157	168	201	247	300	293
	Value	$4,494	$5,316	$6,589	$8,516	[5] $9,722	$10,407
Total exports	Quantity	275	302	328	406	511	485
	Value	$5,878	$7,031	$8,350	$10,891	[5] $12,593	$13,528

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with earlier years.
[2] Figure includes Gross Almerode, 1948–53.
[3] Figure revised to include "Wrought or manufactured," formerly included with "Other clays."
[4] Figure includes fuller's earth (1948–57), bentonite (1948–55 and 1957), Gross Almerode (1954–57).
[5] Revised figure.

REVIEW BY TYPE OF CLAY

CHINA CLAY OR KAOLIN

Domestic kaolin sold or used in 1957 decreased 3 percent in tonnage but increased 3 percent in value compared with 1956.

Eight States produced kaolin in 1957 compared with 9 in 1956. Arkansas did not report production in 1957. Georgia continued to be the principal producing State, with 76 percent of the total United States output; South Carolina was second, with 16 percent. Both Georgia and South Carolina reported decreases in 1957 compared with 1956.

As in several preceding years the paper, rubber, refractories, and pottery industries were the principal kaolin consumers. Paper consumed 54 percent of the total—30 percent for coating and 24 percent for filling. Rubber consumed 14 percent; refractories, 12 percent; and pottery, 4 percent. The remaining 16 percent was consumed for a wide variety of purposes, including cement, floor and wall tile, fertilizers, chemicals, insecticides, paint filler or extender, and linoleum. All large uses for kaolin decreased except refractories and rubber which showed small increases.

TABLE 2.—Kaolin sold or used by producers in the United States, 1956–57, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956						
Arkansas			324	$3,240	324	$3,240
California	(1)	(1)	(1)	(1)	15,711	144,191
Florida and North Carolina	42,687	$1,007,451			42,687	1,007,451
Georgia	(1)	(1)	(1)	(1)	1,663,707	26,604,891
South Carolina	370,949	4,667,321	20,775	51,766	391,724	4,719,087
Other States [2]	1,589,451	26,154,617	225,734	2,619,321	135,767	2,024,856
Total	2,003,087	31,829,389	246,833	2,674,327	2,249,920	34,503,716
1957						
Florida and North Carolina	37,163	903,029			37,163	903,029
Georgia	1,495,905	27,070,261	162,789	1,149,446	1,658,694	28,219,707
Pennsylvania	35,633	195,398			35,633	195,398
South Carolina	(1)	(1)	(1)	(1)	353,698	4,590,182
Other States [2]	373,100	4,903,950	79,095	1,375,697	98,497	1,689,465
Total	1,941,801	33,072,638	241,884	2,525,143	2,183,685	35,597,781

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, and Alabama, California (1957 only), Pennsylvania (1956 only), and Utah.

The average value of domestic kaolin sold or used, as reported to the Bureau of Mines in 1957, was $16.30 per short ton compared with $15.34 in 1956, $14.72 in 1955, $14.96 in 1954, and $14.38 in 1953.

No quotations on domestic kaolin have been reported by E&MJ Metal and Mineral Markets since June 1951. In December 1957 the Oil, Paint and Drug Reporter quoted prices for Georgia kaolin as follows: Dry-ground, air-floated, 300-mesh, in bags, carlots, f. o. b. plant, $13.50 to $14.50 per short ton; l. c. l., same basis, $35 to $36 per short ton.

Prices for imported china clay in December 1957 were quoted by Oil, Paint and Drug Reporter as follows: White lump, carlots, ex dock (Philadelphia, Pa., and Portland, Maine), $20 to $35 per long ton; powdered, ex dock, in bags, $50 per net ton; l. c. l., ex warehouse, $60 to $65.

Imports of kaolin for 1957 decreased 7 percent compared with 1956 and represented 6 percent of the total domestic consumption. Over 99 percent of the 1957 imports came from the United Kingdom and the remainder from Canada.

Exports of kaolin or china clay in 1957 decreased 7 percent compared with 1956; 73 percent went to Canada, 7 percent to Mexico, and 3 percent each to Venezuela and Italy. Small tonnages also were sent to Central and South America, Europe, Africa, and Asia.

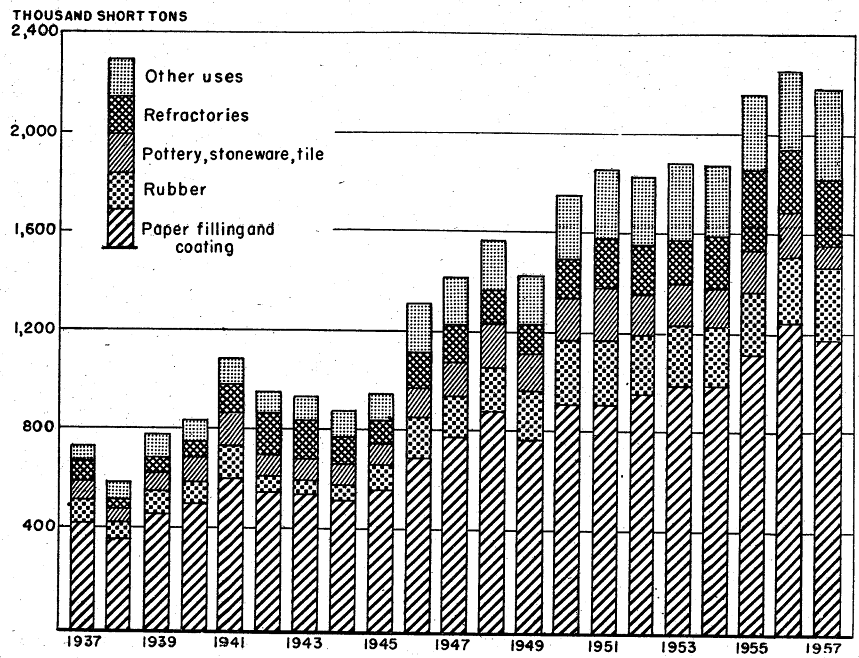

FIGURE 1.—Kaolin sold or used by domestic producers for specified uses, 1937–57.

TABLE 3.—Georgia kaolin sold or used by producers, 1948–52 (average) and 1953–57, 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
1948–52 (average)	1,057,772	$15,776,348	$14.91	144,538	$881,950	$6.10	1,202,310	$16,658,298	$13.85
1953	1,170,679	18,606,351	15.89	171,046	1,053,274	6.16	1,341,725	19,659,625	14.65
1954	1,190,681	(1)	(1)	114,184	(1)	(1)	1,304,865	20,525,906	15.73
1955	1,327,211	(1)	(1)	165,772	(1)	(1)	1,492,983	23,375,768	15.66
1956	1,456,155	(1)	(1)	207,552	(1)	(1)	1,663,707	26,604,891	15.99
1957	1,414,091	(1)	(1)	244,603	(1)	(1)	1,658,694	28,219,707	17.01

[1] Data not available.

BALL CLAY

Ball clay sold or used by producers in 1957 decreased 11 percent in tonnage and 9 percent in value compared with 1956.

Beginning with 1943, Tennessee has produced the most of any State. In 1957 Tennessee production was 64 percent of the United States total; Kentucky was second, with 25 percent. Compared with 1956, ball-clay production decreased 11 percent in Tennessee and 12 percent in Kentucky.

The pottery industry consumed 60 percent of the ball clay produced in 1957, compared with 63 percent in 1956. Ball clay used in making whiteware (the major use) decreased 16 percent; floor and wall tile, 11 percent.

Quotations on domestic ball clay in Oil, Paint and Drug Reporter for December 1957 were: Crushed, in bulk, carlots, f. o. b. plant, $8 to $11 per short ton; air-floated in bags, carlots, f. o. b. plant, $16.50 to $21.50 per short ton; and purified, in bags, carlots, f. o. b. plant, $16.50 to $21.50 per short ton. In 1957 the average value per short ton for ball clay, as reported by producers, was $13.52 compared with $13.25 in 1956. In 1957 the average value per short ton was: Tennessee ball clay, $13.67 compared with $13.42 in 1956; Kentucky ball clay, $13.07 compared with $13.03 in 1956.

Imports of common blue and ball clay in 1957 decreased 16 percent in tonnage and value compared with 1956. Unmanufactured blue and ball clays represented the major share of imports; United Kingdom supplied 98 percent of this classification and most of the imports of manufactured blue and ball clay. Small tonnages of unmanufactured blue and ball clays came from Canada and West Germany. Imports of Gross Almerode clays, including fuller's earth, totaled 1,608 short tons—521 from Canada, 73 from United Kingdom, 902 from West Germany, and 112 from the Netherlands. Exports, if any, are not shown separately on official foreign-trade returns.

TABLE 4.—Ball clay sold or used by producers in the United States, 1955–57, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1955						
Kentucky	111, 600	$1, 498, 950			111, 600	$1, 498, 950
Maryland	20, 640	267, 410			20, 640	267, 410
Tennessee	251, 104	3, 305, 277	2, 930	$29, 300	254, 034	3, 334, 577
Other States	(1)	(1)	(1)	(1)	25, 080	285, 840
Total	383, 344	5, 071, 637	2, 930	29, 300	411, 354	5, 386, 777
1956						
California			14, 860	104, 191	14, 860	104, 191
Kentucky	115, 243	1, 501, 550			115, 243	1, 501, 550
Tennessee	285, 792	3, 849, 709	4, 300	43, 000	290, 092	3, 892, 709
Other States [1]	38, 611	582, 868			38, 611	582, 868
Total	439, 646	5, 934, 127	19, 160	147, 191	458, 806	6, 081, 318
1957						
California			11, 404	80, 332	11, 404	80, 332
Kentucky	101, 953	1, 332, 543			101, 953	1, 332, 543
Tennessee	255, 826	3, 510, 994	3, 575	35, 750	259, 401	3, 546, 744
Other States [1]	35, 528	561, 576			35, 528	561, 576
Total	393, 307	5, 405, 113	14, 979	116, 082	408, 286	5, 521, 195

[1] Includes Maryland (1956–57), New Jersey, Mississippi, and Oregon (1955 only). Individual figures combined to avoid disclosing individual company confidential data.

FIRE CLAY

Fire clay sold or used by producers in the United States decreased 8 percent in 1957 compared with 1956, or to about the same level as in 1955. Lower activity in the refractory and construction industries was responsible for most of the decrease. The three States producing the largest quantities—Ohio, Pennsylvania, and Missouri—all reported decreases. Six of the smaller producing States showed increases over 1956.

The principal uses of fire clay in 1957 were for manufacture of refractories, which consumed 52 percent of the total output, and heavy clay products, including architectural terra cotta and lightweight aggregate, which consumed 43 percent. About 1 percent was consumed in chemicals, 2 percent in floor and wall tile, and 2 percent for a variety of applications.

In 1957 Ohio ranked first in fire-clay production, followed in decreasing order by Pennsylvania, Missouri, California, Texas, Illinois,

TABLE 5.—Fire clay, including stoneware clay, sold or used by producers in the United States, 1956–57, by States [1]

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956						
Alabama	(2)	(2)	(2)	(2)	303,329	$990,240
Arizona			13	$13	13	13
Arkansas			274,698	1,188,843	274,698	1,188,843
California	175,154	$590,374	431,038	1,397,537	606,192	1,987,911
Colorado	185,412	437,975	118,975	380,414	304,387	818,389
Illinois	292,439	547,249	148,542	322,378	440,981	869,627
Indiana	495,499	826,554	149,755	375,309	645,254	1,201,863
Kansas			139,130	308,960	139,130	308,960
Kentucky	54,119	235,195	249,156	1,676,820	303,275	1,912,015
Maryland	(2)	(2)	(2)	(2)	68,434	409,744
Missouri	268,966	1,122,293	1,496,955	5,994,528	1,765,921	7,116,821
Montana	94	376	1,508	6,032	1,602	6,408
Nebraska			2,495	2,495	2,495	2,495
Nevada	597	5,369	750	2,138	1,347	7,507
New Jersey	94,928	765,220	75,218	453,780	170,146	1,219,000
New Mexico	(2)	(2)	(2)	(2)	8,314	27,481
Ohio	988,723	2,872,176	2,175,997	11,125,758	3,164,720	13,997,934
Oklahoma			290	2,900	290	2,900
Pennsylvania	674,124	2,017,498	1,768,862	16,020,260	2,442,986	18,037,758
Texas	(2)	(2)	(2)	(2)	483,417	1,007,188
Utah	37,097	36,274	19,748	51,345	56,845	87,619
Washington	12,000	24,300	74,674	154,256	86,674	178,556
West Virginia	(2)	(2)	(2)	(2)	428,033	2,171,942
Other States [3]	263,389	668,163	1,132,748	4,137,104	104,610	198,672
Total	3,542,541	10,149,016	8,260,552	43,600,870	11,803,093	53,749,886
1957						
Alabama	(2)	(2)	(2)	(2)	174,817	483,635
Arizona			15	15	15	15
Arkansas			390,451	1,360,047	390,451	1,360,047
California	206,318	675,441	456,064	1,367,182	662,382	2,042,623
Colorado	172,444	405,319	57,079	259,895	229,523	665,214
Illinois	277,535	1,383,908	160,109	960,733	437,644	2,344,641
Indiana	(2)	(2)	(2)	(2)	397,825	748,028
Kansas			231,218	550,536	231,218	550,536
Kentucky	60,541	284,629	269,672	1,683,932	330,213	1,968,561
Maryland	(2)	(2)	(2)	(2)	82,130	363,357
Missouri	197,375	679,735	1,534,705	6,047,270	1,732,080	6,727,005
Nebraska			2,500	2,500	2,500	2,500
New Jersey	111,583	828,082	55,622	347,895	167,205	1,175,977
New Mexico	471	2,073	4,421	14,508	4,892	16,581
Ohio	924,254	2,782,152	1,817,730	9,498,199	2,741,984	12,280,351
Oklahoma			309	3,090	309	3,090
Pennsylvania	484,775	1,179,570	1,606,527	15,236,205	2,091,302	16,415,775
Texas	(2)	(2)	(2)	(2)	453,974	1,057,131
Utah	14,866	60,086	18,757	48,768	33,623	108,854
Washington	(2)	(2)	(2)	(2)	117,844	321,119
West Virginia	(2)	(2)	(2)	(2)	402,581	2,445,427
Other States [3]	497,636	1,150,245	1,252,122	4,498,749	120,587	230,297
Total	2,947,798	9,431,240	7,857,301	41,879,524	10,805,099	51,310,764

[1] Includes stoneware clay as follows: 1956—74,143 tons; 1957—30,089 tons.
[2] Included with "Other States."
[3] Includes States indicated by footnote 2 above and Idaho, Iowa, Minnesota, Mississippi, Montana (1957 only), Nevada (1957 only), and Wyoming (1957 only).

West Virginia, Indiana, Arkansas, Kentucky, Kansas, and Colorado. These 12 States furnished 93 percent of the total production. The remainder was produced in 16 States. Of the 12 principal producing States, only California, Arkansas, Kansas, and Kentucky reported increases.

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 1957, was $3.20 compared with $2.86 in 1956, $3.13 in 1955, and $3 in 1954. The average value of all fire clay, including both sales and captive tonnage, was $4.75 in 1957 compared with $4.55 in 1956, $3.89 in 1955, and $3.79 in 1954. The following quotations on firebrick manufactured from fire clay were reported in December 1957 in E&MJ Metal and Mineral Markets: Missouri, Kentucky, and Pennsylvania, superquality, $128; high-heat quality, $114; Ohio firebrick, intermediate grade, $120; second grade, $103 per thousand.

Imports of fire clay are not shown separately in foreign-trade statistics. Exports of fire clay in 1957 decreased 10 percent in tonnage but increased 14 percent in value compared with 1956. Canada received 65 percent, Mexico 21 percent, and Japan 9 percent of the total exports. The remainder (5 percent) comprised small tonnages to many destinations in Central and South America, Europe, Asia, and Africa.

BENTONITE

The quantity of bentonite sold or used by producers in 1957 decreased 8 percent in quantity and 3 percent in value from the alltime highs established in 1956.

The foundry and petroleum industries consumed 78 percent of the total tonnage in 1957, compared with 83 percent in 1956 and 89 percent in 1955 and 1954. Rotary drilling mud consumed 38 percent in 1957 (40 percent in 1956 and 1955 and 43 percent in 1954); foundry-sand bond, 26 percent (26 percent in 1956, 28 percent in 1955, and 23 percent in 1954); and filtering and decolorizing oils and other filtering and clarifying, 14 percent (17 percent in 1956, 21 percent in 1955, and 23 percent in 1954). The remaining 22 percent of the national output was used for a wide variety of purposes. All major uses decreased in 1957 compared with 1956: Foundry-sand bond, 8 percent; filtering and decolorizing, 20 percent; rotary-drilling muds, 11 percent; and insecticides, less than 1 percent. Two minor uses—chemicals and absorbents—showed increases.

The three States producing the largest quantities, whose output in 1957 could be shown, and the percentage of total United States production they furnished were: Wyoming, 57 percent (54 percent in 1956, 56 percent in 1955, and 58 percent in 1954); Mississippi, 15 percent (14 percent in 1956, 15 percent in 1955 and 1954); and Texas, 9 percent (10 percent in 1956 and 1955 and 8 percent in 1954).

The price of Wyoming bentonite was given in the Oil, Paint and Drug Reporter for December 1957 as follows: 200-mesh, carlots, f. o. b. mines, $14 per short ton. The average value per short ton, as reported by the producers to the Bureau of Mines in 1957, was $12.28 compared with $11.72 in 1956.

TABLE 6.—Bentonite sold or used by producers in the United States, 1955–57, by States

State	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona	124,872	$674,309	(1)	(1)	(1)	(1)
California	3,942	66,192	3,618	$70,328	18,646	$302,512
Colorado	207	931			20	80
Idaho			120	1,200	185	3,700
Mississippi	226,852	2,558,399	219,216	2,360,031	220,313	2,372,249
Nevada	442	4,420	(1)	(1)	(1)	(1)
Texas	155,128	1,461,873	160,723	1,182,620	126,635	963,147
Utah	2,520	30,200	2,741	34,700	2,300	29,800
Washington			300	3,000	165	990
Wyoming	825,810	10,721,577	847,266	11,624,185	822,163	11,724,855
Other States [2]	140,432	1,701,114	336,626	3,138,743	261,018	2,433,312
Total	1,480,205	17,219,015	1,570,610	18,414,807	1,451,445	17,830,645

[1] Included with "Other States."
[2] Includes States indicated by footnote 1 and Louisiana, Montana, North Dakota, Oklahoma, and South Dakota.

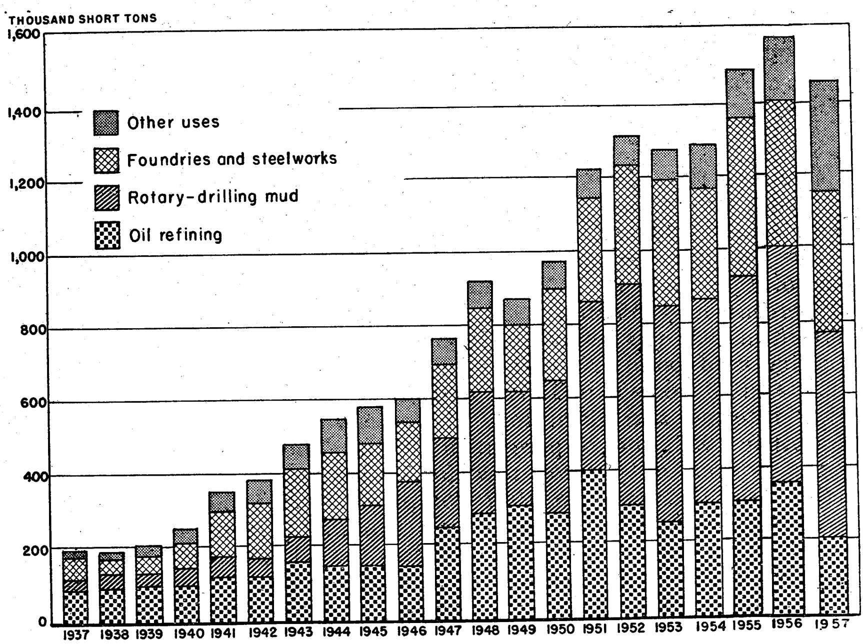

FIGURE 2.—Bentonite sold or used by domestic producers for specified uses, 1937–57.

FULLER'S EARTH

Fuller's earth sold or used by producers decreased 12 percent in tonnage and 9 percent in value in 1957 compared with 1956.

Absorbent uses required 42 percent of the national consumption in 1957 compared with 41 percent in 1956, 37 percent in 1955, and 31 percent in 1954; insecticides and fungicides, 18 percent compared with 27 percent in 1956, 25 percent in 1955, and 19 percent in 1954; rotary-drilling mud, 20 percent compared with 19 percent in 1956, 13 percent in 1955, and 11 percent in 1954; and mineral-oil refining, 12 percent compared with 11 percent in 1956 and 15 percent in 1955. Vegetable-oil refining required slightly more than 0.5 percent of the total consumption in 1957 compared with slightly less than 0.5 percent in 1956, 1 percent in 1955, and 5 percent in 1954. The remainder—about 7 percent of the total—was used in other filtering and clarifying, in exports, and for other unspecified uses.

TABLE 7.—Fuller's earth sold or used by producers in the United States, 1955–57, by States

State	Short tons	Value
1955		
California	14,462	$82,292
Georgia	103,883	2,226,296
Nevada	713	3,565
Tennessee	33,791	473,074
Utah	2,829	35,175
Other States [1]	214,041	4,799,917
Total	369,719	7,620,319
1956		
California	8,936	49,458
Florida	228,624	5,114,050
Georgia	108,632	2,386,122
Tennessee	48,000	658,500
Utah	2,855	36,962
Other States [1]	20,668	634,232
Total	417,715	8,879,324
1957		
California	7,971	44,220
Florida	223,222	5,432,367
Georgia	78,199	1,512,592
Tennessee	35,240	413,240
Utah	2,900	38,000
Other States [1]	18,569	616,422
Total	366,101	8,056,841

[1] Includes Florida (1955 only), Mississippi, Nevada (1956 only), and Texas.

In 1957 Florida furnished 61 percent, Georgia 21 percent, and Tennessee 10 percent of the United States total production. All States reported decreases in 1957 compared with 1956, except Utah, which reported a slight increase.

The average value, per short ton, of fuller's earth reported sold or used in the United States in 1957 was $22.01, compared with $21.26 in $1956, $20.61 in 1955, and $18.23 in 1954. The following quotations on fuller's earth were published in the Oil, Paint and Drug Reporter for December 1957: Insecticide grade, dried, powdered, in bags, carlots, Georgia or Florida mines, $17.50 per short ton; calcined, in bags, carlots, same basis, $20 to $21.75 per short ton; and Oil-Bleaching grade, 100-mesh, in bags, carlots, $16.30 to $17 per short ton; 200-mesh, in bags, carlots, same basis, $17.50 to $18 per short ton.

Effective January 1, 1955, fuller's earth import statistics were not classified separately but were included under "Other clay." Exports are not given separately in official foreign-trade statistics.

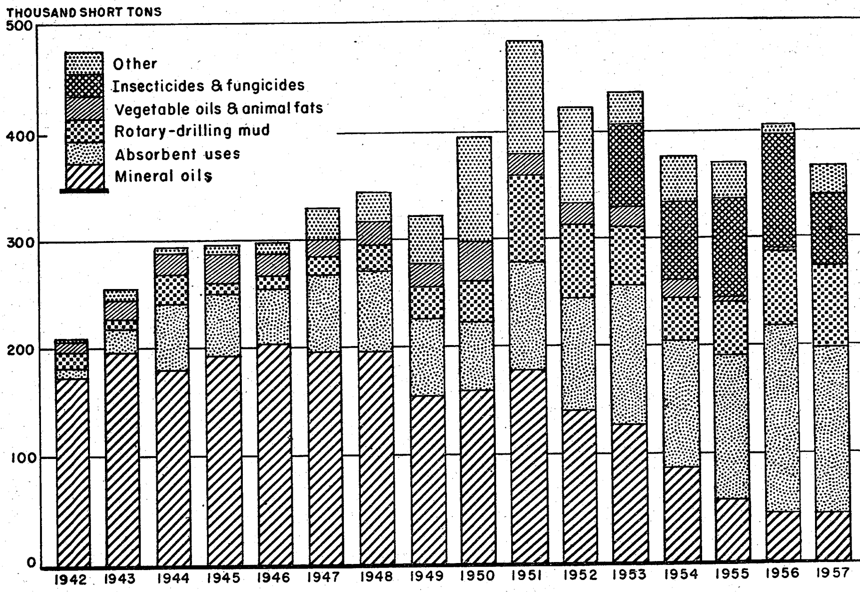

FIGURE 3.—Fuller's earth sold or used by producers for specified uses, 1942–57.

MISCELLANEOUS CLAY

This section presents statistics for the large-tonnage clays and shales—other than those discussed in the preceding pages—used in manufacturing heavy clay products, portland cement, and lightweight aggregate. With these are grouped small tonnages of slip clay, oil-well drilling mud, pottery clay, and clays that cannot clearly be identified with one of the types discussed separately in this chapter.

Miscellaneous clay sold or used by producers decreased 11 percent in tonnage and 9 percent in value in 1957 compared with 1956. Portland-cement production decreased 6 percent in 1957 from an all-time high in 1956, and clay used in cement production decreased 4 percent. Miscellaneous clay consumed in manufacturing heavy clay products decreased 15 percent. In 1957, 58 percent of the total miscellaneous clay was used in manufacturing heavy clay products, 29 percent in cement, and 12 percent in lightweight aggregate. Captive tonnage—clay produced by mine operators for their own use in manufacturing brick, tile, cement, and lightweight aggregate and marketed for the first time as such—was 99 percent of the miscellaneous clay sold or used in 1957. The quantity of miscellaneous clay used in producing lightweight aggregate for concrete mixtures decreased 8 percent in tonnage compared with 1956.

Ohio was the only State that reported tonnage exceeding 3 million short tons. In decreasing order, the following States reported tonnage exceeding 2 million short tons: Texas, North Carolina, and California. States reporting over 1 million and less than 2 million short tons were, in decreasing order of output: Pennsylvania, Michigan, Illinois, Alabama, Indiana, and New York. Of the States for which data are shown in table 8 for both 1956 and 1957, 10 reported increases and 36 decreases.

The average reported value of miscellaneous clay sold as crude or prepared clay in 1957 was $1.45, compared with $1.37 in 1956, $1.49 in 1955, $1.66 in 1954, and $1.91 in 1953. A decline in the construction industry and work stoppages in the cement industry were the basic reasons for the decreased consumption of miscellaneous clay.

Some special types of clay included under the miscellaneous-clay classification, however, sold at much higher prices. The value of the captive tonnage was computed from individual estimates that averaged about $1 per short ton.

TABLE 8.—Miscellaneous clays, including shale and slip clay sold or used by producers in the United States, 1956–57, by States

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956						
Alabama			1,290,830	$1,156,440	1,290,830	$1,156,440
Arizona			111,724	167,587	111,724	167,587
Arkansas			444,229	444,229	444,229	444,229
California	405,434	$831,136	1,926,844	2,950,302	2,332,278	3,781,438
Colorado	(3)	(3)	(3)	(3)	218,186	396,916
Connecticut	92,626	54,018	245,358	336,277	337,984	390,295
Georgia			1,275,128	509,980	1,275,128	509,980
Hawaii			1,590	1,988	1,590	1,988
Idaho			22,500	12,225	22,500	12,225
Illinois	16,062	108,439	1,800,832	3,027,374	1,816,894	3,135,813
Indiana	(3)	(3)	(3)	(3)	1,405,366	2,255,247
Iowa	555	11,127	851,465	1,066,515	852,020	1,077,642
Kansas	6	44	837,963	860,044	837,969	860,088
Kentucky	(3)	(3)	(3)	(3)	486,309	665,620
Louisiana			785,283	785,283	785,283	785,283
Maine			26,162	23,045	26,162	23,045
Maryland	(3)	(3)	(3)	(3)	567,116	636,776
Massachusetts			127,547	213,682	127,547	213,682
Michigan	(3)	(3)	(3)	(3)	2,110,030	2,401,051
Minnesota	53	53	79,647	91,176	79,700	91,229
Mississippi			299,614	299,614	299,614	299,614
Missouri	9,400	21,747	882,494	877,652	891,894	899,399
Montana			31,472	24,597	31,472	24,597
Nebraska			150,642	151,054	150,642	151,054
Nevada	2,625	3,281	8,745	10,931	11,370	14,212
New Hampshire			36,320	47,040	36,320	47,040
New Jersey			480,934	994,965	480,934	994,965
New Mexico	(3)	(3)	(3)	(3)	31,309	67,905
New York	1,430	19,294	1,233,430	1,488,455	1,234,860	1,507,749
North Carolina			2,641,387	1,539,842	2,641,387	1,539,842
North Dakota			52,282	70,555	52,282	70,555
Ohio	265,524	226,841	3,272,287	3,450,729	3,537,811	3,677,570
Oklahoma	47,552	40,919	657,219	657,219	704,771	698,138
Oregon	(3)	(3)	(3)	(3)	256,942	278,205
Pennsylvania	195,057	68,169	1,774,507	5,676,002	1,969,564	5,744,171
Puerto Rico			142,666	129,166	142,666	129,166
South Carolina			695,684	731,598	695,684	731,598
South Dakota	(3)	(3)	(3)	(3)	201,129	201,129
Tennessee			1,040,420	336,400	1,040,420	336,400
Texas	6,388	72,915	2,495,673	2,502,345	2,502,061	2,575,260
Utah	23,064	30,091	141,223	302,417	164,287	332,508
Virginia			1,000,019	1,032,665	1,000,019	1,032,665
Washington	50	150	232,964	257,755	233,014	257,905
West Virginia			341,485	277,266	341,485	277,266
Wisconsin	2,120	2,460	160,969	169,627	163,089	172,087
Wyoming			206,186	207,796	206,186	207,796
Undistributed [4]	419,276	553,873	5,091,696	6,589,610	234,585	240,634
Total	1,487,222	2,044,557	32,897,420	39,471,447	34,384,642	41,516,004

See footnotes at end of table.

TABLE 8.—Miscellaneous clays, including shale and slip clay sold or used by producers in the United States, 1956–57, by States—Continued

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1957						
Alabama	----	----	1,140,838	$1,020,253	1,140,838	$1,020,253
Arizona	----	----	117,797	176,696	117,797	176,696
Arkansas	----	----	226,068	226,068	226,068	226,068
California	379,018	$707,415	1,649,337	2,587,236	2,028,355	3,294,651
Colorado	43,907	77,437	129,906	235,540	173,813	312,977
Connecticut	(3)	(3)	(3)	(3)	308,236	408,669
Georgia	----	----	970,320	388,174	970,320	388,174
Hawaii	----	----	2,488	3,110	2,488	3,110
Idaho	----	----	23,000	12,600	23,000	12,600
Illinois	3,048	4,877	1,476,286	2,805,009	1,479,334	2,809,886
Indiana	170,606	277,695	906,687	1,543,291	1,077,293	1,820,986
Iowa	455	8,970	751,428	935,872	751,883	944,842
Kansas	----	----	677,475	689,253	677,475	689,253
Kentucky	----	----	461,729	614,144	461,729	614,144
Louisiana	----	----	641,939	641,939	641,939	641,939
Maine	----	----	29,924	27,636	29,924	27,636
Maryland	(3)	(3)	(3)	(3)	549,175	599,733
Massachusetts	----	----	77,577	97,577	77,577	97,577
Michigan	(3)	(3)	(3)	(3)	1,841,890	1,981,599
Minnesota	----	----	96,928	113,071	96,928	113,071
Mississippi	----	----	294,842	294,842	294,842	294,842
Missouri	5,394	13,204	910,529	907,674	915,923	920,878
Montana	----	----	31,710	23,860	31,710	23,860
Nebraska	----	----	131,213	132,763	131,213	132,763
Nevada	----	----	9,788	12,235	9,788	12,235
New Hampshire	----	----	37,300	50,500	37,300	50,500
New Jersey	----	----	426,197	696,268	426,197	696,268
New Mexico	3,011	24,088	25,060	41,912	28,071	66,000
New York	(3)	(3)	(3)	(3)	1,002,313	1,270,236
North Carolina	----	----	2,391,622	1,406,860	2,391,622	1,406,860
North Dakota	----	----	54,500	66,700	54,500	66,700
Ohio	189,707	220,753	3,204,333	3,571,779	3,394,040	3,792,532
Oklahoma	43,576	39,219	597,084	599,549	640,660	638,768
Oregon	(3)	(3)	(3)	(3)	239,595	265,556
Pennsylvania	147,156	39,802	1,799,575	5,361,607	1,946,731	5,401,409
Puerto Rico	----	----	158,813	139,813	158,813	139,813
South Carolina	----	----	583,166	571,113	583,166	571,113
South Dakota	(3)	(3)	(3)	(3)	175,680	175,680
Tennessee	----	----	859,201	268,136	859,201	268,136
Texas	3,128	57,148	2,408,441	2,856,203	2,411,569	2,913,351
Utah	(3)	(3)	(3)	(3)	125,491	295,986
Virginia	----	----	893,255	986,302	893,255	986,302
Washington	(3)	(3)	(3)	(3)	179,660	165,962
West Virginia	----	----	304,952	245,182	304,952	245,182
Wisconsin	1,000	1,050	130,007	134,804	131,007	135,854
Wyoming	----	----	246,859	248,164	246,859	248,164
Undistributed [4]	107,614	116,826	4,519,414	5,257,766	204,988	211,171
Total	1,097,620	1,588,484	29,397,588	35,991,501	30,495,208	37,579,985

[1] Purchases by portland-cement companies of common clay and shale: 1956—192,858 tons, estimated at $192,858; 1957—none.
[2] Includes the following: Common clay and shale used by portland-cement companies: 1956—9,067,390 tons, estimated at $9,301,741; 1957—8,858,232 tons, estimated at $8,721,154.
[3] Included with "Undistributed."
[4] Includes States indicated by footnote 3 and Delaware, Florida, and Vermont.

CONSUMPTION AND USES

Heavy clay products (building brick, structural tile, and sewer pipe) in 1957 comprised 49 percent of the total clay compared with 51 percent in 1956. Clays used in portland and other hydraulic cements in 1957 consumed 20 percent of the total clay output; refractories, 14 percent; lightweight aggregate, 8 percent; and rotary-drilling mud, paper filler, paper coating, and pottery, approximately 1 percent each. The remainder was consumed for a number of purposes. Exports were shown separately as a use.

TABLE 9.—Clay sold or used by producers in the United States in 1957, by kinds and uses, in short tons

	Kaolin	Ball clay	Fire clay and stoneware clay	Bentonite	Fuller's earth	Miscellaneous clay, including slip clay	Total
Pottery and stoneware:							
Whiteware, etc	88,305	231,410					319,715
Stoneware, including chemical stoneware	120	3,247	18,505				21,872
Art pottery, flower pots, and glaze slip	1,127	11,528	11,584	105		53,735	78,079
Total	89,552	246,185	30,089	105		53,735	419,666
Floor and wall tile	27,470	79,802	174,064			120,463	401,799
Refractories:							
Firebrick and block	247,375	30,185	4,213,761				4,491,321
Bauxite, high-alumina brick			74,279				74,279
Fire-clay mortar		238	135,774			1,441	137,453
Clay crucibles			1,786				1,786
Glass refractories	12,539	3,700	87,442				103,681
Zinc retorts and condensers			59,370				59,370
Foundries and steelworks	2,366		825,585	367,833		10,797	1,215,581
Saggers, pins, stilts, and wads	4,393	13,900	10,829				29,122
Other refractories	2,477	108	270,391	10		219	273,205
Total	269,150	48,131	5,679,217	376,843		12,457	6,385,798
Heavy clay products: Building brick, paving brick, drain tile, sewer pipe, and kindred products		18,378	4,618,059			17,589,031	22,225,468
Architectural terra cotta	35		41,033				41,068
Lightweight aggregates			292			3,752,455	3,752,747
Filler:							
Paper filling	528,478						528,478
Paper coating	658,335						658,335
Rubber	301,185					147	301,332
Linoleum and oilcloth	7,475		9,770			1,882	19,127
Paint	35,183		1,000			219	36,402
Fertilizers	12,777					3,778	16,555
Insecticides and fungicides	39,150		480	18,743	67,477	1,145	126,995
Plaster and plaster products	1,285						1,285
Plastics, organic	10,236	400				708	11,344
Other fillers	45,769	1,400	479	2,852	2,169	440	53,109
Total	1,639,873	1,800	11,729	21,595	69,646	8,319	1,752,962
Portland and other hydraulic cements	26,555		106,391	3,125		8,858,232	8,994,303
Miscellaneous:							
Enameling	1,468	1,714		54			3,236
Filtering and decolorizing (raw and activated earths):							
Mineral oils and greases				138,940	43,966		182,906
Vegetable or animal oils and fats				62,832	2,270		65,102
Other filtering and clarifying				6,865	4,932		11,797
Rotary-drilling mud			760	556,889	75,017	26,512	659,178
Chemicals	9,065		111,070	8,488			128,623
Absorbent uses				14,120	153,398		167,518
Artificial abrasives			5			1,459	1,464
Exports	19,489	3,376	23,010	74,212	10,814		130,901
Other uses	101,028	8,900	9,380	187,377	6,058	72,545	385,288
Total	131,050	13,990	144,225	1,049,777	296,455	100,516	1,736,013
Grand total:							
1957	2,183,685	408,286	10,805,099	1,451,445	366,101	30,495,208	45,709,824
1956	2,249,920	458,806	11,803,093	1,570,610	417,715	34,384,642	50,884,786

The total tonnage of clays consumed in 1957 decreased 10 percent, but consumption in several branches of the clay industry increased. Some of these increases were as follows: Other refractories, 52 percent; glass refractories, 45 percent; other fillers, 44 percent; enameling, 39 percent; floor and wall tile, 31 percent; fertilizers, 18 percent; paint, 17 percent; and rubber, 12 percent. Decreases were reported for insecticides, 28 percent; pottery, 27 percent; heavy clay products, 15 percent; refractories (except glass and other), 9 percent; and cements, 3 percent.

REFRACTORIES

The value of clay-refractories shipments was approximately the same in 1957 as in 1956. The value of fire-clay brick shipments (except superduty) represented 34 percent of the total value in 1957 compared with 35 percent in 1956; ladle brick, 11 percent, the same as in 1956; superduty fire-clay brick, 11 percent, compared with 9 percent in 1956; and insulating firebrick, 7 percent, the same as in 1956. A number of classifications composed the remaining 37 percent in 1957, compared with 38 percent in 1956, as shown in table 10.

TABLE 10.—Shipments of refractories in the United States, by kinds, 1956–57

[Bureau of the Census]

Product	Unit of quantity	Shipments			
		1956		1957	
		Quantity	Value (thousand dollars)	Quantity	Value (thousand dollars)
Clay refractories:					
Fire-clay brick, standard and special shapes, except superduty.	1,000 9-in. equivalent.	521,604	73,439	469,941	71,764
Superduty fire-clay brick and shapes	do	82,924	18,631	91,221	22,648
High-alumina brick and shapes (50 percent Al_2O_3 and over) made substantially of calcined diaspore or bauxite.[1]	do	23,593	8,631	23,101	9,460
Insulating firebrick and shapes	do	62,490	13,698	57,498	13,583
Ladle brick	do	244,409	21,928	223,094	22,235
Hot-top refractories	do	38,263	6,234	31,762	5,355
Sleeves, nozzles, runner brick and tuyéres	do	59,470	11,105	51,848	11,321
Glasshouse pots, tank blocks, feeder parts and upper structure shapes used only for glass tanks.[1]	Short ton	21,770	4,443	17,837	3,962
Refractory bonding mortars, air-setting (wet and dry) types.[2]	do	[3] 97,071	[3] 8,916	88,543	7,968
Refractory bonding mortars, except air-setting types.[2]	do	[3] 9,755	[3] 975	11,401	1,124
Plastic refractories and ramming mixes [1]	do	[3] 147,585	[3] 10,524	125,827	9,106
Castable refractories (hydraulic setting)	do	98,051	9,089	105,032	10,319
Insulating castable refractories (hydraulic setting).	do	14,966	1,716	16,427	1,852
Ground crude fire clay, high-alumina clay, and silica fireclay.[4]	do	621,504	7,593	658,336	6,717
Clay-kiln furniture, radiant-heater elements, potters' supplies, and other miscellaneous refractory items.			6,963		5,808
Other clay refractory materials sold in lump or ground form.[5]	Short ton		4,723	296,294	5,040
Total clay refractories			208,608		208,262
Nonclay refractories:					
Silica brick and shapes	1,000 9-in. equivalent.	[3] 316,653	[3] 58,979	304,210	62,002
Magnesite and magnesite-chrome (magnesite predominating) brick and shapes (excluding molten cast).	do	49,653	32,742	42,487	31,237
Chrome and chrome-magnesite (chrome ore predominating) brick and shapes (excluding molten cast).	do	61,651	36,725	63,286	42,250

See footnotes at end of table.

TABLE 10.—Shipments of refractories in the United States, by kinds, 1956–57—Continued

Product	Unit of quantity	Shipments 1956 Quantity	Shipments 1956 Value (thousand dollars)	Shipments 1957 Quantity	Shipments 1957 Value (thousand dollars)
Nonclay refractories—Continued					
Graphite and other crucibles, retorts, stopper heads, and other shaped refractories.	Short ton	13,677	8,658	14,094	8,363
Carbon refractories; brick, blocks, and shapes, excluding those containing natural graphite.	do				
Mullite brick and shapes made predominantly of kyanite, sillimanite, andalusite, or synthetic mullite (excluding molten cast).	1,000 9-in. equivalent.	5,687	6,719	4,350	5,043
Extrahigh-alumina brick and shapes made predominantly of fused bauxite, fused or dense-sintered alumina (excluding molten cast).	do	3,186	5,349	2,538	4,227
Silicon carbide brick and shapes made substantially of silicon carbide.	do	4,220	10,152	4,606	9,196
Zircon and zirconia brick and shapes made predominantly of these materials.	do	630	1,631	537	1,738
Forsterite, pyrophyllite, molten-cast, and other nonclay brick and shapes.			[3] 8,794		11,824
Nonclay refractory bonding mortars, air-setting (wet and dry) types.	Short ton	[3] 80,204	8,255	94,160	9,543
Nonclay refractory bonding mortars, except air-setting types.	do	20,148	1,882	17,273	1,528
Nonclay plastic refractories and ramming mixes (wet and dry) types.	do	186,206	17,913	213,857	21,913
Nonclay refractory castables (hydraulic setting)	do	[3] 4,488	[3] 535	6,799	798
Dead-burned magnesia or magnesite [4]	do	([6])	([6])	[6] 214,150	[6] 10,914
Dead-burned dolomite [4]	do			1,367,557	22,424
Other nonclay refractory materials sold in lump or ground form.[4]	do		11,768	156,226	10,060
Total nonclay refractories [6]			[3] 210,102		253,060
Grand total refractories [6]			[3] 418,710		461,322

[1] Does not include mullite or extra-high-alumina refractories. These products are included with mullite and extra-high-alumina brick and shapes in the nonclay refractories section.
[2] Includes bonding mortars which contain up to 60 percent Al_2O_3, dry basis. Bonding mortars that contain more than 60 percent Al_2O_3, dry basis, are included in the nonclay refractories section.
[3] Revised figure.
[4] Represents only shipments by manufacturers who also produce and ship other types of refractories.
[5] Includes calcined clay, ground brick, and siliceous and other gunning mixes.
[6] Figures for 1956 exclude data for dead-burned magnesia and magnesite. The total quantity and value of shipments of dead-burned magnesia and magnesite including quantities shipped to refractory producers for incorporation into refractory products such as magnesite brick and shapes reported to the Bureau of the Census was 796,007 tons value at $24,613,000 in 1956. Data for 1957 exclude shipments of dead-burned magnesia and magnesite to refractory producers for the manufacture of brick and other refractories.

Production of refractories almost doubled between 1947 and 1957. The steel industry was by far the largest single user of refractories; the second largest was the ceramic industry. Consumption of refractories for ceramics was distributed as follows: Glass, 49 percent; whiteware, 22 percent; structural clay products, refractories, and other ceramics, 8 percent each; and enamel, 5 percent.[3]

In 1957 Harbison-Walker Refractories Co. continued its program of expansion and modernization begun in 1951, estimated to cost $78 million ultimately. New basic refractories plants were completed at Ludington, Mich., and Hammond, Ind., bringing the total to 36 plants—33 widely distributed in the United States and 1 each in Canada, Peru, and Mexico. Approaching completion as the year closed

[3] Brick and Clay Record, Near-Doubling of Refractories Industry Brings Need for More Public Attention: Vol. 132, No. 1, January 1958, pp. 59–65, 73.

were a large research center near Pittsburgh, Pa., and a new research laboratory at Marelan, Quebec. The former research laboratory at Hays, Pa., was being converted into headquarters for the company work on quality control for raw materials and products in process.[4] In 1957 Harbison-Walker Refractories Co. acquired the Freeman Fire Brick Co., Canon City, Colo.

A $500,000 improvement and modernization program was initiated by Hiram Swank's Sons, the largest producer of pouring-pit refractories in the United States. The company operated plants at Large, Clymer, Irvona, and Johnstown, all in Pennsylvania. One project was to expand production by 30 percent (about 12,000 tons) at its Large, Pa., plant.

North American Refractories Co. completed a new research center at Curwensville, Pa., and a new plant at Farber, Mo., to produce high-fired superduty brick. The Farber plant contained modern grinding, screening, and forming equipment and a new low-set kiln. Since 1952 North American Refractories Co. had modernized its clay and silica brick plants in Pennsylvania. Two gas-fired tunnel kilns were constructed at the Curwensville fire clay brick plant. At the Lumber City stiff-mud fire-clay brick plant the periodic kilns were converted from coal-burning to gas-burning. Both silica brick plants were converted from wet-grinding to up-to-date dry grinding equipment.[5]

Norton Co. broke ground for a new $1 million refractories plant at Worcester, Mass., scheduled to begin operating in 1958.

H. K. Porter Co., Inc., Laclede-Christie Division, acquired the Mullite Refractories Co., Shelton, Conn.

Expansion at the Bessemer, Ala., fire-clay-refractories plant of H. K. Porter Co., Inc., to be completed in 1958, was announced. A $1 million rehabilitation program, including a tunnel kiln and automatic production controls, was planned.

New facilities and techniques in manufacturing special refractories were introduced at both the Taylor, Ky., and Cincinnati, Ohio, plants of The Chas. Taylor Sons Co., a subsidiary of National Lead Co.

Gladding, McBean & Co. planned a new $1.3 million plant at Mica, Wash., to produce quality refractories. Production will include super-, high-, intermediate-, and low-duty refractories.

Mexico Refractories Co. installed a rotary kiln at its Mexico, Mo., plant to calcine semiflint, hard flint, and high-alumina clays. The kiln had a capacity of 250 tons and required only 2 men per 8-hour shift. The installation permitted closer quality and tolerance control and a wider range of finished products.[6]

HEAVY CLAY PRODUCTS

The Clay City Pipe Co. of Uhrichsville, Ohio, designed and built a plant to replace one destroyed by fire in 1956. Engineering features and modern facilities in this plant reflect improvements made in vitrified clay pipe manufacture in the past 2 decades.[7]

[4] Harbison-Walker Refractories Co., letter to the Bureau of Mines: May 12, 1958.
[5] North American Refractories Co., letter to the Bureau of Mines: June 9, 1958.
[6] Weigel, R. C., Calcining Clays for Better Product Control: Ceram. Age, vol. 69, No. 5, May 1957, pp. 14-16.
[7] Ceramic Age, Plant Design for Efficient Clay-Pipe Production: Vol. 70, No. 6, December 1957, pp. 12-14.

New and better ideas, equipment, and facilities at both the Minerva, Ohio, and Darlington, Pa., plants of Metropolitan Brick Co. resulted in improved clay-products production. Emphasis was on automatic glazing, efficient clay preparation, and forming and sizing.[8]

The trend toward increased plant modernization and improved manufacturing methods in the structural clay products industry continued through 1957.[9]

Buildex, Inc., Pittsburg, Kans., increased its production capacity for lightweight aggregate to 300,000 cubic yards annually by the purchase of Lite Stone Aggregate Corp., New Lexington, Ohio.

The J. L. Stiles & Son Brick Co., North Haven, Conn., utilized the overburden from its clay deposit to produce lightweight aggregate by the sintering method. The capacity of the lightweight aggregate plant was 200 cubic yards per 10-hour day.

WORLD REVIEW

Austria.—The production of kaolin totaled 300,230 short tons in 1956 compared with 289,154 short tons in 1955. The output of bentonite and fuller's earth totaled 4,941 short tons in 1956.[10]

Canada.—The increased output of clay products in Canada in 1956 from domestic and imported clays (shown in table 11) was attributed mainly to greater demand for ceramic products used in structural clay products.[11]

As in a number of prior years, Canadian production of bentonite was confined to Manitoba and Alberta in 1956.[12] Most of the consumption was imported from the United States. Imports in 1956 were valued at $1,484,124, compared with $1,247,355 in 1955.

In Manitoba, bentonite was mined near Morden by Pembina Mountain Clays, Ltd., from shallow beds, with little overburden. The material was dried, crushed, and stored at Morden and later hauled by rail to the Winnipeg plant for grinding and activation. The company marketed both a natural ground bentonite that had good decolorizing properties and an activated bentonite that compared favorably with the best imported.

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[8] Ceramic Age, Modern Production Methods: Vol. 70, No. 2, August 1957, pp. 12–16; Effective Handling of Granular Materials, No. 3, September 1957, pp. 14–17.

[9] Brick and Clay Record, vol. 130, No. 1, January 1957, pp. 42, 50, 53, 92–93, 96–97; No. 2, February 1957, pp. 41, 43, 52–55, 75; No. 3, March 1957, pp. 40–41, 61–63; No. 4, April 1957, pp. 56, 60; No. 5, May 1957, pp. 34, 39, 41, 48–49 and 114, 52–53 and 111, 113; No. 6, June 1957, pp. 37, 39, 42–43, 52–61, 63–68, 71–73 and 110–111, 74–75 and 110–111, 82–85, 89–92, 99; Vol. 131, No. 1, July 1957, pp. 36, 70–71; No. 2, August 1957, pp. 36–37, 63; No. 3, September 1957, pp. 45–46, 55, 64–73, 76–78, 88–89; No. 4, October 1957, pp. 40–41, 69–71; No. 5, November 1957, pp. 42–45, 48–50; No. 6, December 1957, pp. 33, 44–46 and 58.

Ceramic Industry, vol. 68, No. 1, January 1957, p. 58; No. 2, February 1957, pp. 51–52; No. 3, March 1957, pp. 43–44, 78–80 and 94; No. 4, April 1957, pp. 65–66, 69, 82–89; No. 5, May 1957, p. 44; No. 6, June 1957, pp. 72, 86–87, 111–113, 115 and 143, 116–117, 131–133 and 135; Vol. 69, No. 1, July 1957, pp. 49–50; No. 2, August 1957, pp. 43–44, 46; No. 3, September 1957, pp. 59–60, 62; No. 4, October 1957, pp. 63–64, 78, 102–103; No. 5, November 1957, pp. 52, 88–89; No. 6, December 1957, pp. 58–60, 62.

Ceramic Age, vol. 69, No. 1, January 1957, pp. 16–19 and 32–34, 20–21 and 29, 34, 22–27, 30–31; No. 2, February 1957, pp. 14–17, 26, 31; No. 3, March 1957, pp. 28–31, 32–33; No. 4, April 1957, pp. 20–24 and 40, 26–29, 32–33 and 35, 43–45; No. 5, May 1957, pp. 20–23, 24–25; No. 6, June 1957, pp. 12–15 and 29–30, 20–22, 31; Vol. 70, No. 1, July 1957, pp. 14–20, 22–27; No. 3, September 1957, pp. 18–19, 28–31; No. 4, October 1957, pp. 26–28; No. 5, November 1957, pp. 19, 26–29, 43; No. 6, December 1957, pp. 17–21, 25–27.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, p. 22.

[11] Matthews, S., Clays and Clay Products in Canada, 1956 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 5 pp.

[12] Buchanan, R. M., Bentonite in Canada, 1956 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 5 pp.

TABLE 11.—Clays production, products, and trade in Canada, 1955–56

	1955	1956
Production from domestic clays:		
Clays including bentonite	$521,919	$530,000
Clay products, from—		
Common clays	28,913,159	31,388,844
Stoneware clays	4,731,121	4,930,093
Fire clays	820,817	913,175
Other products	272,754	300,000
Total	35,259,770	38,062,112
Production from imported clays, from—		
Stoneware clay	884,997	
Fire clay	2,783,536	
China clay	14,725,857	
Total	18,394,390	[1] 20,500,000
Grand total	53,654,160	58,562,112
Imports:		
Clays:		
Fire clay	421,205	542,167
China clay	1,902,470	2,002,154
All other, including activated, filtering, and bleaching clays	1,726,341	2,081,060
Total	4,050,016	4,625,381
Clay products, from—		
United States	23,040,013	28,801,890
United Kingdom	13,878,775	15,263,875
Other countries	2,893,679	3,693,882
Total	39,812,467	47,759,647
Exports:		
Clays, to—		
United States	93,681	146,736
Other countries	1,004	2,025
Total	94,685	148,761
Clay products, to—		
United States	1,748,227	2,304,911
Germany, West	95,607	221,178
Union of South Africa	72,244	148,939
Belgium	96,990	145,391
Brazil	75,255	67,949
New Zealand	71,958	46,778
Other countries	493,414	405,786
Total	2,653,695	3,340,932

[1] Estimate.

Source: Matthews, S., Clays and Clay Products in Canada, 1956 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, p. 2.

TABLE 12.—Consumption of bentonite in Canada, by uses, in short tons, 1954–55

Uses	1954	1955	Uses	1954	1955
Steel foundries	3,434	4,786			
Cement products	78	[1] 100	Vegetable oil mills	357	302
Miscellaneous nonmetallic mineral products	1,074	958	Polishes and dressings	4	4
Soaps and cleaning compounds	586	622	Miscellaneous chemicals	116	1,103
Pulp and paper	204	346	Iron castings	612	196
Petroleum refining	5,538	[1] 6,000	Gypsum products	66	[1] 50
Oil-well drilling	11,775	12,216	Total	23,844	[1] 26,683

[1] Estimated.

Sources: Buchanan, R. M., Bentonite in Canada, 1956 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, p. 4.

In Alberta, swelling (alkali) bentonite was produced in several localities in the Drumheller area, north of Calgary. The material, in raw lump form, was purchased by Alberta Mud Co., Ltd., which prepared it for market in western Canada. It was sold for use as a component of weed killers, as an aid in diamond drilling, for sealing irrigation ditches, and as a foundry-sand bond.

The price of Alberta bentonite ground to 90 percent minus-200-mesh was quoted at $40 per short ton f. o. b. Calgary in 1956. The price has remained unchanged for several years.

Lightweight aggregate produced from expanded clay and shale increased 20 percent in tonnage and value in 1956 compared with 1955.

Nine plants were listed as producing lightweight aggregate from clay or shale, all by the rotary-kiln process. Expanded clay and shale aggregate sold for $4.50 to $6.50 per cubic yard.

A list of ceramic plants in Canada in 1957 was compiled.[13] The names of the operators, plant locations, key personnel, raw materials used and source, process of manufacture, number and type of kilns, fuel used, products, and plant capacities were given.

Germany, West.—The output of marketable kaolin was 69,312 short tons in 1956.[14]

A clay deposit was developed in the Klardorf basin in eastern Bavaria (West Germany) containing clayey sands, fine gray clays with up to 41 percent Al_2O_3, and black-gray clays with up to 42 percent Al_2O_3. It was stated that all these clays could be used in ceramic products such as chemical stoneware, floor and wall tile, and refractories maturing at cone 34–35.[15]

The refractories industry in West Germany was discussed.[16] The Didier-Werke, A. G., the leading producer of refractories in Europe, founded in 1834, had 16 plants employing more than 7,000 people at the start of World War II, with an annual output of about 500,000 short tons of refractories. At the end of World War II it had lost control of 10 plants and the raw-material sources that accompanied them, resulting in a production loss of more than 300,000 short tons per year. New construction and purchase of other refractories companies since 1946 has increased the number of operating plants to 10 with an estimated production of 500,000 short tons. The general office of this company was in West Berlin.

The review stated that in 1956 there were 105 manufacturers of refractories in West Germany, with 127 plants. Ninety-seven of these refractory manufacturers, operating 119 plants, were members of the Forschungsinstitut—The German Refractories Institute—in Bonn. Approximately 23,000 people were employed in 1956 by the refractories industry in West Germany. The approximate value of all refractories produced in 1956 was US$105 million. The average wage in the refractories plants in West Germany was about US$2.50 per 8-hour day.

West German common practice was to produce a wide variety of dissimilar refractories, such as fire clay, high-alumina sillimanite,

[13] Buck, W. K., Ceramic Plants in Canada, January 1958: Mineral Resources Division, Dept. of Mines and Tech. Surveys, Ottawa, Canada, 35 pp.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 27.
[15] Schüttig R., [Clays of the Klardorf Basin]: Euro-Ceram., vol. 7, No. 3, 1957, pp. 58–59; Ceram. Abs., vol. 40, No. 9, Sept. 1, 1957, p. 213.
[16] Knauft, R. W., Impressions of the Refractories Industry in Western Europe: Refractories Institute (Presented at the 1957 Spring Membership Meeting), June 28, 1957, 7 pp.

and basic in the same works, using separate facilities for grinding, screening, and batching.

West Germany was reported to have an ample supply of fire clay and other plastic clays but no high-quality flint clay similar to that found in the United States. Consequently, the fire-clay and high-alumina refractories contain a high percentage of calcined clay. Magnesite ore does not occur in West Germany but is imported, mostly from Austria and Yugoslavia.

Hong Kong.—Production of kaolin totaled 6,120 short tons in 1956. The market value of the 1956 output was estimated at US-$54,600.[17]

India.—A high-voltage insulator plant was established at Bangalore early in 1957 by the Mysore State Government at a cost of over US$1 million. The only raw material not available locally was said to be ball clay.[18]

A comprehensive report on the Indian refractories industry in 1957 was given,[19] containing statistical data through 1956. The report included data on the history of the industry, producers, capacity, production, raw materials used, and estimated reserves, outlook, and Government policy.

Israel.—A flint clay high in alumina and low in iron was reported at Wadi Ramon.[20]

Peru.—Production of clays totaled 242,712 short tons in 1956, compared with 233,425 short tons in 1955, 200,633 short tons in 1954, and 185,724 short tons in 1953.

Kaolin output totaled 116 short tons in 1956, 105 short tons in 1955, 206 short tons in 1954, and 158 short tons in 1953.

The production of refractory clay totaled 935 tons in 1956.[21]

TECHNOLOGY

In 1957 the Expanded Shale, Clay, and Slate Institute began comparative studies on diagonal tension in concrete beams made with lightweight and normal-weight aggregates.

Lightweight Concrete Information Sheets 5 and 6 on design coeficients were published during 1957. The second edition of the Bridge Deck Survey also was published, listing more than 70 bridges in which expanded shale concrete was used.[22]

Lower in-the-wall cost of unit clay masonry construction remained the ultimate objective of the work of the Structural Clay Products Research Foundation in 1957. Interest in site-construction and material-handling techniques continued, and greater emphasis was placed on new product design, particularly in relation to preassembly of units into panels. The development of lightweight structural units also was an important project. These studies required added research on raw materials.[23] The Structural Clay Products Research Foundation developed a clay-masonry veneer to be attached to ex-

[17] Bureau of Mines, Mineral Trade Notes; Vol. 45, No. 3, September 1957, p. 27.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 27.
[19] Bureau of Mines, Mineral Trade Notes, Special Supplement 52, Refractories Industry in India: Vol. 46, No. 4, April 1958, 21 pp.
[20] Metal Bulletin (London), No. 4213, July 23, 1957, p. 30.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 24.
[22] Expanded Shale, Clay, and Slate Institute, letter to the Bureau of Mines: Apr. 2, 1958.
[23] Structural Clay Products Research Foundation, letter to the Bureau of Mines: Mar. 7, 1958.

terior or interior walls by a special metal clip nailed to the existing wood wall. The unit is a ¾-inch-thick slab of hard-burned, Norman-size brick. An L-shaped corner unit allows cornering with the same appearance as a conventional brick wall.

National Clay Pipe Manufacturers, Inc., continued its research to develop longer lengths, greater strength, and new methods of joining vitrified clay pipe. A research laboratory under construction at Crystal Lake, Ill., was expected to be completed early in 1958.

New factory-prefabricated joints of thermoplastic resins, being made in greater quantities by a larger number of manufacturers, were successful, not only in reducing the jointing time but also in developing excellent resistance to all types of alkalies, acids, bacteria, and fungi present in sanitary sewage.[24]

A series of Paleozoic shales, ranging in age from Ordovician through Pennsylvanian, from widely separated localities in Illinois, was investigated by X-ray diffraction and differential thermal, chemical, and microscopic methods, to determine their clay mineral composition and textural characteristics.[25]

A report on Illinois pottery-clay resources was published as a guide in prospecting for new clay deposits. The report described types of clays by their locations and contained simple field tests to determine the commercial potential of clays for pottery making.[26] A rotational viscosimeter to measure plastic viscosity, yield point, and gel strength of ceramic suspensions, a portable low-pressure filter press and equipment for the concurrent analysis of troublesome soluble salts, and a compact device capable of determining porosity and permeability of fired bodies at the rate of six samples per hour were described.[27] The following tests give useful data for drier and kiln design: Differential thermal analysis, to gain an idea of what to expect from empirical tests; a rate of drying test that yields data on rate of water loss and shrinkage per percent of water; a test for rate of carbon removal at either 1,200° or 1,400° F.; and the temperature gradient method of determining the firing range.[28]

An inexpensive, simple technique for the particle-size analysis of clays was evolved and checked on 75 representative whiteware clays.[29] Tests on a panel simulating a blast-furnace wall indicated that the presence of moisture had no detrimental effect on the degree of spalling, if the wall were heated at a reasonable rate. It was stated that standard tests are needed for predicting spalling behavior during initial heating and for determining maximum heating rate for various sizes of blast-furnace brick.[30] The type of organic matter and relative amount of pyrite in an illitic Texas shale were determined by a new, controlled-atmosphere, differential thermal analysis technique. Based on these data, oxidation tests were run to determine time required

[24] National Clay Pipe Manufacturers, Inc., letter to the Bureau of Mines: Mar. 24, 1958.

[25] Grim, R. E., Bradley, W. F., and White, A. W., Petrology of the Paleozoic Shales of Illinois: Illinois State Geol. Survey Rept. of Investigations 203, 1957, 35 pp.

[26] Jonas, E. C., Pottery Clay Resources of Illinois: Illinois State Geol. Survey Circ. 233, 1957, 8 pp.

[27] Weintritt, D. J., and Ferricone, A. C., New Testing Equipment for Quality Control: Bull. Am. Ceram. Soc., vol. 36, No. 11, November 1957, pp. 401–405.

[28] Stone, R. L., Determinative Tests of Aid in the Design of Driers and Kilns: Bull. Am. Ceram. Soc., vol. 36, No. 1, January 1957, pp. 1–5.

[29] Phelps, G. W., and Maguire, S. G., Jr., Practical Particle-Size Analysis of Clays: I, Sample Preparation: Jour. Am. Ceram. Soc., vol. 40, No. 12, December 1957, pp. 399–402.
Maguire, S. G., Jr., and Phelps, G. W., Practical Particle-Size Analysis of Clays: II, A Simplified Procedure: Jour. Am. Ceram. Soc., vol. 40, No. 12, December 1957, pp. 403–409.

[30] Baab, K. A., Spalling Tests on Blast-Furnace Brick: Bull. Am. Ceram. Soc., vol. 36, No. 1, January 1957, pp. 14–17.

for oxidation at 1,400° to 1,600° F. The effects of wirecut versus smooth-face textures on the rate of oxidation were illustrated.[31] The "drying-ball test," used as a standard control procedure to check the drying characteristics of new clays, proposed new body mixes, and production mixes by a vitrified clay sewer pipe manufacturer, was described.[32]

A plan for quality control in structural clay plants was given.[33] Automatic body-preparation systems at a Pennsylvania floor-tile plant were described. Moisture content of the body mix, distribution of the selected color stain or stains, and degree of mixing are controlled automatically. In addition, pelletizing units provide uniform particle size for dry pressing. Better process control and greater production efficiency resulted.[34]

Differential thermal and X-ray analyses of 11 kaolin-type clays indicated that silicon monoxide (SiO) is formed after the collapse of the clay lattice below 1,000° C. The crystallinity of the SiO is poor until heated to its melting point at about 1,390° C. and cooled, after which the crystals are perfectly formed, although extremely small and intimately mixed with the mullite crystals. Heating above 1,390° C. causes SiO to undergo volatilization and oxidation to amorphous silica or cristobalite below a temperature of 1,650° C. This hypothesis is substantiated by high-temperature X-ray analyses, measurements of gravimetric loss after heating, and specific-gravity measurements.[35] The behavior of minute particles of kaolinite and halloysite under dehydroxylation was studied.[36]

The application of engineering principles to mining, mixing, and refining of ball clays assured uniform quality long-range reserves adaptable to many different ceramic processes at minimum cost.[37]

The mineralogy, properties, uses, and methods of mining fuller's earth at Nutfield near Redhill, Surrey, England, were discussed.[38] The mine is one of the largest fuller's earth mines in United Kingdom.

Twenty-four brands of fire-clay plastic refractories, 12 each of high-duty and super-duty types, were investigated for water content, particle-size distribution, workability index, bulk density, wet strength, pyrometric cone equivalent, and ignition loss. The resistance to thermal shock was determined by the standard panel method. The shrinkage, the modulus of rupture, and Young's modulus of elasticity were determined at several different temperatures. The results of the tests indicated that 10 of the 12 high-duty and 9 of the 12 super-duty plastic refractories were of high enough quality for their respective classes to enable the Federal Government to readily fill its requirements from reliable sources.[39]

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[31] Stone, R. L., Laboratory Tests on the Oxidation Characteristics of a Texas Shale: Bull. Am. Ceram. Soc., vol. 36, No. 5, May 1957, pp. 172–173.
[32] Brick and Clay Record, vol. 131, No. 5, November 1957, pp. 72–73.
[33] Greene, C. F., Quality Control in a Brick Plant: Bull. Am. Ceram. Soc., vol. 36, No. 6, June 1957, pp. 210–211.
[34] Ceramic Age, Controlled Body Preparation: Vol. 70, No. 5, November 1957, pp. 16–18
[35] West, R. R., High-Temperature Reactions in Kaolin-Type Clays: Bull. Am. Ceram. Soc., vol. 36, No. 2, February 1957, pp. 55–58.
[36] Brindley, G. W., and Nakahira, M., Kinetics of Dehydroxylation of Kaolinite and Halloysite: Jour. Am. Ceram. Soc., vol. 40, No. 10, October 1957, pp. 346–350.
[37] Roberts, J. W., Mining and Refining Ball Clays: Ceram. Age, vol. 70, No. 4, October 1957, pp. 16–19.
[38] Mine and Quarry Engineering (London), Quarrying Fuller's Earth: Vol. 23, No. 8, August 1957, pp. 326–333.
[39] Heindl, R. A., and Pendergast, W. L., Results of Laboratory Tests of High-Duty and Super-Duty Fire-Clay Plastic Refractories: Bull. Am. Ceram. Soc., vol. 36, No. 1, January 1957, pp. 6–13.

Young's modulus of elasticity, transverse strength, extensibility, and load resistance were determined at a series of test temperatures on six groups of laboratory prepared refractory castables which had (a) no heat treatment, (b) heat treatment at 1,050° C., and (c) heat treatment at 1,300° C. The data suggested that the alterations in composition that occur with a rise in temperature were related to corresponding changes in modulus of elasticity and strength. The effects of dehydration, conversion of amorphous alumina to gamma alumina, and silica inversions were evident. The cement content and temperature of operation, as well as the heat treatment of the castables, affected all these mechanical properties.[40]

Demands for longer life, higher operating temperatures, and some unique physical and chemical properties now required to meet specific conditions have caused a definite increase in the application and production of special refractories.[41]

The formation and removal of black cores in structural clay products were studied. Analytical procedures indicated that carbonaceous matter caused black cores, but their properties depended on the state of oxidation of the iron.[42]

Vanadium efflorescence in brick made from buff-firing clays was inhibited by adding fluorspar to the body mix. This procedure is more effective when the clays are of low refractory character, that is, where a considerable proportion of the clay minerals present is illitic. For clays in which the clay minerals are predominantly kaolinitic and the quartz content is high, larger quantities of fluorspar and higher temperatures are required.[43]

An investigation revealed that efflorescing salts can originate in concrete backup block and be deposited on the face of a brick wall. The degree of efflorescence was greater in the case of backup material with the greatest soluble-salts content.[44]

The workability, firing behavior, and properties of a high-lime shale deposit were determined. The effect of small additions of wollastonite, flint, and talc upon the fired properties also was determined. Suggested uses for this material were as a building block, interior wall decoration, and brick veneer.[45]

The effects of additions of urea, monobasic ammonium phosphate, dibasic ammonium phosphate, sodium ammonium phosphate, ammonium nitrate, and ammonium chloride on some physical properties of an unfired and a fired illitic shale of high carbonate content were studied.[46]

Seventeen relatively cheap and potentially promising fluxing materials were studied as additives to typical structural clay bodies.

[40] Schneider, S. J., and Mong, L. E., Elasticity, Strength, and Other Related Properties of Some Refractory Castables: Bull. Am. Ceram. Soc., vol. 41, No. 1, January 1958, pp. 27–32.
[41] Easter, G. D., Special Refractories, Properties, and Production: Ceram. Age, vol. 69, No. 3, March 1957, pp. 19–23, 35.
[42] Brownell, W. E., Black Coring in Structural Clay Products: Jour. Am. Ceram. Soc., vol. 40, No. 6, June 1, 1957, pp. 179–187.
[43] Machin, J. S., Allen, A. W., and Deadmore, D. A., Controlling Vanadium Efflorescence: Ceram. Age, vol. 69, No. 4, April 1957, pp. 30–31.
[44] Young, J. E., Backup Materials as a Source of Efflorescence: Jour. Am. Ceram. Soc., vol. 40, No. 7, July 1, 1957, pp. 240–243.
[45] Coffin, L. B., Survey of Uses for a High-Lime Shale: Bull. Am. Ceram. Soc., vol. 36, No. 11, November 1957, pp. 419–421.
[46] Bauleke, M. P., and Dodd, C. M., Effect of Ammonium Salts on an Illitic Shale: Jour. Am. Ceram. Soc., vol. 40, No. 10, October 1957, pp. 325–334.

Several were found that produced significant increases in strength and reductions in porosity. Data concerning the most promising were presented in considerable detail.[47]

The uses of lignin as a deflocculant for slip casting and as an additive for extrusion bodies were investigated. The effect of lignin as an extra additive, when mixed with other additives, upon such properties as warpage, rate of air drying, and unfired dry strength was studied.[48]

Extrusion die problems and their solution in a glazed wall-unit plant were reviewed. A suggested die-control program included engineered die designs, specifications covering satisfactory die materials, precision workmanship, and control of external forces which affect die balance.[49]

An engobe coloring process—a relatively new concept in coloring brick—was explained. It provides a low-cost coloring method and can be applied to virtually any brick body and any brick surface, including red face brick.[50] A report on the several ways to add color to heavy clay products and the problems involved were discussed.[51]

The utilization of Ohio shales, fire clays, and miscellaneous clay to produce expanded lightweight aggregate was discussed.[52] Inherent process variables and specific raw material problems for the downdraft moving grate process for lightweight aggregate production were described. A solution to control raw material preparation and a firing technique were given.[53]

Operation of the plant of Cinder Concrete Products, Inc., Denver, Colo., was discussed. The sintering process is controlled by a push-button arrangement centered on a single electric panel board. The company produces 450 cubic yards per day of sintered lightweight clay aggregate.[54]

Operation of the plant of Lehigh Materials Co., Tamaqua, Pa., was described. The plant produces lightweight aggregate from shale—a byproduct from the mining of anthracite. Outstanding plant features are: Presizing of raw shale to eliminate pelletizing; grate-traveling stokers (sintering machines) of company design; and high-pressure steam installed above the stokers to use waste heat from the stokers and furnish steam for the turbine that make power used in the plant.[55]

Changes in the sintering process at the Livonia plant of the Lightweight Aggregate Corp. were discussed.[56]

Some patents issued during 1957 covered the uses of bentonite: In an improved lubricant for use in the mechanical operations involved

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47 Everhart, J. O., Use of Auxiliary Fluxes to Improve Structural Clay Bodies: Bull. Am. Ceram. Soc., vol. 36, No. 7, July 1957, pp. 268–271.

48 Burgess, D. G., The Use of Lignin in Ceramic Processes: Bull. Am. Ceram. Soc., vol. 36, No. 5, May 1957, pp. 168–171.

49 Alt, L. R., Extrusion Die Problems: Bull. Am. Ceram. Soc., vol. 36, No. 4, April 1957, pp. 137–138.

50 Carnahan, Tom, Engobes: Ceram. Age, vol. 70, No. 4, October 1957, pp. 23–24, 34.

51 Carnahan, T. D., Color, How You Can Use It—and What the Problems Are: Brick and Clay Record, vol. 131, No. 5, November 1957, pp. 52–53, 74–76, 79; No. 6, December 1957, pp. 54–55, 61, 63.

52 Everhart, J. O., Johnson, J. E., and Ehlers, E. G., Evaluating Clay Deposits: Ceram. Age, vol. 70, No. 1, July 1957, pp. 34–36.

53 Pfeiffenberger, L. E., Problems of Manufacturing Lightweight Aggregate by the Moving-Grate Process: Bull. Am. Ceram. Soc., col. 36, No. 7, July 1957, pp. 272–275.

54 Brick and Clay Record, vol. 130, No. 6, June 1957, pp. 74–75, 110.

55 Brick and Clay Record, vol. 130, No. 3, March 1957, pp. 57–59.

56 Ceramic Age, vol. 69, No. 4, April 1957, pp. 36–38.

in making yarn and threads,[57] as a binder for pelletizing iron ores,[58] as a constitutent in foundry mold compositions,[59] in a product used for sound absorption and heat insulation,[60] to decolorize dextrose liquors from starch,[61] to make products by interaction of polymeric organic materials with inorganic solids,[62] and as a dispersing agent in bituminous emulsion compositions.[63] An acid-activated clay or heat-treated montmorillonite was used to modify the combustion of certain binders used in processing tobacco.[64]

A process and portable apparatus for use in kaolin mines to form a low-water slip so it can be transmitted by pipeline was perfected,[65] and a method for speeding up removal of water from paper clays (kaolin) using conventional dewatering equipment was developed.[66] A method for making impermeable paper or paperboard was developed using kaolin or ball clay as the emulsifying agent.[67]

Other patents issued during 1957 were on sulfonation of petroleum oil with fuller's earth and oleum (fuming sulfuric acid),[68] a method and apparatus for converting contaminated fuller's earth from oil refineries to an artificial fertilizer product,[69] the use of acid-activated clay to separate nickel-kieselguhr or similar hydrogenation catalyst from hydrogenated polybutadiene,[70] a protective coating for salt-bath brazing, comprising graphite, a binder, bentonite, and kaolin,[71] a composition using kaolin, ball clay, or calcined alumina, to produce a permanent, porous ceramic mold,[72] methods of manufacturing basic refractory brick and constructing a metallurgical furnace roof to reduce spalling,[73] and a method of drying large clay castings, such as glass-furnace tank blocks.[74]

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57 Barnard, W. S., and Scarbrough, A. L. (assigned to National Lead Co.), Textile Lubricant and Process: U. S. Patent 2,805,993, Sept. 10, 1957.

58 Apuli, W. E. (assigned to the Regents of the University of Minnesota), Pelletizing Process: U. S. Patent 2,805,141, Sept. 3, 1957.

Haley, K. M., and Trask, H. V. (assigned to Oglebay, Norton & Co.), Metalliferous Agglomerates Having Improved Green Strength and Method of Forming Same: U. S. Patent 2,807,534, Sept. 24, 1957.

59 Sauter, N. A., and Horton, M. H. (assigned to Deere & Co.), Waterless Green Molding Sand: U. S. Patent 2,813,035, Nov. 12, 1957.

Wickett, J. A. (assigned to Monsanto Chemical Co.), Foundry-Sand Compositions and Process of Making: U. S. Patent 2,817,128, Dec. 24, 1957.

60 Kulmann, W. (assigned to Industrial Research Laboratores, Inc.), Sound Absorbing and Correcting Material and Method of Making Same: U. S. Patent 2,796,946, June 25, 1957.

61 Gottfried, J. B., Luby, W. K., and Newkirk, W. B. (assigned to Corn Products Refining Co.), Process for Interrupted Hydrolyzing of Starch: U. S. Patent 2,797,176, June 25, 1957.

62 Ruehrwein, R. A. (assigned to Monsanto Chemical Co.), Chemical Product: U. S. Patent 2,795,567, June 11, 1957.

63 Brown, E. C., Driesen, W. H., and Guepet, J. S. (assigned to The Patent & Licensing Corp.), Continuous Process for Producing Bituminous Emulsions: U. S. Patent 2,782,169, Feb. 19, 1957.

64 Frankenburg, W. G. (assigned to General Cigar Co., Inc.), Tobacco Products and Process Therefor: U. S. Patent 2,797,689, July 2, 1957.

65 Williamson, J. T. (assigned to Thiele Kaolin Co.), Process and Apparatus for Forming Clay Slip: U. S. Patent 2,789,772, Apr. 23, 1957.

66 Thiele, W. F. (assigned to Thiele Kaolin Co.), Method for Dewatering Clay: U. S. Patent 2,815,292, Dec. 3, 1957.

67 Cubberley, R. H., and Dell, M. D. (assigned to The Patent & Licensing Corp.), Process for Producing a Water-Vapor-Impermeable Board: U. S. Patent 2,803,171, Aug. 20, 1957.

68 Mitchell, E., and Humphrey, E. L. (assigned to Gulf Research & Development Co.), Production of Surface-Active Agents for Sulfonation of Petroleum Oil: U. S. Patent 2,807,589, Sept. 24, 1957.

69 Poldervaart, J., Kuyvenhoven, W. A., van den Dool, T. C., and Hart, A., Process for the Preparation of Artificial Fertilizer: U. S. Patent 2,805,138, Sept. 3, 1957.

70 Hanson, G. E. (assigned to Phillips Petroleum Co.), Hydrogenation Catalyst Removal With Montmorillonite Clay: U. S. Patent 2,816,097, Dec. 19, 1957.

71 Francisco, A. C., and Gyorgak, C. A. (assigned to Secretary of the Navy), Protective Coating for Salt-Bath Brazing: U. S. Patent 2,812,275, Nov. 5, 1957.

72 Thiess, L. E. (assigned to General Electric Co.), Porous Ceramic Mold and Method of Making Same: U. S. Patent 2,809,898, Oct. 15, 1957.

73 Heuer, R. P., and Fay, M. A. (assigned to General Refractories Co.), Refractory Brick Having Spacer Plates: U. S. Patent 2,791,116, May 7, 1957.

Heuer, R. P. (assigned to General Refractories Co.), Refractory Roof: U. S. Patent 2,799,233, July 16, 1957.

74 Armstrong, L. R., Henry, E. C., Lambie, J. M., and Young, R. A. (assigned to Findlay Clay Products Co., Washington, Pa.), Method of Drying Slip-Cast Materials and the Like: U. S. Patent 2,789,338, Apr. 23, 1957.

Cobalt

By Hubert W. Davis [1] and Charlotte R. Buck [2]

CONSUMPTION of cobalt decreased slightly in 1957, but active interest continued in producing improved high-temperature alloys employing cobalt, in developing processes for recovering cobalt and nickel from ores, and in separating the two metals. Cobalt continued to be used principally in high-temperature and permanent-magnet alloys.

Consumption in the United States declined to 9.2 million pounds in 1957; 77 percent was used as metal. Consumption was the sixth highest of record, but it was 4 percent less than in 1956 and 5 percent below the average for the 5 years 1952–56. Consumption declined chiefly because less cobalt was used in high-temperature alloys and alloy hard-facing rods. This decrease was offset partly by record consumption of cobalt in permanent-magnet alloys.

Output of cobalt products at refining and processing plants in the United States was 5.9 million pounds (contained cobalt), a 10-percent decrease from 1956. Cobalt metal represented 75 percent of the total production but was 12 percent less than in 1956. Domestic concentrates and white alloy from Belgian Congo provided the raw materials for metal production. Calera Mining Co., Garfield, Utah, refined 12 percent less cobalt metal than in 1956.

World production of cobalt decreased 3 percent, reversing a 7-year uptrend. However, the 1957 output exceeded requirements. Seventeen percent more metal was delivered to the National Stockpile and to consumers in the United States than in 1956.

Of the world output, Belgian Congo produced 11 percent less than in 1956 and supplied 58 percent of the total in 1957. Domestic mines produced the equivalent of 36 percent of the cobalt consumed in the United States, compared with 27 percent in 1956.

Despite the smaller consumption of cobalt in the United States in 1957, imports (mainly metal, white alloy, and oxide) increased 12 percent chiefly because of the receipt of 1,732,500 and 530,000 pounds

TABLE 1.—Salient statistics for cobalt, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Domestic mine production of concentrate........pounds..	856,866	1,258,924	1,996,488	2,608,660	3,595,028	4,137,297
Recoverable cobalt..do....	566,840	878,439	1,438,500	1,852,289	2,538,997	3,298,379
Imports for consumption do....	10,148,600	17,237,000	16,865,000	18,732,000	15,577,000	17,451,000
Consumption..........do....	7,751,209	10,748,499	7,350,223	9,740,522	9,562,260	9,156,617
Price per pound of metal [1]....	$1.65–$2.40	$2.40–$2.60	$2.60	$2.60	$2.60–$2.35	$2.35–$2.00
World: Production..short tons..	8,200	12,500	14,500	14,800	16,000	15,500

[1] F. o. b. Niagara Falls or New York, N. Y.

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

of metal from the United Kingdom and Federation of Rhodesia and Nyasaland, respectively, in exchange for surplus agricultural commodities. Belgian Congo and Belgium furnished 62 percent of the total imports of metal; Belgian Congo, the entire supply of white alloy; and Belgium, virtually all of the oxide.

The price of cobalt metal and oxide was lowered 35 cents a pound on February 1, 1957, following the 25-cent reduction of December 1, 1956.

DOMESTIC PRODUCTION

Mine Production.—Although domestic mines furnished a larger proportion than in any other year, foreign sources continued to supply by far the greater part of United States cobalt requirements. A record of 4.1 million pounds of cobalt (equivalent to 3.3 million pounds of recoverable cobalt) was produced from domestic mines in 1957, compared with 3.6 million pounds (equivalent to 2.5 million pounds of recoverable cobalt) in 1956. In 1957 domestic mines produced the equivalent of 36 percent of the cobalt consumed in the United States, compared with 27 percent in 1956.

In the United States in 1957 production and shipments of cobalt ore or concentrate (cobalt content) were 15 and 13 percent, respectively, greater than in 1956.

Calera Mining Co., a wholly owned subsidiary of Howe Sound Co., was again the chief producer of cobalt concentrate in the United States. Its mine and concentrator are at Cobalt, Lemhi County, Idaho. The ore mined contained about 0.7 percent cobalt, about twice as much copper, and minor values in nickel and gold. During the year, 2,681,000 pounds of cobalt in concentrate was produced, a 14-percent increase over 1956. The company refined the concentrate, containing about 15 percent cobalt, to metal at its refinery in Garfield, Utah. It explored for cobalt at its Blackbird property in Idaho, partly under a Defense Minerals Exploration Administration contract, and made a certified discovery of cobalt-nickel.

Bethlehem Cornwall Corp. produced 10 percent more cobalt than in 1956 from its magnetite iron ore at Cornwall, Pa. Magnetite was recovered by wet magnetic separation, and cobalt-bearing pyrite concentrate was produced by differential flotation of the nonmagnetic tailing. The concentrate was roasted to remove sulfur. The residue (averaging 1.51 percent cobalt in 1957) was shipped to the Pyrites Co., Wilmington, Del., where it was processed to cobalt metal and other cobalt products.

Near Fredericktown, Mo., the St. Louis Smelting & Refining Division of National Lead Co. produced and treated pyrite concentrate containing 4.10 percent cobalt, 5.36 percent nickel, and 5.05 percent copper. Also near Fredericktown its refinery produced 41 percent more cobalt metal than in 1956, but did not reach capacity production.

Bunker Hill Zinc Plant, Kellogg, Idaho, recovered cobalt at its electrolytic zinc plant but, as in previous years, made no shipments. In 1957 it recovered 121 short tons of residues, containing 6,700 pounds of cobalt.

TABLE 2.—Cobalt ore or concentrate produced and shipped in the United States, 1948–52 (average) and 1953–57

Year	Produced			Shipped from mines		
	Gross weight (short tons)	Cobalt content (pounds)	Recoverable content (pounds)	Gross weight (short tons)	Cobalt content (pounds)	Recoverable content (pounds)
1948–52 (average)	24, 725	856, 866	566, 840	24, 425	701, 301	456, 886
1953	22, 524	1, 258, 924	878, 439	24, 026	1, 775, 489	1, 271, 583
1954	19, 036	1, 996, 488	1, 438, 500	19, 738	2, 219, 396	1, 608, 980
1955	28, 398	2, 608, 660	1, 852, 289	25, 101	2, 438, 546	1, 741, 494
1956	35, 985	3, 595, 028	2, 538, 997	36, 956	3, 657, 491	2, 586, 462
1957	39, 417	4, 137, 297	3, 298, 379	39, 744	4, 123, 017	3, 281, 300

Refinery Production.—In 1957, the United States ranked second to Belgian Congo in output of cobalt products and third as a world producer of cobalt ore. Domestic production of metal declined 12 percent from the alltime high in 1956. White alloy from Belgian Congo, concentrates from Idaho, Missouri, and Pennsylvania, and domestic scrap yielded the metal. Production of metal decreased 30 percent because of the shutdown of African Metals Corp. refinery at Niagara Falls, N. Y., in October. The plant refined white alloy from Belgian Congo. Calera Mining Co., Garfield, Utah, produced 2,156,000 pounds of metal, a 12-percent decrease from 1956.

TABLE 3.—Cobalt products produced and shipped in the United States, 1951–55 (average) and 1956–57, in pounds

Product	Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content
1951–55 (average)				
Metal	2, 693, 731	2, 631, 509	2, 658, 163	2, 596, 988
Oxide	606, 602	435, 956	604, 478	434, 466
Crude oxide	18, 225	1, 336	18, 225	1, 336
Hydrate	283, 224	131, 180	283, 526	130, 964
Salts:				
Acetate	110, 160	25, 758	108, 765	25, 405
Carbonate	202, 058	96, 036	189, 694	89, 266
Sulfate	647, 364	137, 884	653, 144	138, 498
Other	211, 921	47, 256	201, 903	45, 084
Driers	8, 477, 407	517, 879	8, 397, 150	510, 434
1956				
Metal	5, 122, 571	4, 964, 453	4, 618, 519	4, 466, 383
Oxide	625, 908	448, 350	572, 596	410, 004
Hydrate	422, 288	221, 928	367, 798	191, 887
Salts:				
Acetate	57, 327	13, 354	59, 802	13, 936
Carbonate	298, 642	145, 826	327, 587	160, 633
Sulfate	568, 459	121, 735	515, 599	112, 518
Other	246, 936	54, 231	242, 091	53, 239
Driers	9, 645, 405	549, 581	9, 502, 188	542, 305
1957				
Metal	4, 514, 885	4, 376, 974	4, 409, 727	4, 281, 175
Oxide	594, 690	425, 121	544, 486	387, 844
Hydrate	323, 424	171, 656	310, 408	169, 782
Salts:				
Acetate	64, 068	14, 936	75, 016	17, 480
Carbonate	214, 340	100, 920	239, 524	114, 350
Sulfate	445, 552	99, 751	496, 399	110, 173
Other	253, 270	54, 199	259, 193	57, 205
Driers	10, 581, 898	616, 695	10, 767, 643	623, 677

Five percent less cobalt oxide than in 1956 was produced from white alloy from Belgian Congo, concentrate from Pennsylvania, and metal from New York. Output of hydrate, 23 percent less than in 1956, was prepared from scrap, metal, and concentrate. Production of salts was 19 percent smaller, but output of driers was 12 percent larger; both were derived from purchased hydrate, sulfate, scrap, and metal.

Refiners used 9 percent less cobalt contained in white alloy and concentrate, compared with 1956.

TABLE 4.—Cobalt consumed by refiners or processors in the United States, 1948–52 (average) and 1953–57, in pounds of contained cobalt

Cobalt material [1]	1948–52 (average)	1953	1954	1955	1956	1957
Alloy and concentrate	2,741,811	4,059,287	3,950,826	4,879,608	6,398,709	5,793,359
Metal	674,821	801,192	592,257	884,196	884,032	876,983
Hydrate	104,442	74,504	56,717	79,339	90,740	81,727
Carbonate	5,670	108	100	305	581	
Purchased scrap	33,491	109,204	172,757	114,181	95,942	92,639
Other		8,540	57,284	63,123	61,370	92,901

[1] Total consumption is not shown because the metal, hydrate, and carbonate originated from alloy and concentrate; combining alloy and concentrate with these materials would result in duplication.

TABLE 5.—Refiners or processors of cobalt in the United States in 1957

Refiner or processor	Location of plant	Cobalt product [1] made	Cobalt raw material [1] used
African Metals Corp	Niagara Falls, N. Y.[2]	A, B, D	F
Allied Chemical & Dye Corp., General Chemical Div.	Marcus Hook, Pa	B, D	A
Baker Chemical Co., J. T	Phillipsburg, N. J	B, D	A
Carlisle Chemical Works, Inc	Reading, Ohio	E	A
Carlisle Chemical Works, Inc., Advance Solvents & Chemical Div.	Jersey City, N. J	E	A, D
Calera Mining Co	Garfield, Utah	A	F
Ceramic Color & Chemical Manufacturing Co.	New Brighton, Pa	C, D	A
Chase Chemical Corp	Pittsburgh, Pa	E	C
Ferro Chemical Corp	Bedford, Ohio	C, D, E	A, C
Hall Chemical Co	Wickliffe, Ohio	B, C, D	A, G
Hanson-Van Winkle-Munning Co	Matawan, N. J	D	A
Harshaw Chemical Co	Cleveland, Ohio; Gloucester, N. J	C, D, E	A
Mallinckrodt Chemical Works	St. Louis, Mo	D	A, D
McGean Chemical Co	Cleveland, Ohio	C, D, E	A
Metallurgical Resources, Inc	Newburgh, N. Y.[3]	B	F
Mooney Chemicals, Inc	Cleveland, Ohio	E	A
National Lead Co	Fredericktown, Mo	A	F
Nuodex Products Co., Inc	Elizabeth, N. J	E	A, C
	Long Beach, Calif	E	--
Pyrites Company, The	Wilmington, Del	A, B, C	F
Shepherd Chemical Co	Cincinnati, Ohio	D, E	A, C, D, G
Sherwin-Williams Co	Chicago, Ill	E	A, C
Standard Oil Co. of California	Richmond, Calif	E	A
Stresen-Reuter, Inc., Frederick A	Bensenville, Ill	C, D, E	A, C
Troy Chemical Co	Newark, N. J	E	A
Vitro Rare Metals Co	Cannonsburg, Pa	B, C	G
Whitmoyer Laboratories, Inc	Myerstown, Pa	D	A, C
Witco Chemical Co	Chicago, Ill	C, E	A

[1] Code: A, metal; B, oxide; C, hydrate; D, salts; E, driers; F, concentrate or white alloy; G, scrap.
[2] Discontinued operation in October 1957.
[3] Scheduled to begin commercial operation in 1958.

CONSUMPTION

Industry consumed 4 percent less cobalt than in 1956, the sixth largest quantity on record. For the seventh consecutive year, cobalt-chromium-tungsten-molybdenum cutting, wear-resisting, high-temperature alloys, the largest single use of cobalt, required 33 percent of the total cobalt consumed in 1957—8 percent less than in 1956.

As in 1951–56, magnet-alloys production ranked second in consumption of cobalt, established a new record, required 32 percent of the total, and used 5 percent more than in 1956.

Less cobalt was used for high-speed and low-cobalt alloy steels, alloy hard-facing rods, cemented carbides, ground-coat frit for porcelain enamels, and pigments.

Consumption of cobalt metal, oxide, and purchased scrap was smaller by 4, 12, and 8 percent, respectively, compared with 1956. Cobalt salts and driers were used at a rate about 2 percent more than in 1956.

TABLE 6.—Cobalt consumed in the United States, 1948–52 (average) and 1953–57, by uses, in pounds of contained cobalt

Use	1948–52 (average)	1953	1954	1955	1956	1957
Metallic:						
High-speed steel	269,476	217,652	168,893	208,720	258,924	236,687
Other steel	148,794	162,185	112,323	151,030	122,520	109,330
Permanent-magnet alloys	} 1,851,222	2,336,889	2,123,576	2,818,239	2,787,109	2,926,564
Soft-magnetic alloys		11,559	721	204	821	----------
Cobalt-chromium-tungsten-molybdenum alloys:						
Cutting and wear-resisting materials	} 3,193,804	204,939	182,641	194,253	269,978	264,159
High-temperature, high-strength materials		5,116,750	2,571,089	3,220,939	3,018,930	2,755,331
Alloy hard-facing rods and materials	308,057	591,909	432,342	535,488	625,122	501,043
Cemented carbides	249,855	359,125	166,708	307,366	253,176	248,957
Other metallic	169,862	233,428	113,522	291,191	364,185	236,438
Total metallic	6,191,070	9,234,436	5,871,815	7,727,430	7,700,765	7,278,509
Nonmetallic (exclusive of salts and driers):						
Ground-coat frit	495,861	374,158	403,953	567,645	525,190	474,202
Pigments	163,821	102,612	145,769	235,866	231,961	204,839
Other nonmetallic	59,657	84,293	75,686	115,581	115,344	188,067
Total nonmetallic	719,339	561,063	625,408	919,092	872,495	867,108
Salts and driers: Lacquers, varnishes, paints, inks, pigments, enamels, glazes, feed, electroplating, etc. (estimate)	840,800	953,000	853,000	1,094,000	989,000	1,011,000
Grand total	7,751,209	10,748,499	7,350,223	9,740,522	9,562,260	9,156,617

TABLE 7.—Cobalt consumed in the United States, 1948–52 (average) and 1953–57, by forms in which used, in pounds of contained cobalt

Form	1948–52 (average)	1953	1954	1955	1956	1957
Metal	5,716,642	7,727,210	5,119,853	7,226,383	7,321,477	7,027,738
Oxide	703,896	524,401	587,799	906,265	856,952	755,075
Cobalt-nickel compound	3,790	----------	----------	----------	----------	----------
Ore and alloy	1,322	2,451	301	68	----------	----------
Purchased scrap	484,759	1,541,437	789,270	513,806	394,831	362,804
Salts and driers	840,800	953,000	853,000	1,094,000	989,000	1,011,000
Total	7,751,209	10,748,499	7,350,223	9,740,522	9,562,260	9,156,617

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PRICES

Effective February 1, 1957, the price of metal rondelles (97–99 percent, in containers of 500 or 550 pounds) and metal granules (in containers of 2,152 pounds) was lowered to $2 a pound f. o. b. Niagara Falls or New York, N. Y. Ceramic-grade oxide (72½–73½ percent, in 500-pound containers) was reduced to $1.43 a pound east of the Mississippi River. The former prices of $2.35 a pound for metal and $1.78 a pound for oxide had been in effect since December 1, 1956.

FOREIGN TRADE[3]

Imports.—The United States imported 17.5 million pounds (cobalt content) of cobalt, an increase of 12 percent over 1956 and the second highest on record. In 1957 Belgian Congo, the chief source, supplied 53 percent of total imports; Belgium, 11 percent. However, both the metal and the oxide imported were produced from Belgian Congo white alloy. Imports of metal were 25 percent greater than in 1956,

TABLE 8.—Cobalt imported for consumption in the United States, 1948–52 (average) and 1953–57, by classes

[Bureau of the Census]

Year	White alloy[1] (pounds)		Ore and concentrate[2]		
			Pounds		Value
	Gross weight	Cobalt content	Gross weight	Cobalt content	
1948–52 (average)	4,549,239	2,075,050	[3] 1,838,724	[3] 191,802	[3] $145,729
1953	5,249,781	2,412,804	445,063	51,323	88,470
1954	5,464,511	2,360,360	27,130	3,349	5,914
1955	5,645,894	2,464,336	2,233	223	289
1956	4,707,634	2,013,463	76,729	5,839	2,920
1957	1,882,948	816,501	140,482	15,179	19,961

Year	Metal		Oxide		Sulfate and other compounds	
	Pounds	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value
1948–52 (average)	[4] 7,539,194	[4] $14,314,702	[4] 575,744	[4] $689,557	4,510	$5,407
1953	[4] 14,431,894	[4] 33,203,094	610,054	979,541	273,286	172,986
1954	14,227,868	35,391,209	430,400	723,368	353,094	211,240
1955	15,535,040	38,585,251	1,072,950	1,791,939	361,600	249,409
1956	12,974,393	32,909,699	828,450	1,412,911	397,711	246,704
1957	[4, 5] 16,240,327	[4, 5] 32,558,717	646,750	852,828	364,381	179,035

[1] Reported by importer to Bureau of Mines. Figures for 1948 as reported by the Bureau of the Census cover only partial imports of "White alloy," which were classed as "Ore and concentrates." Figures for "Ore and concentrate" for 1949–57 as reported by the Bureau of the Census have been adjusted by Bureau of Mines to exclude "White alloy" from Belgian Congo.

[2] Figures represent imports from Canada, Morocco, and Mexico, and therefore exclude receipts of "White alloy" from Belgian Congo.

[3] Excludes 7,054,000 pounds of ore containing 742,000 pounds of cobalt, valued at $551,500, imported from Canada in 1948 (see footnote 2, table 9) and 146 pounds of zaffer, valued at $215 in 1951.

[4] Adjusted by Bureau of Mines.

[5] Includes 4,903 pounds of scrap, valued at $1,698.

[3] Figures on U. S. imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

but those of white alloy and oxide were smaller by 59 and 23 percent, respectively. Imports from Belgian Congo and Belgium were smaller by 18 and 3 percent, respectively, but those from Canada, West Germany, and Norway were larger by 75, 72, and 87 percent, respectively. Noteworthy was the receipt of 1,732,500 and 530,000 pounds, respectively, of metal from the United Kingdom and Federation of Rhodesia and Nyasaland; this metal together with 346,000 pounds of metal from Belgium was acquired in exchange for surplus agricultural commodities.

TABLE 9.—Cobalt white alloy, ore, metal, and oxide imported for consumption in the United States, 1956–57, by countries, in pounds

[Bureau of the Census]

Country	White alloy, ore and concentrates				Metal		Oxide (gross weight)	
	1956		1957					
	Gross weight	Cobalt content	Gross weight	Cobalt content	1956	1957	1956	1957
North America:								
Canada	76,729	5,839	140,482	15,179	1,276,763	2,230,672		
Total	76,729	5,839	140,482	15,179	1,276,763	2,230,672		
Europe:								
Belgium					1,360,639	[1] 1,440,980	828,450	646,550
Denmark						[2] 4,903		
France					9,367	41,170		
Germany, West					498,044	[1] 918,700		
Norway					407,255	761,775		200
United Kingdom						1,732,540		
Total					2,275,305	4,900,068	828,450	646,750
Africa:								
Belgian Congo	[3] 4,707,634	[3] 2,013,463	1,882,948	816,501	9,422,325	8,579,587		
Rhodesia and Nyasaland, Federation of						530,000		
Total	4,707,634	2,013,463	1,882,948	816,501	9,422,325	9,109,587		
Grand total	4,784,363	2,019,302	2,023,430	831,680	12,974,393	16,240,327	828,450	646,750

[1] Adjusted by Bureau of Mines.
[2] Scrap.
[3] Reported by importer to Bureau of Mines.

During the 35 years 1923–57 the United States imported 189 million pounds of cobalt—72 percent in the 10 years 1948–57. Metal comprised 69 percent of the cobalt imports during the 35 years, supplied mostly by Belgium and Belgian Congo. Smaller quantities of metal were received from Austria, Canada, Federation of Rhodesia and Nyasaland, Finland, France, Germany, Japan, Norway, Sweden, and United Kingdom. Imports of alloy represented the second largest quantity (24 percent); virtually all came from Belgian Congo. About 6 percent of the imports of cobalt was in the form of oxide, chiefly from Belgium. Substantial quantities of oxide have also been received from Canada and Germany, and smaller quantities chiefly from Australia, Finland, and France. Cobalt ore, virtually all from Canada and Australia, has been about 1 percent of total imports. Substantial quantities of ore were imported from French Morocco in 1943 and 1944 and Canada in 1948; however, these ores were not treated in the United States, and subsequently the French Morocco ore was exported to Belgium in 1952 and 1953 and the Canadian ore returned to Canada in 1952 for refining to metal. As the quantities are included in the imports of metal, the figures for ore have been excluded from the tabulation of imports to avoid duplication. Cobalt sulfate and other compounds have been only 0.3 percent of the total imports.

TABLE 10.—Cobalt imported for consumption in the United States, 1948–52 (average) and 1953–57, in pounds [1]

Year	Gross weight					Total	
	White alloy	Ore and concentrate	Metal	Oxide	Sulfate and other compounds	Gross weight	Cobalt content (estimated)
1948–52 (average)	4,549,239	[2] 1,838,724	7,539,194	575,744	4,510	[2] 14,507,411	[2] 10,148,600
1953	5,249,781	445,063	14,431,894	610,054	273,286	21,010,078	17,237,000
1954	5,464,511	27,130	14,227,868	430,400	353,094	20,503,003	16,865,000
1955	5,645,894	2,233	15,535,040	1,072,950	361,600	22,617,717	18,732,000
1956	4,707,634	76,729	12,974,393	828,450	397,711	18,984,917	15,577,000
1957	1,882,948	140,482	[3] 16,240,327	646,750	364,381	19,274,888	17,451,000

[1] Figures, by years, for 1923–52 in chapter on Cobalt, Minerals Yearbook, 1953, vol. 1, p. 359.
[2] Excludes 7,054,000 pounds of ore containing 742,000 pounds of cobalt imported from Canada in 1948. This ore was reexported to Canada in 1952 for refining. The metal produced from the ore is included in the import figures for 1952–54.
[3] Includes 4,903 pounds of scrap.

Exports.—Exports of cobalt from the United States usually have been small, but from 1953 to 1957 large quantities of cobalt-bearing scrap were shipped abroad. In 1957, 1,443,170 pounds of ore, concentrate, metal and alloys in crude form, cobalt-bearing scrap metal (5 percent or more cobalt), and semifabricated forms valued at $1,919,429 was exported. The bulk of the exports was cobalt-bearing scrap. Some oxide, salts, and driers were also exported, but the figures were not separately recorded by the Bureau of the Census.

Tariff.—Since June 7, 1951, the duty on cobalt sulfate has been 2½ cents a pound and on linoleate 5 cents a pound. On September 10, 1955, the duty on salts and compounds not specifically provided for was lowered to 15 percent ad valorem. On July 1, 1957, the duty on cobalt oxide was reduced to 4½ cents a pound. Cobalt metal and ore entered the United States duty-free.

WORLD REVIEW

The 7-year uptrend in world production of cobalt was reversed in 1957 when 15,500 short tons was produced, a decrease of 3 percent from 1956. Output from Belgian Congo declined 11 percent and furnished 58 percent of the 1957 total. Record quantities were produced in Canada and the United States. Production in Northern Rhodesia was the second largest.

NORTH AMERICA

Canada.—In Canada cobalt production was derived from the cobalt-silver ores in the Cobalt-Gowganda area of northern Ontario and as a byproduct of the nickel-copper ores of the Sudbury district, Ontario, and Lynn Lake area, Manitoba.

TABLE 11.—World mine production of cobalt, by countries,[1] 1948–52 (average) and 1953–57, in short tons of contained cobalt

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada [2]	512	801	1,126	1,659	[3] 1,758	1,868
Mexico (content of ore)	[4] 2		(5)			
United States (recoverable cobalt)[6]	283	439	719	926	1,269	1,649
Total	797	1,240	1,845	2,585	3,027	3,517
Africa:						
Belgian Congo (recoverable cobalt)	5,825	9,125	9,490	9,443	10,019	8,945
Morocco (content of concentrate)	557	661	811	834	710	466
Rhodesia and Nyasaland, Federation of [7] (content of white alloy, cathode metal, and other products): Northern Rhodesia	596	746	1,264	871	1,271	1,330
Total	6,978	10,532	11,565	11,148	12,000	10,741
Oceania: Australia (recoverable cobalt)	11	12	12	12	12	12
Grand total (estimate)[1]	8,200	12,500	14,500	14,800	16,000	15,500

[1] The world total includes an estimate of cobalt recovered from pyrites produced in Finland and other European countries. Data do not add to totals shown because of rounding where estimated figures are included in the detail.
[2] Figures comprise cobalt content of Canadian ore processed in Canada and exported (irrespective of year when mined), plus the cobalt recovered from nickel-copper ores at Port Colborne, Ontario, Fort Saskatchewan, Alberta, and Kristiansand, Norway; consequently, the figures exclude the cobalt recovered at Clydach, Wales, from Canadian nickel-copper ores, which cobalt the senior author of chapter has estimated and included in the world total.
[3] Revised figure.
[4] Imports into the United States.
[5] Less than 0.5 ton.
[6] Not strictly comparable with figures for years preceding 1947, which represented the cobalt contained in concentrate shipped.
[7] Year ended June 30 of year stated.

According to the Dominion Bureau of Statistics, 1,868 short tons of cobalt was produced in 1957, compared with 1,758 tons (revised figure) in 1956. These figures, however, do not include the cobalt recovered by Mond Nickel Co. at its Clydach (Wales) nickel refinery from nickel matte produced from the nickel-copper ores of the Sudbury district.

International Nickel Co. of Canada, Ltd., recovered an impure cobalt oxide from the electrolytic unit at its nickel refinery at Port Colborne, Ontario. The cobalt was contained in nickel-copper ores of the Inco Sudbury district mines. In 1957 considerable quantities of oxide were shipped to Clydach (Wales) for producing high-grade cobalt oxides and salts, which were sold to consumers in the United Kingdom and many other foreign countries; some of it, however, was reduced to metal, which was sold chiefly in the United States. Production of cobalt was about 12 percent more than in 1956; deliveries were 2,400,000 pounds in 1957, compared with 1,543,300 pounds in 1956. The larger part of the deliveries was as oxides and salts from the Clydach refinery for use in driers, ceramics, and catalysts. Cobalt metal from the Port Colborne refinery was sold mainly for use in producing permanent magnets and high-temperature, high-strength materials.

The cobalt circuit of Sherritt Gordon Mines, Ltd., at Fort Saskatchewan, Alberta, was used as a pilot plant from April through August 1957; meanwhile, the cobalt sulfide feed for the circuit was stockpiled for treatment later. Output of cobalt metal was 172,053 pounds in 1957, compared with 107,414 pounds in 1956. The cobalt was contained in the nickel-copper concentrate produced by the company at Lynn Lake, Manitoba.

Falconbridge Nickel Mines, Ltd., produced about 5 percent more electrolytic cobalt at its refinery at Kristiansand, Norway, than in 1956. Deliveries to customers were 777,000 pounds in 1957, compared with 543,000 pounds in 1956. The cobalt was recovered from the matte produced from Sudbury nickel-copper ore.

Deloro Smelting & Refining Co., Ltd., Deloro, Ontario, smelted arsenical cobalt-silver concentrate from the Cobalt-Gowganda area of northern Ontario for itself and Canadian concentrate for the United States Government.

Cuba.—Facilities were being constructed at Moa Bay, Cuba, by Moa Bay Mining Co. (subsidiary of Freeport Sulphur Co.) for producing a high-grade nickel-cobalt concentrate from laterite ore containing 1.35 percent nickel and 0.14 percent cobalt. The concentrate will be shipped to Braithwaite, La., where a refinery will be built to reduce it to yield separate products of high-purity nickel and cobalt. The planned annual cobalt capacity was 4.4 million pounds.

EUROPE

Finland.—The cupriferous pyrite of the Outokumpu mine in eastern Finland contains about 0.2 percent cobalt, 3 percent copper, 25 percent iron, 27 percent sulfur, and 1.2 percent zinc. Sinter produced by roasting pyrite concentrate to remove the sulfur was shipped to Duisburg, West Germany, for recovery of the cobalt, copper, iron, and zinc. The cobalt content of the sinter averaged 0.4 to 0.5 percent.

Germany, West.—No cobalt ore was mined in West Germany in 1957, and its two refineries depended on foreign sources for their raw materials. The Duisburger Kupferhütte refinery at Duisburg, the larger producer of cobalt, recovered it chiefly from pyrite sinter obtained from Finland, Spain, Norway, Sweden, and other countries. The refinery of Gebrüder Borchers A. G. at Goslar treated cobalt-bearing scrap, residues, and speiss.

AFRICA

Belgian Congo.—The Union Minière du Haut-Katanga continued to be the only producer, and Belgian Congo the chief world source of cobalt. Output was 8,945 short tons in 1957, an 11-percent decrease from 1956 (the record year), the smallest since 1952, and the second decline since 1946. The Jadotville-Shituru plant (capacity, 6,000 tons) produced granules containing about 99.5 percent cobalt, and the Jadotville-Panda plant (capacity, 4,400 tons) produced a white alloy containing about 43 percent cobalt, which was shipped to Belgium and the United States for refining. Shipments of white alloy to the United States ceased after April 1957.

The opening of new mines rich in copper and cobalt near Kolwezi and the construction underway of copper and cobalt electrolytic plants at Luilu for refining the ore by the Union Minière will increase its annual capacity to produce electrolytic cobalt by about 4,000 tons. About 1960, when the Kolwezi-Luilu plant begins producing, Union Minière will have a capacity of about 10,000 tons of electrolytic cobalt, but output could easily be expanded to 11,000 or 12,000 tons.

However, because the reserves of cobalt ore or concentrate suitable for treatment in electric furnaces at the Jadotville-Panda plant are limited, future production of white alloy was expected to be of diminishing importance.

Morocco.—Production of cobalt concentrate in Morocco was 4,663 short tons containing 466 tons of cobalt in 1957, compared with 7,097 tons containing 710 tons of cobalt in 1956. The decline in production was reported to be due to curtailment of operation at the Bou-Azzer mine while a new washing plant was being installed. The chapter on Cobalt in Minerals Yearbook, 1956, erroneously stated that installation of the washing plant had been completed. La Société Minière de Bou-Azzer et du Graara, Casablanca, was the only producer.

Rhodesia and Nyasaland, Federation of.—Production of cobalt at the refinery of Rhokana Corp. at Nkana, Northern Rhodesia, was 5 percent more in 1957 than in 1956 and the highest since 1940. In the year ended June 30, 1957, production comprised 1,148 short tons of metal, 141 tons of cobalt in carbonate, and 41 tons of cobalt in ferrocobalt. Thus, total production was 1,330 tons in 1957, compared with 1,271 tons in 1956. The cobalt carbonate was shipped to the United Kingdom for toll refining into cobalt oxide. No cobalt alloy was produced from converter slag in 1957.

The grade of ore treated was 0.191 percent cobalt in 1957, compared with 0.165 percent in 1956. Concentrate produced contained 1.495 percent cobalt in 1957, compared with 1.39 percent in 1956.

Chibuluma Mines, Ltd., near Ndola, Northern Rhodesia, which began producing cobalt concentrate May 6, 1956, treated ore averaging 0.36 percent cobalt in the year ended June 30, 1957. Because its plant for producing cobalt matte was not completed until nearly the end of the fiscal year 1957, none of the 1,962,000 pounds of recoverable cobalt contained in concentrate or semiprocessed materials was prepared for sale. Consequently, no figure for Chibuluma Mines, Ltd., has been included in the world-production statistics. During the latter half of 1957 some cobalt matte was refined to metal in Europe on a toll basis.

Uganda.—At the operation of Kilembe Mines, Ltd., in western Uganda, where production of copper and cobalt concentrates was begun in 1956, the cobalt-leaching plant was still on the design board; meanwhile, the cobalt concentrate was being transferred by pipeline to a stockpile dam near the Kasese roasting plant.[4]

TECHNOLOGY

There was much activity in improving cobalt-refining processes, in producing better high-temperature alloys employing cobalt, in developing methods for recovering cobalt and nickel from various types of ores, and for separating the two metals.

Calera Mining Co. added an electrolytic unit to its plant at Garfield, Utah, in late 1957 for refining cobalt. The unit will produce higher grade cobalt metal at lower cost and eliminate the hydrogen-reduction and arc-furnacing steps formerly used.

[4] Hawkins, D. A., The Kilembe Mine: Min. Mag. (London), vol. 96, No. 3, March 1957, pp. 137–145.

Sherritt Gordon Mines, Ltd., was installing a new and improved cobalt-leaching circuit at its refinery at Fort Saskatchewan, Alberta, Canada. The new circuit will make the old one available for pilot-plant work without interfering with cobalt production.

Chibuluma Mines, Ltd., near Ndola, Northern Rhodesia, completed a plant consisting basically of a fluosolids roaster and an electric furnace for converting cobalt flotation concentrate to a 10-percent matte. Production of matte was begun in the last half of 1957; it was shipped to Belgium for refining.

Incoloy T, a new nickel-cobalt-chromium-iron high-temperature alloy containing 30 to 34 percent nickel and cobalt, 19 to 22 percent chromium, 40 to 47 percent iron, and 0.75 to 1.5 percent titanium, was developed by International Nickel Co., Inc., for use in highly stressed parts of jet-engine-combustion systems and in airframes used for hypersonic flight.[5] As a result of the titanium addition, the alloy exhibits improved tensile and rupture properties and has excellent oxidation resistance up to 1,600°–1,700° F.

A patent was issued for an alloy containing about 53 to 62 percent cobalt, 24 to 28 percent chromium, 14 to 18 percent tungsten, 0.25 to 0.55 percent boron, less than 1 percent each of nickel, manganese, and silicon, and 0.10 to 0.20 percent carbon.[6] The alloy is adapted particularly for use as a bucket material in turbosuperchargers, gas turbines, or other jet apparatus, where great strength and formability at high temperature are required. The alloy improves tensile ductility and impact strength and does not reduce the stress-rupture strength at high temperatures.

Supermendur, a new magnetic alloy containing 49 percent cobalt, 49 percent iron, and 2 percent vanadium, was developed by Bell Telephone Laboratories.[7] It was reported that the alloy will permit reductions in the size of magnetic components without any sacrifice in performance and will facilitate the design of new components having greatly improved performance characteristics.

Patents were issued for processes for recovering nickel and cobalt from laterite ore,[8] garnierite ore,[9] mixed sulfide matte,[10] and an ore also containing iron, sulfur, and at least one metalloid selected from arsenic, antimony, selenium, and tellurium.[11]

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[5] Materials and Methods, Improved Nickel-Alloy Sheet Can Be Used Up to 1,600° F.: Vol. 45, No. 4, April 1957, p. 173.

[6] Jahnke, L. P. (assigned to General Electric Co.), Cobalt Base Alloy: U. S. Patent 2,816,024, Dec. 10, 1957.

[7] American Metal Market, New Magnetic Alloy of Bell Laboratory Contains Cobalt and Vanadium: Vol. 64, No. 20, Jan. 29, 1957, p. 1.

[8] Donaldson, J. W. (assigned to Quebec Metallurgical Industries, Ltd.), Method for Recovering Nicke and Cobalt From Ores: U. S. Patent 2,816,015, Dec. 10, 1957.

Simons, C. S., III (assigned to Freeport Sulphur Co.), Process of Preparing Limonitic Ores for Separation of Metal Content: U. S. Patent 2,798,804, July 9, 1957.

[9] Schaufelberger, F. A. (assigned to Chemical Construction Corp.), Recovery of Nickel and Cobalt Values From Garnierite Ores: U. S. Patent 2,778,729, Jan. 22, 1957.

[10] Kenworthy, Heine, Process for Obtaining Nickel and Cobalt From a Mixed Sulphide Matte: U. S. Patent 2,790,713, Apr. 30, 1957.

[11] Bennedsen, H. O., Process for Extracting Cobalt and Nickel From Their Ores: U. S. Patent 2,805,940, Sept. 10, 1957.

Patents were issued for processes for separating cobalt and nickel;[12] purifying cobalt compounds containing zinc, sulfur, and chlorine;[13] and hydrometallurgical precipitation of nickel and cobalt.[14]

[12] Schaufelberger, F. A., and Czikk, A. M. (assigned to American Cyanamid Co.), Separation of Cobalt From Nickel: U. S. Patent 2,777,753, Jan. 15, 1957.

Roy, T. K., and Bocckino, H. G. (assigned to Chemical Construction Corp.), Hydrometallurgical Separation of Nickel and Cobalt: U. S. Patent 2,778, 728, Jan. 22, 1957.

Voos, Walter (assigned to Lonza Electric & Chemical Works, Ltd.), Method of Separating Nickel and Cobalt Compounds From Each Other: U. S. Patent 2,793,936, May 28, 1957.

DeMerre, Marcel (assigned to Société Générale Métallurgique de Hoboken), Separation of Nickel From Cobalt: U. S. Patent 2,803,537, Aug. 20, 1957.

[13] Schackmann, Heinrich, Gregor, Ulrich, Kayser, Carl, and Teworte, Wilhelm (assigned to Duisburger Kupferhütte), Method for the Recovery of Cobalt From Impure Cobalt Oxide: U. S. Patent 2,793,111, May 21, 1957.

[14] Shaw, J. J., and Schaufelberger, F. A. (assigned to Chemical Construction Corp.), Process for the Hydrometallurgical Precipitation of Nickel and Cobalt: U. S. Patent 2,796,343, June 18, 1957.

Columbium and Tantalum

By William R. Barton [1]

SUPPLY overtook demand for columbium (niobium) and tantalum ores and finished products in 1957. The absence of the United States Government from the market for foreign ores resulted in a second consecutive annual decline in world output of columbium and tantalum concentrates. Increased production and less-than-anticipated steel industry needs for ferrocolumbium, defense requirements for tantalum, and Atomic Energy Commission requirements for columbium resulted in increased stocks in the hands of industrial consumers. All columbium and tantalum products were readily available by the end of 1957. However, metal producers were optimistic about future demand for their products. New plants entered production, and the capacities of other plants were expanded.

TABLE 1.—Salient statistics of columbium-tantalum concentrate, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Columbium-tantalum concentrate shipped from mines: [1]						
Pounds	1,786	14,867	32,829	12,954	216,606	370,483
Value	$14,566	$29,779	$57,262	$22,125	(2)	(2)
Imports for consumption:						
Columbium-mineral concentrate ... pounds	1,734,566	4,186,080	6,804,076	9,612,576	5,699,553	3,348,706
Tantalum-mineral concentrate ... pounds	232,078	759,409	981,872	1,907,686	1,312,865	828,265
World: Production of columbium-tantalum concentrates ... pounds	2,800,000	5,760,000	9,750,000	11,490,000	9,150,000	7,760,000

[1] 1956–57 data are for columbium-tantalum concentrate plus columbium-tantalum oxide content of euxenite concentrate.
[2] Figure withheld to avoid disclosing individual company confidential data.

LEGISLATION AND GOVERNMENT PROGRAMS

In October the Government share in columbium and tantalum mineral exploration under the Defense Minerals Exploration Administration program was reduced from 75 to 50 percent.

Domestic columbium-tantalum ores continued to be purchased under Public Law 733, 84th Congress.

Columbium-tantalum oxides produced from Porter Bros. Corp. euxenite concentrate were purchased by the Government under a special contract.

The first meeting of the Tantalum and Columbium Metal Producers Industry Advisory Committee was held on June 4, 1957, at the United

[1] Commodity specialist.

States Department of Commerce, Washington, D. C. Problems involved in the production of columbium and tantalum were discussed by industry and the Government. The ability to expand columbium and tantalum facilities to meet potential military requirements was affirmed by industry.

DOMESTIC PRODUCTION

Concentrate.—Domestic production of columbium-tantalum mineral concentrate increased 71 percent to a new peak in 1957. The increase was due principally to the higher production reported by Porter Bros. Corp. from its euxenite-columbite-monazite placer at Bear Valley, Idaho. The deposit furnished more than 98 percent of the total domestic production of contained oxides in ore. Other States producing in 1957, in order of decreasing shipments, were Arizona, South Dakota, New Mexico, and Colorado. Maine, a producing State in 1956, reported no production in 1957; Arizona did not produce in 1956. Except for Porter Bros. Corp., all production was a byproduct of pegmatite deposits mined for other minerals; 13 pegmatite mine operators reported shipments compared with 10 in 1956.

A petition was filed by the Federal Fish and Wildlife Service asking that 31,000 acres, including potential sources of columbium ore, in the Bear Valley area be closed to entry under the mining laws. Hearings were held in Boise on September 19 and 20, 1957. Wildlife groups generally supported the measure; the mining industry, business groups, and chambers of commerce opposed the withdrawal.[2]

Metal, Alloys, and Compounds.—Tantalum foil for capacitor use, which required 48 weeks for delivery early in the year, was readily available later in the year. By December new facilities and less urgent defense demands reduced customers' waiting period to about 2 weeks.

A new $6.5-million plant was completed by Fansteel Metallurgical Corp. at Muskogee, Okla., in October 1957. The new plant, designed to increase Fansteel's tantalum capacity by 50 percent and columbium capacity by 150 percent, was expected to be in full production by the end of 1957. Installation of solvent-extraction facilities at the plant was delayed. Construction was begun on an addition to the Fansteel plant at North Chicago, Ill. The $665,000 project was scheduled for completion early in 1958.

Electro-Metallurgical Co., Niagara Falls, N. Y., began commercial production of columbium and tantalum as roundels, pressed electrodes, and ingots.

Kawecki Chemical Co. reported a 100-percent increase in tantalum capacity in September. Columbium capacity remained unchanged.

Wah Chang Corp., late in 1957, began production of columbium and tantalum at existing plants in Albany, Oreg., and Glen Cove, N. Y.

United States Industrial Chemicals Co. began pilot-plant production of columbium and tantalum in November at Ashtabula and Cincinnati, Ohio.

E. I. duPont de Nemours & Co., Inc., announced on November 6, 1957, that they had begun production of demonstration quantities of

[2] Idaho Daily Statesman (Boise, Idaho), Fishing, Mining Conflict to be Aired at Hearing: Sept. 19, 1957, p. 11.

columbium alloys possessing high strength at high temperatures. Thompson Products, Inc., Cleveland, Ohio, will develop fabrication techniques for the Du Pont series of alloys.

A small solvent-extraction plant for producing columbium and tantalum pentoxides from ore was completed at Murray, Utah, by Alpha Mining & Milling Corp.

Transition Metals & Chemicals, Inc., Wallkill, N. Y., began producing ferrocolumbium, chrome-columbium, and aluminum-columbium-titanium alloy.

Vanadium Corporation of America, Cambridge, Ohio, and Shieldalloy Corp., Newfield, N. J., began production of ferrocolumbium.

Reading Chemicals, Wyomissing, Pa., broadened the scope of its operations by starting to produce ferrocolumbium and nickel-columbium in 1957.

Kennametal, Inc., Latrobe, Pa., increased production of columbium metal and became the leading producer of the metal in 1957.

Mallinckrodt Chemical Works, St. Louis, Mo., increased both quantity and quality of mixed columbium-tantalum oxides made from Porter Bros. Corp. euxenite concentrate.

CONSUMPTION AND USES

Domestic industrial consumption of columbium-tantalum-bearing mineral concentrates and slags, measured by contained metal, is estimated to have increased about 10 percent to a record 890 tons of contained metal in 1957 compared with 810 tons in 1956 and 350 tons in 1952. The 1957 total was comprised of about 290 tons of tantalum and 600 tons of columbium.

Consumption of tantalum was expected to continue to expand, chiefly in electronic devices and ferrotantalum-columbium. Demand for columbium also was expected to expand as an alloying element and as a pure metal.

Nuclear uses included columbium-base alloys as structural parts of proposed nuclear-powered air vehicles, columbium metal as a fuel-element sheathing and fuel-alloying element, type 347 columbium-stabilized stainless steel in reactor structural parts and heat-exchange systems, tantalum as a container for uranium-bismuth slurry in the Liquid Metal Fuel Reactor Experiment, as a fuel container in the Los Alamos Molten-Plutonium Reactor Experiment, and in heat-exchanger piping.

A new weldable titanium alloy, MST-821 was introduced, which contained 2 percent columbium, 1 percent tantalum, and 8 percent aluminum. The alloy extends the useful temperature limit 200° F. above conventional alpha-phase titanium alloys.[3]

Wider use of columbium was predicted in carbon and low-alloy steels to improve their high-temperature properties and impact resistance. In addition, E. I. duPont de Nemours & Co., Inc., announced development of a new series of high-temperature, nonferrous, columbium-base alloys that should solve some critical design problems in jet engines, high-speed aircraft, guided missiles, and atomic

[3] Abkowitz, S., and Evers, Dillon, Two Promising New Titanium Alloys: Metal Progress, vol. 72, No. 3, September 1957, pp. 97-102.

reactors. The alloys may lead to more efficient turbines capable of running at temperatures ranging from 2,000° to 2,200° F.[4]

A large new market for high-temperature alloys would be created if automotive gas turbines replace reciprocating engines in motor vehicles. Some engineers have felt that turbines already are practical for heavy-duty and military vehicles.[5]

Nuclear and high-temperature properties and applications of columbium were summarized in a paper by the Director of Research, Murex, Ltd., Rainham, England.[6]

PRICES

The price for foreign columbite concentrate reported in E&MJ Metal and Mineral Markets increased in January, then fell to a new low level late in 1957. At the beginning of the year, ore containing 65 percent combined pentoxides was quoted at $1.25 to $1.35 per pound of contained pentoxides for material with a Cb:Ta ratio of 10:1 and $1.05 to $1.15 for an 8½:1 ratio. On January 10, 10:1 concentrate was quoted at $1.35 to $1.40 and 8½:1 at $1.15 to $1.20. The price remained constant until October 3, when it was adjusted to $1.15 to $1.20 for 10:1 and $1.00 to $1.05 for 8½:1. Prices paid for foreign tantalite were not reported regularly but were several times the price of columbite. Domestic columbite-tantalite prices continued to be affected by Public Law 733, 84th Congress. Most purchases under the law were at a price of $1.70 per pound gross weight on a 50-percent pentoxide basis ($3.40 per pound of contained pentoxides).

On January 1, 1957, ferrocolumbium was quoted at $6.90 per pound of contained Cb, in ton lots, lump (2-inch), packed, f. o. b. destination continental United States (50–60 percent Cb, maximum 0.40 percent C, maximum 8 percent silicon). The price dropped to $5.10, effective March 5, and finally to $4.90, effective May 17. The price of ferrotantalum-columbium, per pound of contained Cb plus Ta, dropped from $4.65 to $4.25 during the year.

High-quality columbium metal was quoted nominally at $120 per pound until October 16, 1957, when Electro-Metallurgical Co. announced its price schedule per pound, 99½ percent pure, depending on size of lot, as: Roundels $55–$70, electrode segments $60–$75, rough ingot $65–$80. Tantalum was quoted nominally throughout the year, per kilogram, base price, at $128 for rod and $100 for sheet. Actually, prices for both forms varied widely, depending upon specified dimensions and size of order.

A Technical-grade columbium powder was made available in May by Shieldalloy Corp., Newfield, N. J. The material imported from H. C. Starck, Aktiengesellschaft, Goslar, Germany, contained not more than 2 percent tantalum and 1 percent titanium; minimum columbium content was 97 percent. The price per pound, f. o. b. Newfield, in large lots, was $16.

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[4] Oil, Paint and Drug Reporter, Niobium Key to Design Problems of Jets and Missiles, duPont Says: Vol. 172, No. 20, Nov. 11, 1957, pp. 5, 79.

[5] American Metal Market, G. M. Engineers See Approach of Gas Turbine: Vol. 64, No. 112, June 8, 1957, pp. 1, 11.

[6] Miller, G. L., Columbium and Its Uses: Materials and Methods, vol. 45, No. 5, May 1957, pp. 131–135.

FOREIGN TRADE [7]

Imports.—Columbium-tantalum mineral imports declined for the second year. Imports of columbium concentrate declined 41 percent in 1957; and imports of tantalum concentrate declined 37 percent. The decline reflected the absence of the United States Government from the market for foreign ores.

In 1957, 3.3 million pounds of columbium-mineral concentrate was imported, compared with 5.7 million pounds in 1956. The average value per pound decreased from $1.47 to $0.91. Nigeria, the principal source of supply, provided 54 percent of the total imports—a 9-percent decrease from 1956. Belgian Congo, Norway, and Malaya supplied 27, 7, and 4 percent, respectively. West Germany again shipped columbium concentrate to the United States after a 1-year

TABLE 2.—Columbium-mineral concentrates imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries, in pounds

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
South America:						
Argentina			11,023	10,800		
Bolivia	2,936	10,375	5,714		3,791	
Brazil	7,574	34,391	124,460	233,012	160,462	54,500
British Guiana	160	2,324		7,033		
Total	10,670	47,090	141,197	250,845	164,253	54,500
Europe:						
Belgium-Luxembourg [1]	5,425					
Germany, West			267,957	849,310		1,653
Norway		40,367	342,886	562,759	521,003	236,147
Portugal	421	68,121	148,732	168,362	31,024	72,953
Spain		4,410		2,525		
Sweden		16,713				
United Kingdom [1]	240				11,200	29,621
Total	6,086	129,611	759,575	1,582,956	563,227	340,374
Asia:						
Aden					1,350	
Japan	6,367					
Korea, Republic of		2,000				
Malaya	4,053	101,967	180,225	515,688	521,741	127,524
Total	10,420	103,967	180,225	515,688	523,091	127,524
Africa:						
Belgian Congo	249,054	580,232	976,832	1,247,901	758,919	905,989
British West Africa				14,521		
French Equatorial Africa				4,700		
Madagascar			11,060	36,412	10,621	3,075
Mozambique	7,897	57,894	31,183	64,974	43,124	81,422
Nigeria	1,447,945	3,167,344	4,575,648	5,739,526	3,593,114	1,804,631
Rhodesia and Nyasaland, Federation of		[2] 20,460	11,788	13,529	6,652	
Uganda [3]	924	19,891	4,446	24,399	18,780	
Union of South Africa	1,570	34,472	76,714	55,539	17,772	31,191
Total	1,707,390	3,880,293	5,687,671	7,201,501	4,448,982	2,826,308
Oceania: Australia		25,119	35,408	61,586		
Grand total: Pounds	1,734,566	4,186,080	6,804,076	9,612,576	5,699,553	3,348,706
Value	$1,140,997	$6,890,914	$14,191,142	$19,912,381	$8,386,659	$3,037,706

[1] Presumably country of transshipment rather than original source.
[2] Southern Rhodesia.
[3] Classified by the Bureau of the Census as British East Africa.

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

lapse. Aden, Bolivia, Rhodesia and Nyasaland, and Uganda supplied concentrate in 1956 but not in 1957.

The United States Department of Commerce reported that West Germany, the United Kingdom, Norway, and Canada shipped 4,061 pounds of columbium metal worth $22,152 to the United States in 1957. It is believed that only about 680 pounds, worth $14,800 was metal; the remainder probably was in alloyed form. Department of Commerce data on 1956 imports of columbium metal were revised to 5,798 pounds of metal valued at $233,939 from the United Kingdom and West Germany. No details of ferroalloy and metal-bearing tin-slag imports were obtained in 1957.

In 1957, 828,265 pounds of tantalum mineral concentrate entered the country, compared with 1,312,865 pounds in 1956. The average value was $1.15 per pound in 1957, compared with $0.90 per pound in 1956. If imports from Belgian Congo are excluded, the average value for 1957 was $2.00 per pound and for 1956, $2.26 per pound. Belgian Congo continued as the world's leading exporter of tantalum minerals to the United States, supplying 59 percent of United States

TABLE 3.—Tantalum-mineral concentrates imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries, in pounds

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
South America:						
Argentina	215			6,614	4,409	
Brazil	27,174	46,146	255,533	221,834	140,039	199,205
French Guiana		10,987	24,809	23,085	14,532	3,075
Total	27,389	57,133	280,342	251,533	158,980	202,280
Europe:						
Belgium-Luxembourg [1]	21,312					6,391
Germany, West			62,865	594,030		
Netherlands [1]	5,900					
Norway				11,729		
Portugal	7,086	154,323	86,279	6,614	7,054	5,966
Spain	148			11,276		
Sweden		4,242	19,251			
United Kingdom				28,533		
Total	34,446	158,565	168,395	652,182	7,054	12,357
Asia:						
Japan [1]	2,138					
Malaya	417	3,639	1,479	5,853		
Total	2,555	3,639	1,479	5,853		
Africa:						
Belgian Congo	158,112	507,282	420,562	539,214	953,092	491,124
Madagascar			6,173	10,693	20,165	6,835
Mozambique			10,893	57,184	4,409	24,046
Nigeria	6,911		50,018	303,692	31,174	16,815
Rhodesia and Nyasaland, Federation of	[2] 1,830	[2] 8,163	4,944	18,326	22,166	38,975
Uganda [3]		2,050	2,158	8,507		
Union of South Africa	224	2,036	4,480	14,428	6,511	6,910
Total	167,077	519,531	499,228	952,044	1,037,517	584,705
Oceania: Australia	611	20,541	32,428	46,074	109,314	28,923
Grand total: Pounds	232,078	759,409	981,872	1,907,686	1,312,865	828,265
Value	$230,706	$1,229,534	$1,972,320	$4,820,453	$1,180,118	$948,638

[1] Presumably country of transshipment rather than original source.
[2] Southern Rhodesia.
[3] Classified by the Bureau of the Census as British East Africa.

imports compared with 73 percent in 1956. Brazil supplied 24 percent, Rhodesia and Nyasaland 5 percent, and Australia 3 percent. Argentina, which supplied tantalum mineral concentrate in 1956, did not ship any to the United States in 1957. Belgium-Luxembourg shipped tantalum concentrate to the United States after a lapse of several years. West Germany, the United Kingdom, and Austria shipped 2,430 pounds of tantalum metal worth $121,474 to the United States in 1957.

Exports.—In 1957, 59,220 pounds of low columbium content material valued at $43,886 was shipped to Canada, West Germany, and Japan. France received 6 pounds of semifabricated columbium forms valued at $1,335. Fifteen pounds of columbium metal in crude form, valued at $1,721, was shipped to the United Kingdom. Tantalum powder, weighing 5,997 pounds and valued at $228,014, was shipped to Brazil, United Kingdom, France, West Germany, and Austria. Tantalum scrap, metal, and alloys in crude form, weighing 2,047 pounds and valued at $44,628, were exported to West Germany, Canada, and Austria. Approximately 2,830 pounds of tantalum in semifabricated forms valued at $206,627 was exported to 13 countries.

WORLD REVIEW

World (except the U. S. S. R.) production of columbium and tantalum mineral concentrates was 7.8 million pounds in 1957—15 percent less than in 1956. The Eastern Hemisphere produced 92 percent of the world supply of ore in 1957 compared with 91 percent in 1956. Record production was reported in 1957 by Belgian Congo, Mozambique, Rhodesia and Nyasaland, and the United States. Swaziland produced concentrate for the first time.

The drop in world production was due largely to cessation of United States Government purchases of foreign ores. Although the United States Government program for purchasing foreign columbium-tantalum materials had been terminated in 1955, large deliveries were made in 1956 under prior commitments to buy. By mid-1957 all deliveries were completed.

The United States used 59 percent of the Free World production of columbium and tantalum concentrates in 1957 compared with 79 percent in 1956. Foreign sources furnished the United States with 92 percent of the country's supply in 1957, compared with 97 percent in 1956.

NORTH AMERICA

Canada.—A subsidiary of Headway Red Lake Gold Mines, Ltd., and Coulee Lead & Zinc Mines, Ltd., continued research on processing pyrochlore ore from its Oka, Quebec, property.[8]

Oka Rare Metals, Ltd., reported plans to conduct a deep-drilling program at its Oka property to prove reserves large enough to justify construction of a chemical plant to treat the pyrochlore-type ore.[9]

[8] Northern Miner (Toronto), Headway and Coulee Continue Research, Columbium Process: Vol. 43, No. 8, May 16, 1957, p. 26.

[9] Northern Miner (Toronto), Deep Drilling Plans for Oka Rare Metals: Vol. 48, No. 14, June 27, 1957 p. 34.

TABLE 4.—World production of columbium- and tantalum-mineral concentrates by countries,[1] 1948–52 (average) and 1953–57, in pounds [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

<table>
<tr><th rowspan="2">Country [1]</th><th colspan="2">1948–52 (average)</th><th colspan="2">1953</th><th colspan="2">1954</th><th colspan="2">1955</th><th colspan="2">1956</th><th colspan="2">1957</th></tr>
<tr><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th></tr>
<tr><td>Argentina</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>[3] 11,023</td><td>-----</td><td>[3] 10,800</td><td>[3] 6,614</td><td colspan="2">3,968</td><td colspan="2">2,205</td></tr>
<tr><td>Australia</td><td colspan="2">10,659</td><td colspan="2">18,124</td><td colspan="2">117,767</td><td colspan="2">27,139</td><td colspan="2">159,655</td><td colspan="2">[4] 65,000</td></tr>
<tr><td>Belgian Congo (including Ruanda-Urundi)[5]</td><td colspan="2">262,700</td><td colspan="2">623,902</td><td colspan="2">967,819</td><td colspan="2">967,819</td><td colspan="2">921,523</td><td>[3] 905,989</td><td>[3] 491,124</td></tr>
<tr><td>Bolivia (exports)</td><td colspan="2">209</td><td>3,366</td><td>-----</td><td>-----</td><td>-----</td><td>2,350</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>Brazil</td><td>[6] 17,365</td><td>[6] 36,372</td><td>64,960</td><td>[6] 40,320</td><td>432,320</td><td>[6] 107,520</td><td>170,240</td><td>[6] 127,680</td><td>394,240</td><td>[6] 208,320</td><td>[3] 54,500</td><td>[3] 199,205</td></tr>
<tr><td>British Guiana</td><td>[7] 2,000</td><td>-----</td><td>11,200</td><td>-----</td><td>4,480</td><td>-----</td><td>6,720</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>Canada</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>90</td><td>77</td><td>42</td><td>390</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>French Equatorial Africa</td><td colspan="2">4,725</td><td colspan="2">3,514</td><td colspan="2">6,261</td><td colspan="2">2,672</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>French Guiana</td><td>-----</td><td>-----</td><td colspan="2">13,228</td><td colspan="2">28,250</td><td colspan="2">19,805</td><td>-----</td><td>[3] 14,532</td><td>-----</td><td>[3] 3,075</td></tr>
<tr><td>Germany, West (U. S. imports)</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>267,957</td><td>62,865</td><td>849,310</td><td>594,030</td><td>-----</td><td>-----</td><td>1,653</td><td>-----</td></tr>
<tr><td>Madagascar</td><td>[8] 7,165</td><td>-----</td><td>8,377</td><td>-----</td><td>36,596</td><td>-----</td><td>38,801</td><td>-----</td><td colspan="2">19,400</td><td>[3] 3,075</td><td>[3] 6,835</td></tr>
<tr><td>Malaya</td><td>[9] 59,733</td><td>-----</td><td>116,480</td><td>-----</td><td>248,640</td><td>-----</td><td>529,104</td><td>-----</td><td>619,136</td><td>-----</td><td>317,462</td><td>-----</td></tr>
<tr><td>Mozambique</td><td colspan="2">[10] 10,432</td><td colspan="2">[10] 58,133</td><td colspan="2">94,031</td><td colspan="2">82,884</td><td>51,971</td><td>-----</td><td colspan="2">288,582</td></tr>
<tr><td>Nigeria</td><td>2,339,008</td><td>4,785</td><td>4,388,160</td><td>-----</td><td>6,527,360</td><td>22,400</td><td>7,047,040</td><td>35,840</td><td>5,832,960</td><td>33,600</td><td>4,307,520</td><td>40,320</td></tr>
<tr><td>Norway</td><td>-----</td><td>-----</td><td>[3] 40,367</td><td>-----</td><td>392,419</td><td>-----</td><td>675,930</td><td>-----</td><td>573,196</td><td>-----</td><td>489,421</td><td>-----</td></tr>
<tr><td>Portugal (U. S. imports)</td><td>-----</td><td>[9] 12,510</td><td>68,121</td><td>154,323</td><td>148,732</td><td>86,279</td><td>168,362</td><td>6,614</td><td>31,024</td><td>7,054</td><td>72,953</td><td>-----</td></tr>
<tr><td>Rhodesia and Nyasaland, Federation of</td><td>[7] 1,120</td><td>7,804</td><td>5,100</td><td>27,060</td><td>18,060</td><td>15,552</td><td>12,240</td><td>4,660</td><td>5,080</td><td>29,320</td><td>760</td><td>76,960</td></tr>
<tr><td>Sierra Leone</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>8,960</td><td>-----</td><td>8,960</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>South West Africa</td><td colspan="2">5,265</td><td colspan="2">17,634</td><td>22,439</td><td>3,868</td><td>8,299</td><td>2,924</td><td>9,607</td><td>3,740</td><td>9,325</td><td>14,676</td></tr>
<tr><td>Spain (U. S. imports)</td><td>-----</td><td>[7] 741</td><td>4,410</td><td>-----</td><td>-----</td><td>-----</td><td>2,525</td><td>11,276</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>Swaziland</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>32,920</td></tr>
<tr><td>Sweden (U. S. imports)</td><td>-----</td><td>-----</td><td>16,713</td><td>4,242</td><td>-----</td><td>19,251</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>Uganda [11]</td><td colspan="2">[6] 14,347</td><td colspan="2">23,542</td><td colspan="2">23,117</td><td colspan="2">34,003</td><td colspan="2">10,080</td><td colspan="2">4,032</td></tr>
<tr><td>Union of South Africa</td><td>-----</td><td>3,600</td><td>-----</td><td>38,000</td><td>-----</td><td>46,000</td><td>-----</td><td>24,000</td><td>-----</td><td>2,900</td><td colspan="2">[4] 2,000</td></tr>
<tr><td>United States (mine shipments)</td><td colspan="2">1,786</td><td colspan="2">14,867</td><td colspan="2">32,829</td><td colspan="2">12,954</td><td colspan="2">216,606</td><td colspan="2">370,483</td></tr>
<tr><td>World total (estimate)[2]</td><td colspan="2">2,800,000</td><td colspan="2">5,760,000</td><td colspan="2">9,750,000</td><td colspan="2">11,490,000</td><td colspan="2">9,150,000</td><td colspan="2">7,760,000</td></tr>
</table>

[1] Frequently the composition (Cb_2O_5–Ta_2O_5) of these concentrates lies in an intermediate position, neither Cb_2O_5 nor Ta_2O_5 being strongly predominant. In such instances the production figure has been centered.

[2] This table incorporates a number of revisions of data published in previous chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.

[3] United States imports.

[4] Estimate.

[5] In addition, tin-columbium-tantalum concentrates were produced as follows: 1948–52 (average), 2,187,404 pounds; 1953, 3,575,861 pounds; 1954, 5,970,057 pounds; 1955, 3,941,825 pounds; 1956, 4,810,437 pounds; 1957, not yet available; columbium-tantalum content averaging about 10 percent.

[6] Exports.

[7] Average for 1 year only, as 1952 was first year of commercial production.

[8] Average for 1951–52.

[9] Average for 1950–52.

[10] In addition to figure shown, 176 pounds of samarskite was produced in 1951 and 132 pounds in 1953.

[11] In addition, tin-columbium-tantalum concentrates were produced as follows: 1951, 336 pounds; 1952, 3,248 pounds; 1953, 4,480 pounds; 1954, 6,720 pounds; 1955, 515 pounds.

SOUTH AMERICA

Brazil.—A recent article[10] described deposits of columbium and tantalum minerals in Brazil and discussed uses, production, and consumption of the minerals. The principal mining regions were listed as the Territory of Amapá and the States of Minas Gerais, São Paulo, Paraná, Rio Grande do Sul, Ceara, Paraíba, and Rio Grande do Norte. Details on reserves were not included.

Surinam.—Surinam Mining Co. (a subsidiary of Union Carbide Corp.) prospected for tantalite and columbite in eastern Surinam.

EUROPE

United Kingdom.—Murex, Ltd., announced plans to erect a new plant at Rainham, England, to produce tantalum and columbium powders. The plant is to be completed in 1959.[11]

ASIA

India.—The Indian Department of Atomic Energy announced that native columbite-tantalite ores of low radioactivity would be purchased at a flat rate of 0.125 rupee per pound. Previously ores were purchased only if the uranium content exceeded 3.8 percent.

Pakistan.—Undetermined quantities of columbite and tantalite were discovered in the northern part of the Hazara district.

U. S. S. R.—At Alyudyanka, at the southern end of Lake Baikal, in south-central Siberia, betafite deposits were mined that contained calcium, columbium, tantalum, and uranium.[12]

AFRICA

Rhodesia and Nyasaland, Federation of.—Two new deposits of pyrochlore were found in the Southern Province of Nyasaland. Reserves were not determined.[13]

Tanganyika.—Mbeya Exploration Co. reported that development was proceeding satisfactorily on its carbonatite deposit at Panda Hill. A pilot plant with a capacity of 150 tons of ore per day began operating in September. It was expected that about 10 tons of columbium concentrate would be marketed in 1958.[14]

Uganda.—Sukulu Mines, Ltd., began operating a pilot plant to treat ore from its apatite-columbium-magnetite deposit in the Sukulu Hills near the Kenya border. The company superseded Tororo Exploration Co.[15]

OCEANIA

Australia.—Euxenite was found on the south coast of Western Australia near Albany. The size of the deposit was not known.

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[10] Soliva Robert, Tantalita e Columbita: Engenharia, Mineracão, e Metalurgia (Rio de Janeiro), vol. 25, No. 146, February 1957, pp. 86–88.

[11] Metal Bulletin (London), Murex Limited—Confidence in Long-Term Prospects: No. 4225, Sept. 6, 1957, p. 24.

[12] Mining World (London), Russia Seeks to Develop New Domestic Sources of Uranium While Exhausting Satellite Supply: Vol. 19, No. 8, July 1957, p. 11.

[13] South African Mining and Engineering Journal, Rare Metals: Vol. 68, pt. 1, No. 3365, Aug. 9, 1957, p. 1555.

[14] American Metal Market, Substantial Reserves of Columbium and Tantalum Ores, in East Africa· Vol. 64, No. 239, Dec. 13, 1957, p. 14.

[15] Mining World (London), Uganda: Vol. 19, No. 8, July 1957, p. 106.

WORLD RESERVES

The known world reserves of columbium were estimated early in 1957 at 1.5 million tons of metal.[16] As a result of prospecting and exploration, the total reserves at the end of 1957 were estimated to exceed 3.5 million tons of contained columbium. Although the search for tantalum also continued, no extensive new sources were found, and most columbium-ore discoveries contained little or no tantalum.

TECHNOLOGY

The increased tempo of technological studies of columbium and tantalum metals, their alloys, compounds, and ores resulted in numerous reports.

A symposium on columbium was held during the 111th meeting of the Electrochemical Society in Washington, D. C., in May 1957. The program comprised 21 papers that ranged in content from sources of columbium ores, through properties of the metal, its compounds and alloys, to the outlook of the industry. The assembled papers were to be published in 1958.

A recent survey of columbium and tantalum included a complete list of Canadian resources of the two metals and data on metallurgy, production, and uses of the two metals.[17]

Geologic reports were published on columbium-tantalum-bearing alluvial deposits in Idaho.[18]

A comprehensive review of columbium and tantalum in iron and steel was published.[19] This well-prepared book included chapters on: Columbium minerals, columbium metal, and ferrocolumbium; the constitution of iron-columbium and iron-columbium-carbon alloys; general effects of columbium in carbon and low-alloy steels; low-carbon, 2- to 30-percent chromium steels containing columbium; austenitic chromium-nickel steels containing columbium; effect of temperature on austenitic stainless steel containing columbium; physical properties and corrosion resistance of austenitic stainless steels containing columbium; and gas-turbine alloys containing columbium and tantalum.

An unusual ore body was reported in Ravalli County, Mont. The minerals included columbite, a rare calcium columbate identified by the Federal Bureau of Mines as fersmite, and rare-earth minerals in a carbonate rock. This is the first domestic columbium-ore deposit of this type.[20]

The exploration, geology, and theories of origin of the Nemogosenda Lake (Ontario) columbium deposit were described. The pyrochlore-

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[16] Higbie, K. B., Sources of Columbium: Pres. before Electrochem. Soc., Washington, D. C., May 15, 1957, 11 pp.

[17] Jones, R. J., Columbium (Niobium) and Tantalum: Canada Dept. Mines and Tech. Surveys, Mines Branch, Memo. Ser. 135, 1957, 56 pp.

[18] Armstrong, F. C., Dismal Swamp Placer Deposit, Elmore County, Idaho: Geol. Survey Bull. 1042-K, 1957, 9 pp.

Armstrong, F. C., and Weis, P. L., Uranium-Bearing Minerals in Placer Deposits of the Red River Valley, Idaho County, Idaho: Geol. Survey Bull. 1046-C, 1957, 11 pp.

[19] Grange, R. A., Shortsleeve, F. J., Hilty, D. C., Binder, W. O., Motock, G. T., and Offenhauer, C. M., Boron, Calcium, Columbium, and Zirconium in Iron and Steel; Alloys of Iron Research Monograph Series: John Wiley & Sons, Inc., New York, N. Y., 1957, 533 pp.

[20] Sahinen, U. M., Mines and Minerals Deposits, Missoula and Ravalli Counties, Mont.: Montana Bureau of Mines and Geol., Bull. 8, January 1957, pp. 53–54.

type ore occurs in a metasomatic aureole surrounding an alkalic syenite plug.[21]

A somewhat similar deposit at Lake Nipissing, Ontario, also was described.[22]

The geology, reserves, and processing techniques at Panda Hill, Tanganyika, were summarized in a short article. The recovery technique included flotation and magnetic separation.[23]

A field method for rapid determination of heavy minerals in sands was devised at the Bureau of Mines Southern Experiment Station, Tuscaloosa, Ala. The method used a heavy liquid to separate constituents having different densities. Results of the rapid evaluation technique approximated closely those of more precise laboratory procedures.[24]

A recent article describes use of gravity, magnetic, and high-tension electrostatic methods to produce a columbium-tantalum concentrate from alluvial sand. The techniques point the way to economic utilization of large low-grade deposits of the two metals.[25]

The use of gravity concentration to recover cassiterite, columbite, zircon, and xenotime from decomposed Nigerian granites was described. The report included experimental flowsheets, which subsequently were modified for commercial application. Flowsheets of this type could be used for treating similar ores.[26]

A process for treating columbium-bearing titanium minerals from Arkansas was developed at the Rolla (Mo.) Station of the Federal Bureau of Mines. The technique comprised coke reduction to form a carbide-suboxide sinter, chlorination in the 400°–500° C. range, and fractional condensation of the chlorides.[27]

A solvent-extraction process was patented, which used hydrofluoric acid plus sulfuric, nitric, hydrochloric, or perchloric acid to be contacted by di-isopropyl ketone. The columbium is recovered as oxide by treating the aqueous phase with ammonium hydroxide and boric acid; the tantalum is extracted from the ketone with water and precipitated as an oxide through contact with ammonium hydroxide and boric acid.[28]

A Canadian paper discussed isolation of pure columbium and tantalum pentoxides from pyrochlore ore by solvent extraction. The paper outlined a technique using the hydrofluoric acid-nitric acid-methyl isobutyl ketone system. It was possible to produce, on a laboratory scale, separated pentoxides of 99.5 percent purity, with a recovery of 95 percent.[29]

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[21] Parsons, G. E., Memegosenda Lake—Columbium Area: Canadian Min. Jour., vol. 78, No. 8, August 1957, pp. 83–87.

[22] Gill, J. E., and Owens, O. E., Columbium-Uranium Deposits at North Bay, Ontario: Canadian Inst. Min. and Met. Bull., vol. 50, No. 544, August 1957, pp. 458–464.

[23] Metal Bulletin (London) Pyrochlore Progress: No. 4229, Sept. 20, 1957, p. 18.

[24] Clemmons, B. H., Stacy, R. H., and Browning, J. S., Heavy-Liquid Techniques for Evaluation of Sands by Prospectors and Plant Operators: Bureau of Mines Rept. of Investigations 5340, 1957, 12 pp.

[25] Shelton, J. E., and Stickney, W. A., How to Process Alluvial Sand for Tantalum-Columbium: Eng. and Min. Jour., vol. 158, No. 4, April 1957, pp. 93–95.

[26] Williams, F. A., Performance Analyses of Screens, Hydrocyclones, Jigs, and Tables Used in Recovering Heavy Accessory Minerals From an Intensely Decomposed Granite on the Jos Plateau, Nigeria: Bull. Inst. Min. and Met. (London), vol. 67, pt. 3, No. 613, December 1957, pp. 89–108.

[27] Nieberlein, V. A., Low-Temperature Chlorination of Columbium-Bearing Titanium Minerals: Bureau of Mines Rept. of Investigations 5349, 1957, 15 pp.

[28] Hicks, H. G., Norvik, W. E., and Stevenson, P. C. (assigned to the U. S. Atomic Energy Commission), Solvent-Extraction Process for the Separation of Tantalum and Niobium Values: U. S. Patent 2,795,481, June 11, 1957.

[29] Faye, G. H., and Inman, G. H., The Isolation and Separation of Niobium and Tantalum Pentoxides From Mineral Concentrates by Liquid-Liquid Extraction: Canadian Inst. Min. and Met. Bull., vol. 50. No. 546, October 1957, pp. 609–613.

At a symposium on the metallurgy of columbium in London on May 1, 1957, five papers were presented: The Development of Niobium, by A. B. McIntosh; The Melting Point of Niobium, by T. H. Schofield; The Physical and Mechanical Properties of Niobium, by C. R. Tottle; Purification of Niobium by Sintering, by W. G. O'Driscoll and G. L. Miller; and The Production and Fabrication of Massive Niobium Metal, by L. R. Williams. The collected papers were published in a British journal.[30]

A general review of columbium metallurgy also discussed properties of the metal. The author pointed out that very few constitutional diagrams of binary columbium alloys are known and that this field must be fully explored if the characteristics of columbium are to be used to their optimum.[31]

Zone melting, levitation melting, and electron-bombardment melting were used to produce ultrapure columbium and tantalum. The techniques were reviewed in the literature.[32]

The Federal Geological Survey published a bibliography on the analytical chemistry of columbium and tantalum.[33]

A spectrophotometric study of columbium and columbium-hydrogen peroxide in aqueous sulfuric acid and sulfuric acid-sulfur trioxide solutions revealed three peroxycolumbium complexes. These were found to be, respectively: $2Cb:3H_2O$, $1Cb:2H_2O$, and $1Cb:1H_2O$. The condensation equilibrium of the first two complexes was investigated.[34]

A rapid and accurate differential spectrophotometric method was given for determining uranium and columbium in binary alloys of the two metals. Columbium is determined by measuring the absorbance of the columbium-hydrogen peroxide complex formed in a sulfuric acid solution against a columbium reference solution. The method also should be useful for determining total columbium in columbium metal, compounds, and alloys.[35]

Tantalum extracted by solvent-extraction methods was determined colorimetrically, using hydroquinone in concentrated sulfuric acid. The only metal interfering seriously was columbium. For solutions containing Ta : Cb in a 10 : 1 ratio, tantalum values were 10 to 15 percent high.[36]

The National Research Council issued a report on high-temperature alloys that contained specific recommendations for accelerating research and development in this field.[37]

Data on several nickel-base high-temperature alloys showed that Inconel 713C, which contains 2 percent columbium, exhibits outstanding rupture strength at 1,700° F. and has excellent resistance to thermal fatigue.[38]

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30 Journal of the Institute of Metals (London), Symposium on the Metallurgy of Niobium: Vol. 85, pt. 8, April 1957, pp. 367–392.

31 Jepson, M. D., The Metallurgy of Niobium: Research, vol. 10, No. 10, October 1957, pp. 390–395.

32 Pfann, W. G., Zone Melting: Met. Rev., vol. 2, No. 5, 1957, pp. 29–76.

33 Cuttitta, Frank, Annotated Bibliography of the Analytical Chemistry of Niobium and Tantalum, January 1935–June 1953: Geol. Survey Bull. 1029–A, 1957, 73 pp.

34 Hiskey, C. F., and Adler, N., Spectra of the Peroxy Complexes of Niobium in Sulfuric Acid; Composition of the Peroxy Complexes of Niobium in Sulfuric Acid; Condensation Equilibrium of the Peroxy Complexes of Niobium in Sulfuric Acid: Jour. Am. Chem. Soc., vol. 79, No. 8, Apr. 20, 1957, pp. 1827–1837.

35 Banks, C. V., Burke, K. E., O'Laughlin, J. W., and Thompson, J. A., Differential Spectrophotometric Determination of Uranium and Niobium: Anal. Chem., vol. 29, No. 7, July 1957, pp. 995–998.

36 Waterbury, G. R., and Bricker, C. E., Separation and Determination of Tantalum: Anal. Chem., vol. 29, No. 10, October 1957, pp. 1474–1479.

37 National Research Council, Report on Alloys for Use at Elevated Temperatures by the Panel on Alloys for Use at Elevated Temperatures: Materials Advisory Board Rept. MAB–115–M, Feb. 25, 1957, 97 pp.

38 Dominic, R. P., New Nickel Alloys for High-Temperature Service: Materials in Design Eng., vol. 46, No. 3, September 1957, pp. 115–119.

High-temperature technology was reviewed in detail. It was concluded that columbium, molybdenum, tantalum, tungsten, and their alloys are the refractory metals with the greatest potential. Columbium-tungsten alloys made at Stanford Research Institute resisted oxidation up to 3,000° F. The carbides of tantalum, mixed with those of hafnium or zirconium, are among the highest melting of the metallic compounds. A mixture of 80 percent tantalum carbide and 20 percent hafnium carbide melts at 7,120° F.; 80 percent tantalum carbide mixed with 20 percent zirconium carbide melts at 7,130° F.[39]

The behavior of columbium and tantalum at temperatures near absolute zero was studied to determine their possible cryogenic uses. Columbium became superconductive at 8° K. and tantalum at 4.4° K. A tin-columbium compound had a transition temperature of 18° K. The columbium-tantalum cryotron and other cryogenic devices were being considered for use in sensitive electrical measuring devices, switches, computer memory devices, resonating chambers in radio equipment and radio telescopes. The cryotron permits use of extremely small currents without loss of energy.[40]

The modes of formation of anodic oxidation films at very low current densities were examined for several metals, including columbium and tantalum. The metals were placed in three categories as a result of the experiments. Tantalum was classed as a film former and columbium as intermediate between film-former and non-film-former metals.[41]

Annealing anodic Ta_2O_5 films lessened the solubility of the films in HF and produced sharper X-ray diffraction patterns. It was concluded that tantalum-ion migration caused local changes in ionic configuration that controlled the specific properties involved.[42] Another article on anodic tantalum pentoxide films discussed crystallization of amorphous films. Initial nucleation took place at heterogeneities on the metal surface where the amorphous film was cracked. These cracks may be due to highly impure inclusions in the metal.[43]

The nuclear properties of columbium and its value as a reactor material were discussed. The most attractive features of columbium are its resistance to corrosion, its high-temperature strength, its comparatively low specific gravity, and its moderate neutron-capture cross section. It also stabilizes uranium in its high-temperature phase and improves the resistance of uranium to corrosion.[44]

A recent article revealed that the Dounreay reactor in Scotland would utilize columbium-clad fuel elements.[45]

The Experimental Boiling-Water Reactor (EBWR), Argonne National Laboratory, Lemont, Ill., was fueled with a uranium-zirconium-columbium alloy containing 1.5 percent columbium. Manufacturing

[39] Hiester, N. K., Ferguson, F. A., and Fishman, N., Todays Frontiers in High-Temperature Technology: Chem. Eng., vol. 64, No. 3, March 1957, pp. 237–252.
[40] Matthias, B. T., Superconductivity: Sci. Am., vol. 197, No. 5, 1957, pp. 92–102.
[41] Johansen, H. A., Adams, G. B., Jr., and van Rysselberghe, Pierre, Anodic Oxidation of Al, Cr, Hf, Nb, Ta, Ti, Vd, and Zr at Very Low Current Densities: Jour. Electrochem. Soc., vol 104, No. 6, June 1957, pp. 339–346.
[42] Vermilyea, D. A., Annealing Anodic Ta_2O_5 Films: Jour. Electrochem. Soc., vol. 104, No. 8, August 1957, pp. 485–488.
[43] Vermilyea, D. A., Nucleation of Crystalline Ta_2O_5 During Field Crystallization: Jour. Electrochem. Soc., vol. 104, No. 9, September 1957, pp. 542–546.
[44] Cotter, M. J., Niobium as a Nuclear Metal: Atomics and Nuclear Energy, vol. 8, No. 9, September 1957, pp. 339–342.
[45] Nucleonics, Dounreay Reactor Center Nears Completion: Vol. 15, No. 10, October 1957, p. 27.

practices for producing the fuel elements were described and the fuel plates evaluated.[46]

Several uranium-columbium-zirconium alloys were evaluated to determine their reactivity when contacted by steam at high temperatures. Reactivity was lowest with an alloy of 90 percent uranium and 10 percent columbium.[47]

A ductile alloy of 1.5 percent columbium, 1.0 percent aluminum, and 97.5 percent zirconium was patented. The alloy was characterized by a low thermal neutron-capture cross section of 0.19 barn and a 0.2 percent offset yield strength at 500° C. of 34,300 pounds per square inch.[48]

A quasi-technologic problem received considerable attention in 1957. American metallurgists and industry continued to support use of the term "columbium" in preference to "niobium." Justification for this support was outlined.[49] The opposition comprised chemists and foreign metallurgists.

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[46] Machery, R. E., Bean, C. H., Carson, N. J., Jr., and Lindgren, J. R., Manufacture of Fuel Plates for the Experimental Boiling-Water Reactor: Argonne Nat. Lab. Rept. ANL-5629, June 1957, 250 pp.
Smith, K. F., The Metallurgy of EBWR: Metal Prog., vol. 72, No. 5, November 1957, pp. 79-83.

[47] Lemmon, A. W., Jr., The Reaction of Steam With Uranium and With Various Uranium-Niobium-Zirconium Alloys at High Temperatures: Battelle Memorial Inst., Rept. BMI-1192, June 1957, 75 pp.

[48] Marsh, L. L., Jr., and Chubb, W. (assigned to U. S. Atomic Energy Commission), Zirconium Ternary Alloys: U. S. Patent 2,784,084, Mar. 5, 1957.

[49] Burke, J. J., Columbium and Niobium—Who Threw the Monkeywrench: Jour. Metals, vol. 9, No. 10, October 1957, pp. 1350-1351.

Copper

By A. D. McMahon [1] and Gertrude N. Greenspoon [2]

THROUGHOUT 1957 the copper industry faced the continuing problem of oversupply, which was not relieved by the 25-percent drop in the price of copper or by the efforts of most producers to curtail mine output at many major producing units in the United States. In slightly over 7 months the producer's price of copper dropped from 36 to 27 cents per pound, the lowest since February 1953. Although most of the major producers made determined efforts to effect a supply-demand balance by closing some mines and shortening work periods at others, continued development toward capacity production at new mines and expanded facilities offset the cutbacks, and high mine production was maintained throughout the year. Mine production of recoverable copper dropped 2 percent from the alltime high in 1956; smelter and refinery production from domestic ores was 3 percent lower; and imports of copper in unmanufactured form remained virtually the same.

The economic downtrend affected important consumers of copper products, including the electrical, construction, automotive, and appliance industries, forcing curtailment of operations and reduced copper purchases. The consumption of refined copper fell 11 percent in 1957, and producers' stocks of refined and blister copper (including materials in process of refining), increased 40 and 5 percent, respectively.

In September 1956 all restrictions on exports of refined copper were removed by the Bureau of Foreign Commerce, and shipments of refined copper from the United States during 1957 rose 55 percent to 346,000 tons—the highest since 1940. As a result of relaxation of export controls on scrap in 1957, exports of old and scrap copper almost doubled those in 1956.

The 2-cents-per-pound excise tax on copper continued under suspension in 1957, subject to the concessions granted at the June 1956 meetings in Geneva on General Agreements Tariffs and Trade (GATT). Suspension of nonferrous scrap duties was extended to June 30, 1958.

Shortly after the price of copper in the United States fell to 27 cents per pound in September the San Manuel Copper Corp. exercised the option to deliver its production to the Government under the Defense

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

Minerals Production Administration (DMPA) floor-price contract negotiated in 1952. In December the White Pine Copper Co. was authorized to make deliveries under a similar Government contract.

Copper prices also were reduced drastically by the London Metal Exchange (LME) and the Rhodesian Selection Trust (RST) Group. The LME quotation was equivalent to 33.3 cents per pound at the beginning of the year, dropped to 21.9 cents in December (the lowest since June 1950), and ended the year at 22.5 cents. The RST fixed price was lowered throughout the year, and on October 7 the group announced that it would return to the LME price basis.

World mine and smelter production of copper rose slightly over 1956 and established new alltime peak rates. Smelter output dropped 9,000 tons in Chile and 8,500 in Belgian Congo, but increases of 18,000 and 37,000 tons, respectively, were recorded for Japan and Rhodesia.

In the United States a strike at the White Pine mine in Michigan from September 23 to October 28 resulted in a 5-percent decrease in output for the State. Operations at the Gaspé mine, Quebec Province, Canada, were curtailed by a 7-month strike; and the Braden mine, Chile, was closed by a 2-week strike in April. Northern Rhodesian properties were affected by a number of work stoppages during the year.

TABLE 1.—Salient statistics of the copper industry in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
New (primary) copper produced—						
From domestic ores, as reported by—						
Mines	870,119	926,448	835,472	998,570	1,106,215	1,086,141
Copper ore produced [1]	90,157,814	101,064,945	93,654,258	112,549,665	131,775,959	129,715,586
Average yield of copper, percent	.85	.85	.83	.83	.78	.77
Smelters	873,980	943,391	834,381	1,007,311	1,117,580	1,081,055
Percent of world total	30	29	25	28	28	27
Refineries	870,107	932,232	841,717	997,499	1,080,207	1,050,496
From foreign ores, matte, etc., refinery reports	261,871	360,885	370,202	344,960	362,426	403,680
Total new refined, domestic, and foreign	1,131,978	1,293,117	1,211,919	1,342,459	1,442,633	1,454,176
Secondary copper recovered from old scrap only	449,397	429,388	407,066	514,585	468,489	428,277
Imports (unmanufactured) [2]	571,711	676,104	594,829	594,100	595,747	594,027
Refined	285,646	274,111	215,086	202,312	191,745	162,309
Exports of metallic copper [3]	194,802	[4] 171,393	[4] 312,433	[4] 259,942	[4] 280,575	[4] 430,446
Refined (ingots and bars)	146,485	109,580	215,951	199,819	223,103	346,025
Stocks at end of year (producers)	252,000	272,000	214,000	235,000	339,000	383,000
Refined copper	43,000	49,000	25,000	34,000	78,000	109,000
Blister and materials in solution	209,000	223,000	189,000	201,000	261,000	274,000
Withdrawals (apparent) from total supply on domestic account:						
Total new copper	1,279,000	1,435,000	1,235,000	1,336,000	1,367,000	1,239,000
Total new and old copper (old scrap only)	1,729,000	1,864,000	1,642,000	1,851,000	1,835,000	1,667,000
Price average....cents per pound	22.1	[5] 28.7	[5] 29.5	[5] 37.3	[5] 42.5	[5] 30.1
World smelter production, new copper	2,865,000	[6] 3,290,000	[6] 3,280,000	[6] 3,620,000	[6] 3,990,000	4,040,000

[1] Includes old tailings smelted or re-treated. Not comparable with mine production figure shown in that latter includes recoverable copper content of ores not classified as "copper."

[2] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering country under bond. Comprises copper in ingots, plates, and bars, ores and concentrates, regulus, blister, and scrap.

[3] Total exports of copper, exclusive of ore, concentrates, composition metal, and unrefined copper. Exclusive also of "Other manufactures of copper," for which quality figures are not recorded before 1953. (See table 40.)

[4] Due to changes in classifications 1953–57 data are not strictly comparable to earlier years.

[5] Exclusive of copper produced abroad and delivered in the United States.

[6] Revised figure.

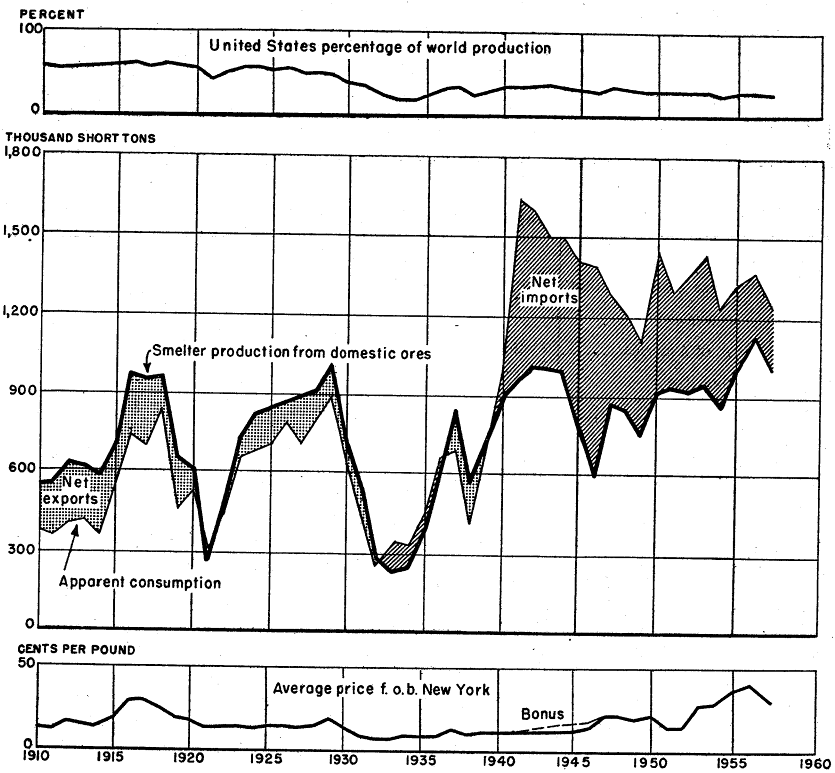

FIGURE 1.—Production, consumption, and price of copper in the United States, 1910–57.

LEGISLATION AND GOVERNMENT PROGRAMS

No contracts for expansion of copper production under the Defense Production Act of 1950, as amended, were entered into by the Government in 1957; also no tax on amortizations were granted.

Defense Minerals Exploration Administration contracts involving copper, executed in 1957, totaled 7 in 7 States.

As the supply of copper expanded, the Bureau of Foreign Commerce (BFC) announced relaxations on export controls. On March 4, BFC announced removal of export-quota limits through the second quarter of 1957 on copper scrap and copper-base-alloy scrap containing less than 5 percent nickel; under open-end licensing no quantitative limit was set, but exports were controlled for national security. Restrictions were relaxed on copper-nickel-alloy scrap containing 40 percent or more copper and 5 percent or more nickel. Export applications, previously not approved, were considered if the applicants certified that at least 90 percent of the nickel content would be returned to the United States in the form of nickel metal. On September 19 a fourth-quarter export quota of 500 tons was established for copper-nickel-alloy scrap containing 40 percent or more copper and 5 percent or more nickel. Applications no longer required certifications that the nickel content would be returned to the United States, but they

TABLE 2.—DMEA contracts involving copper executed during 1957, by States

State and contractor	Property	County	Contract	
			Date	Total amount [1]
ALASKA				
MacLaren River Copper Corp	Kathleen-Margaret	Talkeetna	May 29, 1957	$13,740
IDAHO				
Highland-Surprise Cons. Mining Co.	Copper Camp	Valley	Mar. 20, 1957	16,005
MONTANA				
Uranium Corp. of America	Dailey	Jefferson	Oct. 18, 1957	85,172
OREGON				
Fred M. Converse	Grand Cove	Jackson	July 23, 1957	7,200
TEXAS				
Trans-Pecos Minerals, Inc	Hazel	Culberson	Apr. 30, 1957	61,880
VERMONT				
Appalachian Sulphides, Inc	Elizabeth	Orange	June 13, 1957	62,860
WASHINGTON				
Howe Sound Co	Calumet	Snohomish	July 22, 1957	23,560

[1] Government participation was 50 percent in exploration projects in 1957.

had to be accompanied by evidence of unsalability in the domestic market and identification of the foreign consumer. Identification of foreign consumers also was required on fourth-quarter applications for copperweld rods, new and old copper scrap, and copper-base-alloy scrap containing less than 40 percent copper and less than 5 percent nickel, including ashes, slags, drosses, residues, etc., copper-base-alloy ingots, and other crude forms.

DOMESTIC PRODUCTION

PRIMARY COPPER

Mine Production.—Production of copper in the United States decreased 2 percent from the alltime high of 1956 and was previously exceeded in the World War II year of 1943.

A new mine—the Pima, Pima County, Ariz.—began to produce in 1957. The mill went into operation in January, and it was expected that the mine would be a major source of copper.

Arizona continued to lead all other States in mine production of copper by a wide margin; the State supplied 47 percent of the domestic total and exceeded its previous peak output of 1956 by 2 percent. Utah was second, with 22 percent, but produced 5 percent less than in 1956. Arizona's output came from a number of important copper-producing districts and mines. Output from Utah was principally from one mine—Utah Copper—the largest copper producer in the United States. Production from Montana, Nevada, New Mexico, and Michigan ranked next in importance and made up 27 percent of the total. These 6 States produced 97 percent of the United States total copper output in 1957. Output in Michigan dropped 5 percent, mainly because of a strike at the White Pine mine from September 23 to October 28. Production in Idaho established a peak for the second successive year. In Montana the Mountain Con mine was closed in March; the Banner Mining Co. suspended operations at the Miser's Chest mine, New Mexico, in October; and the Holden mine in Washington was closed in June.

TABLE 3.—Copper produced from domestic[1] ores, as reported by mines, smelters, and refineries, 1953–57, in short tons

Year	Mine	Smelter	Refinery
1953	926, 448	943, 391	932, 232
1954	835, 472	834, 381	841, 717
1955	998, 570	1, 007, 311	997, 499
1956	1, 106, 215	1, 117, 580	1, 080, 207
1957	1, 086, 141	1, 081, 055	1, 050, 496

[1] Includes Alaska.

As the price of copper dropped during the year, a number of producers curtailed output in an effort to bring supply in balance with demand. In October 1956 the Phelps Dodge Corp. had announced a 7½-percent cutback in output, and in March 1957 a further cutback was reported, equivalent to a 10-percent reduction in output for both cutbacks. Another announcement in September of a 5-percent reduction at the Morenci and Lavender open pits in Arizona resulted in a total cut in production of 15 percent and a work schedule of 22 days per month. The Anaconda Company began a 16-percent curtailment in output at its Yerington mine in Nevada, effective July 1; the company had previously announced a similar cutback in October 1956. Also, in July, a 20-percent cut was made by Miami Copper Co., Arizona. The Inspiration Consolidated Copper Co. in Arizona began a 500-ton-per-month curtailment in output in June, and in September, Calumet & Hecla, Inc., Michigan, announced a 10-percent reduction in production. In mid-December Kennecott Copper Corp. reported that it would reduce output approximately 12 percent at its mines in Utah, New Mexico, and Nevada, soon after the first of 1958. The company's Ray mine in Arizona had been on a 6-day-week basis since April 7, 1957.

Classification of production, by mining methods, showed that approximately 72 percent of the recoverable copper and 77 percent of the copper ore came from open pits in 1957. Most domestic copper ore was treated by flotation at or near the mine of origin, and the resulting concentrate was shipped for smelting. Some copper ores were direct-smelted either because of their high grade or because of their fluxing qualities.

The first 5 mines in table 8 produced 52 percent of the United States total, the first 10 produced 76 percent, and the entire 25 furnished 96 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 1957.

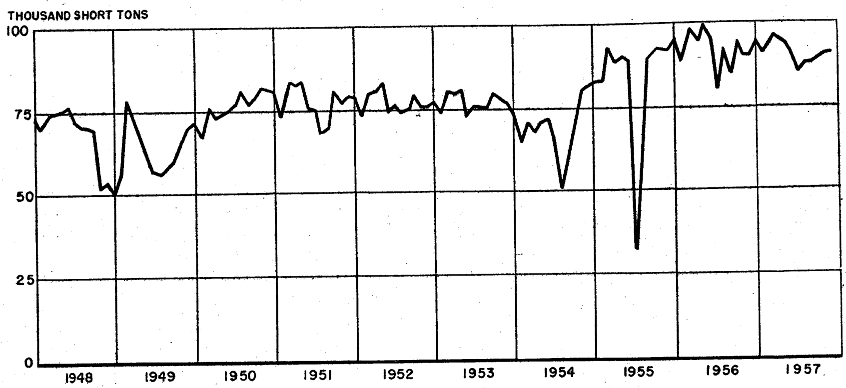

FIGURE 2.—Mine production of recoverable copper in the United States, 1948–57, by months, in short tons.

TABLE 4.—Copper ore and recoverable copper produced by open-pit and underground methods, 1940–57, percent of total

Year	Open pit		Underground		Year	Open pit		Underground	
	Ore	Copper	Ore	Copper		Ore	Copper	Ore	Copper
1940	61	44	39	56	1949	78	70	22	30
1941	63	47	37	53	1950	81	74	19	26
1942	66	51	34	49	1951	84	74	16	26
1943	69	54	31	46	1952	85	77	15	23
1944	68	57	32	43	1953	83	75	17	25
1945	68	61	32	39	1954	83	79	17	21
1946	66	58	34	42	1955	83	77	17	23
1947	73	68	27	32	1956	78	73	22	27
1948	76	68	24	32	1957	77	72	23	28

TABLE 5.—Mine production of recoverable copper in the United States in 1957, by months [1]

Month	Short tons	Month	Short tons
January	93, 294	August	87, 113
February	90, 411	September	87, 120
March	95, 369	October	89, 132
April	94, 561	November	90, 089
May	93, 228	December	90, 386
June	90. 469		
July	84, 969	Total	1, 086, 141

[1] Includes Alaska. Monthly figures adjusted to final annual mine-production total.

TABLE 6.—Mine production of recoverable copper in the United States, 1948–52 (average) and 1953–57, with production of maximum year, and cumulative production from earliest record to end of 1957, by States, in short tons

State	Maximum production [1]		Production by years						Total production from earliest record to end of 1957
	Year	Quantity	1948–52 (average)	1953	1954	1955	1956	1957	
Western States and Alaska:									
Alaska	1916	59,927	5		4	1	(2)	(2)	685,910
Arizona	1957	515,854	389,804	393,525	377,927	454,105	505,908	515,854	15,740,650
California	1909	28,644	699	382	362	613	859	945	634,889
Colorado	1938	14,171	2,932	2,941	4,523	4,323	4,228	5,115	288,651
Idaho	1957	7,912	2,108	3,136	4,828	5,618	6,656	7,912	148,119
Montana	1916	176,464	57,739	77,617	59,349	81,542	96,426	91,512	7,331,394
Nevada	1942	83,663	49,976	61,850	70,217	78,925	82,883	77,750	2,453,776
New Mexico	1942	80,100	69,209	72,477	60,558	66,417	74,345	67,472	2,097,718
Oregon	1916	1,791	11	9	5	4	7	23	12,458
South Dakota	1918	32							106
Texas	1928	224	14			1			1,384
Utah	1943	323,989	251,373	269,496	211,835	232,949	250,604	237,857	7,626,577
Washington	1940	9,612	4,889	3,740	3,636	3,958	2,926	1,700	121,569
Wyoming	1900	2,102		1	1		3	4	16,335
Total			828,759	885,174	793,245	928,456	1,024,845	1,006,144	37,159,536
West Central States: Missouri	1949	3,670	2,804	2,374	1,925	1,722	1,890	886	[3] 44,255
States east of the Mississippi:									
Alabama	1907	42							(4)
Georgia	1917	465							(4)
Maine	1918	383							(4)
Maryland	1917	146							(4)
Massachusetts	1906	5							(4)
Michigan	1916	136,846	23,914	24,097	23,593	50,066	61,526	58,400	5,180,925
New Hampshire	1908	[5] 94							(4)
North Carolina	1930	6,695			(6)	(6)	} 4,102	7,516 {	(4)
Pennsylvania	1942	6,410	4,449	3,027	3,270	4,110			(4)
South Carolina	(4)	(4)							(4)
Tennessee	1930	10,584	6,944	7,829	9,087	9,911	10,449	9,790	(4)
Vermont	1954	4,352	3,249	3,947	4,352	4,305	3,403	3,405	(4)
Virginia	1944	291							(4)
Wisconsin	1914	5							(4)
Total			38,556	38,900	40,302	68,392	79,480	79,111	[7] 5,924,476
Grand total	1956	1,106,215	870,119	926,448	835,472	998,570	1,106,215	1,086,141	[8] 43,128,267

[1] For Missouri and States east of the Mississippi, maximum since 1905.
[2] Less than 1 ton.
[3] Small quantity for Wisconsin included with Missouri. [4] Data not available.
[5] The 1908 volume of Mineral Resources credits this figure to Massachusetts and New Hampshire; the 1909 volume credits it to New Hampshire alone.
[6] Less than 0.5 ton.
[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 7.—Mine production of copper in the principal districts [1] of the United States, 1948–52 (average) and 1953–57, in terms of recoverable copper, in short tons

District or region	State	1948–52 (average)	1953	1954	1955	1956	1957
West Mountain (Bingham)	Utah	250,252	268,511	210,643	232,016	249,417	236,486
Copper Mountain (Morenci)	Arizona	142,748	123,789	114,362	124,630	127,350	106,977
Summit Valley (Butte)	Montana	57,187	77,520	59,240	81,428	96,292	91,392
Globe-Miami	Arizona	87,332	86,478	63,222	86,575	86,947	79,606
Warren (Bisbee)	do	19,420	29,344	41,884	58,145	72,080	73,392
Central (including Santa Rita)	New Mexico	[2] 67,058	69,869	58,178	64,084	71,216	65,377
Ajo	Arizona	61,053	64,730	60,794	70,222	66,432	62,458
Old Hat	do	378	3	2	(3)	39,078	59,902
Lake Superior	Michigan	23,914	24,097	23,593	50,066	61,526	58,400
Mineral Creek (Ray)	Arizona	34,729	47,574	40,462	49,174	53,518	56,888
Robinson (Ely)	Nevada	49,491	60,557	43,972	44,417	50,130	(4)
Yerington	do	12	(4)	26,040	33,918	31,216	27,034
Pioneer (Superior)	Arizona	19,670	25,093	26,521	23,948	23,891	21,776
Pima (Sierritas, Papago, Twin Buttes)	do	464	1,353	4,132	(4)	4,840	20,156
Silver Bell	do	22	85	(4)	(4)	19,975	19,259
Big Bug, Eureka, and Black Canyon	do	8,828	10,072	8,838	11,040	6,752	11,081
Ducktown	Tennessee	6,944	7,829	9,087	9,911	10,449	9,790
Lebanon County	Pennsylvania	4,449	3,027	3,270	4,110	(4)	(4)
Blackbird	Idaho	[5] 274	(4)	(4)	2,673	3,328	(4)
San Juan Mountains	Colorado	2,458	2,376	2,076	1,843	2,835	3,520
Coeur d'Alene	Idaho	1,638	2,100	2,566	2,637	2,889	3,473
Orange County	Vermont	3,249	3,947	4,352	4,305	3,403	3,405
Ashe County	North Carolina	----	----	(4)	(4)	(4)	2,886
Lordsburg	New Mexico	1,740	1,988	2,210	(4)	2,120	1,716
Chelan Lake	Washington	[6] 4,802	[7] 3,614	[8] 3,534	[8] 3,733	2,630	1,571
Redcliff (Battle Mountain)	Colorado	245	440	2,355	2,246	(4)	1,193
Cochise	Arizona	1,069	1,849	1,947	1,948	1,669	1,104
Southeastern Missouri	Missouri	2,804	2,374	1,925	1,722	1,890	886

[1] Districts producing 1,000 short tons or more in any year of the period 1953–57.
[2] Includes average for Burro Mountain for 1948–49 to avoid disclosing individual company operations.
[3] Less than 0.5 ton.
[4] Figures withheld to avoid disclosing individual company operations.
[5] Includes Spring Mountain and Texas for 1952 to avoid disclosing individual company operations.
[6] Includes average for Peshastin Creek and Wenatchee for 1949–50 to avoid disclosing individual company operations.
[7] Includes Ferry to avoid disclosing individual company operations.
[8] Includes Ferry and King to avoid disclosing individual company operations.

TABLE 8.—Twenty-five leading copper-producing mines in the United States, in 1957, in order of output

Rank	Mine	District	State	Operator	Source of copper
1	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
2	Morenci	Copper Mountain (Morenci)	Arizona	Phelps Dodge Corp	Copper, gold-silver ores.
3	Butte Mines (includes Kelley, Berkeley)	Summit Valley (Butte)	Montana	The Anaconda Co	Copper, silver-zinc ores.
4	Copper Queen-Lavender Pit	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper ore.
5	Chino	Central	New Mexico	Kennecott Copper Corp	Do.
6	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Copper, gold-silver ores.
7	San Manuel	Old Hat	do	San Manuel Copper Corp	Copper ore.
8	Ray Pit	Mineral Creek (Ray)	do	Kennecott Copper Corp	Do.
9	White Pine	Lake Superior	Michigan	White Pine Copper Co	Do.
10	Inspiration	Globe-Miami	Arizona	Inspiration Consolidated Copper Co	Do.
11	Yerington	Yerington	Nevada	The Anaconda Co	Do.
12	Magma	Pioneer (Superior)	Arizona	Magma Copper Co	Do.
13	Copper Cities	Globe-Miami	do	Copper Cities Mining Co	Do.
14	Miami	do	do	Miami Copper Co	Do.
15	Liberty Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Do.
16	Silver Bell	Silver Bell	Arizona	American Smelting & Refining Co	Do.
17	Calumet & Hecla, Inc	Lake Superior	Michigan	Calumet & Hecla, Inc	Copper ore and tailings.
18	Pima	Pima	Arizona	Pima Mining Co	Copper ore.
19	Tripp Pit	Robinson (Ely)	Nevada	Consolidated Coppermines Corp	Do.
20	Bagdad	Eureka (Bagdad)	Arizona	Bagdad Copper Corp	Do.
21	Burra Burra, Calloway, Mary, Eureka, Boyd	Polk County	Tennessee	Tennessee Copper Co	Copper-zinc ore.
22	Veteran Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp. and Consolidated Coppermines Corp.	Copper ore.
23	Cornwall	Lebanon County	Pennsylvania	Bethlehem Steel Co	Magnetite-pyrite-chalcopyrite ore.
24	Minnesota-Hi	Robinson (Ely)	Nevada	Kennecott Copper Corp	Copper ore.
25	Mineral Hill, Daisy, Copper Glance	Pima	Arizona	Banner Mining Co	Do.

TABLE 9.—Copper ore sold or treated in the United States in 1957, with copper, gold, and silver content in terms of recoverable metals [1]

State	Ore sold or treated (short tons)	Recoverable metal content				Value of gold and silver per ton of ore
		Copper		Gold (fine ounces)	Silver (fine ounces)	
		Pounds	Percent			
Arizona	59,571,834	947,840,100	0.80	123,375	4,088,618	$0.13
California	8,198	239,200	1.46	540	6,007	2.97
Colorado	32,138	1,872,100	2.91	2,313	599,688	19.41
Idaho	282,550	8,680,800	1.54	4,284	18,160	.59
Michigan [2]	8,308,580	116,800,000	.70	----------	430,000	.05
Montana	9,576,968	176,471,681	.92	16,964	2,480,760	.30
Nevada	11,514,197	155,401,000	.67	48,872	408,441	.18
New Mexico	7,600,248	102,420,000	.67	1,796	51,537	.01
North Carolina	102,635	5,772,000	2.81	628	11,761	.32
Oregon	167	43,100	12.90	38	157	8.81
Tennessee [3]	1,394,020	19,580,000	.70	172	54,407	.04
Utah	30,933,883	460,791,500	.74	352,735	2,871,007	.48
Vermont	222,625	6,810,000	1.53	62	36,794	.16
Washington	167,474	3,308,700	.99	10,453	39,896	2.40
Wyoming	69	7,700	5.58	2	34	1.46
Total	129,715,586	2,006,037,881	.77	562,234	11,097,267	.23

[1] Excludes copper recovered from precipitates as follows: Arizona, 75,180,700 pounds; California, 44,200 pounds; Montana, 2,788,396 pounds; New Mexico, 28,357,100 pounds; Utah, 9,777,200 pounds.
[2] Includes tailing.
[3] Copper-zinc ore.

TABLE 10.—Copper ore concentrated in the United States in 1957, with content in terms of recoverable copper

State	Ore concentrated (short tons)	Recoverable copper content	
		Pounds	Percent
Arizona	[1] 54,835,773	[2] 849,648,900	0.77
California	7,280	162,300	1.11
Colorado	575	7,600	.66
Idaho	276,103	7,862,700	1.42
Michigan [3]	8,308,580	116,800,000	.70
Montana	9,576,788	176,448,081	.92
Nevada	[4] 11,421,709	[4] 151,307,600	.66
New Mexico	[5] 7,393,962	[6] 100,776,100	.68
North Carolina	102,635	5,772,000	2.81
Tennessee [7]	1,394,020	19,580,000	.70
Utah	[8] 30,932,913	[9] 460,622,000	.74
Vermont	222,625	6,810,000	1.53
Washington	167,473	3,308,100	.99
Total	124,640,436	1,899,105,381	.76

[1] In addition 4,112,282 tons was treated by straight leaching.
[2] In addition 35,310,800 pounds of copper was recovered by straight leaching.
[3] Includes tailings.
[4] Includes ore treated by straight leaching, and copper precipitates recovered therefrom; Bureau of Mines not at liberty to publish.
[5] In addition 135,592 tons was treated by straight leaching.
[6] In addition 131,200 pounds of copper was recovered by straight leaching.
[7] Copper-zinc ore.
[8] In addition 50 tons was treated by straight leaching.
[9] In addition 700 pounds of copper was recovered by straight leaching.

Smelter Production.—The total recovery of copper by smelters in the United States was nearly 1.3 million tons—4 percent less than in 1956. The output from all sources was lower than in the previous year. In 1957 production from domestic ores constituted 27 percent of world production, compared with 51 percent in 1925–29 and a range of 25–34 percent in 1945–56.

TABLE 11.—Copper ore shipped to smelters in the United States in 1957, with content in terms of recoverable copper

State	Ore shipped to smelters			State	Ore shipped to smelters		
	Short tons	Recoverable copper content			Short tons	Recoverable copper content	
		Pounds	Percent			Pounds	Percent
Arizona	623,779	62,880,400	5.04	New Mexico	70,694	1,512,700	1.07
California	918	76,900	4.19	Oregon	167	43,100	12.90
Colorado	31,563	1,864,500	2.95	Utah	920	168,800	9.17
Idaho	6,447	818,100	6.34	Washington	1	600	30.00
Montana	180	23,600	6.56	Wyoming	69	7,700	5.58
Nevada	92.488	4,093,400	2.21	Total	827,226	71,489,800	4.32

TABLE 12.—Copper ores [1] produced in the United States, 1948–52 (average) and 1953–57, 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
1948–52 (average)	765,715	3.51	85,730,351	0.87	90,157,814	0.89	0.0059	0.089	$0.29
1953	893,248	3.47	96,594,903	.82	101,064,945	.85	.0061	.091	.30
1954	896,363	4.02	89,620,197	.79	93,654,258	.83	.0056	.087	.27
1955	877,287	3.81	108,060,525	.81	112,549,665	.83	.0052	.102	.28
1956	906,319	4.11	127,251,488	.75	131,775,959	.78	.0044	.087	.23
1957	827,226	4.32	124,640,436	.76	129,715,586	.77	.0043	.086	.23

[1] Includes old tailings, smelted or re-treated, etc., for 1948–52.
[2] Includes some ore classed as copper-zinc ore.
[3] Includes copper ore leached.

Smelter-production data are based upon reports from domestic primary smelters handling copper-bearing materials. Blister copper is accounted for in terms of fine-copper content. Production of furnace-refined copper in Michigan is included in smelter production, as well as in refinery output. Metallic and cement copper recovered by leaching is included in smelter production.

The quantity and value of copper produced from domestic ores by smelters in the United States were shown by years for 1845–1955 in Minerals Yearbook, 1955, volume I.

TABLE 13.—Copper produced by primary smelters in the United States, 1948–52 (average) and 1953–57, in short tons

Year	Domestic	Foreign	Secondary	Total
1948–52 (average)	873,980	96,955	62,094	1,033,029
1953	943,391	104,419	72,532	1,120,342
1954	834,381	111,518	83,747	1,029,646
1955	1,007,311	99,215	53,554	1,160,080
1956	1,117,580	113,772	81,374	1,312,726
1957	1,081,055	97,090	75,931	1,254,076

Refinery Production.—The refinery output of primary copper in the United States in 1957 was made by 14 plants; 8 of these employed the electrolytic method only, 3 used the furnace process on Lake Superior copper, and 2 used both the electrolytic and furnace methods. One western smelter fire-refined its blister but shipped part of its blister output to electrolytic refineries in 1957. The leaching plant of the Inspiration Consolidated Copper Co. at Inspiration, Ariz., produced electrolytic copper direct from leaching solutions; all this copper was shipped as cathodes to other refineries for melting and casting into merchant shapes.

These 14 plants constitute what commonly are termed "primary refineries." The electrolytic plants, exclusive of that at Inspiration, had a rated capacity of 1,687,000 tons of refined copper a year and produced at 90 percent of capacity in 1957, the same as in 1956.

Five large electrolytic refineries were on the Atlantic seaboard; 3 lake refineries, on the Great Lakes; 4 electrolytic refineries, west of the Great Lakes (1 each at Great Falls (Mont.), Tacoma (Wash.),

TABLE 14.—Primary and secondary copper produced by primary refineries in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Primary:						
From domestic ores, etc.: [1]						
Electrolytic	765,738	826,086	777,507	883,674	948,732	945,394
Lake	24,133	23,671	22,510	35,387	57,053	58,814
Casting	80,236	82,475	41,700	78,438	74,422	46,288
Total	870,107	932,232	841,717	997,499	1,080,207	1,050,496
From foreign ores, etc.: [1]						
Electrolytic	261,871	353,727	353,667	320,822	351,768	372,791
Casting and best select		7,158	16,535	24,138	10,658	30,889
Total refinery production of new copper	1,131,978	1,293,117	1,211,919	1,342,459	1,442,633	1,454,176
Secondary:						
Electrolytic [2]	166,738	166,802	156,764	196,386	220,340	203,073
Casting	14,245	22,783	23,179	10,169	13,477	8,521
Total secondary	180,983	189,585	179,943	206,555	233,817	211,594
Grand total	1,312,961	1,482,702	1,391,862	1,549,014	1,676,450	1,665,770

[1] The separation of refined copper into metal of domestic and foreign origin is only approximate, as accurate separation is not possible at this stage of manufacture.
[2] Includes copper reported from foreign scrap.

TABLE 15.—Copper cast in forms at primary refineries in the United States, 1955–57

Form	1955		1956		1957	
	Thousand short tons	Percent	Thousand short tons	Percent	Thousand short tons	Percent
Wirebars	963	62	1,049	63	1,028	62
Cathodes	109	7	125	8	170	10
Billets	162	11	190	11	165	10
Ingots and ingot bars	141	9	155	9	152	9
Cakes	158	10	141	8	136	8
Other forms	16	1	16	1	15	1
Total	1,549	100	1,676	100	1,666	100

El Paso (Tex.), and Garfield (Utah)). The El Paso plant of the Phelps Dodge Refining Corp. and the Carteret plant of the American Metal Climax, Inc., produced fire-refined copper, in addition to the electrolytic grade.

Copper Sulfate.—Shipments of copper sulfate increased 5 percent over 1956. Of the total shipments, producers' reports indicated that 15,700 tons (13,900 in 1956) was for agricultural uses, 20,800 (22,000) for industrial uses, and 33,800 (31,100) for other purposes, chiefly for export.

TABLE 16.—Production, shipments, and stocks of copper sulfate, 1948–52 (average) and 1953–57, in short tons

Year	Production		Shipments (gross weight)	Stocks at end of year[1] (gross weight)
	Gross weight	Copper content		
1948–52 (average)	92,896	23,224	93,106	6,434
1953	72,944	18,236	72,188	7,072
1954	65,308	16,327	66,488	5,540
1955	78,088	19,522	79,112	4,852
1956	66,808	16,702	67,008	4,068
1957	70,680	17,670	70,256	3,828

[1] Some small quantities are purchased and used by producing companies, so that the figures given do not balance exactly.

SECONDARY COPPER AND BRASS [3]

Domestic recovery of copper in unalloyed and alloyed form, from all classes of nonferrous scrap metals, totaled 825,000 short tons in 1957—11 percent lower than the 931,000 tons recovered in 1956 and the lowest since 1949, when 713,000 tons was reclaimed. Production of refined copper and of brass ingot by secondary smelters declined 8 and 10 percent, respectively; the secondary copper content of brass-mill products dropped 14 percent, and the output of refined copper from secondary sources, by primary producers, decreased 10 percent.

Demand for copper scrap was weaker in 1957 than in 1956, but this did not result in an oversupply. The lower industrial activity reduced generation of process scrap; and low prices, together with high labor costs, curtailed old scrap-collection operations. Total copper-scrap consumption declined 10 percent in 1957 and affected nearly all items consumed. There were moderate increases in the use of No. 2 wire by secondary smelters, of low-grade scrap and residues by primary producers, and of low-brass scrap by brass mills. According to the Bureau of Census,[4] shipments of brass-mill products decreased 12 percent to 974,000 tons.

Domestic consumption of brass and bronze ingot reported by foundries in 1957 decreased 26 percent. A total of 1,741 plants reported use of ingot and/or refined copper and scrap in 1957. Of these plants, 1,349 used brass ingot, 636 used scrap, and 454 used refined copper. In California 49 percent of the foundries reporting used scrap, in Pennsylvania 48 percent, in Ohio 37 percent, and in Illinois 20 percent.

[3] Prepared by Archie J. McDermid, commodity specialist.
[4] Bureau of the Census, Facts for Industry, Shipments of Copper-Base Mill and Foundry Products: Fourth Quarter and Summary for 1957, ser. BDSAF-84-07, Apr. 22, 1958, p. 1.

Of the total copper-scrap consumption by foundries, 56,000 tons consisted of railroad-car boxes, distributed as follows:

	Short tons
Indiana, Kansas, and Texas	4,934
California, Colorado, Oregon, and Washington	6,943
Florida, Georgia, Tennessee, and Virginia	10,241
Illinois	5,924
Minnesota and Wisconsin	4,662
Massachusetts, New York, and Pennsylvania	9,629
Missouri	7,490
Ohio	5,813
Total	55,636

TABLE 17.—Secondary copper produced in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957 (preliminary)
Copper recovered as unalloyed copper	231,037	242,855	212,241	246,928	273,060	248,940
Copper recovered in alloys [1]	668,693	715,609	627,666	742,076	657,604	575,964
Total secondary copper	899,730	958,464	839,907	989,004	930,664	824,904
From new scrap	450,333	529,076	432,841	474,419	462,175	396,627
From old scrap	449,397	429,388	407,066	514,585	468,489	428,277
Percentage equivalent of domestic mine output	103	103	101	99	84	76

[1] Includes copper in chemicals, as follows: 1948–52 (average), 17,632; 1953, 21,550; 1954, 18,055; 1955, 15,898; 1956, 14,739; 1957, 14,240.

TABLE 18.—Copper recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1956–57, in short tons

Kind of scrap	1956	1957 (preliminary)	Form of recovery	1956	1957 (preliminary)
New scrap:			As unalloyed copper:		
Copper-base	456,099	390,203	At primary plants	233,817	211,594
Aluminum-base	5,727	6,013	At other plants	39,243	37,346
Nickel-base	311	232			
Zinc-base	38	179	Total	273,060	248,940
Total	462,175	396,627	In brass and bronze	620,779	544,394
			In alloy iron and steel	2,917	2,169
Old scrap:			In aluminum alloys	18,784	14,833
Copper-base	464,623	424,445	In other alloys	385	328
Aluminum-base	2,744	2,909	In chemical compounds	14,739	14,240
Nickel-base	1,038	689			
Lead-base	5	5	Total	657,604	575,964
Tin-base	33	29			
Zinc-base	46	200	Grand total	930,664	824,904
Total	468,489	428,277			
Grand total	930,664	824,904			

TABLE 19.—Copper recovered as refined copper, in alloys and in other forms, from copper-base scrap processed in the United States, 1956–57, in short tons

	From new scrap		From old scrap		Total	
	1956	1957 (preliminary)	1956	1957 (preliminary)	1956	1957 (preliminary)
By secondary smelters	62,493	52,592	214,703	202,662	277,196	255,254
By primary copper producers	105,570	98,910	135,345	119,251	240,915	218,161
By brass mills	264,446	222,782	26,090	26,814	290,536	249,596
By foundries and manufacturers	21,754	14,686	83,654	70,699	105,408	85,385
By chemical plants	1,836	1,233	4,831	5,019	6,667	6,252
Total	456,099	390,203	464,623	424,445	920,722	814,648

TABLE 20.—Production of secondary copper and copper-alloy products in the United States, 1955–57, in short tons

Item produced from scrap						Gross weight produced		
						1955	1956	1957 (preliminary)
Unalloyed copper products:								
Refined copper by primary producers						206,555	233,817	211,594
Refined copper by secondary smelters						29,762	27,382	25,312
Copper powder [1]						9,138	9,337	7.348
Copper castings						1,473	2,524	2,064
Total						246,928	273,060	246,318
Item produced from scrap	Nominal composition (percent)							
	Cu	Sn	Pb	Zn	Ni			
Brass and bronze ingots (gross weight):								
Tin bronze	88	10		2		14,911	17,803	15,728
Leaded tin bronze	88	6	1.5	4.5		20,129	20,816	18,253
Leaded red bronze	85	5	5	5		115,888	104,698	91,790
Leaded semired brass	81	3	7	9		69,844	58,054	57,096
High-leaded tin bronze	80	10	10			21,446	22,915	19,268
Do	84	6	8	2		16,928	20,311	16,876
Do	75	5	20			6,889	5,742	4,098
Leaded yellow brass	66	1	3	30		25,062	18,834	16,817
Nickel silver	58	2	7	18	14	} 3,230	} 4,107	} 3,634
Do	65	4	3	5	22			
Low brass	80			20		4,012	3,272	2,481
Conductor bronze	94	2	2	2		1,031	760	696
Manganese bronze	60Cu, 40Zn, ±Mn, Al, etc					13,840	15,483	15,777
Aluminum bronze	90Cu, 10Al, ±Mn, Zn, Fe, etc					5,137	6,421	5,907
Silicon bronze	92Cu, +Si, ±Zn, Fe, Al, Mn					4,677	4,888	4,243
Copper-base hardeners and miscellaneous alloys						12,884	12,896	11,583
Total						335,908	317,000	284,247
Brass-mill products						470,780	383,057	329,956
Brass and bronze castings						105,670	102,806	84,998
Brass powder						1,715	1,027	2,622
Copper in chemical products						15,898	14,739	14,240
Grand total						1,176,899	1,091,689	962,381

[1] Includes black-copper shipments.

TABLE 21.—Composition of secondary copper-alloy production, 1955–57, gross weight in short tons

Year	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Total
BRASS- AND BRONZE-INGOT PRODUCTION [1]							
1955	259,384	16,670	21,481	37,896	411	66	335,908
1956	248,828	14,703	20,240	32,639	526	64	317,000
1957 (preliminary)	224,703	12,828	17,425	28,737	493	61	284,247
SECONDARY METAL CONTENT OF BRASS-MILL PRODUCTS							
1955	356,489	119	4,059	108,095	1,948	70	470,780
1956	290,552	94	3,359	87,349	1,627	76	383,057
1957 (preliminary)	249,597	94	3,167	75,597	1,406	95	329,956
SECONDARY METAL CONTENT OF BRASS AND BRONZE CASTINGS							
1955	81,168	4,857	13,005	6,413	62	165	105,670
1956	80,540	4,666	11,602	5,795	51	152	102,806
1957 (preliminary)	66,081	3,926	10,166	4,699	34	92	84,998

[1] About 95 percent secondary metal and 5 percent primary metal.

TABLE 22.—Stocks and consumption of new and old copper scrap in the United States in 1957 (preliminary), gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts		Consumption				Stocks, end of year
		Purchased scrap	Machine-shop scrap	Purchased scrap			Machine-shop scrap	
				New	Old	Total		
Secondary smelters:								
No. 1 wire and heavy copper	2,600	37,802	--------	3,526	34,023	37,549	--------	2,853
No. 2 wire, mixed heavy, and light copper	3,001	45,693	--------	1,759	43,427	45,186	--------	3,508
Composition or red brass	4,009	86,350	--------	31,889	54,217	86,106	--------	4,253
Railroad-car boxes	41	344	--------	2	295	297	--------	88
Yellow brass	5,343	61,555	--------	9,212	52,161	61,373	--------	5,525
Cartridge cases	76	1,804	--------	3	1,618	1,621	--------	259
Auto radiators (unsweated)	3,041	46,562	--------	--------	46,583	46,583	--------	3,020
Bronze	1,574	28,435	--------	9,664	18,421	28,085	--------	1,924
Nickel silver	453	3,582	--------	751	2,690	3,441	--------	594
Low brass	339	3,048	--------	1,909	1,216	3,125	--------	262
Aluminum bronze	181	463	--------	64	344	408	--------	236
Low-grade scrap and residues	5,717	41,247	--------	22,899	16,791	39,690	--------	7,274
Total	26,375	356,885	--------	81,678	271,786	353,464	--------	29,796
Primary producers:								
No. 1 wire and heavy copper	1,401	47,064	--------	21,504	26,296	47,800	--------	665
No. 2 wire, mixed heavy, and light copper	4,921	101,208	--------	55,424	47,716	103,140	--------	2,989
Refinery brass	3,017	27,507	--------	8,400	20,712	29,112	--------	1,412
Low-grade scrap and residues	53,881	145,505	--------	59,487	108,645	168,132	--------	31,254
Total	63,220	321,284	--------	144,815	203,369	348,184	--------	36,320
Brass mills: [1]								
No. 1 wire and heavy copper	3,857	61,222	--------	48,067	13,155	61,222	--------	4,633
No. 2 wire, mixed heavy, and light copper	4,290	26,644	--------	24,526	2,118	26,644	--------	1,798
Yellow brass	24,452	166,827	--------	163,589	3,238	166,827	--------	22,037

See footnote at end of table.

TABLE 22.—Stocks and consumption of new and old copper scrap in the United States in 1957 (preliminary), gross weight in short tons—Continued

Class of consumer and type of scrap	Stocks, beginning of year	Receipts		Consumption				Stocks, end of year
		Purchased scrap	Machine-shop scrap	Purchased scrap			Machine-shop scrap	
				New	Old	Total		
Brass mills:[1]—Continued								
Cartridge cases and brass	3,505	41,807	--------	29,286	12,521	41,807	--------	1,635
Bronze	1,272	1,698	--------	1,449	249	1,698	--------	1,028
Nickel silver	2,202	6,416	--------	6,350	66	6,416	--------	2,119
Low brass	2,722	22,706	--------	21,883	823	22,706	--------	2,760
Aluminum bronze	355	934	--------	934	--------	934	--------	248
Mixed alloy scrap	3,206	6,894	--------	6,894	--------	6,894	--------	3,739
Total [1]	45,861	335,148	--------	302,978	32,170	335,148	--------	39,997
Foundries, chemical plants and other manufacturers:								
No. 1 wire and heavy copper	2,547	18,988	432	5,592	13,894	19,486	270	2,211
No. 2 wire, mixed heavy, and light copper	1,894	11,022	167	5,400	6,279	11,679	172	1,232
Composition or red brass	3,152	5,263	9,273	1,590	4,857	6,447	9,712	1,529
Railroad-car boxes	3,117	56,076	2,037	--------	55,636	55,636	2,036	3,558
Yellow brass	1,743	11,447	6,040	3,208	7,411	10,619	6,173	2,438
Auto radiators (unsweated)	110	5,256	--------	--------	5,236	5,236	--------	130
Bronze	1,014	4,354	2,889	951	2,995	3,946	2,859	1,452
Nickel silver	42	48	224	10	43	53	205	56
Low brass	153	752	696	12	802	814	624	163
Aluminum bronze	248	790	517	177	581	758	510	287
Low-grade scrap and residues	724	6,526	1,453	2,261	3,392	5,653	1,405	1,645
Total	14,744	120,522	23,728	[2] 19,201	[2] 101,126	[2] 120,327	23,966	14,701
Grand total:[3]								
No. 1 wire and heavy copper	10,405	165,076	432	78,689	87,368	166,057	270	10,362
No. 2 wire, mixed heavy, and light copper	14,106	184,567	167	87,109	99,540	186,649	172	9,527
Composition or red brass	7,161	91,613	9,273	33,479	59,074	92,553	9,712	5,782
Railroad-car boxes	3,158	56,420	2,037	2	55,931	55,933	2,036	3,646
Yellow brass	31,538	239,829	6,040	176,009	62,810	238,819	6,173	30,000
Cartridge cases and brass	3,581	43,611	--------	29,289	14,139	43,428	--------	1,894
Auto radiators (unsweated)	3,151	51,818	--------	--------	51,819	51,819	--------	3,150
Bronze	3,860	34,487	2,889	12,064	21,665	33,729	2,859	4,404
Nickel silver	2,697	10,046	224	7,111	2,799	9,910	205	2,769
Low brass	3,214	26,506	696	23,804	2,841	26,645	624	3,185
Aluminum bronze	784	2,187	517	1,175	925	2,100	510	771
Low-grade scrap and residues [4]	63,339	220,785	1,453	93,047	149,540	242,587	1,405	41,585
Mixed alloy scrap	3,206	6,894	--------	6,894	--------	6,894	--------	3,739
Total [3]	150,200	1,133,839	23,728	548,672	608,451	1,157,123	23,966	120,814

[1] Brass-mill stocks include home scrap; purchased scrap consumption assumed equal to receipts, so lines in brass-mill and grand total sections do not balance.
[2] Of the totals shown, chemical plants reported the following: Unalloyed copper scrap, 1,114 tons of new and 3,934 old; copper-base alloy scrap, 1,261 tons of new and 3,387 old.
[3] Includes machine-shop scrap receipts and consumption for foundries, chemical plants, and other manufacturers.
[4] Includes refinery brass.

TABLE 23.—Consumption of copper and brass materials in the United States, 1956–57, by principal consuming groups, in short tons

Item consumed	Primary producers	Brass mills	Wire mills	Foundries and miscellaneous minor users	Secondary smelters
1956					
Copper scrap	370,946	388,738		135,933	384,780
Refined copper [1]		611,098	864,585	36,294	7,654
Brass ingot		7,670	731	[2] 305,049	
Slab zinc		111,778		5,304	6,922
Miscellaneous		348		302	15,267
1957 (preliminary)					
Copper scrap	348,184	335,148		110,631	353,464
Refined copper [1]		533,954	773,632	30,873	7,876
Brass ingot		6,757	734	[2] 281,472	
Slab zinc		101,212		4,240	6,938
Miscellaneous		181		201	14,041

[1] Detailed information on consumption of refined copper will be found in table 27.
[2] Shipments to foundries by smelters plus decrease in stocks at foundries.

TABLE 24.—Foundry consumption of brass ingot by types, refined copper, and copper scrap, in the United States in 1957 (preliminary), by geographic divisions and States, in short tons

Geographic division and State	Tin bronze	Leaded tin bronze	Leaded red brass	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total brass ingot	Refined copper consumed	Copper scrap consumed
New England:												
Connecticut	181	1,220	2,576	371	2,037	100	7	10	482	6,984	1,336	1,057
Maine	17	23	134	84	1	53	13			325	} 488	1,080
Massachusetts	871	1,368	3,409	463	56	384	22	164	245	6,982		
New Hampshire	8	18	418	114	383	59	1	176	75	1,252	} 144	23
Rhode Island and Vermont	27	62	865	23	12	16	6		537	1,548		
Total	1,104	2,691	7,402	1,055	2,489	612	49	350	1,339	17,091	1,968	2,160
Middle Atlantic:												
New Jersey	938	523	3,809	524	233	581	22	103	29	6,762	709	4,168
New York	933	2,517	8,537	1,893	248	812	95	130	1,247	16,412	1,954	6,565
Pennsylvania	2,689	3,361	14,520	1,104	995	2,721	255	205	1,386	27,236	7,433	15,456
Total	4,560	6,401	26,866	3,521	1,476	4,114	372	438	2,662	50,410	10,096	26,189
East North Central:												
Illinois	871	1,773	15,578	1,201	135	495	48	313	572	20,986	501	8,182
Indiana	359	135	9,746	732	42	109	45	30	15	11,213	1,149	5,623
Michigan	798	260	9,456	312	776	688	81	5	199	12,575	4,187	2,394
Ohio	1,589	5,554	16,310	8,154	214	845	195	260	645	33,766	4,925	10,788
Wisconsin	564	878	6,043	1,895	890	309	116	913	202	11,810	4,419	2,630
Total	4,181	8,600	57,133	12,294	2,057	2,446	485	1,521	1,633	90,350	15,181	29,617
West North Central:												
Iowa	26	27	1,778	61	1	139	8	49		2,089	} 451	{ 48
Kansas	64	3	248	12	76	19		3	5	430		2,349
Minnesota	721	35	1,425	269	30	31	6	3	254	2,774	75	3,194
Missouri	74	41	1,424	173	606	70	2	1	507	2,898	445	10,288
Nebraska and South Dakota	26	1	108		144	5				284	8	17
Total	911	107	4,983	515	857	264	16	56	766	8,475	979	15,896

TABLE 24.—Foundry consumption of brass ingot by types, refined copper, and copper scrap, in the United States in 1957 (preliminary), by geographic divisions and States, in short tons—Continued

Geographic division and State	Tin bronze	Leaded tin bronze	Leaded red brass	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total brass ingot	Refined copper consumed	Copper scrap consumed
South Atlantic:												
Delaware	15	14	601	11	4	17				662		205
Florida	3		67		13	36			1	120	29	
Georgia	27	593	30	5	47	6			14	722		1,158
Maryland and District of Columbia	155	90	150	185		72	10	94	16	772	294	643
North and South Carolina	35	24	796	164	85	12		3	5	1,124	436	118
Virginia	420	226	98	343	142	20	10			1,259	213	9,069
West Virginia	20		4,028	138	460	77			12	4,735	155	252
Total	675	947	5,770	846	751	240	20	97	48	9,394	1,127	11,445
East South Central:												
Alabama	11	310	1,274	76		110		35	336	2,152	203	77
Kentucky	2	63	166	235	4,556	1	2		12	5,037		227
Mississippi			4			3				7		4,720
Tennessee	77	324	888	880	15	37	8			2,229		
Total	90	697	2,332	1,191	4,571	151	10	35	348	9,425	203	5,024
West South Central:												
Arkansas and Louisiana	63	21	83	19	7	42	1		9	245		440
Oklahoma											568	30
Texas	84	103	3,769	296	71	388	14	32	171	4,928		2,849
Total	147	124	3,852	315	78	430	15	32	180	5,173	568	3,319
Mountain:												
Arizona, Colorado, and New Mexico	105	31	122	21	2	55	1	11	19	367	56	1,644
Montana, Nevada, and Utah		10	68	1	3	19			8	109	258	440
Total	105	41	190	22	5	74	1	11	27	476	314	2,084
Pacific:												
California	289	546	6,942	547	921	265	42	21	141	9,714	169	12,008
Oregon											53	1,404
Washington	8	8	51	36		8	1			112	215	1,485
Total	297	554	6,993	583	921	273	43	21	141	9,826	437	14,897
Grand total	12,070	20,162	115,521	20,342	13,205	8,604	1,011	2,561	7,144	200,620	30,873	110,631

TABLE 25.—Dealers' monthly average buying prices for copper scrap and consumers' alloy-ingot prices at New York in 1957, in cents per pound

[Metal Statistics, 1958]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
No. 1 Heavy Copper Scrap	25.16	22.08	22.26	22.70	21.95	21.00	19.75	19.20	16.35	17.03	17.03	16.60	20.09
No. 1 Composition Scrap	24.11	21.53	20.75	21.20	20.61	19.67	18.75	18.58	16.49	16.08	15.75	15.75	19.11
No. 1 Composition Ingot	34.68	31.56	31.50	31.50	30.95	30.15	29.50	29.26	27.45	27.23	27.19	27.25	29.85

CONSUMPTION

Apparent consumption of primary copper, which includes deliveries to the national strategic stockpile, when there are any, decreased 9 percent in 1957.

TABLE 26.—New refined copper withdrawn from total year's supply on domestic account, 1953–57, in short tons

	1953	1954	1955	1956	1957
Production from domestic and foreign ores, etc	1,293,117	1,211,919	1,342,459	1,442,633	1,454,176
Imports [1]	274,111	215,086	202,312	191,745	162.309
Stock at beginning of year [1]	26,000	49,000	25,000	34,000	78,000
Total available supply	1,593,228	1,476,005	1,569,771	1,668,378	1,694,485
Copper exported [1]	109,580	215,951	199,819	223,103	346,025
Stock at end of year [1]	49,000	25,000	34,000	78,000	109,000
Total	158,580	240,951	233,819	301,103	455,025
Apparent withdrawals on domestic account [2]	1,435,000	1,235,000	1,336,000	1,367,000	1,239,000

[1] May include some copper refined from scrap.
[2] Includes copper delivered by industry to the national strategic stockpile.

Actual consumption of refined copper in 1957 was 11 percent below that in 1956. Consumption in the first and second quarters of the year averaged 118,000 and 118,800 tons per month, respectively. Vacations at fabricators in July and the decrease in demand in consumers' activities resulted in a drop to a monthly average of 101,700 tons in the third quarter; consumption then rose to 111,500 tons in the last 3 months of 1957.

Distribution of consumption by principal consuming groups followed the pattern of recent years, with wire mills using 57 percent and brass mills 40 percent of the total consumed in 1957 (1956 percentages were identical). Unlike table 26, in which all but new copper is eliminated so far as possible, table 27 does not distinguish between new and old copper but lists all copper in refined form.

Some copper precipitates were used directly in manufacturing paint and other items. The figures may not be shown separately and are not covered by table 27, which relates to refined copper only.

TABLE 27.—Refined copper consumed in 1955–57, by classes of consumers, in short tons

Class of consumer	Cathodes	Wire bars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1955							
Wire mills	9,050	791,816	11,797				812,663
Brass mills	100,819	63,394	133,710	200,012	149,064	45	647,044
Chemical plants			564			1,180	1,744
Secondary smelters	4,768		1,213	469		377	6,827
Foundries	4,063	58	13,004	3	211	139	17,478
Miscellaneous [1]	1,403	131	4,079	318	377	9,940	16,248
Total	120,103	855,399	164,367	200,802	149,652	11,681	1,502,004
1956							
Wire mills	9,694	838,476	16,415				864,585
Brass mills	91,887	72,716	102,451	177,583	166,426	35	611,098
Chemical plants			559			1,199	1,758
Secondary smelters	5,602		1,411	207		434	7,654
Foundries	5,180	76	13,341	3	237	143	18,980
Miscellaneous [1]	1,824	85	5,532	402	538	8,933	17,314
Total	114,187	911,353	13[illegible],709	178,195	167,201	10,744	1,521,389
1957 (preliminary)							
Wire mills	5,641	751,815	15,406			770	773,632
Brass mills	85,833	57,399	76,046	158,344	156,292	40	533,954
Chemical plants			708			772	1,480
Secondary smelters	5,197		1,839	212		628	7,876
Foundries	4,113	417	12,177		154	138	16,999
Miscellaneous [1]	1,905	204	2,285	204	495	8,781	13,874
Total	102,689	809,835	108,461	158,760	156,941	11,129	1,347,815

[1] Includes iron and steel plants, primary smelters producing alloys other than copper, consumers of copper powder and copper shot, and miscellaneous manufacturers.

Figures on apparent consumption of primary copper are available for a long period, whereas compilations on the actual consumption of refined copper were begun in 1945. In estimating apparent consumption it has been assumed that copper used in primary fabrication of copper is consumed. Although table 26 aims to show primary consumption only, it should be noted that exports and stocks, as well as the import component of "total supply," doubtless include some refined secondary copper that cannot be determined separately. Actual consumption of new copper would also differ from the figures shown in the table by changes in consumers' stocks.

STOCKS

Producers' stocks of refined and unrefined copper rose 13 percent in 1957. These stocks rose in February and, except for slight declines in April, September, and November, continued to increase throughout the year. Refined stocks increased 40 percent over 1956 and were the largest since 1945. Inventories of unrefined copper were 5 percent higher. Of the total stocks at the end of 1957, 28 percent was in the form of refined copper, and the remainder consisted of smelter shapes in inventory at smelters, in transit to refineries, and smelter shapes and materials in process of refining at refineries.

Figures compiled by the Copper Institute show that domestic stocks of refined copper increased from 120,645 tons to 181,024 in

TABLE 28.—Stocks of copper at primary smelting and refining plants in the United States at end of year, 1952–57, in short tons

Year	Refined copper [1]	Blister and materials in process of refining [2]	Year	Refined copper [1]	Blister and materials in process of refining [2]
1952	26,000	185,000	1955	34,000	201,000
1953	49,000	223,000	1956	78,000	261,000
1954	25,000	189,000	1957	109,000	274,000

[1] May include some copper refined from scrap.
[2] Includes copper in transit from smelters in the United States to refineries therein.

TABLE 29.—Stocks of copper in fabricators' hands at end of year, 1953–57, in short tons

[United States Copper Association]

Year	Stocks of refined copper [1] (1)	Unfilled purchases of refined copper from producers (2)	Working stocks (3)	Unfilled sales to customers (4)	Excess stocks over orders booked [2] (5)
1953	380,881	25,022	309,664	170,917	−74,678
1954	360,526	58,125	304,619	136,581	−22,549
1955	389,974	139,094	314,145	293,264	−78,341
1956	437,187	117,601	336,217	183,834	34,737
1957	430,171	75,627	347,465	138,631	19,702

[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).

1957. Inventory data of the Bureau of Mines and Copper Institute always differ, owing to somewhat different bases. Before 1947 a principal reason was that Copper Institute coverage was limited to duty-free copper. After January 1, 1947, all copper was included by the Copper Institute, and differences were reduced chiefly to the method of handling metal in process of refining (included as "refined" by Copper Institute and as "unrefined" by the Bureau of Mines) and to other minor variations in interpretation until May 1951, when the institute's inventory data began to include tonnages delivered to United States consumers at foreign ports. Bureau of Mines figures are on the basis of metal physically held at primary smelting and refining plants in the United States. In the Bureau of Mines classification cathodes to be used chiefly for casting into shapes are considered stocks in process and not refined stocks.

Fabricators' stocks of refined metal (including in-process copper and primary fabricated shapes), according to the United States Copper Association, were 430,200 tons at the end of 1957 (a 2-percent decrease over those on hand at the beginning of the year). Working stocks (see table 29) were 347,500 tons (3 percent more than at the end of 1956). Fabricators' inventory position improved during the year, and for the second successive year there was no deficit in stocks. After the unfilled sales of metal were accounted for, copper classed as "available for sale" was 19,700 tons at the close of 1957, compared with 34,700 tons at the end of 1956.

PRICES

Reports from copper-selling agencies indicate that 1,119,500 tons of domestic refined copper was delivered to purchasers at an average price of 30.1 cents a pound. The average price of foreign copper delivered in the United States was 29.6 cents a pound.

Copper prices were subject to frequent changes during 1957, both in the United States and abroad. At the beginning of the year domestic primary producers were quoting 36 cents per pound for electrolytic copper, delivered. Early in February the principal producers lowered their price to 34 cents and still later in the month to 32 cents. Effective June 20, all primary producers were quoting 29.25 cents. On August 6 and August 8 the price was dropped to 28.5 cents and on September 3 to 27 cents, where it remained beyond the end of 1957. The total drop in price was 19 cents from the high of 46 cents in effect from February 17, 1956, to July 10, 1956, a decrease of 41 percent.

TABLE 30.—Average weighted prices of copper deliveries,[1] f. o. b. refinery,[2] 1953–57, in cents per pound

Year	Domestic copper	Foreign copper	Year	Domestic copper	Foreign copper
1953	28.7	34.1	1956	42.5	43.2
1954	29.5	29.4	1957	30.1	29.6
1955	37.3	37.5			

[1] Covers copper produced in the United States and delivered here and abroad and copper produced abroad and delivered in the United States; excludes copper both produced and delivered abroad, whether or not handled by United States selling agencies.
[2] In 1953 a substantial quantity of copper was sold on a delivered consumers' plant basis; beginning in 1954 all deliveries were made on that basis, and the delivered price is reflected in averages shown.

Quotations by domestic custom smelters declined persistently throughout 1957, except for recoveries of ½ cent and 1 cent for a few short periods. Early in January the market was quoted at a range of 35–36 cents per pound, delivered; 2 reductions late in the month brought the price to 34 cents; and 3 reductions in February resulted in a 31-cent price by February 20. On March 25 a custom smelter reduced its price to 30.5 cents, but on March 27 and 28, the price advanced, and the market was quoted at a range of 30.75–31.00 cents; on April 1 the customer-smelter market was at a flat 31.5 cents. The price was lowered to 31 cents on April 12, to 30.5 cents on May 3, and to 30 cents on May 9. Following the reduction in the primary producers' price in June, custom smelters lowered their price to 29 cents. Additional price cuts in July resulted in a price of 28.25 cents by July 19 (1 cent per pound below the price of the primary producers). Custom smelters continued to lower their price during August, and on September 9 were quoting 25 cents—the lowest since the period October 2, 1950, to February 24, 1953, when the price was 24.5 cents. Two ½-cent-per-pound advances on September 12 and 13 raised the price to 26 cents, but on October 15 it was lowered to 25.5 cents. On November 6 the price rose to 26 cents, on November 13 it dropped to 25.5 cents, and on November 21 it declined to 25 cents. An increase of ½ cent per pound on December 13 raised the price to 25.5 cents, and it was unchanged at the end of 1957.

TABLE 31.—Average yearly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1948–57, in cents per pound

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Domestic f. o. b. refinery [1]	22.20	19.36	21.46	24.37	24.37	28.92	29.82	37.39	41.88	29.99
Domestic f. o. b. refinery [2]	22.038	19.202	21.235	24.200	24.200	28.798	26.694	37.491	41.818	29.576
Export f. o. b. refinery [2]	22.348	19.421	21.549	26.258	31.746	30.845	29.889	39.115	40.434	27.157

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

TABLE 32.—Average monthly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1956–57, in cents per pound

Month	1956			1957		
	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	42.87	43.749	45.562	35.82	35.526	33.337
February	43.90	44.588	45.822	33.05	32.576	30.553
March	45.87	46.728	48.532	31.82	31.452	29.555
April	45.87	46.161	46.964	31.82	31.517	29.775
May	45.87	45.531	43.118	31.82	31.288	29.448
June	45.87	45.056	40.260	30.72	30.334	28.410
July	41.59	40.807	36.002	29.07	28.690	26.727
August	39.87	39.625	37.667	28.46	28.098	25.694
September	39.87	39.597	37.511	26.82	26.435	23.926
October	39.15	38.623	35.431	26.82	26.335	22.931
November	35.87	35.696	34.466	26.82	26.339	23.109
December	35.87	35.649	33.876	26.82	26.320	22.418
Average for year	41.88	41.818	40.434	29.99	29.576	27.157

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

TABLE 33.—United Kingdom monthly average prices in 1957 [1]

Month	Cash				3 months				Settlement			
	Per long ton			Cents per pound [2]	Per long ton			Cents per pound [2]	Per long ton			Cents per pound [2]
	£	s.	d.		£	s.	d.		£	s.	d.	
January	265	17	11	33.19	264	14	4	33.04	266	3	2	33.22
February	245	11	2	30.67	244	2	0	30.49	245	16	3	30.71
March	239	10	11	29.87	239	2	9	29.82	239	14	6	29.89
April	241	19	2	30.12	242	15	9	30.23	242	2	0	30.14
May	237	17	5	29.64	238	1	2	29.66	238	0	3	29.66
June	227	2	8	28.29	228	16	2	28.50	227	5	9	28.31
July	217	10	12	27.08	219	11	9	27.33	217	14	9	27.10
August	208	12	3	25.92	210	12	7	26.17	208	15	9	25.94
September	193	18	8	24.11	197	5	1	24.53	194	3	4	24.14
October	186	9	8	23.31	190	0	9	23.75	186	14	7	23.34
November	187	18	7	23.51	191	17	9	24.01	188	3	4	23.54
December	181	8	8	22.73	185	14	5	23.26	181	12	0	22.75
Average	219	8	10	27.36	221	0	3	27.56	219	12	10	27.39

[1] Metal Bulletin (London).
[2] Based on average monthly rates of exchange by Federal Reserve Board.

London Price.—Quotations on the London Metal Exchange (LME) opened the year at £266 10s. per long ton (equivalent to 33.3 cents per pound). It rose to £273 (34.125 cents) on January 9 and dropped to £175 10s. (21.9 cents) on December 11—the lowest since June 5, 1950, when the Government-controlled price was £170. The LME price closed the year at £180 (22.5 cents).

Effective February 1 the Rhodesian Selection Trust (RST) price was reduced to £250 per long ton c. i. f. London (31.25 cents per pound) from £270 (33.75 cents) established on December 17, 1956. On February 19 the price was quoted at £240 (30 cents) which held until June 17 when it dropped to £230 (28.75 cents). It was further reduced to £220 (27.5 cents) on July 1, and to £210 (26.25 cents) on August 12. Two reductions occurred in September—on September 5 to £200 (25 cents) and on September 9 to £190 (23.75 cents). The RST Group announced that, effective October 7, it would price copper on the LME price basis. The group had established its fixed-price basis on May 9, 1955, and the changeover to the LME basis ended the dual pricing for Rhodesian copper that had been in effect for more than 2 years.

FOREIGN TRADE [5]

Imports.—Imports of unmanufactured copper in 1957 were virtually unchanged from 1956. Chile continued to be the chief source of supplies from abroad and supplied 40 percent of the total—the same as in 1956. Increased receipts from Rhodesia, the Philippines, Cyprus, and Cuba nearly equaled the smaller imports from Mexico, Australia, Belgian Congo, and Peru.

Although Canada was the chief supplier of refined copper for the third successive year, shipments to the United States dropped 6 percent. Receipts from Chile and Peru decreased 76 and 11 percent, respectively, whereas those from Rhodesia more than doubled the 1956 imports.

Imports of unrefined copper rose 7 percent, chiefly because of a 16-percent increase in receipts from Chile. Canada, Cuba, Peru, and the Philippines sent more unrefined metal, but Mexico and Union of South Africa shipped smaller quantities. Much of the foreign copper that entered the country was later exported in refined or manufactured forms. United States smelters and refineries continued in 1957 to treat foreign crude materials, both purchased and toll.

Exports.—Most of the copper exported from the United States was in the form of refined copper and in advanced forms of manufacture in which the copper content is not calculable. As indications that supply exceeded requirements became more pronounced during the year, the Bureau of Foreign Commerce announced relaxations on export controls. Exports of refined copper in 1957 rose 55 percent to 346,000 tons, the largest since 1940. More than half of the total exported went to European countries—United Kingdom, France, Germany, Italy, and Switzerland. Shipments to Japan represented 14 percent of the United States exports and were 58 percent greater than the quantity shipped in 1956. Exports of old and scrap almost doubled those in 1956 and went mainly to Japan and Germany.

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

TABLE 34.—Copper (unmanufactured) imported into the United States, 1948–52 (average) and 1953–57, in short tons, in terms of copper content [1]

[Bureau of the Census]

	Ore	Concentrates	Regulus, black, or coarse copper and cement copper	Unrefined, black, blister, and converter copper in pigs or converter bars	Refined in ingots, plates, or bars	Old and scrap copper fit only for remanufacture, and scale and clippings	Total
1948–52 (average)[2]	4,569	98,003	3,185	167,310	285,646	12,998	571,711
1953 [2]	6,997	106,574	7,019	273,610	274,111	7,793	676,104
1954 [2]	5,343	107,438	5,795	256,484	215,086	4,683	594,829
1955 [2]	8,132	109,497	7,898	253,693	202,312	12,568	594,100
1956							
North America:							
Canada	292	22,857	1,581	1,038	93,525	1,196	120,489
Cuba	354	15,040				951	16,345
Mexico	447	6,482	4,017	37,411	4,033	445	52,835
Other North America	5	(3)	3			663	671
Total	1,098	44,379	5,601	38,449	97,558	3,255	190,340
South America:							
Bolivia	1,417	3,066	17				4,500
Chile	3,307	15,404		175,889	41,915	108	236,623
Peru	3,146	8,226	1,174	14,294	16,001		42,841
Other South America	18	444				310	772
Total	7,888	27,140	1,191	190,183	57,916	418	284,736
Europe:							
Belgium-Luxembourg					769	31	800
France						991	991
Germany, West					2,738	6	2,744
Malta, Gozo, and Cyprus		6,945					6,945
Netherlands					1	10	11
Norway					5,969		5,969
Sweden					224	30	254
United Kingdom					3,348	8	3,356
Yugoslavia					138		138
Total		6,945			13,187	1,076	21,208
Asia:							
Philippines	11	10,896	4				10,911
Turkey				5,586			5,586
Other Asia	12				799		811
Total	23	10,896	4	5,586	799		17,308
Africa:							
Belgian Congo				4,345	8,419		12,764
Rhodesia and Nyasaland, Federation of		244		13,452	13,866		27,562
Union of South Africa	7,907	7,321	9	6,054			21,291
Other Africa				1,085			1,085
Total	7,907	7,565	9	24,936	22,285		62,702
Oceania: Australia	543	479	506	16,931		994	19,453
Grand total	17,459	97,404	7,311	276,085	191,745	5,743	595,747
1957							
North America:							
Canada	833	27,637	1,070		87,482	3,160	120,182
Cuba	1,004	15,846				585	17,435
Mexico	165	3,659	3,318	37,574	2,924	107	47,747
Other North America			3			540	543
Total	2,002	47,142	4,391	37,574	90,406	4,392	185,907
South America:							
Argentina	13	105	191				309
Bolivia	1,513	2,937	13				4,463

See footnotes at end of table.

TABLE 34.—Copper (unmanufactured) imported into the United States, 1948–52 (average) and 1953–57, in short tons, in terms of copper content [1]—Continued

	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
South America—Continued							
Chile	1,609	15,678	79	208,460	10,190	----------	236,016
Peru	3,636	8,027	1,253	14,486	14,224	----------	41,626
Other South America	11	----------	----------	----------	----------	666	677
Total	6,782	26,747	1,536	222,946	24,414	666	283,091
Europe:							
Belgium-Luxembourg	----------	----------	----------	----------	447	----------	447
Germany, West	----------	----------	----------	----------	2,545	7	2,552
Malta, Gozo, and Cyprus	----------	8,937	----------	----------	----------	----------	8,937
Sweden	----------	----------	----------	----------	2,688	1	2,689
United Kingdom	----------	----------	----------	----------	2,413	2	2,415
Other Europe	----------	----------	----------	616	----------	682	1,298
Total	----------	8,937	----------	616	8,093	692	18,338
Asia:							
Philippines	7	13,053	7	----------	----------	----------	13,067
Turkey	----------	----------	----------	3,496	----------	----------	3,496
Other Asia	21	----------	----------	----------	(3)	1	22
Total	28	13,053	7	3,496	(3)	1	16,585
Africa:							
Belgian Congo	----------	----------	----------	----------	10,221	----------	10,221
Rhodesia and Nyasaland, Federation of	----------	75	2	16,728	28,055	----------	44,860
Union of South Africa	9,243	3,838	----------	5,744	1,120	----------	19,945
Total	9,243	3,913	2	22,472	39,396	----------	75,026
Oceania:							
Australia	773	----------	224	14,078	----------	(3)	15,075
Other Oceania	----------	----------	----------	----------	----------	5	5
Total	773	----------	224	14,078	----------	5	15,080
Grand total	18,828	99,792	6,160	301,182	162,309	5,756	594,027

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] Some copper in "Ore" and "Other" from Republic of the Philippines is not separately classified and is included with "Concentrates."
[3] Less than 1 ton.

TABLE 35.—Copper (unmanufactured) imported into the United States, 1948–52 (average) and 1953–57 [1]

[Bureau of the Census]

Year	Contained copper (short tons)	Year	Contained copper (short tons)
1948–52 (average)	571,711	1955	594,100
1953	676,104	1956	595,747
1954	594,829	1957	594,027

[1] Data are "General" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.

TABLE 36.—Copper (unmanufactured) imported into the United States, 1948–52 (average) and 1953–57, by countries, in short tons, in terms of copper content [1]

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada (including Newfoundland and Labrador)	69,788	107,427	89,911	107,034	120,489	120,182
Cuba	19,449	18,206	18,282	21,122	16,345	17,435
Mexico	56,784	65,818	51,229	49,642	52,835	47,747
Other North America	571	629	406	693	671	543
Total	146,592	192,080	159,828	178,491	190,340	185,907
South America:						
Bolivia	4,833	3,972	3,913	3,301	4,500	4,463
Chile	305,793	281,074	266,933	226,772	236,623	236,016
Peru	18,301	26,523	22,450	31,119	42,841	41,626
Other South America	845	328	7	20	772	986
Total	329,772	311,897	293,303	261,212	284,736	283,091
Europe:						
Belgium-Luxembourg	290	5,615	718	383	800	447
France	1,491	2,160	1,587	2,128	991	660
Germany	1,795	[2] 3,570	[2] 81	[2] 3,582	[2] 2,744	[2] 2,552
Malta, Gozo, and Cyprus	5,421	3,680		4,388	6,945	8,937
Netherlands	293	175		2,291	11	22
Norway	828	4,427	5,664	149	5,969	
Sweden	11	2,217		1,024	254	2,689
United Kingdom	781	2,194	25	11,650	3,356	2,415
Yugoslavia	9,816	7,775	3,886	2,149	138	
Other Europe	154		17			616
Total	20,880	31,813	11,978	27,744	21,208	18,338
Asia:						
Japan	11,540		1	75	799	1
Philippines	9,549	13,538	19,425	13,321	10,911	13,067
Turkey	2,324	11,894	2,664	547	5,586	3,496
Other Asia	507	110	32	170	12	21
Total	23,920	25,542	22,122	14,113	17,308	16,585
Africa:						
Belgian Congo	21	5,799	15,539	14,160	12,764	10,221
Northern Rhodesia	40,020	88,042	[4] 61,905	73,464	27,562	44,860
Southern Rhodesia	[3] 1,142	212				
Union of South Africa	8,128	7,678	13,482	13,089	21,291	19,945
Other Africa	24				1,085	
Total	49,335	101,731	90,926	100,713	62,702	75,026
Oceania:						
Australia	1,129	13,041	16,672	11,827	19,453	15,075
Other Oceania	83					5
Total	1,212	13,041	16,672	11,827	19,453	15,080
Grand total	571,711	676,104	594,829	594,100	595,747	594,027

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] West Germany.
[3] Chiefly from Northern Rhodesia.
[4] Beginning July 1, 1954, classified as Federation of Rhodesia and Nyasaland.

TABLE 37.—Old brass and clippings from brass or Dutch metal [1] imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons		Value	Year	Short tons		Value
	Gross weight	Copper content			Gross weight	Copper content	
1948–52 (average)	27,570	19,410	$7,824,129	1955	11,758	8,295	$5,170,383
1953	9,679	7,503	3,737,085	1956	6,519	4,310	[2] 3,002,940
1954	5,272	3,657	1,567,574	1957	7,911	4,643	2,393,405

[1] For remanufacture.
[2] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

TABLE 38.—Copper imported for consumption in the United States, 1948–52 (average) and 1953–57, by classes [1] (Quantity in terms of copper content)

[Bureau of the Census]

Year	Ore		Concentrates		Regulus, black, or coarse copper and cement copper	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average) [2]	3,281	$1,373,122	84,154	$36,529,540	2,123	$1,122,859
1953 [2]	5,560	3,057,966	96,448	53,006,531	6,547	4,040,632
1954 [2]	6,182	3,398,562	114,353	62,675,609	5,408	3,088,549
1955 [2]	7,476	4,948,251	105,045	68,405,687	6,386	4,515,264
1956	6,089	4,048,965	74,651	54,514,496	5,198	4,395,456
1957	20,940	12,211,784	62,398	34,275,077	5,324	3,195,764

Year	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	
1948–52 (average) [2]	146,814	$66,126,747	287,734	$140 295 401	12,452	$4,534,708	$249,982,377
1953 [2]	279,242	179,225,693	274,111	182,190,014	7,827	4,017,577	425,538,413
1954 [2]	257,393	150,790,719	215,118	127,130,493	4,752	[3] 2,080,720	[3] 349,164,652
1955 [2]	253,693	182,073,314	202,312	154,137,270	12,577	[3] 9,030,398	[3] 423,110,184
1956	276,085	[3] 225,931,796	191,812	157,943,985	5,410	[3] 3,463,270	[3] 450,297,968
1957	301,182	179,440,276	162,309	97,024,574	5,801	3,038,915	329,186,390

[1] Exclude imports for manufacture in bond and export, which are classified as "imports for consumption" by the Bureau of the Census.
[2] Some copper in "Ore" and "Other" from Republic of the Philippines is not separately classified and is included with "Concentrates."
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

TABLE 39.—Copper exported from the United States, 1948–52 (average) and 1953–57, in short tons

[Bureau of the Census]

	Ore, concentrates, composition metal, and unrefined copper (copper content)	Refined in bars, ingots, or other forms	Rods	Old and scrap	Pipes and tubes	Plates and sheets	Wire and cable, bare [1]	Wire and cable, insulated	Other copper manufactures [1]
1948–52 (average)	834	146,485	6,662	7,327	3,066	1,129	8,146	21,987	(2)
1953	495	109,580	321	34,568	1,622	367	9,313	15,622	294
1954	2,369	215,951	344	75,749	1,199	300	4,548	14,342	250
1955	12,897	199,819	202	31,137	1,292	542	6,976	19,974	234
1956	13,717	223,103	366	25,681	1,550	337	11,104	18,434	185
1957									
North America:									
Canada	2,095	3,546	63	3,596	391	79	128	2,821	204
Cuba	--------	6	1,295	--------	112	15	112	1,306	--------
Mexico	11,240	158	2	--------	42	21	137	848	10
Other North America	--------	14	2	2	76	28	182	1,182	(3)
Total	13,335	3,724	1,362	3,598	621	143	559	6,157	214
South America:									
Argentina	121	11,152	55	--------	16	(3)	64	93	--------
Brazil	--------	8,776	(3)	--------	8	9	450	74	--------
Chile	--------	10	--------	--------	2	33	20	410	17
Colombia	--------	214	1	--------	64	4	794	463	4
Peru	--------	2	2	7	41	8	105	839	--------
Venezuela	--------	8	30	--------	286	6	1,422	2,320	--------
Other South America	--------	261	1	--------	17	1	22	266	--------
Total	121	20,423	89	7	434	61	2,877	4,465	21
Europe:									
Belgium-Luxembourg	--------	1,127	--------	256	7	--------	(3)	37	--------
Denmark	--------	800	112	--------	--------	--------	--------	261	--------
France	--------	54,687	2	3,754	5	(3)	10	31	--------
Germany, West	567	50,773	--------	10,670	--------	3	2	17	--------
Italy	224	33,535	--------	--------	1	(3)	136	25	--------
Netherlands	--------	7,846	--------	429	(3)	1	--------	42	2
Norway	--------	3,212	--------	400	1	2	34	7	(3)
Portugal	--------	50	--------	339	--------	--------	5	4	--------
Spain	--------	2,192	--------	183	5	1	2,169	394	--------
Sweden	--------	2,519	--------	281	3	--------	2	47	--------
Switzerland	--------	14,620	56	180	1	(3)	--------	6	--------
United Kingdom	--------	89,649	--------	884	--------	--------	--------	28	--------
Other Europe	--------	4,777	--------	22	1	1	548	25	--------
Total	791	265,787	170	17,398	24	8	2,906	924	2
Asia:									
India	--------	7,617	29	561	4	5	874	289	--------
Indonesia	--------	--------	1	--------	13	1	95	317	--------
Japan	1,409	46,850	--------	26,984	67	--------	(3)	158	--------
Korea	--------	210	--------	28	6	1	86	3,516	--------
Pakistan	--------	--------	1	11	6	--------	1,548	152	--------
Philippines	--------	9	--------	--------	81	3	500	1,924	--------
Taiwan	--------	129	3	--------	4	18	157	648	--------
Turkey	--------	--------	(3)	--------	5	(3)	474	968	--------
Other Asia	--------	--------	2	342	64	4	95	850	--------
Total	1,409	54,815	36	27,926	250	32	3,829	8,822	--------
Africa:									
Rhodesia and Nyasaland, Federation of	--------	181	--------	--------	--------	--------	526	1	--------
Union of South Africa	--------	535	1	--------	16	--------	114	520	--------
Other Africa	--------	--------	1	60	7	2	305	108	1
Total	--------	716	2	60	23	2	945	629	1

See footnotes at end of table.

TABLE 39.—Copper exported from the United States, 1948–52 (average) and 1953–57, in short tons—Continued

	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]
Oceania:									
Australia		560			2	1		12	
Other Oceania					(3)	18	3	26	
Total		560			2	19	3	38	
Grand total	15,656	346,025	1,659	48,989	1,354	265	11,119	21,035	238

[1] Owing to changes in classification, 1952–57 data not strictly comparable with earlier years.
[2] Weight not recorded.
[3] Less than 1 ton.

TABLE 40.—Copper exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Ore, concentrates, composition metal, and unrefined copper (copper content)		Refined copper and semimanufactures [1]		Other copper manufactures [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	834	$400,041	194,802	$109,243,249	(2)	$1,520,273	195,636	$111,163,563
1953	495	290,405	171,393	116,212,961	294	352,124	172,182	116,855,490
1954	2,369	1,309,158	312,433	197,050,734	250	307,848	315,052	198,667,740
1955	12,897	9,478,941	259,942	207,741,551	234	308,792	273,073	217,529,284
1956	13,717	11,648,348	280,575	253,614,925	185	290,552	294,477	265,553,825
1957	15,656	9,963,640	430,446	288,936,283	238	321,237	446,340	299,221,160

[1] Owing to changes in classifications, 1953–57 data not strictly comparable with earlier years.
[2] Weight not recorded.

TABLE 41.—Unfabricated copper-base alloy [1] ingots, bars, rods, shapes, plates, and sheets exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	4,470	$3,530,140	1955 [2]	2,175	$3,200,780
1953 [2]	4,453	3,568,657	1956 [2]	2,233	3,844,261
1954 [2]	3,492	2,924,161	1957 [2]	1,747	2,943,557

[1] Includes brass and bronze.
[2] Owing to changes in classifications, data not strictly comparable with earlier years.

TABLE 42.—Copper-base alloys (including brass and bronze) exported from the United States, 1956–57, by classes

[Bureau of the Census]

Class	1956 Short tons	1956 Value	1957 Short tons	1957 Value
Ingots	662	$1,242,624	373	$655,938
Scrap and other forms	50,485	29,814,431	69,996	32,968,165
Bars, rods, and shapes	734	1,039,402	585	863,812
Plates, sheets, and strips	837	1,562,235	789	1,423,807
Pipes and tubes	1,420	2,293,238	1,461	2,367,487
Pipe fittings	1,197	3,265,883	1,301	3,362,056
Plumbers' brass goods	2,887	8,198,263	2,870	7,733,242
Welding rods and wire	890	2,192,198	777	1,659,934
Castings and forgings	405	772,850	435	699,405
Powder	181	239,025	209	221,805
Hardware	(1)	3,783,403	(1)	3,863,742
Semifabricated forms, not elsewhere classified	34	63,183	27	62,968
Other copper-base-alloy manufactures	(1)	380,331	(1)	488,866
Total	(1)	54,847,066	(1)	56,371,227

[1] Weight not recorded.

TABLE 43.—Copper sulfate (blue vitriol) exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	38,110	$6,444,692	1955	37,382	$8,381,815
1953	32,659	6,250,121	1956	30,177	8,036,233
1954	29,762	5,780,801	1957	33,644	6,534,037

TABLE 44.—Brass and copper scrap imported into and exported from the United States, 1948–52 (average) and 1953–57, in short tons

[Bureau of the Census]

	1948–52 (average)	1953	1954	1955	1956	1957
Imports for consumption:						
Brass scrap (gross weight)	27,570	9,679	5,272	11,758	6,519	7,911
Copper scrap (copper content)	12,452	7,827	4,752	12,577	5,410	5,801
Exports:						
Brass scrap	[1] 8,144	[1] 33,680	[1] 93,972	[1] 45,260	[1] 50,485	[1] 69,996
Copper scrap	7,327	34,568	75,749	31,137	25,681	48,989

[1] Copper-base-alloy scrap (new and old); not strictly comparable with earlier years.

Tariff.—The 2-cent-per-pound excise tax on copper continued under suspension in 1957, subject to the concessions granted at the June 1956 meetings in Geneva on General Agreements Tariffs and Trade (GATT). On April 25, 1957, a bill to continue suspension of duties on metal scrap was signed by President Eisenhower.

TABLE 45.—Copper scrap imported into and exported from the United States, 1957, by countries, in short tons

[Bureau of the Census]

Country	Exports		Imports	
	Unalloyed copper scrap	Copper-alloy scrap (gross weight)	Unalloyed copper scrap (copper content)	Copper-alloy scrap (gross weight)
North America:				
Canada	3,596	68	3,160	5,113
Cuba		1	655	113
Other North America	2	17	622	632
Total	3,598	86	4,437	5,858
outh America:				
Venezuela			650	271
Other South America	7	11	16	50
Total	7	11	666	321
Europe:				
France	3,754	4,867	660	1,471
Germany, West	10,670	18,590	7	
Italy		7,423		
United Kingdom	884	1,059	2	67
Other Europe	2,090	2,469	23	4
Total	17,398	34,408	692	1,542
Asia:				
India	561	3,067		
Japan	26,984	31,555	1	
Other Asia	381	869		167
Total	27,926	35,491	1	167
Africa	60			
Oceania			5	23
Grand total	48,989	69,996	5,801	7,911

WORLD REVIEW

World mine production of copper was 2 percent higher in 1957 than in 1956 and established a new alltime record output. Small decreases in the United States, Belgian Congo, and Chile were more than offset by increases of 8 percent in Northern Rhodesia, 50 percent in the Philippines, and 27 percent in Peru. Production in Canada and Northern Rhodesia established new peaks; Chile's output was slightly less than in 1956 but maintained its rank as the world's second largest producer.

Labor strikes and voluntary cutbacks prevented even higher outputs in some of the principal copper-producing countries. In Canada the Gaspé mine was struck for 7 months, and in Chile the Braden mine was closed by a 2-week strike. A number of work stoppages affected operations at Northern Rhodesian properties. Roan Antelope Copper Mines, Ltd., and Mufulira Copper Mines, Ltd., announced 10-percent reductions from June 1 at their Northern Rhodesian properties. On December 17 Cerro de Pasco Corp. stated that a cutback of approximately 11 percent would be made in copper output in Peru.

TABLE 46.—World mine production of copper, by countries, 1948–52 (average) and 1953–57 in short tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	260,191	253,252	302,732	325,994	354,860	360,745
Cuba	20,216	17,800	17,500	20,800	18,200	18,000
Mexico	66,984	66,302	60,413	60,269	60,478	66,800
United States	870,119	926,448	835,472	998,570	1,106,215	1,086,141
Total	1,217,510	1,263,802	1,216,117	1,405,633	1,539,753	1,531,686
South America:						
Bolivia (exports)	5,720	4,920	4,034	3,855	4,896	4,320
Chile	433,990	400,287	400,861	477,873	539,844	533,855
Ecuador	376	------	------	6	------	------
Peru	30,600	39,023	42,356	47,844	50,966	64,493
Total	470,686	444,230	447,251	529,578	595,706	602,668
Europe:						
Austria	1,851	3,279	3,381	2,841	2,579	2,574
Finland	20,531	21,000	23,150	23,700	23,150	28,700
France	635	500	88	580	660	[2] 550
Germany:						
East [2]	12,600	17,600	22,000	25,300	27,500	27,500
West	1,462	2,262	2,600	1,335	1,077	1,203
Hungary	[2] 490	(3)	(3)	(3)	(3)	(3)
Italy	101	236	357	273	373	310
Norway	16,148	14,362	14,980	15,419	15,432	16,525
Poland	[4] 2,240	4,700	5,300	6,100	8,000	8,300
Portugal	600	826	475	600	1,066	1,100
Spain [5] [6]	7,697	9,406	7,951	6,726	7,525	11,077
Sweden	17,092	14,924	14,565	17,275	18,436	19,914
U. S. S. R. [2] [7] [8]	253,000	334,000	352,000	385,000	430,000	450,000
Yugoslavia [8]	38,838	34,381	33,394	31,151	32,390	37,186
Total [2] [7]	373,000	457,000	480,000	516,000	568,000	605,000
Asia:						
China [2] [8]	4,100	8,800	8,800	9,900	11,000	13,000
Cyprus (exports)	24,825	23,937	30,059	26,179	39,497	43,676
India	7,391	5,500	8,300	8,500	8,800	9,000
Japan	42,852	64,907	73,056	80,466	86,497	89,200
Korea, Republic of	138	1,540	550	1,760	970	710
Philippines	10,294	14,016	15,817	19,247	29,722	44,513
Taiwan	1,146	287	550	1,100	1,593	1,840
Turkey [8]	15,518	25,901	27,042	26,234	27,297	29,896
Total [2] [7] [9]	106,300	144,900	164,200	173,400	205,400	231,800
Africa:						
Algeria	56	153	236	74	160	476
Angola	1,026	1,397	3,691	2,011	3,154	[2] 3,300
Belgian Congo [8]	191,914	236,057	243,424	259,161	275,538	267,026
French West Africa	------	------	90	152	105	------
Morocco: Southern Zone	381	1,264	884	823	811	694
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	315,678	410,808	438,708	395,308	445,466	480,313
Southern Rhodesia	117	197	298	1,179	1,931	2,118
South-West Africa	12,176	13,357	15,668	23,588	28,980	29,910
Tanganyika [10]	95	543	478	650	1,276	[2] 1,100
Union of South Africa	35,987	39,843	46,638	49,239	51,252	50,959
Total	557,430	703,619	750,115	732,185	808,673	835,896
Oceania: Australia	17,345	40,875	45,760	50,956	59,406	63,407
World total (estimate)	2,740,000	3,050,000	3,100,000	3,410,000	3,780,000	3,870,000

[1] This table incorporates a number of revisions of data published in previous Copper chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] Estimate.
[3] Negligible.
[4] Average for 1950–52.
[5] According to Yearbook of American Bureau of Metal Statistics.
[6] Does not include content of iron pyrites, the copper content of which may or may not be recovered.
[7] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[8] Smelter production.
[9] Includes estimates for Burma, beginning in 1951.
[10] Copper content of exports and local sales.

TABLE 47.—World smelter production of copper, 1948–52 (average) and 1953–57, by countries, in short tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	225,470	236,966	253,365	288,997	331,174	323,588
Mexico	56,660	57,633	48,527	49,730	52,089	62,061
United States [2]	970,935	1,047,810	945,899	1,106,526	1,231,352	1,178,145
Total	1,253,065	1,342,409	1,247,791	1,445,253	1,614,615	1,563,794
South America:						
Chile	411,049	371,745	372,818	447,292	506,256	496,939
Peru	22,272	25,802	29,178	34,862	34,259	45,292
Total	433,321	397,547	401,996	482,154	540,515	542,231
Europe:						
Austria	5,334	10,278	10,357	11,363	11,799	10,450
Finland	19,541	21,814	23,551	24,583	24,767	28,469
Germany:						
East [3]	19,200	27,500	28,000	30,000	33,000	33,000
West [4]	176,951	233,328	258,271	286,306	279,463	279,231
Italy	127	160	140	1,024	373	310
Norway	10,128	13,342	14,221	15,142	16,457	17,245
Poland	[4] 10,000	[4] 17,000	9,000	17,300	22,400	22,000
Spain	5,680	6,590	6,374	6,477	6,940	6,600
Sweden	16,913	19,215	18,422	19,159	18,673	21,472
U. S. S. R. [3 5]	252,900	334,000	352,000	385,000	430,000	452,000
Yugoslavia	38,838	34,381	33,394	31,151	32,390	37,186
Total [3 5 6]	555,600	718,000	754,000	828,000	876,000	908,000
Asia:						
China [3 4]	4,000	8,800	8,800	9,900	11,000	13,000
India	7,175	5,510	8,020	8,155	8,543	8,790
Japan	43,651	70,080	75,914	89,353	101,946	120,012
Korea:						
North	[3] 1,200	(7)	(7)	(7)	(7)	(7)
Republic of	270	219	265	362	1,000	874
Taiwan	580	655	1,012	1,295	1,659	1,883
Turkey	15,518	25,901	27,042	26,234	27,297	29,896
Total [3 5]	72,400	111,200	121,100	135,400	151,400	174,500
Africa:						
Angola	[8] 1,807	1,304	1,989	926	1,425	[3] 1,800
Belgian Congo	191,914	236,057	243,424	259,161	275,538	267,026
Morocco: Northern Zone	[9] 172	63	----------	----------	----------	----------
Rhodesia and Nyasaland, Fed. of: Northern Rhodesia	306,881	406,087	424,045	384,357	429,503	466,157
Uganda	----------	----------	----------	----------	168	8,361
Union of South Africa	35,092	38,575	45,152	47,480	48,681	48,229
Total	535,866	682,086	714,610	691,924	755,315	791,573
Oceania: Australia	16,103	38,258	42,613	41,932	54,914	56,987
World total (estimate)	2,865,000	3,290,000	3,280,000	3,620,000	3,990,000	4,040,000

[1] This table incorporates a number of revisions of data published in previous Copper chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] Smelter output from domestic and foreign ores, exclusive of scrap. Production from domestic ores only, exclusive of scrap, was as follows: 1948–52 (average), 873,980; 1953, 943,391; 1954, 834,381; 1955, 1,007,311; 1956, 1,117,580; and 1957, 1,081,055.
[3] Estimate.
[4] Includes scrap.
[5] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[6] Belgium reports a large output of refined copper which is believed to be produced principally from crude copper from Belgian Congo; it is not shown here, as that would duplicate output reported under latter country.
[7] Negligible.
[8] Average for 1949–52.
[9] Average for 1950–52.

NORTH AMERICA

Canada.—Production of copper rose 2 percent over 1956 and established a new production peak. A 15-percent drop in output in Quebec Province, because of a 7-month strike at Gaspé Copper Mines, Ltd., was partly offset by substantial production in New Brunswick Province. The largest production in Canada—49 percent of the total—came from the nickel-copper ores of the Sudbury district, Ontario. Output increased 8 percent in 1957 and was the largest since 1940. Quebec Province was second, with 30 percent of the total production, and the remainder was supplied by Saskatchewan, Manitoba, British Columbia, New Brunswick, Newfoundland, and Northwest Territories, in that order. Output from the latter Province was the first since 1952.

Output of refined copper (all from plants of The International Nickel Co. of Canada, Ltd., at Copper Cliff, Ontario, and the Canadian Copper Refiners, Ltd., Montreal East, Quebec) was 324,000 tons. Consumption of refined copper totaled 118,000 tons compared with 145,000 tons in 1956.

TABLE 48.—Copper produced (mine output) in Canada, 1948–52 (average) and 1953–57, by Provinces, in short tons [1]

Province	1948–52 (average)	1953	1954	1955	1956	1957 (preliminary)
British Columbia	22,473	24,148	25,088	22,127	21,682	14,879
Manitoba	16,390	9,411	12,274	19,380	17,973	18,725
New Brunswick				35	6	5,487
Newfoundland	3,449	2,814	3,481	3,052	3,108	3,035
Northwest Territories	1					143
Nova Scotia	77	788	991	1,027	404	
Ontario	120,957	130,583	140,776	146,407	156,271	168,976
Quebec	65,447	54,920	83,930	101,021	122,300	103,836
Saskatchewan	31,397	30,588	36,192	32,945	33,116	30,946
Total	260,191	253,252	302,732	325,994	354,860	346,027

[1] Dominion Bureau of Statistics, Department of Trade and Commerce, Government of Canada, Preliminary Report on Mineral Production, 1957.

The International Nickel Co. of Canada, Ltd., in *Ontario*, was by far the leading copper producer in Canada. The 16,049,000 tons of ore mined in 1957 was the largest attained in any year and consisted of 14,948,000 tons (14,351,000 in 1956) from underground and 1,101,000 tons (1,159,000 in 1956) from open-pit operations. The Frood-Stobie and Levack mines were largely responsible for the increased output from underground operations. Development programs were continued at the Creighton, Frood-Stobie, Garson, Levack and Murray mines; the Crean Hill mine was being prepared for production; and an additional mining program begun in 1956 at the Frood open-pit was continued. At Levack work continued on construction of the 6,000-ton-per-day concentrator. Ore reserves as of December 31, 1957, totaled 264.5 million tons containing 8 million tons of nickel and copper. The company delivered 140,400 tons of copper to customers in Canada and the United Kingdom in 1957.

Falconbridge Nickel Mines, Ltd., the other important producer of copper in the Province made a record output of ore. A total of 2,018,800 tons of ore was produced from company mines; receipts of ore and concentrate for treatment for independent mines decreased during 1957 and by the end of the year had ceased. Production from the Onaping area (Hardy, Fecunis Lake, and Longvack mines) increased from 31 percent in 1956 to 43 percent in 1957; mining at the Mount Nickel mine stopped in November. Development was continued at the Boundary, Onaping, and Fecunis Lake mines. Mining of a large ore body, formed by deposits at Fecunis Lake, and at the Levack mine started in November. The property will be mined jointly by Falconbridge Nickel Mines, Ltd., and the International Nickel Co. of Canada, Ltd. The first level was turned over to the International Nickel Co. for preparation for mining. Construction of the Fecunis concentrator was completed early in 1957, and operations began in May. Mill feed consisted of the Longvack-mine production and development ore from the Fecunis Lake mine. The new smelter was completed in 1957, and production was expected to begin in January 1958. The developed and indicated ore reserve on December 31, 1957 was 45.8 million tons, containing 1.44 percent nickel and 0.79 percent copper. The company delivered 12,614 tons of copper to customers in 1957, a 5-percent decrease from the record 13,211 tons in 1956.

Production at Geco Mines, Ltd., was begun in September; a total of 345,800 tons of ore averaging 2.40 percent copper was milled, and 27,900 tons of 28.26-percent copper concentrate was produced. Concentrate was shipped to the Noranda smelter and accounted for 7,900 tons of copper. The ore reserve was 14.8 tons averaging 1.76 percent copper and containing zinc, silver, and pyrite.

At the Horne mine of Noranda Mines, Ltd., in *Quebec*, 1,336,400 tons of ore was mined; the smelter treated 1,303,800 tons of ore, concentrate, and secondary materials, of which 647,800 tons was smelted for other companies on a toll basis. The total estimated recovery from new metals was 109,600 tons. Copper recovered from Horne ore and concentrate was estimated at 26,000 tons. The third reverberatory furnace began operating October 1.

The copper was recovered at the electrolytic copper refinery of Noranda's subsidiary—Canadian Copper Refiners, Ltd., Montreal East. The output of refined copper was 175,000 tons, compared with 187,000 tons in 1956. The 6-percent decrease was due to lower receipts from Gaspé Copper Mines.

The indicated ore reserve in the Horne mine on January 1, 1958, was 11.7 million tons, of which 10.8 million tons was sulfide ore averaging 2.26 percent copper and 0.9 million tons of siliceous fluxing ore averaging 0.15 percent copper.

Output at Gaspé Copper Mines, Ltd., subsidiary of Noranda, was considerably less than in 1956 because of a strike that began March 11. By June production was at about 50 percent of the normal rate, and the first shipment to the refinery was made in August; the strike ended early in October. Production of ore totaled 873,900 tons, compared with 1,333,000 tons in 1956, and ore treated totaled 941,000 tons. Production of copper totaled 17,700 tons compared with 27,600 tons in 1956. The ore reserve was 64 million tons, averaging 1.3 percent copper.

The Quemont Mining Corp. Ltd., which adjoins the Horne mine, treated 837,000 tons of ore averaging 1.46 percent copper and 2.53

percent zinc. The copper concentrate, which was smelted at Noranda, accounted for a production of 11,300 tons of copper. Ore reserves at the end of 1957 amounted to 7 million tons averaging 1.33 percent copper and containing zinc, gold, silver, and pyrite.

The Waite Amulet Mines, Ltd., a subsidiary of Noranda, treated 290,000 tons of ore averaging 3.64 percent copper from the East Waite No. 3 shaft, Amulet Dufault, and "A–11" winze. Copper production totaled 9,900 tons. The treatment of West Macdonald ore continued during the year, and 329,300 tons was milled. The total ore reserve was 846,000 tons, consisting of 326,000 tons of 3.01-percent copper and 71,000 tons of 4.15-percent copper at the Waite Amulet, and 335,000 tons of 6.2-percent copper and 114,000 tons of 3.35-percent copper at Amulet Dufault.

The Normetal Mining Corp. Ltd., milled 378,300 tons of ore containing 2.33 percent copper. Concentrate produced yielded 8,200 tons of copper, which was smelted at Noranda. The ore reserve on December 31, 1957, was estimated at 2.4 million tons, averaging 3.51 percent copper and 5.02 percent zinc.

Operations at the Opemiska Copper Mines (Quebec), Ltd., were resumed March 1, following a fire in October 1956. In the 10 months of 1957, 240,400 tons of ore averaging 3.90 percent copper was milled, and 8,055 tons of copper was produced. The ore reserve on December 31, 1957, was estimated at 4.7 million tons averaging 3.21 percent copper.

Rainville Mines, Ltd., treated 161,600 tons of ore and produced 2,234 tons of copper. The mill capacity (500 tons of ore per day) was attained during the first 6 months of 1957. The ore reserve above the 550 level in the No. 4 and No. 2 zones was estimated at 368,000 tons averaging 1.3 percent copper.

Saskatchewan and *Manitoba* together produced 14 percent of Canada's total output in 1957. The Hudson Bay Mining & Smelting Co., Ltd., and Sherritt Gordon Mines, Ltd., accounted for almost the entire output.

The Hudson Bay Mining & Smelting Co. mined and milled 1,644,300 tons of ore from 5 mines; 1,377,800 tons came from the Flin Flon mine. The Schist Lake mine supplied 73,300, North Star 106,700, Don Jon 33,500, and Birch Lake 53,000 tons. Mining operations at the Don Jon ended and production began at the Birch Lake in August. Development work at three other mines—Coronation, Chisel Lake, and Stall Lake—was continued. Production of copper was 44,300 tons, compared with 46,300 tons in 1956. The ore reserve at the end of 1957 was 19.5 million tons, averaging 2.71 percent copper and 5 percent zinc.

Sherritt Gordon Mines, Ltd., mined and milled 833,000 tons of nickel-copper ore at its Lynn Lake property during 1957. All ore was produced from the "A" and "EL" mines. The company was preparing the "E" and "C" ore bodies for mining, and part of the mill feed in 1958 will come from these properties. Copper concentrate produced contained 4,700 tons of copper. The ore reserve at the end of 1957 was 13.6 million tons averaging 1.064 percent nickel and 0.561 percent copper.

The Granby Consolidated Mining, Smelting & Power Co., Ltd., operated the Copper Mountain mine in *British Columbia* until April, when operations were terminated. During the 4-month period 568,000 tons of ore containing 0.82 percent copper was treated and 3,583 tons of copper produced. Development was continued at the Granduc property, but work was expected to be deferred early in 1958 because of the low price of copper. Construction of a 700-ton-per-day plant at the Phoenix property was also delayed; much of the equipment from Copper Mountain was installed at Phoenix.

Exports of copper in ore, matte, regulus, etc., totaled 46,548 (40,994 in 1956) tons, of which the United States was the destination of 30,484 (25,354) tons, Norway 13,817 (13,373), the United Kingdom 1,103 (1,175), Belgium 455 (398), West Germany 342 (693), Mexico 286 (none), and Netherlands 61 (none). In addition, 11,793 (11,915) tons of rods, strips, sheet, and tubing was shipped, of which 4,372 (4,570) went to Switzerland, 2,411 (1,730) to United Kingdom, and 2,312 (2,350) to the United States. Copper-slag skimmings totaling 12,281 (14,593) tons also was exported in 1957.

Imports of refined copper totaled 4,175 tons in 1957 compared with 2,541 tons in 1956.

Exports of ingots, bars, and billets from Canada in 1957, as compared with 1956, were as follows, by countries of destination, in short tons:

Destination:	*1956*	*1957*
United States	96, 747	86, 300
United Kingdom	63, 990	84, 672
France	9, 860	12, 502
India	3, 972	3, 968
Sweden	------	3, 381
Switzerland	------	1, 567
Brazil	257	1, 541
West Germany	------	1, 315
Italy	------	1, 092
Australia	------	1, 007
Other	18	1, 449
Total	174, 844	198, 794

SOUTH AMERICA

Chile.—Slightly less copper was mined than in 1956; Chile, however, maintained its rank as the world's second largest producer. Operations at the Braden mine were adversely affected by a 2-week strike in April.

At the Braden mine of the Braden Copper Co., a subsidiary of Kennecott Copper Corp., 10,919,500 short tons of ore was mined and milled, and 172,700 tons of copper was produced compared with 10,767,300 and 179,900 tons, respectively, in 1956. The ore contained 39.3 pounds of copper per ton (40.3 pounds in 1956) in 1957. Improved mill recovery from new flotation equipment in the concentrator and enough rainfall for power generation made possible a near record mine and mill output.

Copper production at the Chuquicamata mine of the Chile Exploration Co., a subsidiary of The Anaconda Company, dropped slightly in 1957 to 263,400 tons (266,000 in 1956). Work was continued on the expansion projects announced in 1956. Additional mine equipment was in operation, as well as more flotation machines in the concentrator and the cooling system for condenser water in the waste-heat powerplant. Progress continued on converting part of the electrolytic tankhouse for refining blister copper. The company estimated that, with these additions and others still under construction, Chuquicamata's annual capacity would be 300,000 tons of copper. Additional oxide ore was developed by drilling on the north and northeast margins of the Chuquicamata ore body.

At the Andes Copper Mining Co., another subsidiary of The Anaconda Company, production was unchanged from 1956. The output totaled 43,300 tons of copper compared with 43,200 in 1956. Development of the El Salvador mine continued throughout the year and resulted in an increase in the ore reserve from 300 million tons to approximately 375 million averaging 1.50 percent copper. It was still expected that work would be completed in time for ore production to begin early in 1959.

The La Africana mine of the Santiago Mining Co., another subsidiary of The Anaconda Company, began producing in September.

Empresa Nacional de Fundiciones, the Government agency that operates the national smelter at Paipote, produced about 17,000 tons of blister copper in 1957 compared with 17,000 tons in 1956.

On February 6 the Chilean Government [6] announced that the Government Mine Credit Bank (CACREMI) would suspend indefinitely exports of ore and concentrate because of increases in ocean freight rates and foreign refinery fees, and the decline in copper prices. CACREMI would continue to buy ore and concentrate from the small and medium mines. The high-grade ore and the concentrate would be treated at the Paipote smelter; the other raw material would be stockpiled until the expanded smelter (as planned) could treat it.

TABLE 49.—Principal types of copper exported from Chile, in 1957, by countries, in short tons

Country	Refined		Standard (blister)	Total
	Electrolytic	Fire-refined		
Argentina	660			660
France	1,654	1,654		3,308
Germany	41,032	5,432	26,287	72,751
Italy	17,204	7,757	7,675	32,636
Netherlands	48,288	3,471	3,946	55,705
Spain			10,345	10,345
Sweden	11,248			11,248
Switzerland		2,941		2,941
United Kingdom	43,367	44,647	3,644	91,658
United States	4,376	4,238	207,530	216,144
Other	337	450		787
Total	168,166	70,590	259,427	498,183

In addition to the exports shown in table 49, 37,971 tons of ore and concentrate was shipped, of which 17,838 tons went to the United States, 11,102 to Germany, 7,348 to Japan, 747 to Netherlands, 413 to Belgium, 379 to Sweden, 125 to Brazil, and 19 to Argentina.

Peru.—Mine production of copper in Peru rose for the fifth consecutive year; output in 1957 was 27 percent higher than in 1956. Ac-

[6] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 7.

cording to the annual report to stockholders of the Cerro de Pasco Corp. (Peru's leading producer), the output of ore rose 9 percent to 2,115,800 tons. Production of copper totaled 45,300 tons (34,100 in 1956), of which 33,800 tons (26,700) was from company ores and 11,500 tons (7,400) from purchased ores. Production at the small open-pit copper mine, which began early in 1957, was discontinued in December, when Cerro de Pasco announced a cutback in copper production. In March the Paucartambo hydroelectric powerplant began operations. The initial capacity was 72,000 kv.-a but can be expanded to 96,000 kv.-a, if needed, at small cost. The additional power from Paucartambo prevented curtailment of refinery operations during the dry season.

Remarkable progress was made in Southern Peru Copper Corp. stripping schedule at its Toquepala project in Peru.[7] Between November 1956 and November 1957, 20 million tons of waste was removed from 10 benches. In one of the largest open-pit blasts in history, 270,000 pounds of powder loaded in 700 churn- and rotary-drilled holes totaling 51,589 feet in length was detonated to start the stripping operation; over 1 million tons of waste was broken with this initial blast. Work on the railroad from sea level to the mine at an elevation of 10,600 feet and construction of the 30,000-ton-per-day flotation mill and crushing plant are underway. The permanent wharf at the port of Ilo was completed, and construction of the smelter 15 miles north of Ilo is planned to start soon.

Copper exports in 1957 totaled 54,200 tons, of which 38,100 tons went to the United States, 7,400 to Germany, 4,700 to the United Kingdom, and 3,600 to Japan.

EUROPE

United Kingdom.—Consumption of primary and secondary copper in the United Kingdom (the second largest consumer in the world) was slightly more than in 1956. Of the total of 718,500 tons consumed in 1957, 548,400 tons was refined copper and 79,800 tons scrap for wrought products; and 19,900 tons of refined and 70,200 tons of scrap for castings, sulfate, and miscellaneous products. Inventories of blister and refined copper, exclusive of Government stocks, rose from 66,800 tons at the end of 1956 to 102,500 at the end of 1957.

In August the British Board of Trade announced that it would sell 27,000 tons of copper from the stockpile. The monthly rate of disposal was not expected to exceed 2,700 tons, and no metal would be offered before October. On September 16 the board stated that sale of this copper was deferred and on December 24 was postponed indefinitely.

According to the British Bureau of Nonferrous Metal Statistics, imports of copper into United Kingdom in 1956 and 1957 were as follows:

[7] Mining World, How Southern Peru Stripped 20,000,000 Tons of Toquepala Waste In First Year: Vol. 19, No. 13, December 1957, pp. 50–52.

TABLE 50.—Copper imported into United Kingdom, 1956–57, in short tons

Country	1956			1957		
	Blister	Electro-lytic	Fire-refined	Blister	Electro-lytic	Fire-refined
Northern Rhodesia	117,076	144,071		124,617	118,098	
Chile		48,497	37,402	3,298	45,211	40,632
United States		10,716			82,630	10,639
Canada		65,708			85,794	
Belgian Congo		8,624			3,360	
Peru		2,958			2,669	
Norway		548			1,228	
Turkey	2,232			999		
Union of South Africa			954		225	532
Belgium		5,475			675	
Sweden		977			529	
Germany, West		1,887			84	
Other countries	223	756	267	635	34	1
Total	119,531	290,217	38,623	129,549	340,537	51,804

Exports and reexports of refined copper were 53,178 tons (54,563 in 1956), of which 14,832 (6,379) went to France, 9,538 (22,221) to Germany, 4,780 (4,161) to the United States, 4,317 (none) to Argentina, 3,244 (3,386) to Switzerland, 2,866 (1,221) to Portugal, 2,416 (2,970) to Italy, 2,377 (3,735) to the Netherlands, 1,483 (3,666) to India, and 1,086 (2,289) to Belgium. In 1957, 551 tons (616 in 1956) of blister was reexported.

Yugoslavia.—It was reported[8] that work on the Majdanpek copper deposits, begun in 1949, was completed. Ore reserves were estimated to total 220 million short tons, containing about 1.7 million tons of copper. Three to four years may be required to remove the overburden, after which the property will be operated by open-pit methods. A 23,000-ton-per-day flotation plant will be built, and 27,500 tons of concentrate will be produced annually. At the Bor mine it was planned to increase copper production from 33,100 tons to 60,600 annually.[9]

ASIA

Cyprus.—Production of the Cyprus Mines Corp., the principal producer, totaled 327,100 tons in 1957 compared with 277,300 tons in 1956, an increase of 18 percent. The output consisted of 125,900 tons of copper concentrate containing 21.36 percent copper, 3,800 tons of precipitate averaging 77 percent copper, and 197,400 tons of cupreous pyrite containing 3.04 percent copper. In addition, 593,500 tons of flotation pyrite averaging 49.85 percent sulfur was produced. The Cyprus Sulphur and Copper Co., Ltd., produced 76,200 tons of cupreous pyrite containing 2.17 percent copper. Very little exploration work was done in 1957 because of the unsettled conditions in the country, but the Cyprus Mines Corp. plans to resume work on the Skouriotissa mine as an open-pit operation in about 2 or 3 years and to work a smaller ore body south of the main Mavrovouni mine.

Philippines.—Copper production in the Philippines rose for the fourth successive year. Output by the 2 principal producers was 8,500 tons greater than in 1956.

[8] American Metal Market, vol. 65, No. 25, Feb. 5, 1958, p. 4.
[9] Mining World, vol. 19, No. 13, December 1957, p. 88.

The Atlas Consolidated Mining Co. produced 3,402,000 tons of ore averaging 0.68 percent copper and milled 3,388,000 tons. The output of copper was 19,100 tons compared with 12,000 tons in 1956. The Lepanto Consolidated Mining Co. produced 14,300 tons of copper in 1957 compared with 12,800 tons in 1956.

The Marinduque Iron Mines, Inc., mill at the Sipalay mine in Negros Occidental began operations in May, and the company planned to build a smelter at Iligan, Lanão. The plant will treat ore from the Elizalde properties in Visayas and Mindanão, and concentrate recovered at the Sipalay and Bagacay mines. In 1957 the Bagacay mine shipped 44,000 tons of 15.1-percent copper ore to Japan.

AFRICA

Belgian Congo.—Production of copper reversed the upward trend of the past 7 years and was 3 percent lower than in 1956. The Union Minière du Haut-Katanga (UMK) was, as heretofore, the only producer. In July the company announced that, effective August 1, the UMK price of copper in the United States was equalized to that at European ports. The 1-cent-per-pound differential due to freight and insurance was eliminated.

Most of the output continued to come from mines in the Western Group and the Prince Leopold mine. The Kamoto open pit supplied increasing tonnages of ore, and the Kolwezi mine was reopened after being closed for more than 3 years. A total of 11,076,000 tons of ore was mined, and 8,463,000 tons was sent to concentrators, washing plants, and the smelter.

The Kolwezi concentrator treated 4,314,000 tons of copper and mixed ores from the Musonoi, Ruwe, Kamoto, and Kolwezi mines; it produced 665,600 tons of concentrate assaying 27.3 percent copper and 1.31 percent cobalt and 38,500 tons of concentrate averaging 9.9 percent copper and 8.05 percent cobalt.

The Prince Leopold mine sent 1,279,900 tons of ore to the Kipushi concentrator. Production consisted of 59,500 tons of concentrate, averaging 21.42 percent copper, from straight copper ore, 279,800 tons of 26.62-percent copper concentrate, and 207,400 tons of 56.97-percent zinc concentrate from copper-zinc ore.

The Ruwe concentrator treated 2,466,100 tons of material and produced 152,900 tons of 22.49-percent copper concentrate and 191,200 tons of intermediate products running 5.49 percent copper that required further treatment.

The Ruashi washery treated 137,800 tons of ore from small mines in the southeast region and produced 31,600 tons of products.

Production of copper at the Lubumbashi smelter and Shituru electrolytic plant dropped 8,000 tons from 1956. The company stated that, as part of the reduction in output decided upon in 1957, operations at the Lubumbashi smelter were curtailed during the latter half of the year, but production increased at the Shituru electrolytic plant. Production of scalped wirebars was begun. In addition, certain expansion programs were to be delayed at the Kamoto open pit, the West Kambove underground mine, and the Luilu copper-cobalt electrolytic plant.

The output of copper, in short tons, was distributed as follows:

	1956	1957
Lubumbashi smelter (blister)	132, 093	118, 276
Jadotville-Shituru (electrolytic plant)	138, 867	144, 782
Jadotville-Panda (electric copper-cobalt alloy furnaces)	997	919
Copper recoverable contained in zinc concentrates	812	886
Total	272, 769	264, 863

The company produced 5,787,000 tons of copper from the beginning of operations through 1957.

Kenya.—Production of copper rose from 900 tons in 1956 to about 2,000 tons in 1957 as a result of the first full year's operation of the Macalder mine of Macalder-Nyanza Mines, Ltd.

Rhodesia and Nyasaland, Federation of.—Mine production of copper in *Northern Rhodesia* established a new record in 1957, despite work stoppages and announced curtailment at some properties. The output was 480,300 tons and exceeded the 1956 record by 8 percent. There was no shortage of power supplies following importation of power from the Le Marinel installation, and wood burning was discontinued in February after nearly 11 years. Total wood burned on the Copperbelt was approximately 3.8 million cords, equivalent to over 1.7 million tons of coal. Work was continued on the Kariba hydroelectric project on the Zambezi River, and power was expected to be available in 1960.

In May Roan Antelope Copper Mines, Ltd., and Mufulira Copper Mines, Ltd., announced a 10-percent cutback on current production rates, effective June 1.

The Rhodesian Selection Trust Group, which had established a fixed copper price May 9, 1955, reverted to the London Metal Exchange price basis in October, and the dual pricing of Rhodesian copper ended.

A total of 5,582,800 tons of ore containing 1.95 percent copper was mined and milled by Roan Antelope Copper Mines, Ltd., in the fiscal year ended June 30, 1957—5 percent more than the record output of the preceding fiscal year. The grade of ore milled, however, was the lowest since operations were begun in 1932. The concentrate smelted yielded 96,600 tons of blister copper compared with 99,400 tons in 1956. In addition, 5,600 tons of blister was produced for Chibuluma and 1,600 tons for Nchanga (including 900 tons from Nchanga ore used as a flux). At the end of June the ore reserve totaled 95.2 million tons averaging 3.09 percent copper. About 10.6 million tons was added to the ore reserve during the year, mainly because of inclusion, for the first time, of ore in the Muliashi Special Grant area.

High-record tonnage of ore was mined and milled by Mufulira Copper Mines, Ltd., in the fiscal year ended June 30, 1957. Ore mined totaled 4,498,600 tons, averaging 2.86 percent copper; a total of 4,481,300 tons was milled and 110,500 tons of copper produced, of which 19,700 tons was blister, 26,500 tons cathodes, and 64,300 tons wire bars. A third reverberatory furnace began operations in the smelter in January 1957. Smelting of concentrate for Chibuluma Mines, Ltd., continued throughout the year. In the refinery a second wire-bar furnace began production in November 1956, and installation of a billet-casting wheel was almost completed by the end of

June. The ore reserve estimated on June 30, 1957, was 151 million tons averaging 3.35 percent copper. During the year the company announced plans for the development of Mufulira West. Annual copper production will be increased from 112,000 to 173,600 tons. It is estimated that 5 years will be required to complete the program, which will cost £16 million.

Chibuluma Mines, Ltd., completed its first full year's operation in the fiscal 1956–57 year. Ore mined totaled 460,900 tons averaging 5.84 percent copper and 0.36 percent cobalt, and 504,400 tons was milled. Copper concentrate treated was 49,700 tons; the Mufulira smelter treated 32,700 tons and produced 10,600 tons of blister, and the Roan smelter treated 17,000 tons and produced 5,600 tons of blister. Smelting capacity was not available to treat the total output of 75,800 tons of copper concentrate in the 1957 fiscal year, and arrangements were made to treat the remainder in the next fiscal year. The ore reserve on June 30, 1957, was estimated at 6.7 million tons averaging 5.10 percent copper.

Progress was maintained on all phases of construction work at the electrolytic refinery of Ndola Copper Refineries, Ltd., Ndola, a subsidiary of Roan Antelope. In the first section of the refinery most of the electrolytic cells have been erected, and machinery was being installed in all major sections of the plant. Power from the interconnected system of the Rhodesia Congo Border Power Corp., Ltd., became available in 1957. The first section of the refinery was expected to begin operations in August 1958 and the second section in April 1960.

Bancroft Mines, Ltd., came into production at the beginning of 1957, and 3,800 tons of blister copper was produced at the Rhokana smelter. The estimated ore reserve on June 30, 1957, was 102.6 million tons averaging 3.88 percent copper.

The Rhokana Corp., Ltd., mined and milled record tonnages of ore in the fiscal year ended June 30, 1957. A total of 4,230,900 tons was mined from the Nkana and Mindola mines, and 4,265,000 tons of ore averaging 2.54 percent copper was treated in the concentrator. Concentrate produced totaled 345,800 tons, averaging 28.92 percent copper and 1.495 percent cobalt. Finished copper produced was 25,500 tons of blister and 73,400 tons of electrolytic copper. The smelter produced 190,200 tons of copper, of which 25,500 tons was blister and 71,400 tons was anode copper for Nkana, 22,900 tons was blister and 64,500 anode copper for Nchanga, 3,800 tons was blister for Bancroft, 2,100 tons was blister for Kansanshi, and 78 tons was blister for other companies. Ore reserves at the end of June 1957 were as follows:

	Short tons (million)	*Copper (percent)*
Nkana north ore body	25	2. 99
Nkana south ore body	27	2. 70
Mindola south ore body	82	3. 31
	134	3. 13

In the year ended March 31, 1957, 3,163,200 tons of ore was mined and 3,116,300 tons milled by Nchanga Consolidated Copper Mines, Ltd. Production of finished copper was 23,200 tons of blister and 102,900 tons of electrolytic. Preparation of the Nchanga ore body for open-pit mining was continued during the year, and operations were begun in April 1957. An extensive exploration program on the Chingola ore body resulted in an estimated ore reserve of 7.4 million tons, averaging 5.68 percent copper, and it was decided to mine this property by open-pit methods. Overburden stripping was begun, and it was expected that mining operations would be started in 1958. The Nchanga mill was being enlarged to treat 360,000 tons per month, of which about 240,000 tons will come from the Nchanga West, 80,000 tons from the Nchanga open pit, and 40,000 tons from the Chingola open pit. The ore reserve on April 1, 1958, in the Nchanga West and Nchanga ore bodies was estimated at 154.7 million tons averaging 4.55 percent copper, an increase of over 8 million tons from April 1, 1957.

Production was begun in late 1956 at the Kansanshi mine, of Kansanshi Copper Mining Co., Ltd., about 100 miles west of Nchanga and 6 miles south of Belgian Congo border. Copper concentrate was treated at the Rhokana smelter, and 2,100 tons of blister copper was produced. The mine was flooded and closed in November 1957.

The Rhodesia Copper Refineries, Ltd., produced 182,000 tons of electrolytic copper in the fiscal year ended June 30, 1957, compared with 176,000 tons in the 1956 fiscal year. The output consisted of 173,000 tons of refinery shapes and 9,000 tons of cathodes. In addition, bismuth-bearing cathodes and refinery slimes containing small quantities of copper were shipped elsewhere for treatment.

TABLE 51.—Copper exported from Federation of Rhodesia and Nyasaland in 1957, in short tons

Destination	Ore and concentrates	Blister	Electrolytic			Copper slimes
			Bar and ingot	Cathodes	Wire-bars	
Argentina					5,893	
Australia					1,681	
Belgium	1,627	56	2,072	1,682	3,334	212
Brazil					10,098	
France		1,056	2,856	2,306	11,199	
Germany, West		39,914		5,544	2,130	
India		1,587	2,809		22,135	
Italy		2,547		56	10,169	
Japan	2,498	2,128				
Netherlands	8	7,396	196	840	6,905	
Spain	6,000	2,958				
Sweden	20		644		13,806	
Union of South Africa	5,053	175	829		18,353	
United Kingdom		116,334	2,591	13,199	94,614	
United States	880	17,558		1,289	28,394	34
Other countries					310	
Total	16,086	191,709	11,997	24,916	229,021	246

Production of copper in *Southern Rhodesia* rose 10 percent to 2,100 tons in 1957. The Umkondo mine of Messina (Transvaal) Development Co., Ltd., was the principal producer. The Mangula mine in the Sinoia district began operations in 1957, 18 months before the target date (1959). It was planned to double the daily mill capacity (1,500 tons) and to build a smelter near the mine. Concentrate was being shipped overseas for smelting. The reserve of sulfide ore was estimated to be 25.9 million tons averaging 1.36 percent copper.

South-West Africa.—Production of copper continued the upward trend for the fourth successive year and exceeded the previous 1956 peak by 3 percent. At the Tsumeb mine of the Tsumeb Corporation, Ltd., 638,500 tons of ore averaging 5.03 percent copper was milled. Sales of copper in the fiscal year ended June 30, 1957, totaled 27,800 tons compared with 25,800 in the 1956 fiscal year. The ore reserve at the end of June was estimated at 9.5 million tons averaging 5.38 percent copper.

Uganda.—In the first full year's operation of the Kilembe mine, Kilembe Mines, Ltd., treated 479,300 tons of ore averaging 2.23 percent copper and 0.17 percent cobalt. Blister copper shipped totaled 8,400 tons. According to the annual report to stockholders of Ventures, Ltd., the daily tonnage milled was increased to 1,550 tons from the rated capacity of 1,335 tons, and production of blister copper substantially exceeded the initial target of 840 tons per month. The ore reserve totaled 17 million tons averaging 2.02 percent copper and 0.17 percent cobalt, of which 9 million tons was proved and probable ore, averaging 2.24 percent copper and 0.18 percent cobalt. The company planned to install a 500-ton-per-day concentrator to begin operating early in 1959.

Union of South Africa.—Production of blister copper by the O'okiep Copper Co. Ltd., in the fiscal year ended June 30, 1957, was 31,300 tons, a 3-percent decrease from the record output of 32,300 tons in fiscal 1956. A total of 1,428,400 tons of ore averaging 2.15 percent copper was milled from the Nababeep, East O'okiep, West O'okiep, and Wheal Julia mines. During 1957 the high-grade section of the Wheal Julia, which had accounted for the increased production in the past 4 years, was exhausted. A new mine, the Nababeep West, began producing in March and was expected to attain full production of 600,000 to 700,000 tons of ore annually by late 1958. The combined capacity of the Nababeep and East O'okiep concentrators was expanded to 1.8 million tons of ore per year, because of the necessity of mining lower grade ore. The ore reserve on June 30, 1957, was 25.4 million tons, averaging 2.23 percent copper.

OCEANIA

Australia.—The upward trend in production in Australia continued in 1957; output was 63,400 tons compared with 59,400 tons in 1957, an increase of 7 percent.

The Mount Isa Mines, Ltd., milled a record tonnage of 1,573,400 tons of copper and silver-lead-zinc ores in the year ended June 30, 1957. Copper ore treated totaled 821,400 tons averaging 4.5 percent copper compared with 812,800 tons averaging 3.8 percent copper in the 1956 fiscal year. Blister copper produced (32,300 tons) was also a record. On June 30 the ore reserve totaled 14.3 million tons averaging 3.75 percent copper. The company decided to proceed with part of the expansion program to increase production from the current rate of 4,480 tons per day of silver-lead-zinc and copper ores to 14,560 tons. The entire program depended upon rehabilitation of the Townsville-Mount Isa railway. The intermediate stage in process would increase output to 7,840 tons of sulfide ore per day, and the first part of the expansion was reached in October. It was expected that by April 1958 production would be at the rate of 6,720 tons per day and full production of 7,840 tons would be attained by December 1959. Work on the electrolytic refinery at Townsville was proceeding satisfactorily, and production was expected in June 1958.

Mount Morgan, Ltd., Queensland, delivered 839,000 tons of ore averaging 0.81 percent copper to the mills, compared with 943,000 tons averaging 0.93 percent in 1956. Copper production dropped 1,600 tons to 6,100 tons (7,700 tons in 1956). The ore reserve was 16.8 million tons containing 1 percent copper.

Other producers in Australia included Mount Lyell Mining & Railway Co., Ltd., Tasmania; Peko Gold Mines, N. L., Northern Territory; and Ravensthorpe Copper Mines, N. L., Western Australia.

TECHNOLOGY

During the year the Bureau of Mines [10] published information on results of investigations at copper deposits and laboratory studies on concentration of ores.

The Geological Survey [11] published information on deposits in California, Peru, and Central America.

The geophysical work responsible for locating the copper ore body now being mined by the Pima Mining Co.[12] was begun in 1949. The ore body was delineated by using hand instruments (magnetic, electromagnetic) followed by some work with a mobile magnetometer. Analysis of the geophysical surveys indicated a lenticular deposit dipping steeply to the south and striking nearly east-west. Diamond drilling and underground development confirmed the projections. Oxide mineralization was found at 209 feet and sulfide ore at 225 feet. Ore mineralization occurs along a large east-west thrust fault or at near intrusive contacts with limestone or quartzite. Chalcopyrite is the principal ore mineral, with small amounts of bornite and chalcocite. The oxide minerals chrysocolla (copper silicate) and tenorite (black copper oxide) are found above the sulfide zone. After approximately 3 million cubic yards of material had been stripped, the first official production was made on January 1, 1957.

[10] Peyton, A. L., Examination of Copper-Lead-Zinc Deposits, Cabarrus and Union Counties, N. C. Bureau of Mines Rept. of Investigations 5313, 1957, 13 pp.
Mihelich, Miro, and Wells, R. R., Copper Mines and Prospects Adjacent to Landlocked Bay, Prince William Sound, Alaska: Bureau of Mines Rept. of Investigations 5320, 1957, 21 pp.
Wilson, E. D., Geologic Factors Related to Block Caving at San Manuel Copper Mine, Pinal County, Ariz.; Progress Report April 1954–March 1956: Bureau of Mines Rept. of Investigations 5336, 1957, 78 pp.
Magill, E. A., and Appling, R. N., Jr., The Miners Queen Copper Deposit, Skamania County, Wash.: Bureau of Mines Rept. of Investigations 5343, 1957, 16 pp.
Look, Allen D., and Williams, M. L., Safety Plan at Ray Mines Division, Kennecott Copper Corp., Ray, Ariz.: Bureau of Mines Inf. Circ. 7772, 1957, 19 pp.
Look, Allen D, and Anderson, Ludlow G., Use of Precast Shaft Supports, Banner Mine, Lordsburg, N. Mex.: Bureau of Mines Inf. Circ. 7775, 1957, 15 pp.
Storms, Walter R., and Bowman, Allan B., Mining Methods and Practices at the Mineral Hill Copper Mine, Banner Mining Co., Pima County, Ariz.: Bureau of Mines Inf. Circ. 7786, 1957, 25 pp.
Hardwick, W. R., and Sierakoski, Joe, Mining Methods and Practices at the Johnson Camp Copper-Zinc Mine, Coronado Copper & Zinc Co., Cochise County, Ariz.: Bureau of Mines Inf. Circ. 7788, 1957, 27 pp.
Wells, R. R., Erspamer, E. G. and Sterling, F. T., Beneficiation of Iron-Copper Ore From Kasaan Peninsula, Prince of Wales Island, Alaska: Bureau of Mines Rept. of Investigations 5312, 1957, 15 pp.
Engle, A. L., and Heinen, H. J., Leach-Precipitation-Flotation Tests of a California Copper-Gold Ore: Bureau of Mines Rept. of Investigations 5342, 1957, 9 pp.

[11] Kinkel, A. R., Jr., Hall, W. E., and Albers, J. P., Geology and Base-Metal Deposits of West Shasta Copper-Zinc District, Shasta County, Calif.: Geol. Survey Prof. Paper 285, 1956 (1957), 156 pp.
Bodenlos, A. J., and Straczek, J. A., Base-Metal Deposits of the Cordillera Negra, Departamento de Ancash, Peru: Geol. Survey Bull. 1040, 1957, 165 pp.
Roberts, R. J., and Irving, E. M., Mineral Deposits of Central America, With a section on Manganese Deposits of Panama by F. S. Simons: Geol. Survey Bull. 1034, 1957, 205 pp.

[12] Huttl, John B., How Scientific Exploration Found Pima Mine: Eng. Min. Jour., vol. 159, No. 3, March 1958, pp. 100–106.

The Pima and Twin Buttes districts in Arizona [13] have been the scene of intense exploration and development in recent years. Known ore deposits of both districts occur at or near the contacts of intrusive granites with limestones and quartzites. The deposits are typical of pyrometasomatic mineralization with contact zoning of high-temperature gangue minerals. The principal copper mineralization is chalcopyrite, with minor amounts of bornite and chalcocite. Locally magnetite and pyrrhotite are associated with the ore minerals and have served as exploration aids. Magnetic surveys have been extensively used as guides to possible alluvial-covered deposits. The Banner Mining Company Mineral Hill, Daisy, and Copper Glance mines, the Duval Sulphur & Potash Co. open-pit Esperanza mine to the south, and the American Smelting and Refining Co. encouraging diamond drilling on the Papago Indian Reservation to the north are significant achievements so far in the area.

Theories [14] on the genesis of copper deposits of the "manto" type in Lower California, Mexico, including hydrothermal solutions of magmatic origin, submarine mud volcanoes, hot springs, supergene enrichment, and lateral secretion are questioned. Field observations during extensive geological investigations of the Boleo copper district indicate that the copper deposits are of sedimentary rather than magmatic origin.

The Cuajone porphyry-copper deposit in Peru lies north of Toquepala and Quelleveco on the western slope of the Andean Range, where quartz-monzonite invaded earlier diorite intrusives and volcanic flows.[15] Sulfide mineralization occurs in small veinlets and disseminations in intervening fragments. Pyrite predominates, and chalcopyrite is the principal ore mineral. Nearly all of the well-known copper minerals are found in small quantities—bornite, chalcocite, covellite, and enargite, plus the oxide forms of chrysocolla, cuprite, and tenorite. Lead and zinc minerals occur in the periphery of the ore zone but apparently in uneconomic concentrations. Drilling data indicate that copper values were deposited along zones of shattering or brecciation that were open when copper-bearing solutions were introduced.

Mining costs at The Anaconda Co. Berkeley pit [16] in Butte, Mont., were reduced by using ammonium nitrate of Fertilizer grade for blasting benches. The cost of nitro-carbo-nitrate previously used was $225 per ton as against $78.25 for Fertilizer-grade ammonium nitrate. This material alone is not explosive or cap-sensitive and is therefore safer to handle, store, and transport than most other explosives. Good fragmentation in both ore and waste by using ammonium nitrate, with no secondary blasting required, contributed to a higher mining rate with resultant lower mining costs.

Kennecott Copper Corporation plans and development operations for mining the Deep Ruth ore body involved [17] sealing off water-bearing formations in sinking the Deep Ruth and Kellinshe shaft,

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[13] The Mining World, Geology and Exploration Point Way for Banner's Copper Developments: Vol. 19, No. 12, November 1957, pp. 38–42.

[14] Nishihara, Hironao, Origin of The "Manto" Copper Deposits in Lower California, Mexico: Econ. Geol., vol. 52, No. 8, December 1957, pp. 944–951.

[15] Lacy, W. C., Porphyry-Copper Deposit, Cuajone, Peru: Min. Eng., vol. 10, No. 1, January 1958, pp. 104–107.

[16] Engineering and Mining Journal, At Berkeley Pit, Blasting Is an Art: Vol. 158, No. 12, December 1957, pp. 107–110.

[17] Huttl, John B., Bringing Deep Ruth Into Production: Eng. Min. Jour., vol. 158, No. 5, May 1957, pp. 82–87.

establishing three haulage levels, moving office buildings and numerous homes to the New Ruth townsite, and constructing a modern surface plant at the Deep Ruth shaft. Deep Ruth production was scheduled for 1958.

Appalachian Sulphides, Inc., began to produce from the famous Ore Knob mines in North Carolina in March 1957.[18] The ore body is a vertically dipping fissure approximately 200 feet wide and 1,500 feet long, containing copper-bearing ore minerals of pyrrhotite and pyrite.

The American Smelting and Refining Company announced a major copper discovery at its properties in the Papago Indian Reservation about 15 miles south of Tucson, Arizona.[19] Exploration by diamond, churn, and rotary drilling has developed reserves of about 65 million tons of ore averaging 0.90 to 1.00 percent copper.

Underground truck haulage [20] is being reduced at the White Pine Copper Co. mine in Michigan's Upper Peninsula. When the mine first was opened, all ore was trucked to a conveyor system installed in the slope leading out of the mine; however, as new mining areas have been opened up increasing distances from the slope, conveyors have replaced the trucks for much of the haulage. This conveyor program is expected to continue as mining progresses.

The Sherritt Gordon Co. original Lynn Lake discovery of nickel-copper ore was made in 1941, where a small occurrence of massive pyrrhotite and disseminated sulfides yielded some ore-grade specimens containing nickel and copper.[21] Geophysical surveys covering 42.4 square miles, and costing $5,212 per square mile, resulted in the subsequent delineation of 14 million tons of ore averaging 1.22 percent nickel and 0.62 percent copper. Five ore bodies were found, and 2 were being mined. Ore hoisted in 1955 amounted to 761,000 tons at a distributed cost of $4.04 per ton; production rates were 2,087 tons per day, 22.71 tons per shift worked underground, or 6.22 tons per shift for the total payroll.

Three articles [22] described smelter equipment and operations and show statistics of copper smelting at 1 Canadian and 2 United States smelters.

In a 24-hour full-scale experimental test at the Cerro de Pasco Corporation Oroya smelter in Peru it was determined [23] that the high magnetite content and the copper losses in reverberatory slags are partly related to the presence of converter slag in the reverberatory furnace. Increased slag-settling time, addition of pyrites on top of the slag, and elimination of converter slag from the reverberatory-furnace charge lower copper losses in reverberatory slags.

[18] Engineering and Mining Journal, Reopened Ore Knob Copper Is Thriving: Vol. 158, No. 10, October 1957, pp. 104–105.
[19] Mining World, ASARCO Announces Major Arizona Copper Discovery: Vol. 19, No. 10, September 1957, p. 49.
[20] Speaker, F. B., Conveyor Operation in Michigan Wilderness: Min. Eng., vol. 9, No. 12, December 1957, pp. 1324–1325.
[21] Gallie, Alan E., Sherritt Gordon Nickel-Copper Mines: Min. Eng., vol. 9, No. 3, March 1957, pp. 330–333.
[22] McKerrow, G. C., The Gaspé Smelter: Jour. Metals, vol. 9, No. 9, September 1957, pp. 1114–1117.
Woodside, T. J., and Roberts, B., The El Paso Smelter: Jour. Metals, vol. 9, No. 9, September 1957, pp. 1118–1121.
Wilson, R. C., The San Manuel Smelter: Jour. Metals, vol. 9, No. 9, September 1957, pp. 1122–1124.
[23] Barker, I. L., Jacobi, J. S., and Wadia, B. H., Some Notes on Oroya Copper Slags: Jour. Metals, vol. 9, No. 6, June 1957, pp. 774–780.

Several articles [24] constituting a symposium on powder metallurgy describe the uses, properties, fabrication, and technology as applied to copper and copper-alloy products.

The roast-leach-electrolytic precipitation process [25] in the development stage, with a 5-ton-per-day pilot plant operated by the Bagdad Copper Corporation, is showing encouraging results. The process is not new, having been described to the American Electrochemical Society by Charles T. Baroch in June 1930. The solubility of iron is apparently the principal problem to be solved. Close control at high temperatures in FluoSolids roasters appears to be responsible for better solubilities of both iron and copper.

The Braden Copper Co. El Teniente mine at Sewell, Chile, was the largest underground copper mine in the world.[26]

When operating at capacity the mill recovered 2,000 tons of copper concentrates from 34,000 tons of dry ore daily. The tonnage of tailings is equivalent to about 100,000 tons of pulp. Because the streams flowing from the Andes are used for irrigation, tailings cannot be dumped directly into the river, and the pulp is separated into solids and water. The coarse sand is separated in settling boxes and used to build dams at various sites, while the slimes are transported to the reservoirs behind the dams; the clear water is returned to the originating watershed. Disposal of tailings from the concentrator to the final area of deposition required 37 miles of wooden flumeline, about 3 miles of tunnel through rock, 1¼ miles of false tunnels and snowsheds, 275 bridges, and 8 partial camps.

Design of a gravity tailing-disposal system [27] for the San Manuel concentrator required controlled pH value and density of the tailings pulp. Laboratory tests showed that a pH of approximately 11.0 was required for satisfactory tailings thickening and a clear overflow. A higher pH (11.4) caused plugging of the entire tailing line, while a lower pH (below 10.85) produced a murky overflow.

The Phelps Dodge Corp. Lavender-pit concentrator, treating low-grade porphyry copper ore from the nearby mine, handles 16,000 tons per day having an average total copper content of 1.039 percent; sulfide copper composes 0.985 percent and oxide 0.054 percent.[28] The chalcocite content in the millheads varies greatly from hour to hour, shift to shift, and day to day. In 1 month the daily chalcocite content ranged from 0.86 to 1.87 percent; hourly variations from 0.70 to 1.50 percent copper are not uncommon.

Cyclones [29] were used for thickening copper concentrate, classifications of ore in fine grinding circuits, classification of middling concentrate for regrinding, desanding milk of lime, and classification and thickening of tailings at disposal areas. At the Chino Mines Division of Kennecott Copper Corp. they have been employed widely to supplement existing equipment or improve efficiencies of particular operations.

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[24] Journal of Metals, Powder-Metallurgy Symposium: Vol. 9, No. 3, March 1957, p. 325.

[25] Howell, E. S., Grothe, J. D., and McLeod, B. H., Bagdad Reports Metallurgical Test Results On Copper Recovery Method: Eng. Min. Jour., vol. 158, No. 7, July 1957, pp. 86–89.

[26] Jigins, R. W., Tailings Disposal at Braden Copper Co.: Min. Eng., vol. 9, No. 10, October 1957, pp. 1135–1140.

[27] Wallach, A. A., Tailings Line Design as Affected by pH: AIME Tech. Paper, Prepr. 5819AII. (Pres. at Annual Meeting of AIME, February 1958.)

[28] Martin, H. K., Milling Practice at the Lavender-Pit Concentrator: Min. Eng., vol. 9, No. 11, November 1957, pp. 1229–1235.

[29] Lemke, Paul A., Experience With Cyclones At Chino: Min. Cong. Jour., vol. 43, No. 9, September 1957, pp. 42–45.

In January 1957 Inspiration Consolidated Copper Company at Inspiration, Ariz.[30] placed in operation its dual metallurgical process for treating mixed oxide-sulfide copper ore. The new process increased the company ore reserve by allowing treatment of lower grade ore and eliminated the necessary control of the oxide-sulfide ratio required by acid ferric-sulfate leaching practice. The dual process is essentially a straight acid leach to extract the copper oxide fraction from the ore, followed by flotation of the washed residue to recover the sulfide portion.

Intimate blending of a concentrated siliceous flux with copper concentrate allows Magma Copper Company[31] to provide a predetermined uniform charge for its reverberatory furnace at Superior, Ariz. A specially designed circuit installed in the mill that floats pyrite from a portion of the mill scavenger tailings gives a finely ground flux averaging 70 percent silica. The flux is mixed with the copper concentrate in a pump sump. The mixture is pumped almost 3,000 feet through a 4-inch pipeline to the filtering plant at the smelter. Daily observation and analysis of the reverberatory slag indicate the quantity of crushed silica that must be charged with the filtercake for necessary minor adjustment to control composition of the slag.

[30] Dayton, Stanley, Dual-Process Metallurgy Stretches Inspiration Ore Reserves: Min. World, vol. 19, No. 10, September 1957, pp. 50–59.
[31] Caldwell, E. J., and Rex, Halder, Fluxed Concentrate Pumped to Magma's Copper Smelter: Min. World, vol. 20, No. 4, April 1958, pp. 43–45.

Diatomite

By L. M. Otis[1] and James M. Foley[2]

OUTPUT of diatomite in the United States in 1957 was appreciably greater than in 1956, continuing the uninterrupted upward trend in production since 1952. Production data cannot be published for 1957 until the 1959 release when the 3-year average for 1957–59 will be available.

TABLE 1.—Diatomite production, 1939–56

	1939–41	1942–44	1945–47	1948–50	1951–53	1954–56
Domestic production short tons	360, 502	524, 872	640, 764	722, 670	908, 448	1, 105, 279
Average value per ton	$15. 94	$18. 85	$20. 17	$25. 55	$29. 97	$39. 21

DOMESTIC PRODUCTION

Since 1910 California has been the leading diatomite-producing State. In 1957 Nevada was second, followed in order by Oregon and Washington. Arizona and New Mexico have not produced since 1955. Thirteen plants reported output during the year, compared with 12 in 1956.

Great Lakes Carbon Co. began stripping operations in Lake County, Oreg., in October 1957. Ore was to be shipped to the company processing plant at Lower Bridge (near Terrebonne).

CONSUMPTION AND USES

The market for diatomite appeared to be widening, owing to new uses. Most new uses are not important tonnagewise, but the aggregate is reflected in the gradual increase in the proportion classified as miscellaneous.

Filtration continued to be the principal sales outlet; 45 percent was sold for this purpose, compared with 48 percent in 1956.

Diatomite was originally used as a filter aid for clarifying raw cane-sugar solution. In 1957 it was used for almost every industrial filtration application, including processing water, alcoholic and nonalcoholic beverages, antibiotics, oils, solvents, and various chemicals.

Since 1943 its use as a filler or extender has ranked second, 26 percent being sold for this purpose in 1957, the same as in 1956. Diatomite was used as a filler in paper, paints, varnish, brick, tile, ceramics, oilcloth, linoleum, plastics, soap, detergents, welding-rod coatings, belt dressing, crayons, phonograph records, and in many other items.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

Insulation against temperature change and sound ranked third in use. The cellular structure and irregular outline of the grouped, many-shaped diatoms entrap a mass of dead air, inhibiting the passage of heat and sound. Diatomite was used as insulation for ovens, kilns, safes, refrigerators, driers, evaporators, cold-storage space, pipes, flues, furnaces, retorts, stacks, stills, stoves, tanks, etc. Acoustical plaster and panels for sound-deadening walls and ceilings also used diatomite. The quantity consumed in all types of insulation in 1957 was 7 percent of the total sales, the same as in 1956.

Hundreds of miscellaneous uses comprised the remainder of diatomite sales, and included: Abrasives, absorbents, catalyst carriers, herbicide and fungicide vehicles, glazes, enamels, flatting agents for paints, and manufacturing sodium and calcium silicates. These miscellaneous uses increased from 19 percent in 1956 to 22 percent in 1957.

In 1956 Canada used 45 percent for fertilizer dusting, 41 percent for filtration, 12 percent as fillers, 1 percent for insulation, and less than 1 percent in miscellaneous uses.

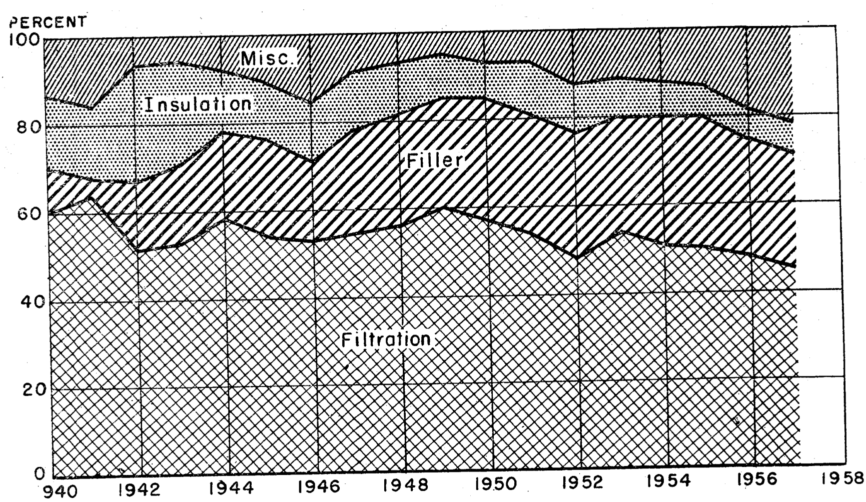

FIGURE 1.—Proportion of diatomite sales in the United States for each principal class of use, 1940–57.

PRICES

Prices varied according to purity, particle-size range, whether uncalcined, calcined, or calcined with fluxes, whether sold in bulk or bagged, and type of bag used. The following prices were average bulk values per short ton at producers' plants for five use categories, covering 1957 transactions, as reported to the Bureau of Mines: Filtration, $42.13; insulation, $39.91; abrasives, $136.79; fillers, $37.44; miscellaneous, $22.81. The weighted average for all domestic diatomite sold during 1957 was $36.48 per short ton, 17 percent less than in 1956.

FOREIGN TRADE

Because exports and imports of diatomite are not reported separately by the United States Department of Commerce, reliable statistics are lacking. Crude material may be imported into the United States duty-free under paragraph 1775 of the Tariff Act of 1930. Refined diatomite, principally of filtering quality, was exported to many countries from the United States.

WORLD REVIEW

Some foreign prices in 1956 for diatomite as calculated from available information, per short ton, were: Kenya, $49; South Korea, $27; France, $5; Finland, $4.

NORTH AMERICA

Canada.[3]—Although there has been small sporadic production since 1896, the most recent from Nova Scotia, present requirements depend on imports from the United States and Denmark, which totaled 21,000 short tons in 1956. The largest known Canadian deposits (but so far undeveloped) are along the Fraser River in the Quesnel area of British Columbia.

Costa Rica.—Requirements of a new pesticide-manufacturing plant in Costa Rica increased the local production of diatomite in 1956 125 percent above 1955 to 6,737 short tons.[4]

AFRICA

Algeria.—Disturbed political conditions were responsible for curtailment of production. The geographic distribution of Algerian exports for the first quarter of 1957, in percent, was: France, 50 percent; Netherlands, 16 percent; Great Britain, 16 percent; Belgium-Luxembourg, 9 percent; Netherlands Guiana, 3 percent; Italy, 1 percent; Indonesia, 1 percent; miscellaneous, 4 percent.

TECHNOLOGY

A new filter aid on the market used a combination of asbestos and diatomite. The producer claimed improved clarity and simplified use, particularly for the final clarifying stage in beermaking.[5]

Patents.—Various patents were granted covering diatomite as a filler in resinous coatings, reinforcing in molding compounds, and to lend consistency to foamed resins.[6]

Materials used in a patented white, quick-setting cement include a pozzolan cement made from fly ash, kaolin or ball clay, and diatomite.[7]

[3] Department of Mines and Technical Surveys, Ottawa, Diatomite in Canada, 1956 (Preliminary): Bull. 35, 3 pp.
[4] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 28.
[5] Industrial and Engineering Chemistry, vol. 49, No. 9, September 1957, Pt. I, p. 126 A.
[6] Mittl, S. J. (assigned to Glidden Co., Cleveland, Ohio), Process for Preparing Polyester-Faced Bodies: U. S. Patent 2,817,619, Dec. 24, 1957; Weyer, D. E. (assigned to Dow Corning Corp., Midland, Mich.), Powdered Siloxane Resin and Process of Preparing Cellular Resin Therefrom: U. S. Patent 2,803,606, Aug. 20, 1957; Biefeld, L. P., and Shannon, R. F. (assigned to Owens-Corning Fiberglas Corp.), Fibrous Glass Reinforced Resinous Molding Compound: U. S. Patent 2,804,438, Aug. 27, 1957.
[7] Randall, M. C., and Gethen, G. S. (assigned to M. I. Randall, Notre Dame, Ind., and E. G. Gethen, Collingwood, N. J.), Insulating Finishing Cement and Structural Material: U. S. Patent 2,815,293, Dec. 3, 1957.

TABLE 2.—World production of diatomite, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	55	103	4	16	2	168
Costa Rica	285	430	595	3,000	6,737	[3] 6,600
Guatemala	[3] 9,500	[3] 11,900	[3] 12,900	[3] 16,500	[3] 16,600	20,600
United States	265,000	[4] 302,816	[5] 368,426	[5] 368,426	[5] 368,426	[5] 368,426
South America:						
Argentina	[3] 1,980	(6)	(6)	2,750	6,600	[3] 6,600
Chile	1,222	11	31	550	----	----
Peru	----	2	2	1	34	[3] 30
Europe:						
Austria	4,279	3,435	3,532	4,445	5,490	3,823
Denmark:						
Diatomite	[7] 22,238	12,454	30,337	39,103	[7] 22,238	[7] 22,238
Moler [8]	[3] 62,000	[9] 39,080	42,990	39,442	[9] 39,080	[9] 39,080
Finland	1,329	1,985	1,367	2,059	2,535	[3] 2,800
France [10]	56,325	76,235	68,092	70,025	69,440	[3] 69,500
Germany, West [10]	39,691	54,530	53,666	62,575	72,890	[3] 77,000
Italy	9,572	10,158	11,160	11,314	13,244	[3] 13,000
Portugal [10]	1,792	1,089	2,011	2,499	1,985	[3] 2,200
Spain [10]	7,950	7,975	10,002	15,927	10,915	12,315
Sweden	1,942	1,504	1,013	1,625	1,243	[3] 1,200
United Kingdom:						
Great Britain	10,648	13,974	10,778	24,656	19,361	[3] 22,000
Northern Ireland	8,627	8,139	4,675	7,293	6,577	6,842
Yugoslavia	[11] 2,250	3,901	4,439	4,490	(6)	(6)
Asia:						
Korea, Republic of	(6)	245	1,377	3,393	3,912	1,472
Africa:						
Algeria	16,912	28,162	38,581	30,384	29,201	[3] 11,000
Egypt	1,559	353	173	545	320	[3] 330
Kenya	3,568	4,903	3,649	3,304	5,418	4,737
Union of South Africa	897	120	1,047	850	635	606
Oceania:						
Australia	6,679	4,973	6,091	5,647	6,484	[3] 4,900
New Zealand	143	115	188	623	152	[3] 220
World total (estimate) [1 2]	580,000	635,000	725,000	765,000	760,000	750,000

[1] Diatomaceous earth believed to be also produced in Brazil, Hungary, Japan, Mozambique, Rumania, 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. Data do not add to totals shown, owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Average annual production, 1951–53.
[5] Average annual production, 1954–56.
[6] Data not available; estimate by senior author of chapter included in total.
[7] Average annual production, 1947–55.
[8] A clay-contaminated diatomite used principally for lightweight building brick.
[9] Average annual production, 1951–56.
[10] Includes Tripoli.
[11] Average for 1 year only, as 1952 was first year of commercial production.

A patented insecticide carrier specified mixtures of gum and diatomite or kaolin to form hardened pellets containing the poison, which is released in the soil as the binder in the pellets slowly dissolves.[8]

The use of diatomite to prevent atmospheric condensation on finished surfaces was patented.[9]

Two patents were granted covering the use of diatomite as aggregate in oil-well concretes. Permeability of the concrete and the pozzolanic effect are the principal reasons for its use in this application.[10]

[8] Hortley, G. S. (assigned to Pest Control, Ltd., Bourn, England), Method and Means of Introducing a Predetermined Amount of Poisonous Material Beneath the Surface of the Soil: U. S. Patent 2,809,469, Oct. 15, 1957.
[9] Katz, S., and Kut, S. (assigned to Pearl Varnish Co., Ltd., Pontypridd, Wales), Diatomite—Phenol-Formaldehyde Antisweat Coating: U. S. Patent 2,804,437, Aug. 27, 1957.
[10] Mangold, G. B., Dyer, J. A., and Hart, J. T. (assigned to Petroleum Engineering Associates, Inc., Pasadena, Calif.), Permeable Concrete: U. S. Patent 2,793,957, May 28, 1957; Mangold, G. B., Dyer, J. A., and Hart, J. T. (assigned to Petroleum Engineering Associates, Inc., Pasadena, Calif.), Well Completion With Permeable Concrete: U. S. Patent 2,786,531, Mar. 26, 1957.

A patented surfacing material for roads and floors contains gypsum, a lime-reactive silica, such as diatomite, and an anhydrous metal sulfate.[11]

A mixture of diatomite, asbestos fiber, hydrated lime, bentonite, and magnesium carbonate was patented as the ingredients in high-temperature insulating blocks and shapes.[12]

A patented method of making a fireproof acoustical tile consists of mixing a carbonaceous material with a ceramic product, such as fire clay, potter's clay, and diatomite.[13]

A dimensionally stable sheet used for reproducing drawings on template stock is made by a patented method, which employs a glass-cloth base impregnated with a polyester or alkyd resin admixed with talc and diatomite.[14]

A patented tobacco-smoke-filter material uses a zirconium compound applied in solution to a porous carrier base, such as diatomite.[15]

Diatomite is admixed with the soil surrounding septic-tank outlets in a patented method of handling the effluent.[16]

A high-temperature insulation material was patented and is made by binding a mixture of expanded perlite, long-fiber asbestos, and diatomite with lime. It can be used in both high- and low-temperature applications.[17]

Diatomite is used in patented formulas for reinforced inorganic molding compositions.[18]

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[11] Lipkind, H., Sherer, A. I., and Zara, M. H. (assigned to L. Sonneborn Sons, Inc.), Surfacing Materials: U. S. Patent 2,785,988, Mar. 19, 1957.

[12] Binkley, M. E. (assigned to Johns-Manville Corp., New York, N. Y.), Thermal Insulating Shape and Method of Manufacture: U. S. Patent 2,793,131, May 21, 1957.

[13] Heine, H. W., Method of Making Composite Fireproof Acoustical Tile: U. S. Patent 2,791,020, May 7, 1957.

[14] Eichorn, A. (assigned to Screen Engineering Co., Santa Monica, Calif.), Photographic Method for Making Templates: U. S. Patent 2,801,919, Aug. 6, 1957.

[15] Seldeen, M., Tobacco-Smoke Filter: U. S. Patent 2,795,227, June 11, 1957.

[16] Horne, F. F., and Edwards, T. J. (assigned by Edwards to Horne), Disposal of Septic Tank Effluent and the Like: U. S. Patent 2,795,542, June 11, 1957.

[17] Denning, P. S. (assigned to F. G. Schundler & Co., Inc., Joliet, Ill.), Manufacture of High Temperature Insulating Materials: U. S. Patent 2,784,085, Mar. 5, 1957.

[18] Slayter, G. (assigned to Owens-Corning Fiberglas Corp.), Reinforced Inorganic Molded Products U. S. Patent 2,781,274, Feb. 12, 1957.

Feldspar, Nepheline Syenite, and Aplite

By Taber de Polo[1] and Gertrude E. Tucker[2]

DOMESTIC PRODUCTION of crude feldspar and flotation concentrate declined in 1957 because of decreased demand from the glass and pottery industries. Many expansion programs planned in 1956 were curtailed.

The price of Glass-grade feldspar from North Carolina, the largest producing area in the United States, dropped 20 percent in July 1957 from $12.50 to $10 per ton.

The entry into the field of Lawson-United Feldspar & Mineral Co. late in 1957 at Minpro, N. C., and the completion of a new plant by Spar-Mica Corp., Ltd., in Canada raised the industry's milling capacity to approximately twice the demand.

TABLE 1.—Salient statistics of the feldspar industry, 1948–52 (average) and 1953–57

	1948-52 (average)	1953	1954	1955	1956	1957
United States:						
Crude feldspar:						
Domestic sales: [1]						
Long tons	411,857	452,600	411,018	465,378	[2] 693,276	611,801
Thousand dollars	2,783	4,594	3,490	3,801	[2] 6,014	5,439
Average per long ton	$6.76	$10.15	$8.49	$8.17	[2] $8.67	$8.89
Imports:						
Long tons	16,389	5,901	79	105	258	72
Thousand dollars	122	61	3	9	9	7
Average per long ton	$7.46	$10.25	$42.49	$89.01	$36.09	$92.03
Ground feldspar:						
Sales by merchant mills:						
Short tons	450,643	463,876	428,895	479,567	[2] 762,868	634,211
Thousand dollars	6,412	7,149	6,517	7,699	[2] 9,300	7,451
Average per short ton	$14.23	$15.41	$15.20	$16.05	[2] $12.19	$11.75
Apparent domestic consumption:						
Long tons	428,246	458,501	411,097	465,483	[2] 693,534	611,873
World production:						
Long tons	740,000	780,000	820,000	960,000	1,230,000	1,160,000

[1] Includes flotation concentrate, 1951–57.
[2] Revised figure.

DOMESTIC PRODUCTION

Crude Feldspar.—Crude feldspar (including concentrate obtained by flotation of feldspathic rocks and sands) sold or used by domestic producers in 1957 decreased 12 percent in quantity and 10 percent in value from 1956. Production was reported from 12 States, the same as in 1956.

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

North Carolina continued to lead in production, with 38 percent of the quantity and 50 percent of the value. California again ranked second, producing 30 percent of the quantity and 20 percent of the value. The California figures are not comparable with figures before 1956. Figures for 1956 and 1957 were revised to include the substantial production of "Silspar" (a mixture of feldspar and silica) from dune sands by Del Monte Properties Co. and a similar material produced by Owens-Illinois Glass Co., both of which contain more than 50 percent feldspar.

Over 40 percent of all marketable feldspar was obtained by flotation treatment of feldspar and feldspathic rock in 1957.

Toward the end of 1957 Lawson-United Feldspar & Mineral Co. opened its new plant at Minpro, N. C., to recover feldspar and other minerals from alaskite ore. The plant was equipped to produce 8,000 tons of Glass-grade feldspar, 2,500 tons of low-iron, glass-melting sand, and 400 tons of mica per month.

In connection with its long-range exploration program, Bell Minerals Co. opened two new mines.

TABLE 2.—Crude feldspar sold or used by producers in the United States, 1948–52 (average) and 1953–57 [1]

Year	Long tons	Value		Year	Long tons	Value	
		Total	Average per ton			Total	Average per ton
1948–52 (average)	411,857	$2,782,565	$6.76	1955	465,378	$3,801,291	$8.17
1953	452,600	4,594,450	10.15	1956 [2]	[3] 693,276	[3] 6,013,797	8.67
1954	411,018	3,490,466	8.49	1957	[3] 611,801	[3] 5,439,209	8.89

[1] Includes flotation concentrate, 1951–57.
[2] Revised figures.
[3] Includes feldspar-silica mixture not previously reported. Figures comparable to previous years are as follows: 1956: 485,300 long tons valued at $5,169,861; 1957: 454,313 tons, $4,655,487.

TABLE 3.—Crude feldspar [1] sold or used by producers in the United States, 1955–57, by States

State	1955		1956		1957	
	Long tons	Value	Long tons	Value	Long tons	Value
California	(2)	(2)	[3] 241,160	[3] $1,265,149	[3] 181,613	[3] $1,085,500
Colorado	46,114	$313,716	47,014	327,276	43,818	307,033
Connecticut, New Hampshire	44,064	366,383	28,657	286,802	53,776	566,410
Maine	26,282	188,961	22,219	143,495	14,330	91,795
North Carolina	242,724	2,184,793	255,637	3,191,559	233,439	2,728,153
South Dakota	42,164	267,286	45,226	288,843	41,316	266,780
Wyoming			1,201	8,195	(2)	(2)
Other States [4]	64,030	480,152	[5] 52,162	[5] 502,478	43,509	393,538
Total	465,378	3,801,291	[5,6] 693,276	[5,6] 6,013,797	[6] 611,801	[6] 5,439,209

[1] Includes flotation concentrate.
[2] Included with "Other States" to avoid disclosing individual company confidential data.
[3] Includes silspar.
[4] Includes Arizona, Georgia, Texas, Virginia, and States indicated by footnote 2.
[5] Revised figure.
[6] Includes feldspar-silica mixture not previously reported. Figures comparable to previous years are as follows: 1956: 485,300 long tons valued at $5,169,861; 1957: 454,313 tons, $4,655,487.

Golding-Keene Co. used electrostatic beneficiation methods at its Keene, N. H., plant in 1957. In November the first shipment of electrostatically beneficiated feldspar was received at its Trenton, N. J., plant from its affiliated company, Spar-Mica Corp., Quebec, Canada.

Ground Feldspar.—Ground feldspar sold by merchant mills in the United States decreased 17 percent in quantity and 20 percent in value, compared with 1956. The average value dropped from $12.19 to $11.75 per short ton. Twelve States with 23 active mills reported production of ground feldspar, compared with 14 States with 25 mills in 1956. Texas and New Jersey reported in 1956 but not in 1957.

North Carolina, California, Colorado, and South Dakota were again the leading producers, in that order. The Southeastern States (Georgia, North Carolina, Tennessee, and Virginia) produced 46 percent of the total tonnage of ground feldspar and furnished 56 percent of the value. Ground feldspar figures include flotation concentrate and feldspar–silica mixture containing more than 50 percent feldspar.

TABLE 4.—Ground feldspar sold by merchant mills [1] in the United States, 1948–52 (average) and 1953–57

Year	Active mills	Domestic feldspar			Canadian feldspar			Total	
		Short tons	Value		Short tons	Value		Short tons	Value
			Total	Average		Total	Average		
1948–52 (average)	25	435,467	$6,052,381	$13.90	15,176	$359,681	$23.70	450,643	$6,412,062
1953	22	454,692	6,909,177	15.20	9,184	239,512	26.08	463,876	7,148,689
1954	24	427,161	6,471,621	15.15	1,734	45,837	26.43	428,895	6,517,458
1955	23	479,567	7,698,905	16.05				479,567	7,698,905
1956 [3]	25	[2] 762,868	[2] 9,299,790	12.19				762,868	9,299,790
1957	23	[2] 634,211	[2] 7,451,427	11.75				634,211	7,451,427

[1] Exclude potters and others who grind for consumption in their own plants.
[2] Includes feldspar-silica mixture not previously reported. Figures comparable to previous years are as follows: 1956: 529,935 short tons valued at $8,333,376; 1957: 457,824 tons, $6,667,705.
[3] Revised figures.

CONSUMPTION AND USES

Crude Feldspar.—Crude feldspar was either ground by the producing company or sold to merchant grinders. Some pottery, enamel, and soap manufacturers purchased crude feldspar for all or part of their requirements and ground it to company specifications in their own mills.

TABLE 5.—Ground feldspar sold by merchant mills in the United States, 1948–52 (average) and 1953–57, in short tons, by uses

Year	Glass	Pottery	Enamel	Other [1]	Total
1948–52 (average)	226,274	194,027	25,451	4,891	450,643
1953	253,596	179,323	14,383	16,574	463,876
1954	226,157	167,824	18,088	16,826	428,895
1955	204,757	224,162	25,919	24,729	479,567
1956	[2] 502,318	198,595	24,732	37,223	[3] 762,868
1957	331,864	168,041	26,052	[4] 108,254	[3] 634,211

[1] Includes other ceramic uses, soaps, and abrasives.
[2] Revised figure.
[3] Includes feldspar-silica mixture not previously reported. Figures comparable to previous years are as follows: 1956: 529,935 short tons valued at $8,333,376; 1957: 457,824 tons, $6,667,705.
[4] Includes some miscellaneous uses not previously included in feldspar data.

Ground Feldspar.—Most feldspar consumers bought material already ground, sized, and ready for use in their manufactured products. In 1957 the glass, pottery, and enamel industries consumed over 82 percent of the ground feldspar sold by merchant mills. Glass consumed about 52 percent (66 percent in 1956); pottery, 26 percent (26 percent in 1956); and enamel, 4 percent (3 percent in 1956). Smaller quantities were used for scouring powders and soaps, abrasives, and artificial teeth. Of the tonnage shipped to the 3 principal classes of consumers, glass decreased 34 percent and pottery, 15 percent, but enamel increased 5 percent. Other uses rose almost 200 percent.

Shipments of ground feldspar to 25 States were specified in 1957; some destinations were not reported. California, Illinois, New Jersey, Ohio, Pennsylvania, and West Virginia furnished 73 percent of the total.

TABLE 6.—Ground feldspar shipped, by States of destination, from merchant mills in the United States, 1953–57, in short tons

Destination	1953	1954	1955	1956	1957
California	11,386	(1)	(1)	275,148	206,053
Illinois	61,751	60,391	37,305	73,067	56,852
Indiana	20,024	13,864	(1)	(1)	(1)
Maryland	16,871	16,324	15,016	18,835	15,930
Massachusetts	5,010	4,764	5,539	5,647	4,697
New Jersey	45,835	32,465	38,125	41,144	28,314
New York	30,950	28,923	22,242	23,169	22,769
Ohio	63,410	58,198	102,273	79,757	61,844
Pennsylvania	66,302	79,688	62,072	69,506	64,203
Tennessee	14,468	12,618	(1)	(1)	(1)
West Virginia	51,029	46,636	36,677	(1)	44,958
Wisconsin	8,617	6,534	10,674	10,813	10,217
Other destinations [2]	68,223	68,490	149,644	[3] 165,782	118,374
Total	463,876	428,895	479,567	[3 4] 762,868	[4] 634,211

[1] Included with "Other destinations."
[2] Includes Alabama (1953–54), Arkansas, Colorado, Connecticut (1953–54 and 1956), Florida (1953–54), Georgia (1953–54), Kansas (1954), Kentucky, Louisiana, Maine (1953 and 1957), Michigan, Minnesota, Mississippi, Missouri, New Hampshire (1953–54 and 1956), New Mexico (1955), North Carolina (1953–54), North Dakota (1956), Oklahoma, Puerto Rico, Rhode Island, Texas, Washington (1954–57), shipments that cannot be segregated by States, and shipments to States indicated by footnote 1. Also includes shipments to Belgium (1953), Canada, Cuba (1953), England (1954–57), Mexico, Panama (1954 and 1957), Peru (1954), Philippines (1954), Venezuela (1954–57), and West Germany (1957).
[3] Revised figure.
[4] Includes feldspar-silica mixture not previously reported. Figures comparable to previous years are as follows: 1956: 529,935 short tons valued at $8,333,376; 1957: 457,824 tons, $6,667,705.

TABLE 7.—Crude feldspar sold or used by producers in the United States, imports, and apparent domestic consumption, 1948–52 (average) and 1953–57

Year	Production		Imports		Apparent domestic consumption	
	Long tons	Value	Long tons	Value	Long tons	Value
1948–52 (average)	411,857	$2,782,565	16,389	$122,285	428,246	$2,904,850
1953	452,600	4,594,450	5,901	60,501	458,501	4,654,951
1954	411,018	3,490,466	79	3,357	411,097	3,493,823
1955	465,378	3,801,291	105	9,346	465,483	3,810,637
1956	[1 2] 693,276	[1 2] 6,013,797	258	9,311	[1] 693,534	[1] 6,023,108
1957	[2] 611,801	[2] 5,439,209	72	6,626	611,873	5,445,835

[1] Revised figure.
[2] Includes feldspar-silica mixture not previously reported. Figures comparable to previous years are as follows: 1956: 485,300 long tons valued at $5,169,861; 1957: 454,313 tons, $4,655,487.

PRICES

Crude-feldspar prices are not given in the trade publications. The average value, computed from producers reports to the Bureau of Mines in 1957, was $8.89 per long ton, compared with $8.67 in 1956.

Computed from reports from merchant grinders, the average selling price of ground feldspar in 1957 was $11.75 per short ton, decreasing 4 percent from 1956.

The following producing States had the highest selling price per short ton: Illinois, $25.25; Tennessee, $21.50; Arizona, $20.79; New Hampshire, $20; Maine, $19.93; and Virginia, $19.50.

The highest average value by uses was reported for enamel feldspar at $20.24 per short ton.

Quotations on ground feldspar appearing in E&MJ Metal and Mineral Markets for December 1957 were as follows: North Carolina, bulk carlots, 200-mesh, $18.50 per short ton; 325-mesh, $22.50; glass, No. 18 grade, $12.50; and semigranular, $10–$11 (add $3 per ton to bulk quotations for bags and bagging).

FOREIGN TRADE[3]

Imports of crude feldspar for consumption in 1957 (all from Canada) decreased to less than 28 percent of the 1956 figure; the average value per long ton increased from $36 a ton in 1956 to $92 in 1957.

Imports of ground feldspar increased 189 percent in quantity and 98 percent in value.

According to reports from grinders, ground-feldspar exports increased 2 percent in 1957. Countries of destination were Mexico, Canada, Puerto Rico, Venezuela, England, West Germany, and Panama.

Cornwall Stone.—Imports for consumption of ground cornwall stone (from England) decreased from 90 long tons in 1956 to 70 in 1957.

TABLE 8.—Feldspar imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Crude		Ground		Year	Crude		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1948–52 (average)	16,389	$122,285	(1)	$71	1955	105	$9,346	1,254	$31,737
1953	5,901	60,501	98	2,740	1956	258	9,311	1,374	33,589
1954	79	3,357	898	22,449	1957	72	6,626	3,969	66,548

[1] Less than 1 ton.

WORLD REVIEW

The estimated Free World production of feldspar decreased 6 percent from 1956. The United States furnished 53 percent of the Free World output. West Germany, France, Italy, Norway, Sweden,

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

and Japan were other major producers, in that order, together supplying 40 percent of production. No data are available on feldspar production in China, Rumania, and U. S. S. R.

Canada.—Shipments of feldspar to the United States from the newly completed plant of Spar-Mica Corp. on the St. Lawrence River in Quebec began in November 1957.

TABLE 9.—World production of feldspar by countries,[1] 1948–52 (average) and 1953–57, in long tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada (sales)	33,636	18,970	14,371	16,207	16,208	18,363
United States (sold or used)	411,857	452,600	411,018	465,378	693,276	611,801
Total	445,493	471,570	425,389	481,585	709,484	630,164
South America:						
Argentina	[3] 5,900	(4)	(4)	4,921	9,842	[3] 7,900
Brazil	[3] 9,800	(4)	(4)	(4)	(4)	(4)
Chile	725	2,047	1,319	854	826	[3] 800
Peru	126					
Uruguay	1,569	779	696	381		168
Total [3]	18,100	21,000	21,000	19,000	23,000	22,000
Europe:						
Austria	2,609	1,332	2,137	2,510	2,677	2,492
Finland	8,292	9,180	12,062	12,529	8,799	9,055
France	54,202	59,053	61,021	71,847	70,863	[3] 71,000
Germany, West	70,673	94,190	124,586	163,599	172,718	188,269
Italy	19,219	24,342	28,449	52,097	49,676	57,012
Norway	28,485	18,411	27,764	39,434	[3] 54,000	[3] 49,000
Portugal	781	59		592	912	[3] 1,000
Spain (quarry) [5]	2,048				3,245	4,392
Sweden	39,884	37,333	48,494	50,639	52,500	[3] 49,000
Total [1] [3]	233,000	249,000	309,000	398,000	421,000	436,000
Asia:						
India	1,802	3,881	6,476	5,230	3,263	7,872
Japan [6]	21,094	24,682	33,627	30,587	48,665	44,977
Total	22,896	28,563	40,103	35,817	51,928	52,849
Africa:						
Eritrea	98	3	6	12	12	[3] 12
Kenya	6					120
Madagascar		24				
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	[7] 919					
Union of South Africa	4,517	5,480	3,525	6,421	9,730	11,381
Total	5,540	5,507	3,531	6,433	9,742	11,513
Oceania: Australia [8]	12,368	6,883	16,384	20,833	18,629	9,607
World total (estimate) [1] [2]	740,000	780,000	820,000	960,000	1,230,000	1,160,000

[1] In addition to countries listed, feldspar is produced in China, Czechoslovakia, Rumania, and U. S. S. R., but data are not available; no estimates included in total except for Czechoslovakia.
[2] This table incorporates a number of revisions of data published in previous Feldspar chapters. Data do not add to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] In addition the following quantity of feldspar is reported as ground, but there is no crude production data to support these ground figures: 1948–52 (average), 7,406 tons; 1953, 10,495 tons; 1954, 8,160 tons; 1955, 5,041 tons; 1956, 898 tons; 1957, not available.
[6] In addition, the following quantities of aplite and other feldspathic rock were produced: 1948–52 (average), 51,926 tons; 1953, 71,263 tons; 1954, 74,817 tons; 1955, 66,291 tons; 1956, 63,723 tons; 1957, 80,772 tons.
[7] Average for 1950–51.
[8] Includes some china stone.

TABLE 10.—Canadian production and trade of feldspar, 1955–56 [1]

	1955		1956	
	Short tons	Value	Short tons	Value
Production: Quebec	18,152	$355,879	17,763	$365,370
Imports:				
Ground: United States	137	3,106	196	4,530
Crude: United Kingdom			5	228
Total	137	3,106	201	4,758
Exports:				
United States	1,419	37,553	1,771	45,464
Germany, West	7	572	33	2,904
Total	1,426	38,125	1,804	48,368

[1] Canada Department of Mines and Technical Surveys, Feldspar in Canada, 1956 (Preliminary): Ottawa, 1956, p. 3.

TECHNOLOGY

Feldspar deposits of the Winnipeg River area, Manitoba, Canada,[4] and the occurrence and uses of feldspathic sands in California were described.[5]

A patent was granted for an electrostatic process for beneficiating feldspathic ore.[6] An article was published describing the new feldspar operation in Canada of the Spar-Mica Corp., Ltd., including the background of electrostatic beneficiation and details of mining and milling methods.[7] A reagent obtained by oxidizing the residue from petroleum distillate was used successfully to float feldspar and other ores.[8] The procedures and results of pilot-plant-beneficiation experiments on granites and feldspar-quartz sands in the Asov region for ceramic uses were published. Magnetic separation of the ground material and flotation were used. It was claimed that the product was more uniform than that obtained from pegmatites.[9]

The procedures and results of tests to determine the relative translucency of bodies made of mixtures of quartz and potash feldspar, and quartz and soda feldspar, were published.[10]

The origin of pores in soda- and potash-feldspathic glasses and their development during firing was studied. The pores were attributed to gases released from impurities, such as clay minerals, in feldspar grains and retained until the grains melt. Soda-feldspathic glass contained more pores than potash-feldspathic glass, but the size of the pores was smaller, resulting in the lower translucence of soda-feldspathic glass.[11]

[4] Davies, J. F., Geology of the Winnipeg River Area, Manitoba: Manitoba Dept. Mines Nat. Res., Mine Branch Pub. 56–1, 1957, 27 pp.
[5] Seitz, W. A., Glass-Making Raw Materials of California: Glass Industry, vol. 38, No. 9, September 1957, pp. 497–500, 509–510, 512, 514.
[6] Lawver, J. E. (assigned to International Minerals & Chemical Corp.), Method of Beneficiating Feldspar: U. S. Patent 2,805,771, Sept. 10, 1957.
[7] Diamond, G. S., Electrostatic Separation of Feldspar and Other Non-Metallic Minerals: Canadian Min. Met. Bull. (Montreal), vol. 50, No. 547, November 1957, pp. 669–673.
[8] Pascovici, S., and Pascalide, Gh. [A Flotation Reagent Produced From Residues of Petroleum Industry]: Rev. Minelor (Bucharest), vol. 8, 1957, pp. 392–394; Chem. Abs., vol. 52, No. 1, Jan. 10, 1958, p. 197a.
[9] Vartanyan, K. T., and Lutsenko, V. I. [Beneficiation of Granites and Feldspar-Quartz Sands for Fine Ceramics]: Steklo i Keram. (Moscow), vol. 13. No. 6. 1956, pp. 19–23; Chem. Abs., vol. 51, No. 16, Aug. 25, 1957, p. 12,458d.
[10] Hamano, Kenya [Translucency of Bodies Consisting of Feldspar and Quartz]: Yogyo Kyokai Shi (Tokyo), vol. 64, 1956, pp. 271–279; Chem. Abs., vol. 51, No. 19, Oct. 10, 1957, p. 15,088g.
[11] Hamano, Kenya [Pores in Feldspathic Glasses]: Yogyo Kyokai Shi (Tokyo), vol. 65, 1957, pp. 44–54; Chem. Abs., vol. 51, No. 20, Oct. 25, 1957, p. 15,912g.

Viscosity and surface tension of bodies of the feldspar-quartz system decreased when firing temperature and soaking time increased. The viscosity of bodies of soda-feldspar is higher than that of potash-feldspar bodies, while surface tension of the former is higher than that of the latter. The flow point of soda-feldspar bodies fired at 60° per hour is 1,270°–1,280° C. and that of potash-feldspar bodies is 1,350°–1,360° C.[12]

Infrared absorption spectra were determined for powdered samples of 18 plagioclase feldspars. Band positions and number of bands were definitely correlated with composition throughout the albite-anorthite series.[13] Optical and geometrical properties and the chemistry of the authigenic feldspars were discussed.[14] Experiments were conducted on the effect of heat on microcline and albite crystals.[15]

NEPHELINE SYENITE

Domestic Consumption.—Domestic consumption, in the glass and ceramic industries, of nepheline syenite imported from Canada continued to increase. Nepheline syenite unsuitable for the glass and ceramic industries was mined in Arkansas for use as roofing granules, and production statistics are included in the Stone chapter.

Prices.—In 1956 prices of processed nepheline syenite per short ton were quoted as follows, f. o. b. Nephton or Lakefield, Ontario, Canada, carlots, in bulk: Glass grade (30-mesh) $14.50; Pottery grade (200-mesh) $18.50; Pottery grade (270-mesh) $19; Pottery grade (325-mesh) $24; Lower grade (100-mesh) $10. There was an additional charge for bagged material.[16]

TABLE 11.—Nepheline syenite imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Crude		Ground		Year	Crude		Ground	
	Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
1948–52 (average)	20,751	$83,778	42,954	$600,480	1955			111,863	$1,856,062
1953	181	659	89,195	1,308,058	1956			140,306	[1] 2,136,092
1954			95,782	[1] 1,436,325	1957			166,989	2,505,248

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

Foreign Trade.—Imports of ground nepheline syenite, mostly for use in the glass industry (all from Canada) increased 19 percent in quantity and 17 percent in value over 1956.

[12] Hamano, Kenya [Viscosity of Bodies of the Feldspar-Quartz System With Special Reference to High Feldspar Content]: Yogyo Kyokai Shi (Tokyo), vol. 65, 1957, pp. 1–8; Chem. Abs., vol. 51, No. 20, Oct. 25, 1957, p. 15,914i.

[13] Thompson, C. S., and Wadsworth, M. E., Determination of the Composition of Feldspars by Means of Infrared Spectroscopy: Am. Mineral., vol. 42, No. 3–4, March-April 1957, pp. 334–341.

[14] Baskin, Yehuda, Study of Authigenic Feldspars: Jour. Geol., vol. 64, No. 2, February 1956, pp. 132–155.

[15] Baskin, Yehuda, Observation on Heat-Treated Authigenic Microcline and Albite Crystals: Jour. Geol., vol. 64, No. 3, March 1956, pp. 219–224.

[16] Reeves, J. E., Nepheline Syenite in Canada, 1956 (Preliminary): Canada Dept. of Mines and Tech. Surveys, Ottawa, No. 47, 1956, p. 4.

World Review.—From available data Canada appears to be the major producer of nepheline syenite for the ceramic industries. Table 12 shows Canadian production and trade of nepheline syenite.

TABLE 12.—Canadian production and trade of nepheline syenite, 1955–56 [1]

	1955		1956	
	Short tons	Value	Short tons	Value
Production, crude (crude ore mined)	194,205	(2)	233,011	(2)
Shipments:				
Ground:				
Glass grade	99,651	(2)	(2)	(2)
Pottery grade	33,551	(2)	(2)	(2)
Miscellaneous	10,694	(2)	(2)	(2)
Total	143,896	(2)	177,599	(2)
Crude	2,172	(2)	2,407	(2)
Total shipments	146,068	$2,099,512	180,006	$2,574,140
Exports, crude and processed material:				
United States	114,297	1,682,372	130,318	1,773,706
Netherlands	1,832	32,960	4,272	76,896
United Kingdom	848	14,669	1,951	34,704
Puerto Rico	720	12,480	1,230	21,175
Other countries	578	10,636	1,534	28,834
Total	118,275	1,753,117	139,305	1,935,315

[1] Canada Department of Mines and Technical Surveys, Nepheline Syenite in Canada, 1956 (Preliminary): Ottawa, 1956, p. 2.
[2] Data not available in detail; included in total.

Technology.—An article was published giving the background, development, mining, and processing of nepheline syenite at Nephton, Ontario. Detailed flowsheets were included.[17]

Results of a study to determine the effect of substituting nepheline syenite for high-potash feldspar in a high-voltage electric porcelain were reported.[18]

Articles described investigations and results of using nepheline syenite in high-talc-ball-clay bodies,[19] and nepheline syenite tailings in sewer-pipe bodies.[20] Small percentages of nepheline syenite, ground very finely, improved the properties of 60-percent-talc 40-percent-ball-clay type bodies, but there was little improvement using nepheline syenite ground to 270-mesh. Small additions of low-cost nepheline syenite tailings containing 2 to 3 percent Fe_2O_3 significantly improved the physical properties of sewer-pipe bodies.

The Volkhov Aluminum Works near Leningrad was reported to be successfully utilizing nepheline instead of bauxite as the raw material for alumina production. The nepheline is associated with apatite in deposits on the Kola Peninsula.[21] Investigations and tests on the foregoing and other deposits were reported in a Soviet publication.[22]

[17] Deeth, H. R., Nepheline Syenite at Blue Mountain: Min. Eng., vol. 9, No. 11, November 1957, pp. 1,241–1,244.
[18] Oberschmidt, L. E., Jr., The Use of Nepheline Syenite in Electrical Porcelain Bodies: Bull. Am. Ceram. Soc., vol. 36, No. 12, December 1957, pp. 464–465.
[19] Wilson, R. C., and Koenig, C. J., Use of Nepheline Syenite in High-Talc-Ball-Clay Bodies: Bull. Am. Ceram. Soc., vol. 36, No. 9, September 1957, pp. 347–351.
[20] Wilson, R. C., and Koenig, C. J., Use of Nepheline Syenite Tailings in Sewer-Pipe Bodies: Jour. Am. Ceram. Soc., vol. 41, No. 1, Jan. 1, 1958, pp. 33–39.
[21] Ceramic Trade Journal and Chemical Engineer, vol. 141, No. 3672, Oct. 18, 1957, p. 953.
[22] Ponomarev, V. D., and Sazhin, V. S. [Hydrochemical Alkaline Method for Nepheline-Rock Treatment]: Tsvetnye Metally (Moscow), No. 12, December 1957, pp. 45–51.

There are huge apatite-nepheline and nepheline syenite deposits in the U. S. S. R., and much attention has been devoted to treating nepheline. The alumina content of some of the deposits makes them comparable to high-grade bauxite. The most successful treatment appears to be the dry-alkaline method based on the principle of decomposition of the mineral during a high-temperature (1,250° C.–1,300° C.) sintering with lime and the formation of sodium (potassium) aluminate.

The use of nepheline syenite as a paint-pigment extender was discussed.[23]

APLITE

Production of aplite increased 1 percent in tonnage and value, compared with 1956, but sales of ground aplite declined 13 percent in quantity and 16 percent in value. Two companies in Virginia produced aplite, which was entirely consumed in the glass industry.

Japan has rich sources of aplite and in 1957 produced 46,563 short tons for use in its glass industry.[24]

[23] Armstrong, W. N. B., and Croutch, V. K., Nepheline Syenite as an Extender Pigment for Paint: Official Digest, Foundation Paint and Varnish Production Clubs, 1957, pp. 272–330.
[24] U. S. Embassy, Tokyo, Japan, State Department Dispatch 783: Jan. 17, 1958, enclosure 1, p. 1.

Ferroalloys

By H. A. Tucker[1] and Hilda V. Heidrich[2]

A FERROALLOY is an alloy of iron so rich in some element other than carbon that it can be used as a vehicle for introducing that element in the manufacture of iron and steel. Usually the iron content is not important, and some products that contain little or no iron are now considered with ferroalloys. Each ferroalloy is described only in its role as an alloying vehicle in this chapter; other aspects are reported in the separate chapters in this volume.

During 1957 total production, consumption, and sales value of ferroalloys decreased only slightly from the peak quantity of 1956, the record-setting year. Nevertheless, great fluctuations occurred in the unit values of some of the individual ferroalloys. For example, titanium, tungsten, and columbium decreased in unit values—the latter 28 percent. On the other hand, chromium, molybdenum, and exported ferrophosphorus increased in unit value—the latter 22 percent.

Significantly, the inventories of ferromanganese, ferrosilicon, and silvery iron have increased at producers' plants. Other changes, such as prices, have already been mentioned.

The quantity of foreign ferromanganese consumed in the United States in 1957 was the largest of any in the last 5 years.

The Pittsburgh Coke and Chemical Company made the first smelting runs of ore in its Neville Island, Pa., blast furnaces preparatory to producing ferromanganese.

The Vanadium Corporation of America began the first production of ferrochromium and ferrochrome-silicon alloys in its new electric-furnace plant at Vancoram, Ohio.

DOMESTIC PRODUCTION AND SHIPMENTS

Ferroalloy production declined slightly to 2.5 million tons in 1957 from the record high of 2.6 million tons established in 1956. This 4.70-percent decline in 1957 is comparable with the decrease in steel-ingot production of 2.17 percent, which dropped from 115.2 million ingot tons in 1956 to 112.7 in 1957.

Shipment weights of ferroalloys followed the same trend, declining 7.96 percent in 1957 from 1956. The combined weights of the ferroalloys containing the 3 principal alloying elements (manganese, silicon, and chromium) amount to more than 90 percent of the total ferroalloys produced and shipped, and the value is 97 percent of the

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total value of the shipments. The total dollar value declined less than 1 percent from the 1956 total, since the average unit value of ferroalloys continued its increase from $197 a ton in 1955 to $233 in 1956 to $251 in 1957.

The difference between the quantity of ferroalloys produced and that shipped in 1957 was 9 percent, increasing significantly from the 2-percent difference in 1956.

A better balance of the number of producers and the amount of ferroalloy they made permits a more detailed presentation in 1957 than in 1956. The data for silicomanganese, ferronickel, ferrocolumbium, ferrotantalum-columbium, and chrom-columbium are published as individual items for the first time.

Manganese Alloys.—To obtain comparative figures for 1956 and 1957 for "Total ferromanganese" in table 1, silicomanganese for 1957 must be added to the total ferromanganese figures above, giving 1,078,380 tons gross weight produced, 990,012 tons shipped, and a value of $237,857,328. These figures show that manganese-alloy

TABLE 1.—Ferroalloys produced and shipped from furnaces in the United States, 1956–57

	1956				1957			
	Production		Shipments		Production		Shipments	
	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value
Ferromanganese:								
Blast furnace	(1)	(1)	(1)	(1)	735,493	77.03	665,011	$157,813,411
Electric furnace	(1)	(1)	(1)	(1)	228,321	77.53	217,055	52,190,835
Total ferromanganese	[2] 1,062,171	75.43	1,052,432	$240,220,802	[3] 963,814	77.14	882,066	210,004,246
Silicomanganese	(1)	(1)	(1)	(1)	114,566	66.07	107,946	27,853,082
Ferrosilicon	460,193	57.93	434,213	75,187,741	417,025	55.24	395,454	70,788,584
Silvery iron	438,694	12.17	413,953	33,906,541	351,826	12.20	360,649	31,655,823
Ferrochromium	----------	----------	----------	----------	[5] 410,327	67.11	402,115	175,628,196
Other chromium alloys	----------	----------	----------	----------	[6] 84,260	40.71	76,492	23,452,364
Total ferrochromium	[5 6] 498,855	62.56	480,169	188,727,356	494,587	62.61	478,607	199,080,560
Ferrotitanium	7,762	24.63	7,228	4,628,779	6,676	21.55	6,831	3,410,204
Ferrophosphorus	73,175	23.60	94,545	3,292,591	77,167	24.26	69,127	2,502,371
Ferrocolumbium, ferrotantalum-columbium and chrom-columbium	(4)	(4)	(4)	(4)	530	58.11	434	2,357,383
Ferronickel	(4)	(4)	(4)	(4)	20,564	44.08	19,708	} 49,835,838
Other	[7] 98,831	28.70	107,033	57,882,859	[8] 68,780	26.17	62,590	}
Total	2,639,681	55.78	2,589,573	603,846,669	2,515,535	57.63	2,383,412	597,488,091

1 Data not available; included with total ferromanganese.
2 Includes manganese briquets and silicomanganese.
3 Includes manganese briquets.
4 Included with "Other."
5 Includes low- and high-carbon ferrochromium and chromium briquets.
6 Includes ferrochrome-silicon, exothermic chromium additives, and other chromium alloys.
7 Includes alsifer, ferroboron, ferrocolumbium, ferrotantalum-columbium, ferronickel, ferrotungsten, ferromolybdenum, simanal, spiegeleisen, zirconium-ferrosilicon, ferrovanadium, and miscellaneous ferroalloys.
8 Includes same as in 1956, except ferrocolumbium, ferrotantalum-columbium, and ferronickel.

production in 1957 increased 2 percent, shipments decreased 15 percent, and the value declined 1 percent.

Excluding silicomanganese, the average value for ferromanganese in 1957 was $238 a ton. Total unsold alloy amounted to 138,000 tons.

Ferromanganese produced in 1957 in 6 blast-furnace plants by 4 companies in 4 States represented 76 percent of the total. Shipments were 11 percent less than production. The average value was $237 a ton. Stocks on hand at year end totaled 92,898 tons.

The 4 companies operating blast furnaces smelted 1 million short tons of ore with an average grade of 43.3 percent manganese. Manganese recovery and coke consumption per ton of manganese produced at 5 ferromanganese blast plants were as follows:

	Manganese recovery (percent)	*Coke consumption (pounds)*
	63. 00	3, 260
	84. 75	3, 702
	87. 00	3, 755
	89. 30	3, 780
	89. 55	3, 955
Average	87. 10	3, 768

The ferromanganese produced in 10 electric furnace plants by 5 companies in 8 States was 228,321 tons—24 percent of the total. Shipments of ferromanganese from electric-furnace plants were 217,055 tons—9 percent less than that produced. The value was $52 million, averaging $240 a ton. Stocks on hand at the end of the year totaled 44,893 tons.

Additionally 257,821 tons (29 percent of the domestic production total) of ferromanganese valued at $60 million imported for consumption in the United States was used. The average unit price was $233 per ton, $4.51 less than that domestically produced which, with the vastly increased tonnage in 1957, may indicate a trend toward more foreign production.

Silicomanganese, the high-silicon, low-carbon alloy, reported separately in table 1 for 1957, represents 10.62 percent of the total manganese alloys produced. Its average value is $258 a ton. It is produced by 5 companies in 10 electric-furnace plants in 5 States.

Ferrosilicon.—Ferrosilicon, ranging in silicon content from 22 to 75 percent, declined in 1957 in all categories except unit value. Production was down 9 percent, shipments 9 percent, and total value 6 percent. The average unit value of ferrosilicon in 1957 was $179 a ton compared with $173 in 1956, an increase of $5.85 or 3 percent. Producing ferrosilicon in 1957 were 11 companies at 23 electric-furnace plants in 11 States. At the end of 1957, 79,560 tons of alloy remained unsold.

Silvery Iron.—Output of silvery iron by 5 companies at 6 furnace plants in 4 States declined in all categories except unit value. Production was down 20 percent, consumption 13 percent, and total value 7 percent. The average unit value of silvery iron was $88 a ton in 1957 compared with $82 in 1956, an increase of $5.86 (7 percent).

Again in 1957, comparable tonnages of silvery iron were produced by the blast and electric furnaces. The 3 blast-furnace plants made an average of 8.5 percent-silicon grade of silvery iron and the 3 electric, a 15.9-percent grade.

More silvery iron was sold than was made by 8,823 tons, leaving 62,618 tons in stock at the end of 1957.

Chromium Alloys.—In 1957, 1.2 million tons of chromite was smelted in 18 electric furnace plants operated by 10 companies in 9 States. This is 23,486 tons (2 percent) less ore than was used in 1956. A new electric furnace plant of Vanadium Corporation of America at Vancoram, Ohio, near New Alexandria, began operating in October, increasing the number of producing plants by one over those in 1956.

The chromite ore used in 1957 averaged 47.1 percent Cr_2O_3, and the ferrochromium produced averaged 62.6 percent chromium.

In 1957, chromium-alloys production and shipments decreased 8.5 and 0.3 percent, respectively, but the total value increased 17.7 percent because the average unit value increased 5.8 percent—from $393 to $416 a ton.

Molybdenum Products.—Ferromolybdenum and other molybdenum products continued to be produced by Climax Molybdenum Company and Molybdenum Corporation of America plants in Pennsylvania. In 1957 the Electro Metallurgical Company made molybdenum products at its Alloy, W. Va. plant. According to the AISI, ferromolybdenum retained the same relationship with molybdic oxide in 1957 as in previous years, the latter supplying 65.3 percent of molybdenum metal used in the production of steel. Ferromolybdenum with average grade of 61.6 percent was valued at $2,100 per ton, equivalent to $1.70 per pound of contained metal. This price exceeded the peak price of $1.65 established in 1953 and represented a 7.6-percent increase in cost per ton and a 6.9-percent increase in cost per pound of contained metal in sales prices in 1957, compared with those in 1956. The average cost per ton of the miscellaneous molybdenum products in 1957 was $967 per ton where the range was $360 to $3,500 per ton.

Ferrophosphorus.—Ferrophosphorus was produced as a byproduct of 8 phosphate chemical producers at 10 electric furnace plants in 6 States.

During 1957, 77,167 short tons of ferrophosphorus was produced, a gain of 6 percent over 1956, but the quantity sold was 27 percent less than in 1956. Continuing the trend upward for the second year, the unit cost increased 4 percent to an average of $36.20 per ton. The stock on hand at the year end was 97,186 tons.

Exports declined 25,093 tons (33 percent), but the average of the 4 years calculated from table 4 is only 50,782 tons, 464 more than that exported in 1957. The unit price rose $6.76 per ton to $37.78 a ton in 1957, an increase of 22 percent.

Titanium Alloys.—Five companies at 6 plants in 3 States produced titanium alloys; about one-half was high-carbon ferrocarbontitanium. Of the total tonnage produced, 3,218 tons was ferrotitanium. The reported value of all ferrotitanium-type alloys sold in 1957 was $1 million less than that of 1956, a decrease of 26 percent. Production and consumption tonnages declined 14 and 6 percent, respectively, compared with 1956. The average unit value of all these alloys for the year was $499 a ton, a decrease of 22 percent from the $640 a ton corresponding value for 1956. The average value of the metal contained (21.55 percent) of the several grades is $1.15 per pound as compared with $1.30 in 1956, a decrease of 12 percent. Producers' stocks on hand at the end of 1957 total 1,130 tons—9 percent less than at the beginning of the year.

Ferrovanadium.—Ferrovanadium was produced in 1957 by 2 companies at 2 plants in 2 States. The average grade of the ferroalloy was 54.1 percent, little changed from the 54.05-percent figure of 1956 or the 54.23-percent average of the 1951–55 period. The average value of contained vanadium was $3.21 a pound in 1957 as compared with $3.15 in 1956. The production, consumption, and total value of ferrovanadium sold declined sharply and uniformly by 35, 32, and 30 percent, respectively, in 1957 compared with 1956. The stock on hand at year end was 15 percent less than a year ago. In 1957, the quantity of ferrovanadium exported remained nearly the same as that in 1956, but the unit value dropped 17 percent to $3,880.26 per ton.

Ferrozirconium.—One company continued to produce ferrozirconium in 2 plants in 2 States. The average grade of the alloy, 13 percent, was the same as in 1956, and the value of the contained zirconium was 72 cents a pound—4 percent more than the 69 cents a pound value for 1956. Production, consumption, and total value of alloy sold dropped precipitously and uniformly by about 60 percent. Shipments exceeded production by 6.75 percent.

Ferroboron.—Ferroboron continued to be produced by 3 companies at 3 plants in 3 States. The boron content of the alloy produced was 15.8 percent, which falls between the 16.8 and 15.1 percent averages for 1956 and 1955, respectively. The value of the element contained was $6.03 a pound—a 3-percent decrease over the $6.21 a pound value for 1956. Production, consumption, and total value declined in 1957.

Ferrotungsten.—Ferrotungsten was produced by 3 companies at 3 plants in 2 States. The average value of the tungsten in the ferrotungsten was $2.67 a pound in 1957—a 20-percent decline from the $3.34 a pound value for 1956. The prices quoted at year end were $2.15 to $2.25, indicating further price declines. The average tungsten content was 79.33 percent and was within the range held since 1953.

Columbium and Tantalum.—Ferrocolumbium was produced in 1957 by 6 companies at 6 plants in 4 States. Ferrotantalum-columbium was produced by three of the above companies in the same plants and locations used for ferrocolumbium production. These ferroalloys contained alloying elements as follows: Ferrocolumbium averaged 56.9 percent columbium; ferrotantalum-columbium was reported by 2 producers to have a 60-percent columbium—40-percent tantalum content, and a 40-percent columbium—20-percent tantalum content made by the third producer. The average value of ferrocolumbium was $4.89 per pound of contained columbium, a 28-percent decrease in unit value from 1956. The 2 grades of ferrotantalum-columbium had an average value of $4.40 a pound of rare elements contained, which is comparable with the $4.51-a-pound price of 1956, a decrease of 2 percent. Production of ferrocolumbium exceeded sales by 23 percent, compared with 16 percent in 1956. Ferrocolumbium-tantalum production exceeded sales by 13 percent compared with 9 percent in 1956.

Nickel.—One producer (Hanna Nickel Smelting Co., Riddle, Oreg.), made all the ferronickel in 1957. The value of the element contained is $1.04 per pound in the 1 grade (44 percent) produced. Production, consumption, and total value increased 66, 64, and 74 percent, respectively, in 1957 over 1956.

CONSUMPTION AND USES

Alloy-steel-ingot production was reported to the AISI as: 5.78 million ingot tons of heat-treatable, engineering and constructional steel; 1 million tons of high-silicon electrical sheets; 1 million tons of low-alloy, high-strength non-heat-treated engineering and constructional alloy; 604,078 tons of nominal 18–8 nickel-chrome stainless steels (AISI 300 series); 414,113 tons of essentially nickel-free, chromium steels (AISI 400 and 500 series). Additionally, ferroalloys were used in 1.5 million tons of steel made into castings by foundries independent of the ingot producers. Shipments of alloy tool and die steels amounted to 88,385 tons, resulting from the production of an unknown quantity of tons of ingot.

Discussions of the purpose and use of many of the ferroalloys are given in the Ferroalloys chapter of Minerals Yearbook, 1956.

Manganese Alloys.—Consumed in the production of 112.7 million ingot tons of steel in 1957 was 1 million tons of ferromanganese, consisting of 816,179 tons of high-carbon and 58,940 tons of medium- and low-carbon ferromanganese; 90,558 tons of high-silicon, low-carbon alloy (silicomanganese); 36,574 tons of spiegeleisen; and 6,787 tons of manganese metal.

Manganese additions to steel ingots in 1957 were distributed: 80.9 percent as high-carbon ferromanganese, 5.8 percent as medium- and low-carbon alloy, 9.0 percent as silicomanganese, 3.6 percent as spiegeleisen, and 0.7 percent as manganese metal.

Additional manganese was used in producing 1.5 million tons of castings by independent foundries. These castings consumed 27,192 tons of ferromanganese. In producing Hadfield-type castings, 4,800 tons of manganese is estimated to have been used in 1957. The remaining low-alloy and carbon-steel castings are estimated to have consumed 34 pounds of manganese per ton.

Silicon Alloys.—The consumption of silicon alloys was about the same in quantity and distribution (table 2) as in 1956. An exception was in the "Iron foundries and miscellaneous" columns for table 2 and the comparable table of the Ferroalloys Chapter of the Minerals Yearbook for 1956, which show that the use of silicon briquets increased 25 percent (7,706 tons), and the use of silicon metal and refined metal decreased 30 percent (6,056 tons). The greatest divergence in silicon-alloy tonnages between 1956 and 1957 was the amount of unsold product. In 1957, 151,015 tons of all silicon alloys remained in the producers' stock bins compared with 25,980 tons in 1956, an increase of 481 percent.

The AISI reported 263,506 tons of ferrosilicon used by the steel industry in 1957 compared with 215,345 tons for steel ingots and 14,935 tons of steel castings, a total of 230,280 tons, 33,226 tons more (14 percent) than that reported to the Bureau of Mines. The AISI showed that the consumption of the total tonnage of silicon alloys in 1957 decreased 7 percent, compared with 1956, and the comparable Bureau of Mines figure showed a 4-percent decrease.

TABLE 2.—Consumption of silvery pig iron, ferrosilicon, silicon metal, briquets, and miscellaneous silicon alloys in the United States, in 1957 by end uses, in short tons [1]

Alloy	Silicon content (percent)	Steel ingots	Steel castings	Iron foundries and miscellaneous	Total	Stocks on hand Dec. 31
Silvery pig iron	5–13	14,474	14,309	126,671	155,454	26,046
Do	14–20	87,192	7,284	78,559	173,035	72,796
Ferrosilicon	[2] 21–55	141,805	13,388	47,805	202,998	28,144
Do	56–70	27,686	67	360	28,113	1,626
Do	71–80	37,835	810	6,899	45,544	7,525
Do	81–89	1,979	647	1,895	4,521	978
Do	90–95	6,040	23	2,614	8,677	1,112
Silicon metal and refined silicon		3	2	14,092	14,097	1,932
Silicon briquets		663	1,877	28,763	31,303	7,256
Miscellaneous silicon alloys		17,843	1,918	8,918	28,679	3,600
Total		335,520	40,325	316,576	692,421	151,015

[1] Coverage estimated as 97, 54, and 85 percent complete for ingots, steel castings, and foundries and miscellaneous, respectively.
[2] Nearly all this material is in the range from 40 to 55 percent silicon.

Ferrophosphorus.—Less ferrophosphorus (17 percent) was consumed in producing steel ingots than in 1956; 73 percent or 50,300 tons was exported for making pig iron and phosphorus used mostly in fertilizer. Exports usually average 88 percent of the annual production.

Chromium Alloys.—The shipments of chromium alloys of all grades totaled 478,607 tons, containing 299,400 tons of chromium. Of this amount, 269,784 tons containing 152,465 tons of chromium, as reported by the AISI, was used in producing alloy-steel ingots. Ferrochromium represents 84 percent of the total chromium alloys used by industry. Of the ferrochromium consumed by the steel industry, 64 percent was used in producing stainless steel.

Consumption of chromium ferroalloys and chromium metal by major end uses was reported to the Bureau of Mines as: 167,002 tons (68 percent) for stainless steel and heat-resisting alloy production (AISI types 200, 300, 400, 500, and the like), 62,380 tons (25 percent) for engineering and constructional steels, and 16,209 tons (7 percent) for tool and die steels.

Ferrochromium was produced and used in several grades. Low-carbon ferrochromium represented 47.2 percent of the total alloys and 53.4 percent of the chromium content and was employed mostly (78.9 percent) in making stainless steels. Low-carbon ferrochromium silicon (15 percent of the total alloys) also was used mostly in stainless-steel production. High-carbon ferrochromium was used partly in stainless and partly in other alloy-steel ingotmaking.

As in other years, approximately 40 percent of the ingot production of stainless steel became scrap in processing to finished products.

The ferrochromium consumed in 1957 was 17 percent less than in 1956, but the distribution as to uses was the same.

Nickel.—A total of 48,402 tons of nickel (exclusive of scrap) was consumed as a ferroalloying element in 1957—14 percent less than the unsurpassed yearly total of 56,115 tons in 1956. Another 9,837 tons was used in high-temperature and heat-resistant alloys—14 percent less than in 1956. Of the 48,402 tons of nickel used as a ferroalloying element in 1957, 26,986 tons went into stainless steels, 15,882 tons into engineering and constructional steels, and 5,534 tons into cast iron. These quantities were apportioned as in 1956 but the greatest decrease, 18 percent, in use of nickel was in stainless steel.

Molybdenum.—Consumers of molybdenum used 15,009 tons in 1957; 70 percent (10,522 tons) of the total was in molybdic oxide, 23 percent (3,389 tons) in ferromolybdenum and molybdenum silicide, and the remaining 7 percent (1,098 tons) in other compounds and in molybdenum metal. The steel industry used 10,113 tons of contained molybdenum in producing wrought products; 89 percent (8,946 tons) was consumed in producing heat-treatable engineering steels and in stainless steels; the remaining 11 percent (1,167 tons) was used in high-speed tool steels. The steel industry also used 1,098 tons in steel castings. Foundries used 1,137 tons of molybdenum in gray and malleable castings. These figures are 12 percent less than those for 1956 for the quantity of molybdenum used in high-speed steel; the quantity used in engineering steels was 9 percent less.

The AISI reports 1,781 tons of contained molybdenum used in the form of ferromolybdenum and 8,195 tons as molybdic oxide by the steel industry. These quantities show a 12 percent (1,207 tons) decline in the use of molybdenum in 1957 by the steel industry. These figures agree closely with those of the Bureau of Mines.

Tungsten Products.—A total of 8,978 tons of 60-percent grade calcium tungsten oxide, containing 4,272 tons of tungsten was consumed in 1957. Manufacturers of steel ingots and ferrotungsten consumed 25 percent of the total—2,217 tons of oxide, containing 1,055 tons of tungsten.

Reports to the Bureau of Mines from steel makers showed that 1,064 tons (75 percent) of tungsten was used in producing high-speed tool steel, 209 tons in other tool steels, and 149 tons in all other kinds of steel. These uses amounted to 1,422 tons of tungsten—33 percent of the total consumed in 1957. The AISI reported 1,365 tons of tungsten consumed in steel production, only 4 percent less than the Bureau of Mines total.

The consumption of tungsten for producing tool steel declined 25 percent in 1957 from that consumed in 1956, probably because of the business recession.

Columbium and Tantalum Alloys.—The Bureau of Mines reports show that 126 short tons of contained metal in ferrocolumbium was consumed in 1957. Of this quantity 79 percent was used in producing stainless steels 12 percent in nonferrous high-temperature alloys, 7 percent in other alloy steels, and 2 percent in welding rods and other uses. Additionally, 137 tons of tantalum and columbium contained in the alloy, ferrotantalum-columbium, was consumed. The proportion of tantalum to columbium for most of this alloy was 60 to 40, respectively. Of this combination of metals 60 percent was used in stainless steels, 16 percent in other alloy steels, and 24 percent in non-ferrous, high-temperature alloys. These metals (columbium singly and tantalum-columbium combined) were used mostly as additives to stainless steels (AISI 347 and 348) in order to stabilize the carbon during welding operations. The steel industry consumed 17 percent less in quantity than in 1956, for the ferroalloy and 19 percent less for the contained metals, according to AISI.

Titanium Alloys.—Titanium, like columbium, was used in producing stainless steels as a stabilizing agent for those alloys later to be welded.

The Bureau of Mines figures show that 6,831 tons of ferrotitanium with 1,472 tons of contained metal was shipped. These figures compare well with those reported by the AISI, 5,794 tons of ferrotitanium and 1,537 tons of metal. However, the AISI quantity for the total of all titanium products used in making steel is 7,123 tons, containing 2,819 tons of metal. Consumption of titanium alloys declined only 6 percent in 1957. An estimated 7 percent of the total titanium consumed was used in producing 36,000 tons of AISI Type–321 stainless steel.

Ferrovanadium.—A total of 1,418 short tons of vanadium metal was alloyed with steel in 1957. High-speed tool-steel production consumed 395 tons (28 percent) of the total quantity; AISI 6100 series, 83 tons; and heat-resisting and other alloy steels, the remainder.

Of the several vanadium compounds, ferrovanadium amounted to 77 percent (1,374 tons) of all consumed in 1957. Also reported to the Bureau of Mines was consumption of 132 tons of vanadium pentoxide, 100 tons of ammonia metavanadate, and 184 tons of other compounds including vanadium oxide, grainal, and briquets.

Vanadium was used in steel principally for its grain-refining and alloying effects and secondarily for its hardenability contribution.

Ferrozirconium.—According to the AISI, the steel industry consumed 4,303 tons of ferrozirconium in 1957 compared with its revised figure of 6,718 tons in 1956—a decrease of 36 percent. However, consumption of the contained metal decreased only 10 percent in 1957, because the grade increased from 15 percent in 1956 to 21 percent in 1957. The reports to the Bureau of Mines differ considerably on grade of alloy with that stated by AISI, the former being 13 percent for both 1956 and 1957.

Ferroboron.—The sole purpose of ferroboron is to increase the ability of steel to harden, thereby permitting the use of a thicker cross section, or of a milder quenching medium, or permitting the saving of all or part of the more expensive alloying elements. The AISI reported that only 16 tons of ferroalloy was consumed in manufacturing steel in 1957, a decrease of 48 percent from that consumed in 1956. This continues the trend that began in 1953 indicating that the steel producers and their customers regard the value of ferroboron as a hardening intensifier with decreasing favor, in spite of the fact that one-half an ounce of boron to a ton of steel causes a 79-percent increase in the steel's depth of hardening.

Bureau of Mines figures show that 22 tons of ferroboron was shipped at an average price of $6.73 per pound of contained metal.

FOREIGN TRADE [3]

Although the domestic trade in ferroalloys changed little from 1956 to 1957, imports consumed increased 74 percent in tonnage and 80 percent in value from 233,980 tons in 1956 (valued at $46 million) to 408,230 tons in 1957 (valued at $83.6 million). The

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

overall average value of imported ferroalloys increased from $198 in 1956 to $204 in 1957. The large increase in tonnage and value of imports consumed from 1956 to 1957 was owing largely to the greatly increased quantity of ferromanganese and the lesser gains in ferrochromium. As usual, the imported manganese and chromium alloys comprised the bulk of the tonnage and value followed by ferrosilicon and ferrotungsten.

TABLE 3.—Ferroalloys and ferroalloy metals imported for consumption in the United States, 1956–57, by varieties

[Bureau of the Census]

Variety of alloy	1956			1957		
	Gross weight (short tons)	Content (short tons)	Value	Gross weight (short tons)	Content (short tons)	Value
Calcium silicide	97	(1)	$32,191	249	(1)	$97,077
Chromium metal	409	(1)	[2] 687,244	1,354	(1)	2,747,923
Chromium nickel and chromium vanadium	---	---	---	(3)	(1)	1,692
Chromium silicon	244	(1)	45,852	---	---	---
Ferrocerium and other cerium alloys	6	(1)	40,108	4	(1)	26,393
Ferrochrome and ferrochromium:						
Containing 3 percent or more carbon	27,152	[4] 16,921	6,323,037	31,316	19,543	8,155,493
Containing less than 3 percent carbon	[4] 12,730	[4] 9,057	[4] 5,080,497	16,353	11,367	6,304,912
Ferrochromium-tungsten, chromium tungsten, chromium-cobalt-tungsten, tungsten nickel, and other compounds of tungsten, n. s. p. f. (tungsten content)	(1)	73	[2] 328,154	(1)	33	112,099
Ferromanganese:						
Containing not over 1 percent carbon	166	123	60,856	767	676	617,329
Containing over 1 and less than 4 percent carbon	19,051	15,622	4,846,062	15,237	12,268	3,970,527
Containing not less than 4 percent carbon	140,986	108,208	[4] 23,593,306	322,626	244,877	55,644,018
Ferromolybdenum, molybdenum metal and powder, calcium molybdate and other compounds and alloys of molybdenum (molybdenum content)	(1)	5	23,058	(1)	748	2,047,540
Ferrosilicon	22,017	5,005	1,736,946	19,904	3,813	1,678,814
Ferrosilicon-aluminum, ferroaluminum-silicon, and alsimin	(5)	(1)	256	---	---	---
Ferrotitanium	113	(1)	92,450	128	(1)	99,982
Ferrotungsten	537	435	1,944,595	252	207	674,364
Manganese silicon (manganese content)	(1)	6,357	1,385,759	(1)	5,109	1,140,679
Silicon-aluminum and aluminum-silicon	91	(1)	46,679	40	(1)	21,252
Silicon metal (silicon content)	(6)	(7)	8,121	(8)	(9)	4,150
Spiegeleisen	234	(1)	18,085	---	---	---
Tungsten and combinations, in lump, grains, or powder (tungsten content)	(1)	19	118,988	(1)	41	238,663
Tungstic acid and other alloys of tungsten, n. s. p. f. (tungsten content)	(1)	1	4,920	(1)	6	34,005

1 Not recorded.
2 Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable to earlier years.
3 400 pounds.
4 Revised figure.
5 100 pounds.
6 147 pounds.
7 129 pounds.
8 110 pounds.
9 99 pounds.

TABLE 4.—Ferromanganese and ferrosilicon imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	Ferromanganese (manganese content) (excluding silico-manganese)				Ferrosilicon (silicon content)			
	1956		1957		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	2,897	$694,371	94,873	$22,544,924	4,956	$1,723,001	3,776	$1,635,261
Mexico	3,832	702,722	1,628	366,793				
Total	6,729	1,397,093	96,501	22,911,717	4,956	1,723,001	3,776	1,635,261
South America: Chile	1,861	392,310	1,022	230,183				
Europe:								
Belgium-Luxembourg	1,628	340,165	3,571	740,210				
France	17,149	3,831,150	76,219	17,412,582				
Germany, West	58,672	12,920,697	24,403	5,807,324	5	5,038	37	43,553
Norway	9,901	2,596,373	9,465	2,529,046	44	8,907		
Yugoslavia	1,925	423,085	3,465	866,307				
Total	89,275	20,111,470	117,123	27,355,463	49	13,945	37	43,553
Asia: Japan	26,088	[1] 6,599,351	42,734	9,638,636				
Africa: Belgian Congo			441	95,875				
Grand total	123,953	[1] 28,500,224	257,821	60,231,874	5,005	1,736,946	3,813	1,678,814

[1] Revised figure.

TABLE 5.—Ferroalloys and ferroalloy metals exported from the United States, 1954–57, by varieties

[Bureau of the Census]

Variety of alloy	1954		1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Ferrochrome	2,105	$995,797	4,693	$2,266,579	5,538	$2,891,379	4,535	$2,419,102
Ferromanganese	1,732	614,544	1,789	642,806	2,248	682,257	7,395	1,866,456
Ferromolybdenum	124	237,698	175	353,073	472	1,052,281	192	447,098
Ferrophosphorous	24,342	792,671	53,055	1,345,514	75,411	2,339,328	50,318	1,901,036
Ferrosilicon	2,080	365,338	1,689	308,033	2,115	483,021	2,649	502,401
Ferrotitanium and ferrocarbon-titanium	172	39,885	245	65,091	364	148,459	367	130,046
Ferrotungsten	5	3,963	2	9,698	1	4,203	2	10,092
Ferrovanadium	70	237,333	220	991,955	[1] 139	[1] 650,955	134	519,955
Other ferroalloys	168	102,748	457	258,187	316	158,805	262	129,468
Spiegeleisen							29	2,735
Total	30,798	3,389,977	62,325	6,234,636	[1] 86,604	[1] 8,410,688	65,883	7,928,389

[1] Revised figure.

Fluorspar and Cryolite

By Robert B. McDougal [1] and Louise C. Roberts [2]

DOMESTIC fluorspar production during 1957 was below the output in 1956; but there was an increase in imports, and consumption reached a new record.

Domestic Acid-grade fluorspar was purchased in 1957 under a program established by Public Law 733. Metallurgical grade was purchased for the national stockpile.

TABLE 1.—Salient statistics of crude and finished fluorspar in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Domestic production:						
Crude fluorspar:						
Mine production	688,463	903,400	616,900	656,500	922,100	861,500
Crude material milled or washed	718,721	823,900	622,600	667,500	775,700	790,600
Cleaned or concentrated fluorspar recovered	308,520	322,700	247,700	[1] 268,400	[1] 306,500	322,600
Finished fluorspar production (shipments from mines and mills)	309,652	318,000	245,600	279,500	329,700	328,900
Value, thousand dollars	$11,968	$15,737	$12,333	$12,590	$14,257	$15,777
Foreign trade:						
Imports for consumption	181,131	359,569	293,320	363,420	485,552	[2] 631,367
Exports	811	767	643	874	197	754
Domestic consumption	438,964	586,798	480,374	570,261	621,354	644,688
Stocks on hand at end of year:						
Domestic mines:						
Crude [3]	77,450	176,248	184,143	139,077	[1] 189,021	207,686
Finished	26,834	31,896	26,370	23,439	21,794	17,329
Consumers' plants	172,699	227,511	143,813	140,577	189,679	227,990
Importers	10,549	15,492	26,100	54,021	53,900	70,600
Total	287,532	451,147	380,426	357,114	[1] 454,394	523,605

[1] Revised figure.
[2] See footnote 1, table 10.
[3] This crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

TABLE 2.—Domestic mine production of crude fluorspar, 1956–57, according to size of operation, in tons per year

Production	1956 [1]		1957	
	Short tons	Percent	Short tons	Percent
Under 1,000 [2]	10,100	1.1	2,800	0.3
1,000–10,000	44,400	4.8	68,600	8.0
10,000–20,000	71,900	7.8	41,000	4.8
Over 20,000	795,700	86.3	749,100	86.9
Total	922,100	100.0	861,500	100.0

[1] Revised to correspond with 1957 canvass data reported by producers.
[2] Includes prospects and reworked dumps and tailings of previous mining and milling operations.

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

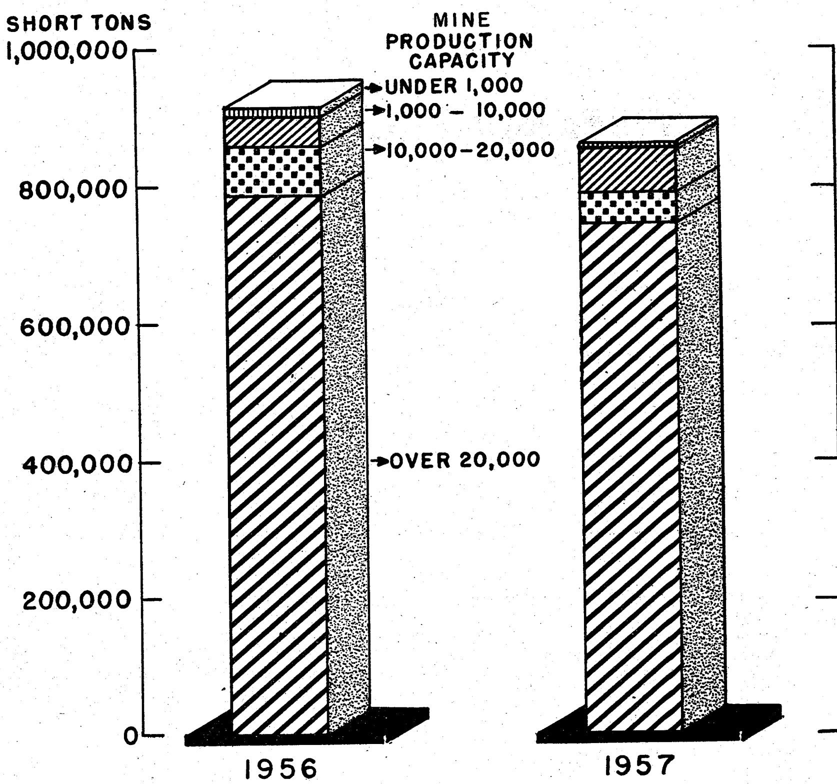

FIGURE 1.—Domestic production of crude fluorspar by mine capacity, 1956–57

DOMESTIC PRODUCTION

Mine production of crude ore totaled 861,500 short tons in 1957 compared with 922,100 tons in the preceding year. About 86 percent of the mine run ore was from mines producing over 20,000 tons.

Sixteen mills, including those operated by consumers, in 1957 processed 790,600 tons of crude ore to recover 322,600 tons of finished fluorspar that included 224,500 tons of flotation concentrate. In 1956 the output of finished fluorspar from 15 mills totaled 306,500 tons, recovered from 755,700 tons of crude ore. Of this 217,600 tons was flotation concentrate. The balance of production, during 1957, approximately 104,300 tons, consisted of crude fluorspar that was of finished grade without processing, compared with the production of nearly 76,000 tons in 1956.

Consumer-operated mines produced 168,700 tons of crude material in 1957, and their mills recovered 86,700 tons of finished fluorspar from processing 206,900 tons.

Illinois was again the primary producing area. Production decreased slightly from output in 1956, supplying about 52 percent (169,939 short tons) of finished fluorspar including 152,700 tons of flotation concentrate. Shipments in 1956 totaled 178,300 tons (of which 131,500 tons was flotation concentrate) and provided about 54 percent of the United States supply.

Production of fluorspar in Montana increased 8 percent in 1957 to 64,300 tons from 59,800 tons in the preceding 12 months. Of this output, 59,500 tons was from the Cummings-Roberts operation east of Darby, Ravalli County. A heavy-medium plant was installed on the property during the latter part of the year. The Finlen & Sheridan Mining Co., which had begun operations at a site in the Fish Creek area of Mineral County in August 1956, ceased operations during the fall of 1957.

Fluorspar production, virtually all Acid grade, in Colorado increased slightly in 1957 from the output in 1956.

Production of fluorspar rose slightly in Utah in 1957 to 11,087 short tons above the output of 10,581 tons in 1956. Early in the year the Bell Hill Mining Co. fluorspar property on Topaz Mountain, Juab County, was purchased by Quo Vadis Mines, Inc., Salt Lake City.[3] Development by the new owner disclosed additional ore reserves beyond previously announced reserves. Construction of a flotation mill with a capacity of about 150 tons per day was begun by the new firm at Delta, Utah, to upgrade local ore to Acid-grade material.

In mid-November H. Evans Roberts, partner in the Montana operation, purchased the Mackey-Humm Mining Co. and Hicks Creek Fluorspar Mining Co. and announced plans for expanding Acid-grade fluorspar production.[4] The new name of the firm was Southern Illinois Mining Co., with local offices in Rosiclare.

Near the end of the year Union Carbide Nuclear Co. and Kaiser Aluminum Co. were reported to be exploring for new deposits in the Hardin County area.[5]

Production of finished fluorspar in Kentucky increased slightly to 20,626 short tons in 1957—about 39 percent over the 1956 output of 14,865 tons. The Rosiclare Lead & Fluorspar Mining Co. Pigmy

TABLE 3.—Shipments of domestic fluorspar, 1956–57, by State of origin

State	1956			1957		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Illinois	178,254	$8,469,450	$47.51	169,939	$8,827,171	$51.94
Kentucky	14,865	607,704	40.88	20,626	979,357	47.48
Utah	10,581	265,449	25.09	11,087	387,042	34.91
Other States:						
Montana	59,775			64,339		
Arizona						
California						
Colorado		4,914,574	39.00	62,881	5,583,318	43.89
Nevada	66,244					
Tennessee						
Total	329,719	14,257,177	43.24	328,872	15,776,888	47.97

[3] Mining Record, Quo Vadis Mines Is Speeding Up Plans at Fluorspar Mill: Vol. 68, No. 36, Sept. 5, 1957, p. 8.
[4] Hardin County Independent, Elizabethtown, Ill., 2 Fluorspar Mines Bought by E. Roberts: Vol. 88, No. 48, Nov. 7, 1957, p. 1.
[5] Engineering and Mining Journal, vol. 158, No. 12, December 1957, p. 182.

mine in Crittenden County closed since the end of 1952 resumed production during the early part of the year.[6] The mine was leased by J. Willis Crider, fluorspar operator in Marion, Ky., after the Rosiclare firm pumped out and retimbered the mine.

TABLE 4.—Shipments [1] of domestic fluorspar by State of origin, 1948–52 (average) and 1953–57, with shipments of maximum year and cumulative shipments from earliest record to end of 1957, in short tons [2]

State	Maximum shipments		Shipments by years							Total shipments to date	
								1957			
	Year	Short tons	1948–52 (average)	1953	1954	1955	1956	Short tons	Percent of total	Short tons	Percent of total
Tennessee	1956	(3)	[4] 98	[4] 426	------	------					
Colorado [5]	1944	65,209	23,671	53,276	59,197						
California	1934	181	------	------	------						
New Mexico	1944	42,973	19,739	11,890	8,876	71,753	66,244	62,881	19.1	1,501,620	15.0
Arizona	1953	1,951	1,025	1,951							
Nevada	1953	(3)	9,449	18,487	14,389						
Idaho	1951	(3)	------	------		------	------	------	------	------	------
Illinois [5]	1951	204,328	168,137	163,303	107,830	166,337	178,254	169,939	51.7	5,322,462	53.1
Kentucky [5]	1941	141,862	69,081	47,244	35,831	8,899	14,865	20,626	6.2	2,838,885	28.4
Montana	1957	64,339	3,388	5,932	15,102	25,223	59,775	64,339	19.7	187,312	1.9
New Hampshire	1917	1,274	------	------	------	------	------	------	------	8,302	.1
Texas	1944	4,769	679	------	------	------	------	------	------	14,779	.1
Utah	1950	18,936	14,384	15,527	4,403	7,328	10,581	11,087	3.3	136,316	1.4
Washington	1945	132	------	------	------	------	------	------	------	382	(6)
Wyoming	1944	19	------	------	------	------	------	------	------	19	(6)
Total	1944	413,781	309,651	318,036	245,628	279,540	329,719	328,872	100.0	10,010,077	100.0

[1] Figures for 1880–1905 represent production.
[2] Quantity and value figures, by States, for 1880–1925 in Mineral Resources, 1925, pt. 2, pp. 13–14, and for 1910–40 in Minerals Yearbook Review of 1940, p. 1297.
[3] Figures withheld to avoid disclosing individual company confidential data.
[4] Synthetic calcium fluoride recovered by TVA.
[5] 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.
[6] Less than 0.05 percent.

Finished-fluorspar output in Nevada declined in 1957 from that produced in 1956 owing to the closing of the Kaiser Aluminum & Chemical Corp. flotation mill near Fallon, Nev., during 1957.[7] Earlier in the year its mine near Gabbs, Nev., closed owing to depletion of the deposit, and for a while the mill continued to operate on stockpile ore. Acid-grade fluorspar was recovered as a byproduct of scheelite processing by the Wah Chang Mining Co. at its mill near Tempiute, Nev.

Metallurgical-grade fluorspar was produced in Tennessee during the first part of 1957.

Fluorspar was produced in Arizona and California in 1957.

In 1957 the Bureau of Mines canvass was revised to present better detail on production and shipments of fluorspar by grade and consumption by grade and end use. Data on the production, shipment, and consumption by grade of fluorspar in tables 5 and 6 have been estimated for 1956 based upon 1957 information.

[6] Engineering and Mining Journal, vol. 158, No. 7, July 1957, pp. 144, 150.
[7] Oil, Paint, and Drug Reporter, Kaiser Fluorspar Mill in Nevada Shut Down: Vol. 172, No. 12, Sept. 16, 1957, p. 3.

TABLE 5.—Fluorspar shipped from mines in the United States, by grades and industries, 1956–57, in short tons and value

Grade and industry	1956 [1]				1957			
	Quantity		Value		Quantity		Value	
	Short tons	Percent of total	Total	Average	Short tons	Percent of total	Total	Average
Ground and flotation concentrates:								
Hydrofluoric acid [2]	161,930	78.1	$9,022,848	$55.72	186,946	83.0	$10,502,364	$56.18
Glass	[3] 20,492	[3] 9.9	[3] 843,432	[3] 41.16	18,693	8.3	831,454	44.48
Ceramic and enamel	4,828	2.3	207,315	42.94	4,181	1.8	197,975	47.35
Nonferrous	2,711	1.3	117,607	43.38	2,119	0.9	100,135	47.26
Ferrous [4]	15,025	7.2	527,233	35.09	11,198	5.0	425,088	37.96
Exported	20	(5)	900	45.00	(6)	(6)	(6)	(6)
Miscellaneous	2,374	1.2	96,514	40.65	[6] 2,124	1.0	97,741	46.02
Total	207,380	100.0	10,815,849	52.15	225,261	100.0	12,154,757	53.96
Fluxing gravel and foundry lump:								
Glass	(7)	(7)	(7)	(7)				
Nonferrous	1,160	0.9	32,264	27.81	548	0.5	17,940	32.74
Ferrous [2]	120,191	98.3	3,376,960	28.10	100,191	96.7	3,478,081	34.71
Exported	30	(5)	1,269	42.30	(6)	(6)	(6)	(6)
Miscellaneous	958	0.8	30,835	32.19	[6] 2,872	2.8	126,110	43.91
Total	122,339	100.0	3,441,328	28.13	103,611	100.0	3,622,131	34.96
All grades:								
Hydrofluoric acid [2]	161,930	49.1	9,022,848	55.72	186,946	56.8	10,502,364	56.18
Glass	20,492	6.2	843,432	41.16	18,693	5.7	831,454	44.48
Ceramic and enamel	4,828	1.5	207,315	42.94	4,181	1.3	197,975	47.35
Nonferrous	3,871	1.2	149,871	38.72	2,667	0.8	118,075	44.27
Ferrous [2] [4]	135,216	41.0	3,904,193	28.87	111,389	33.9	3,903,169	35.04
Exported	50	(5)	2,169	43.38	(6)	(6)	(6)	(6)
Miscellaneous	3,332	1.0	127,349	38.22	[6] 4,996	[6] 1.5	[6] 223,851	[6] 44.81
Total	329,719	100.0	14,257,177	43.24	328,872	100.0	15,776,888	47.97

[1] Revised for 1956 on basis of classifying shipments in 1957; see 1956, Fluorspar chapter, tables 5 and 6, p. 5.
[2] Includes shipments to G. S. A.
[3] Includes gravel and lump material to avoid disclosing individual company confidential data.
[4] Includes pelletized flotation concentrates.
[5] Less than 0.05 percent.
[6] Included with miscellaneous to avoid disclosing individual company confidential data.
[7] Included with glass under ground and flotation concentrate; see footnote 3.

In May 1957 the new Olin Mathieson Chemical Corp. sodium silicofluoride plant at Pasadena, Tex., went into full production, recovering fluorides from the phosphoric-acid-manufacturing facilities at its Ammo-Phos fertilizer plant.[8] Effluent gas from TVA's nodulizing kilns, containing low concentrations of fluorine as HF and SiF_4 was given an expensive treatment to inactivate the fluorine prior to discarding it as a waste product.[9] TVA reported that cryolite meeting aluminum specifications can be recovered from such gases.

International Minerals & Chemical Corp. contracted to supply Kaiser Aluminum & Chemical Corp. annually with more than 10,000 tons of fluosilicic acid.[10] Fluorine compounds will be recovered in processing phosphate chemicals at International's plant at Bonnie, Fla. Kaiser's new plant at Mulberry, Fla., will convert the fluosilicic

[8] Farm Chemicals, OM Recovers Fluoride from P_2O_5 at Pasadena: Vol. 120, No. 5, May 1957, p. 8.
[9] Chemical and Engineering News, Fluorine From Phosphate Rock: Vol. 35, No. 38, Sept. 23, 1957, pp. 81–82.
[10] Mining Congress Journal, vol. 43, No. 12, December 1957, p. 79

acid into sodium silicofluoride, which will be shipped for final processing into synthetic cryolite at its Chalmette, La., plant.

Synthetic calcium fluoride (and other fluorine values) were recovered by the Columbia-Geneva Division, United States Steel Corp., at its mill near Provo, Utah, which treated Minnesota iron ore, relatively high in fluorine content. Furnace charges averaged 0.003 percent F.[11]

CONSUMPTION AND USES

Industrial consumption of fluorspar reached a new record totaling 644,700 short tons in 1957, compared with 621,400 tons in the previous year. Of this total 334,300 tons was Acid-grade fluorspar, 41,500 tons Ceramic-grade, and 268,900 tons Metallurgical-grade.

Fluorspar consumed in producing hydrofluoric acid increased to 328,700 tons compared with 289,500 tons in 1956. Acid-grade fluorspar was used also as a flux in the production of primary aluminum being added directly to the electrolyte in the reduction cell.

Glass and enamel plants reported consuming 37,300 tons of three fluorspar grades; 32,200 tons were Ceramic-grade. Other uses in which this grade was consumed were for welding-rod coatings, nonferrous, special flux, ferroalloys, and also in magnesium reduction.

The steel industry, which in 1957 operated below capacity, consumed about 243,100 tons, in contrast with 264,400 tons in the previous year, when there was a month-long strike at the plants. An average of 4.2 pounds of fluorspar was consumed per short ton of basic open-hearth steel produced in 1957, compared with 4.8 pounds in the previous year.

Fluorspar was reported consumed in 37 States in 1957; the three largest—Illinois, Pennsylvania, and Ohio—consumed about 39 percent of the total.

Allied Chemical & Dye Corp. expects to consume quantities of fluorine for the production of uranium hexafluoride at its plant now under construction at Metropolis, Ill.[12] The plant is scheduled to go into production late in 1958 and is to supply the Atomic Energy Commission with 5,000 tons of U_3O_8 equivalent annually. Eventually other fluorine chemicals are expected to be produced.

Activity in the fluorocarbon field was further increased.[13] A plant was under construction at Institute, W. Va., scheduled to begin production of various fluorinated hydrocarbons for refrigerants and aerosol propellants late in 1958.

Use of fluorochemicals to replace oil as coolants in electronic transformers makes possible a reduction in size and weight.[14]

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11 Engineering and Mining Journal, USS Unveils $9-Million Fluorine Plant: Vol. 159, No. 1, January 1958, p. 154; Chemical Engineering, Giant Fume Catcher Stops Fluoride Emission: Vol. 65, No. 4, Feb. 24, 1958, pp. 66, 68.

12 Chemical and Engineering News, vol. 35, No. 11, Mar. 18, 1957, p. 7.

13 Chemical and Engineering News, vol. 35, No. 8, Feb. 25, 1957, p. 7; Chemical and Engineering News, Fluorocarbons to the Fore: Vol. 35, No. 13, Apr. 1, 1957, pp. 14, 16.

14 Chemical and Engineering News, Chemicals Cut Transformer Size: Vol. 35, No. 51, Dec. 23, 1957, p. 38.

STOCKS

Producers reported that stocks of fluorspar at mines, mills, and shipping point at the end of 1957 were 17,300 tons of finished and 207,700 tons of crude fluorspar.

Stocks at consumers' plants on December 31, 1957, were 20 percent larger than at the close of 1956. Fluorspar stocks at steel plants increased about 7 percent and were equivalent to a 9-month supply at the December 1957 consumption rate. Stocks at hydrofluoric acid plants increased about 86 percent over those in December 1956.

TABLE 6.—Fluorspar (domestic and foreign) consumed and in stock in the United States, by grades and industries, 1956–57, in short tons

Grade and industry	1956 [1]		1957	
	Consumption	Stocks at consumers' plants, Dec. 31	Consumption	Stocks at consumers' plants, Dec. 31
Acid grade:				
Hydrofluoric acid	289,523	23,187	328,672	43,234
Glass	4,694	336	3,221	361
Enamel	158	42	118	27
Welding rod coatings	803	33	819	60
Nonferrous	----	----	131	29
Special flux	----	----	}	
Ferroalloys	}		} 1,352	1,185
Primary aluminum	} 1,192	984	}	
Total	296,370	24,582	334,313	44,896
Ceramic grade:				
Glass	25,172	3,618	27,899	3,746
Enamel	4,274	758	4,314	697
Welding rod coatings	1,310	115	1,154	149
Nonferrous	----	----	118	26
Special flux	} 6,961	1,375	7,983	1,363
Ferroalloys	}			
Total	37,717	5,866	41,468	5,981
Metallurgical grade:				
Glass	995	207	1,017	127
Enamel	1,010	136	800	96
Welding rod coatings	369	60	343	44
Nonferrous	879	368	5,123	1,653
Special flux	}			
Ferroalloys	}			
Primary aluminum	} 5,842	1,381	3,134	907
Primary magnesium	}			
Iron foundry	13,738	2,748	15,382	9,618
Basic open-hearth steel	227,943	}	212,304	}
Electric-furnace steel	35,967	} 154,331	30,376	} 164,668
Bessemer steel	524	}	428	}
Total	287,267	159,231	268,907	177,113
All grades:				
Hydrofluoric acid	289,523	23,187	328,672	43,234
Glass	30,861	4,161	32,137	4,234
Enamel	5,442	936	5,232	820
Welding rod coatings	2,482	208	2,316	253
Nonferrous	879	368	5,372	1,708
Special flux	6,880	1,332	7,959	1,356
Ferroalloys	4,601	1,074	1,981	610
Primary aluminum	1,682	1,131	} 2,529	1,489
Primary magnesium	832	203	}	
Iron foundry	13,738	2,748	15,382	9,618
Basic open-hearth steel	227,943	}	212,304	}
Electric-furnace steel	35,967	} 154,331	30,376	} 164,668
Bessemer steel	524	}	428	}
Total	621,354	189,679	644,688	227,990

[1] Data by grade estimated.

TABLE 7.—Production of steel, and consumption and stocks of fluorspar (domestic and foreign) at basic open-hearth and electric-furnace steel plants, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Production of basic open-hearth steel ingots and castings at plants consuming fluorspar..short tons..	82,299,947	95,972,563	79,099,507	99,926,806	95,175,209	100,297,307
Consumption of fluorspar in basic open-hearth steel production short tons..	216,596	252,442	174,198	217,353	227,943	212,304
Consumption of fluorspar per short ton of basic open-hearth steel made..pounds..	5.3	5.3	4.4	4.3	4.8	4.2
Stocks of fluorspar at basic open-hearth steel plants at end of year short tons..	132,200	163,300	95,200	102,100	[1] 142,500	158,100
Production of electric-furnace steel ingots and castings at plants consuming fluorspar......short tons..	5,832,972	7,219,262	5,380,180	7,510,684	8,813,722	9,551,301
Consumption of fluorspar in electric-furnace steel production short tons..	27,954	35,027	21,409	33,436	35,967	30,376
Consumption of fluorspar per short ton of electric-furnace steel made pounds..	9.6	9.7	7.9	8.9	8.2	6.4
Stocks of fluorspar at electric-furnace steel plants at end of year short tons..	4,200	7,600	8,300	4,900	11,700	6,500

[1] Revised figure.

TABLE 8.—Fluorspar (domestic and foreign) consumed in the United States, by States, in 1956–57, in short tons

State	1956 [1]	1957	State	1956 [1]	1957
Alabama, Georgia, North Carolina, and South Carolina	11,851	12,268	Kentucky	24,836	30,111
Arkansas, Kansas, Louisiana, and Oklahoma	76,859	88,622	Maryland	5,357	5,494
California	30,766	35,985	Massachusetts	629	443
Colorado and Utah	21,209	22,944	Michigan	21,013	20,453
Connecticut	1,148	585	Missouri	3,987	4,340
Delaware and New Jersey	81,272	79,275	New York	20,088	20,204
Florida, Rhode Island, and Virginia	[2] 44	1,059	Ohio	74,544	72,151
Illinois	92,016	97,454	Oregon and Washington	1,685	1,686
Indiana	33,311	33,451	Pennsylvania	87,729	82,882
Iowa, Minnesota, Nebraska, South Dakota, and Wisconsin	5,234	4,948	Tennessee	610	1,058
			Texas	16,315	21,221
			West Virginia	6,329	8,054
			Undistributed	4,522	-------
			Total	621,354	644,688

[1] Consumption partly estimated from sample canvass of consumers who accounted for more than 95 percent of total usage in 1955.
[2] Virginia only.

PRICES [15]

Acid-grade fluorspar prices declined slightly. Ceramic-grade prices increased while those for Metallurgical-grade remained virtually unchanged in 1957. Mexican fluorspar prices dropped slightly toward the end of the year. Domestic Acid-grade concentrate, f. o. b. Rosiclare, Ill., was quoted at $52.50 per short ton contract and $55 spot lots until April. From then until the end of the year the price,

[15] E&MJ Metal and Mineral Market quotations during 1957.

TABLE 9.—Stocks of fluorspar at mines of shipping points in the United States, by States, at end of year, 1955–57, in short tons

State	1955		1956		1957	
	Crude [1]	Finished	Crude [1]	Finished	Crude [1]	Finished
California	1,300	----------	1,300	----------		
Colorado	66,843	1,067				
Nevada			} 118,546	1,017	} 72,831	1,101
New Mexico	} 14,091	420				
Illinois	48,271	13,236	98,913	11,748	126,123	7,359
Kentucky	7,272	----------	[2] 1,126	6,372	5,914	5,905
Montana	1,000	8,716	----------	2,657	2,813	2,964
Utah	300	----------	[2] 800	----------	5	----------
Total	139,077	23,439	[2] 220,685	21,794	207,686	17,329

[1] This crude (run of mine) fluorspar must be beneficiated before it can be marketed.
[2] Revised figure.

f. o. b. Illinois-Kentucky and Colorado, was quoted at $50, with some sales at $55. European Acid-grade fluorspar, c. i. f. United States ports, duty paid, was quoted until November at $52.50, when the price changed to $52 with spot lots at $53.

Ceramic-grade fluorspar containing 93–94 percent CaF_2, variable amounts of calcite and silica, and 0.14 percent of Fe_2O_3 was quoted at $43 per short ton, in bulk, f. o. b. Rosiclare, Ill., until mid-April, when the price advanced to $46 for the remainder of the year. This grade containing 95 percent CaF_2, was quoted during the same period at $45 and $48 per short ton, in bulk, f. o. b. Rosiclare, Ill. Quoted prices for Ceramic-grade fluorspar in 100-pound bags was $4 to $5 per ton higher than those for bulk shipments.

Metallurgical-grade fluorspar containing 72½ percent CaF_2 was quoted at $41 per short ton, f. o. b. shipping point, Illinois-Kentucky throughout the year, following the increase from $39 per ton in September 1956. Metallurgical-grade containing 70 and 60 percent CaF_2 was quoted at $40 and $36.50, respectively, per short ton, f. o. b. shipping point, Illinois-Kentucky during 1957 after the advance in September 1956. Pelletized Metallurgical-grade flotation concentrate containing 65 percent effective CaF_2 was quoted at $30 per short ton, f. o. b. shipping point, Illinois-Kentucky until October, when the price advanced to $33 per ton.

Foreign Metallurgical-grade fluorspar containing 72½ percent effective CaF_2, c. i. f. United States ports, duty paid, fluctuated from $34 per short ton until April, when it rose to $35 per ton; in June it was again $34, where it remained through November. In November the price increased to $35 per ton, but after mid-December it was quoted at $33 per ton contract and $35 per ton spot lots. Mexican Metallurgical-grade fluorspar price quotations declined. The price for 72½-percent effective CaF_2, all rail, duty paid, f. o. b. border, was $27.75 per short ton from January through June, $25.75 per ton to November, when it declined to $25 per ton. Prices of this grade, f. o. b. border, barge, Brownsville, Tex., were as follows: January to April $30 per short ton, April to June $29 per ton, June to November $27.50 per ton, and from November to the end of the year $27 per ton.

FOREIGN TRADE[16]

Imports.—Imports for consumption were recorded in 1957 at a new high of 631,400 short tons valued at $16 million and for the sixth consecutive year exceeded domestic production. In May and September 1957 the imports for consumption from Italy and Mexico included withdrawals from bonded warehouses of entries made in 1955–56, which were not officially recorded as withdrawn by the Bureau of the Census until 1957. Actual imports for consumption in 1957 would total 546,648 short tons, comprising 327,527 tons containing more than 97 percent CaF_2 and 219,121 tons containing less than 97 percent CaF_2. Revised total import figures would be 532,000 short tons for 1956 and 401,700 tons for 1955. As in recent years, Mexico was the principal foreign source, supplying 365,000 tons or approximately 67 percent of the total quantity imported in 1957. Italy supplied 82,000 tons, about 15 percent, and Spain 62,000 tons, about 11 percent, of the total. Duty-free imports by the United States Government totaled nearly 78,000 short tons in 1957 compared with 130,000 tons (revised) in the previous year.

Early in the year domestic fluorspar producers supported an effort to gain Congressional support for import quotas as a means of protecting domestic industries from foreign competition.[17]

Table 11, compiled from data supplied to the Bureau of Mines by importers and domestic companies milling or otherwise handling foreign fluorspar, shows the quantities of imported fluorspar delivered to consumers in the United States. Most of the imports were sold to manufacturers of hydrofluoric acid and steel producers. The quantities in table 11 represent the finished product recovered from milling or drying foreign ores or concentrates rather than the crude ores milled or concentrate dried.

Exports.—The Bureau of the Census, United States Department of Commerce, reported that exports totaled 754 short tons valued at $80,703. Canada received the bulk, 642 tons, of the exports; Chile, Colombia, Cuba, Venezuela, Belgium-Luxembourg, France, Netherlands, West Germany, and the Union of South Africa received smaller shipments.

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

[17] Engineering and Mining Journal, Fluorspar Miners Gird for Import Quota Fight: Vol. 158, No. 5, May 1957, pp. 122–123.

TABLE 10.—Fluorspar imported for consumption in the United States in 1957, by countries and customs districts

[Bureau of the Census]

Country and customs district	Containing more than 97-percent calcium fluoride		Containing not more than 97 percent calcium fluoride		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada: Philadelphia	19,099	$865,943	955	$43,888	20,054	$909,831
Mexico:						
Arizona			58	857	58	857
Buffalo			10,583	158,753	10,583	158,753
El Paso	18,621	477,221	30,034	579,358	48,655	1,056,579
Galveston	189	6,054	70	2,222	259	8,276
Laredo	139,843	4,426,139	132,840	1,773,681	272,683	6,199,820
Michigan			6,352	113,463	6,352	113,463
Philadelphia			28,193	567,210	28,193	567,210
St. Louis	[1] 24,236	[1] 922,686			[1] 24,236	[1] 922,686
San Diego			29	582	29	582
Total Mexico	[1] 182,889	[1] 5,832,100	208,159	3,196,126	[1] 391,048	[1] 9,028,226
Total North America	[1] 201,988	[1] 6,698,043	209,114	3,240,014	[1] 411,102	[1] 9,938,057
Europe:						
Germany, West:						
New Orleans	6,653	271,870			6,653	271,870
Philadelphia	6,974	249,136			6,974	249,136
Total	13,627	521,006			13,627	521,006
Italy:						
Maryland	[1] 22,173	[1] 717,710			[1] 22,173	[1] 717,710
Michigan			485	18,648	485	18,648
Ohio	15,120	403,260			15,120	403,260
Philadelphia	[1] 101,472	[1] 2,882,872	1,032	18,250	[1] 102,504	[1] 2,901,122
Total	[1] 138,765	[1] 4,003,842	1,517	36,898	[1] 140,282	[1] 4,040,740
Spain:						
Maryland			1,861	24,930	1,861	24,930
Ohio	9,115	229,497			9,115	229,497
Philadelphia	44,514	1,034,150	6,617	88,828	51,131	1,122,978
Total	53,629	1,263,647	8,478	113,758	62,107	1,377,405
United Kingdom: New York			12	420	12	420
Yugoslavia: Philadelphia	3,104	131,731			3,104	131,731
Total Europe	[1] 209,125	[1] 5,920,226	10,007	151,076	[1] 219,132	[1] 6,071,302
Africa: Union of South Africa:						
Michigan	1,133	21,726			1,133	21,726
Grand total: 1957	[1] 412,246	[1] 12,639,995	219,121	3,391,090	[1] 631,367	[1] 16,031,085
1956	251,039	7,858,850	234,513	3,366,118	485,552	11,224,968

[1] The following material, that had entered bonded warehouses during 1955 and 1956, was withdrawn from bonded warehouses for the United States Government in 1957: Mexico: St. Louis, 24,236 tons ($922,686); Italy: Maryland, 22,173 tons ($717,710), Philadelphia, 39,444 tons ($1,243,755); Total Italy 61,617 tons ($1,961,465); Grand total, 85,853 tons ($2,884,151).

TABLE 11.—Imported fluorspar delivered to consumers in the United States, 1956–57, by uses

Use	1956[1]			1957[1]		
	Short tons	Selling price at tidewater, border, or f. o. b. mill in the United States, including duty		Short tons	Selling price at tidewater, border, or f. o. b. mill in the United States, including duty	
		Total	Average		Total	Average
Hydrofluoric acid	170,739	$7,803,732	$45.71	189,327	$8,311,428	$43.90
Glass and enamel	16,802	610,071	36.31	9,310	430,751	46.27
Steel	274,348	7,402,284	26.98	188,566	4,639,962	24.60
Other	13,553	410,019	30.25	20,635	637,315	30.88
Total	475,442	16,226,106	34.13	407,838	14,019,456	34.37

[1] Estimated in part.

TABLE 12.—Fluorspar reported by producers as exported from the United States, 1948–52 (average) and 1953–57

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1948–52 (average)	794	$34,014	$42.59	1955	52	$2,055	$39.52
1953	695	36,906	53.10	1956	50	2,169	43.38
1954	479	23,838	49.77	1957	(1)	(1)	(1)

[1] Figures withheld to avoid disclosing individual company confidential data.

WORLD REVIEW

NORTH AMERICA

Canada.—The Department of Mines and Technical Surveys, Ottawa,[18] reported that fluorspar production in Canada in 1956 totaled 151,738 short tons valued at Can$3,835,565, compared with 128,114 tons valued at Can$2,708,437 in 1955.

Exports in 1956, shipped entirely to the United States, reached a new record of 78,380 tons valued at Can$1,941,500, compared with 58,390 tons (revised figure) valued at Can$1,460,844. Imports in 1956 increased to 28,148 tons. Of this, 26,523 tons came from Mexico, 1,566 tons from the United States, and 59 tons from the United Kingdom, whereas in 1955 a total of 21,774 tons came from Mexico, Spain, the Union of South Africa, the United States, and the United Kingdom in the order named. Consumption of flurospar totaled 87,927 short tons in 1955, of which 68,592 tons was used to produce heavy chemicals, 18,610 tons was used at steel plants, 592 tons in glass plants, 97 tons in the enameling and ceramic industries, and 36 tons for white metal alloys. By comparison, consumption in 1954 totaled 80,610 tons, including 63,751 tons for heavy chemicals, 16,002 tons in the steel plants, 757 tons in the glass industry, 85 tons in the enameling and glazing industries, and 15 tons for white-metal alloys.

[18] Canada Department of Mines and Technical Surveys, Fluorspar in Canada, 1956 (preliminary): Ottawa, 6 pp.

TABLE 13.—World production of fluorspar, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	75,211	88,569	118,969	128,114	140,071	68,463
Mexico (exports)	97,845	173,163	146,198	200,220	360,117	389,807
United States (shipments)	309,652	318,036	245,628	279,540	329,719	328,872
Total	482,708	579,768	510,795	607,874	829,907	787,142
South America:						
Argentina	5,053	[3] 8,000	14,308	14,991	12,983	[3] 16,500
Bolivia (exports)	148	21	213	569	300	
Brazil	549	----------	[4] 487	----------	----------	----------
Total	5,750	[3] 8,021	15,008	15,560	13,283	[3] 16,500
Europe:						
Belgium	[3] 5,000	(5)	(5)	(5)	(5)	(5)
France	54,463	69,702	81,788	94,863	89,287	88,185
Germany:						
East [3]	62,000	90,000	90,000	90,000	90,000	90,000
West	104,888	177,719	190,916	170,816	160,937	154,323
Italy	41,732	83,544	85,041	110,694	136,675	158,915
Norway	978	777	488	317	198	331
Spain	56,105	56,426	81,032	73,653	81,281	[3] 88,200
Sweden (sales)	4,000	4,773	4,140	1,459	976	[3] 1,100
United Kingdom	77,412	88,624	92,607	96,235	102,536	104,467
Total [3]	407,000	575,000	630,000	645,000	665,000	690,000
Asia:						
Japan	2,513	7,206	6,771	5,738	8,911	8,404
Korea, Republic of	3,709	12,139	9,360	11,105	3,431	5,644
Turkey	165	110	----------	23	----------	----------
U. S. S. R.[3] [6]	83,800	90,000	110,000	110,000	165,000	165,000
Total [1] [3]	103,000	140,000	170,000	180,000	245,000	245,000
Africa:						
Morocco: Southern zone	1,271	3,188	1,188	11	170	----------
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	179	373	120	480	943	97
South-West Africa	1,162	5,641	3,063	675	----------	24
Tunisia	745	2,249	----------	----------	----------	----------
Union of South Africa	8,406	16,029	21,996	32,839	35,065	35,106
Total	11,763	27,480	26,367	34,005	36,178	35,227
Oceania: Australia	498	373	21	316	834	305
World total (estimate) [1] [3]	1,010,000	1,330,000	1,350,000	1,485,000	1,790,000	1,775,000

[1] In addition to countries listed, fluorspar is produced in China and North Korea. Estimates by author of chapter are included in the total.
[2] This table incorporates a number of revisions of data published in previous Fluorspar chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Exports.
[5] Data not available; estimate by author of chapter included in total.
[6] U. S. S. R. in Europe included with U. S. S. R. in Asia, as the deposits are predominantly in Asiatic U. S. S. R.

The St. Lawrence Corp. of Newfoundland, Ltd., recovered from 111,062 tons of ore mined 73,393 tons of "heavy-medium" concentrate; 72,718 tons was shipped to St. Lawrence Fluorspar Corp., a subsidiary company, at Wilmington, Del. Newfoundland Fluorspar, Ltd., recovered 76,049 tons as heavy-medium concentrate from 118,154 tons mined and shipped 68,083 tons to its parent company, Aluminum Co. of Canada, Ltd., at Arvida, Quebec. Production, though small in recent years, was reported from the Madoc area in Ontario by the Huntingdon Fluorspar Mines, Ltd., at its Kilpatrick mine.

St. Lawrence Fluorspar Corp. of Newfoundland, Ltd., suspended mining on June 4, 1957, following expiration of a contract with the United States Government earlier in the year.[19] Since then alternative markets were sought in the United States by the company as it was unable to compete in the Canadian market with foreign fluorspar.

A complete investigation into the fluorspar tariff structure was ordered by the Canadian Finance Minister; public hearings were scheduled to begin May 6, 1958.[20]

In 1957 fluorspar entered Canada duty free from all sources under Canadian tariff item No. 296, but this free rate was not bound by the General Agreement on Tariffs and Trade (GATT).[21] It was reported by the Tariff Board that one Canadian producer requested that a tariff of $10 per net ton be imposed on all grades of fluorspar entering Canada.

Newfoundland Fluorspar, Ltd., was planning by the end of the year to expand the capacity of its Burin Peninsula mines from 75,000 tons to 110,000 tons annually.[22]

Mexico.—Principal producers of Acid-grade fluorspar were Fluorita de Mexico, S. A., Muzquiz, Coahuila, and Cia Minero Nacional, S. A., Rosita, Coahuila, with a combined current capacity of about 100,000 tons.[23] In the fall of 1957 Fluor-mex, S. A., opened a hydrofluoric acid plant, which was expected to produce at full capacity—1,200–1,500 tons—early in 1958. Fluor-mex, S. A., was the only producer in Mexico. Imports in 1956 totaled 585 tons.

SOUTH AMERICA

Argentina.—On October 10, 1957, a Freon manufacturing plant was placed in operation by Ducilo, a DuPont affiliate, at Berazategui, Province of Buenos Aires.[24] The plant will consume fluorspar from mines operated by the National Lead Co. Its annual capacity of 1,360 tons was believed sufficient to meet all domestic requirements. In addition to Freon for use as a refrigerant, the plant will produce aerosol-type products for insecticide, cosmetic, paint, pharmaceuticals, and other industries in the country.

Brazil.—Northeast Brazil, embracing the States of Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, and the Territory, Island of Fernando de Noronha, has attracted little attention as a source of minerals other than gypsum, dolomite, and scheelite.[25] Intensive aerial surveys and ground prospecting during the last 6 years revealed more than 20 minerals, including fluorite. The official Bank for Northeast Brazil reported that many of the minerals, fluorite included, were being exploited with relative success.

EUROPE

Germany, West.—Output of crude fluorspar totaled 277,231 short tons in 1956 compared with 281,089 tons in 1955. Marketable production totaled 170,858 tons in 1956 compared with 176,370 tons in

[19] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 26.
[20] Northern Miner (Toronto), Fluorspar Tariffs To Be Investigated: Vol. 43, No. 27, Sept. 26, 1957, p. 7.
[21] U. S. Department of Commerce, Foreign Commerce Weekly: Vol. 59, No. 8, Feb. 24, 1958, p. 5.
[22] Engineering and Mining Journal, vol. 158, No. 7, July 1957, p. 184.
[23] U. S. Embassy, Mexico, D. F., Mexico, State Department Dispatch 699, Jan. 2, 1958, pp. 17, 18.
[24] U. S. Embassy, Buenos Aires, Argentina, State Department Dispatch 529: Oct. 14, 1957, 1 p.
[25] Mining Journal, Brazil's Growing: Vol. 250, No. 6385, Jan. 3, 1958, p. 12.

1955.[26] Imports, including those into the Soviet Zone of East Germany, totaled 30,390 tons in 1956, an increase over the 27,215 tons, which entered in 1955. Exports, mostly Acid-grade, totaled 36,287 tons in 1956 compared with 35,380 tons in 1955. The principal consuming industries, metallurgical, chemical, ceramics, and cement, used an estimated 134,263 tons in 1956 and 127,005 tons in 1955. Fluorspar reserves in West Germany, estimated at nearly 2 million tons, will last for 10 years at the current rate of production.

Italy.—Production of Acid-grade fluorspar totaled 112,481 short tons in 1956 compared with 91,099 tons in 1955.[27]

United Kingdom.—Production of fluorspar during 1957 was reported as follows: Acid-grade, 24,409 short tons; Metallurgical-grade, 72,644 tons; and ungraded or crude, 7,414 tons; total, 104,467 tons.[28]

ASIA

Korea.—Production of fluorspar in Korea in 1957 totaled 4,645 short tons, with an average content of 80 percent CaF_2.[29]

Pakistan.—Fluorspar was mined on a small scale in the Koh-I-Maran Range from a deposit first discovered in 1954, and prospecting work was done during 1955–57 by the Geological Survey of Pakistan (GSP) and the Pakistan Industrial Development Corp.[30] GSP recommended mining the fluorspar veins in the Zori-Badami-Aapurshi area, as they were relatively accessible at an average elevation of 6,850 feet.

AFRICA

Egypt.—Unexplored fluorspar deposits were reported in Wadi Igla and Jebel Al Enaigi east of the Bramia district and in Wadi El Gammal.[31]

South-West Africa.—Production of fluorspar in South-West Africa totaled 24 short tons in 1957.[32]

Union of South Africa.—Exports in 1956 totaled 19,413 short tons valued at £110,133 (£ equals US$2.80), f. o. b. from the Union of South Africa.[33] Japan received 10,776 tons; Sweden, 4,541 tons; and Kenya, 2,286 tons; the remainder was exported to Finland, Germany, the Netherlands, Norway, Rhodesia, and the United Kingdom.

Seven major fluorspar producers were reported in 1956: G. R. Steenkamp (Antoinette mine), Vryheid, Natal; Fluorspar Export (Pty.), Ltd., Johannesburg (direct exporters); Frank Martin & Co. (Pty.), Ltd., Gemiston; Leeuwbosch Lead Mines, Ltd., Thabanzimbi, Transvaal; Rhenosterfontein Fluorspar Mines (Pty.), Ltd., Zeerust, Transvaal; Rhino Springs Mining Co., Zeerust, Transvaal; Vergenoeg Mining Co., care of General Overseas Traders (Pty.), Johannesburg.

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[26] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 23.
[27] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, p. 26.
[28] U. S. Embassy, London, England, State Department Dispatch 3768: May 19, 1958, pp. 14–15.
[29] U. S. Embassy, Seoul, Korea, State Department Dispatch 631: Apr. 2, 1958, p. 2.
[30] U. S. Embassy, Karachi, Pakistan, State Department Dispatch 712: Feb. 17, 1958, 1 p.
[31] U. S. Embassy, Cairo, Egypt, State Department Dispatch 632: Dec. 21, 1957, pp. 24–25, encl. 2.
[32] American Consul General, Johannesburg, Union of South Africa, State Department Dispatch 200: Feb. 21, 1958, p. 1, encl. 1.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, pp. 23–24.

TECHNOLOGY

Nearly 30 patents, relating to methods of processing and recovering fluorspar and fluorine compounds and to uses, were issued in 1957. Two patents were concerned with recovering calcium fluoride in either solid or filter-cake form in processing phosphate rock.[34] The first described a process for the simultaneous production of fluorine chemicals and a commercial silica gel. Phosphate rock was treated with sulfuric acid, and the resulting hydrofluosilicic acid solution was heated with marble dust. Filtering produced a calcium fluoride cake containing silica gel.

Some 15 processes for recovering or producing fluorine compounds from phosphate rock and other sources were patented. One described a method of recovering fluorine compounds from the "den gases" evolved during acid treatment of apatite, phosphate rock, or other phosphatic material.[35] Another patent related to a process for recovering boron trifluoride.[36]

An improved process for manufacturing gasoline with boron trifluoride and liquid phosphoric acid was described in another patent.[37]

About midyear duPont announced that it will expand production of all four of its commercial tetrafluoroethylene resins at its Parkersburg, W. Va., plant.[38]

Expansion of its plant capacity was announced by the manufacturer of a new fluorochemical for treating fabrics and suede leather first sold commercially in 1957.[39] Used on wool apparel, upholstery, and on suede leather, this new product repelled water and oilborne stains, but its effectiveness on cotton apparel was lost with frequent laundering or cleaning.

The $9-million fluorine-recovery system at United States Steel's Provo, Utah, mill in operation for 2 years was described.[40] Farmers in the area made some 900 claims that the stack gases had contaminated nearby lands, damaging crops and dairy herds. Principal complaint was that fluorine caused fluorosis—a bone disease—in the livestock. It was found that fluorine was being emitted from two separate places in the mill—the sintering plant and open-hearth department.

Fluorine emission was reduced 50 percent in the sinter plant, without detriment to the sintering properties, by mixing powdered limestone with the sinter charge. The CaF_2 formed remained in the charge to blast furnaces and passed off when the slag was tapped. Gases, at 800° F., from the plant were collected, and hydrated lime dust (95 percent passing 325-mesh) was forced at a rate of 20 pounds per minute into the collecting duct at two points. From the collecting

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[34] Butt, C. A. (assigned to International Minerals & Chemical Corp.), Process for Producing Colloidal Silica-Free Calcium Fluoride: U. S. Patent 2,780,251, Feb. 5, 1957; Gloss, G. H. (assigned to International Minerals & Chemical Corp.), Process for Recovering Solid Calcium Fluoride Containing Product and Colloidal Silica Solution from a Weak Aqueous Fluosilicic Acid Solution: U. S. Patent 2,780,253, Feb 5, 1957.

[35] Gloss, G. H., and Gross, J. H. (assigned to International Minerals & Chemical Corp.), Production of Fluorine Compounds: U. S. Patent 2,780,522, Feb. 5, 1957.

[36] Kilpatrick, M. (assigned to the United States Atomic Energy Commission), Method for Recovering Boron Values: U. S. Patent 2,787,527, Apr. 2, 1957.

[37] Serniuk, G. E. (assigned to Esso Research & Engineering Co.), Polymerization With Boron Trifluoride-Phosphoric Acid Catalyst: U. S. Patent 2,810,774, Oct. 22, 1957.

[38] Chemical Engineering Progress, Major Teflon Resin Expansion: Vol. 53, No. 7, July 1957, p. 78.

[39] Chemical and Engineering News, vol. 35, No. 34, Aug. 26, 1957, p. 7.

[40] Work cited in footnote 11.

duct the gases containing 0.4 percent solids entered the cyclone-precipitator unit, where the bulk of the solid was removed. The process was completed when powdered limestone (80 percent passing 200-mesh) was injected at two points at a rate of 64 pounds per minute; the gases then passed into electrostatic precipitators, where most of the remaining particles were removed.

Though similar in principle, the open-hearth treatment section did not require the second limestone addition. Gases at 600° F., from 10 open-hearth furnaces, containing 160 parts per million fluorine were channeled through a 16-foot-diameter distributing duct along which at 8 points lime dust was forced into the gas stream at the rate of 7 pounds per minute. About 96 percent of fluorine effluent was removed by cyclone-precipitator units. Steam injected into the collecting mains kept the humidity around 20 percent, enough to precipitate CaF_2, which does not take an electrostatic charge when dry.

A total of 115 tons per day in dust was removed from effluent gases by the precipitating units—50 tons, containing 1.5 tons of fluorine, from the sinter plant and 65 tons, containing 2.5 tons of fluorine, from the open-hearth furnaces—then discharged into hoppers, agglomerated to prevent blowing, and dumped on slag piles. Eventually, the company hopes to find some commercial use for the fluorine values now being disposed.

An article described a method of using a fluidized bed in producing uranium tetrafluoride.[41] The benefits claimed included reduction of capital and operating costs, uniform-temperature control, simplified heat removal, and the absence of moving mechanical parts.

CRYOLITE

Natural cryolite was mined from the only known commercial-size deposit at Ivigtut, Greenland, owned by the Danish Government. The mining concession was held by the Kryolitselskabet Oresund Ald, Copenhagen. Part of the output was shipped to the United States, where the Pennsalt Chemicals Corp. (formerly Pennsylvania Salt Manufacturing Co.) processed the ore in its mill at Natrona, Pa. Synthetic cryolite was produced in the United States by the Aluminum Company of America at East St. Louis, Ill., and Reynolds Metal Co. at Bauxite, Ark. The Kaiser Aluminum & Chemical Corp., in addition to the Aluminum Company and Reynolds Metals, reclaimed cryolite from scrapped pot linings of aluminum reduction cells.

Cryolite prices quoted throughout the year in the Oil, Paint and Drug Reporter were as follows: "Cryolite, nat., indust., bgs., c. l., works, 100 lb. $13.00; l. c. l., works, 100 lb., $14.25." These listings, representing the lowest prices, were firsthand quotations prevailing on large lots, f. o. b. New York, and did not represent bid and asked prices or a range over the week.

During the year several patents were issued for recovering and using cryolite. An improved process for producing synthetic cryolite from certain chemical-industry byproducts was reported.[42]

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[41] Lewitz, N. M., Petkus, E. J., Katz, H. M., and Jonke, A. A., A Fluidized Bed Process for the Production of Uranium Tetrafluoride: Chem. Eng. Prog., vol. 53, No. 4, April 1957, pp. 199–201.

[42] Wendt, G. (assigned to Verinigte Aluminium-Werke Artiengesellschaft, Bonn, Rhine, Germany), Process of Producing Cryolite From Washing and Waste Liquors Containing Sodium Fluoride: U. S. Patent 2,783,128, Feb. 26, 1957.

The use of cryolite in an improved aluminum-brazing flux was described in another patent issued later in the year.[43]

Cryolite imports for 1948 through 1957 shown in table 14 do not differentiate between natural and synthetic, but most of the shipments from countries other than Greenland and Denmark are believed to have been synthetic cryolite.

Exports of natural and synthetic cryolite in 1957, totaling 165 short tons valued at $55,300, were shipped mostly to Canada and Mexico; India, Turkey, and the Union of South Africa received smaller shipments.

TABLE 14.—Cryolite imported for consumption in the United States, 1948–52 (average), 1953–55 (totals), and 1956–57, by countries, in short tons

[Bureau of the Census]

	Short tons	Value
1948–52 (average)	23,443	$1,563,082
1953	29,457	3,528,148
1954	21,141	2,215,887
1955	21,980	3,189,761
1956		
North America: Greenland [1]	12,212	507,650
Europe:		
Denmark	531	41,271
France	2,204	526,661
Germany, West	5,307	1,200,760
Italy	2,866	624,265
Spain	2	748
Total	10,910	2,393,705
Grand total	23,122	2,901,355
1957		
North America:		
Canada	2,380	100,938
Greenland [1]	14,398	610,615
Total	16,778	711,553
Europe:		
Denmark	408	29,537
France	1,102	206,944
Germany, West	10,407	2,217,107
Italy	4,017	857,245
Total	15,934	3,310,833
Grand total	32,712	4,022,386

[1] Crude natural cryolite.

[43] Hanink, D. K. (assigned to General Motors Corp., Detroit, Mich.), Salt Flux and Method for Brazing Aluminum Parts Therewith: U. S. Patent 2,809,423, Oct. 15, 1957.

Gem Stones

By John W. Hartwell[1] and Betty Ann Brett[2]

GEM MATERIAL collected during 1957 in the United States was valued at about $900,000, slightly less than in 1956.

New regulations on the advertising of jewelry and gem stones in publications, circulars, or orally, were issued by the Federal Trade Commission on June 28, 1957. These regulations apply to all manufacturers, importers, and sellers and are designed to protect the trade and public from unfair practices.

DOMESTIC PRODUCTION

No new localities for gem materials were reported in 1957. Sources of gem materials were listed in previous Gem Stones chapters.

About 800 gem and mineral clubs were active in the United States in 1957, mostly in the Rocky Mountain and Pacific Coast areas. The number of members was not known but was reported to be close to 40,000; about one-quarter owned and operated their own lapidary equipment.

Collecting gem material in the Pacific Northwest by amateurs was reported becoming more difficult, as more privately owned properties were closed to collectors. Collecting gained popularity in the East.

Some owners of gem-stone claims opened their land to collectors for certain fees and used power-operated dirt-moving equipment to uncover the gem material.

In the Pacific Northwest commercial producers of baroque or "tumbled"-type gems reported production valued at nearly $100,000. Because of the popularity of baroque jewelry, suitable "tumbling" material was difficult to obtain. Commercial lapidaries sold less of this type of jewelry because more amateurs "tumbled" their own material.

Six States—Oregon, California, Nevada, Texas, Arizona, and Washington—produced 72 percent of the total reported value of gem materials in 1957. Oregon led in production, with an estimated $200,000—20 percent less than was reported in 1956.

Agate.—Agate produced in the United States during 1957 was valued at more than $125,000, a 25-percent increase over 1956. Commercial and amateur lapidaries sold about 200 short tons of "tumbled" agate material as baroque gems. Principal States, in decreasing order of production, were: Oregon, New Mexico, Arizona, Texas, and Wyoming. Output in Oregon was valued at approximately $60,000, a 20-percent increase over 1956. Principal areas of production were Jefferson, Crook, and Deschutes Counties. Reports from New Mexico indicated an agate production of nearly $25,000, largely from near Deming, Luna County.

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

Arizona produced agate worth an estimated $15,000, principally from Greenlee, Maricopa, Pima, and Yuma Counties; this was a 40-percent decrease from the value reported in 1956.

Emerald.—The emerald mine near Little Switzerland, N. C., formerly leased by the American Gem and Pearl Co., was reopened by Little Switzerland Emerald Mines, Inc.

Yearly production of synthesized emeralds by C. F. Chatham, San Francisco, Calif., was estimated at 60,000 carats. About 10 percent of the stones were high quality, retailing at $90 to $120 per carat.[3]

Jade.—Jade production in the United States during 1957 was valued at $50,000, a 50-percent reduction from 1956. About half of the total value was reported from Wyoming.

During 1957 the Empire Jade Co., Shungnak district, Alaska, produced jade estimated equal to the 1956 output. Some jade boulders were cut to sizes suitable for 24-inch saws and sold to retailers in the United States. The balance of the material was exported to Germany for finishing into jewelry. The Government-sponsored Shungnak Jade Project in Alaska did not sell raw jade but continued to finish ornamental objects and jewelry. Only a small part of the jade, purchased from Eskimo claim owners, was gem quality.

Petrified Wood.—Production of petrified wood decreased in quantity and value from the record reported during 1956. Estimated value of production from four States was as follows: Arizona, $25,000; Utah, $5,000; Wyoming, $4,000; and Colorado, $3,000.

Gingko, tempska, and other rare fossil woods were produced in small quantities in California, Montana, Oregon, and Washington.

Turquois.—Arizona became the principal turquois-producing State in 1957, surpassing Nevada, the leading State in 1956. Arizona production of turquois was $30,000. Localities near Miami and Kingman produced about 7,500 pounds of low-grade material valued at $17,000. Nevada reported production of 1,300 pounds of high-grade material, which was valued at $13,000. The Lone Mountain and Battle Mountain mines were the principal producers. Turquois also was produced in Colorado.

Miscellaneous Gem Materials.—Fire-opal production from the Virgin Valley area, Nevada, was reported for the first time since 1955. Production was valued at $52,000.

A dispatch from the Pike County diamond field, Arkansas, states that a diamond weighing 3.11 carats was found during 1957. One diamond weighing 15.33 carats was found in 1956 near the same location.[4]

Development of the Yogo sapphire mine in Judith Basin County, Mont., uncovered 2 large stones, weighing 4½ and 5½ carats. Plans were made to build a mill in 1958.

Over 5 tons of obsidian and quantities of other durable gem materials were used by lapidaries for "tumbling" during 1957 to fill the demand for baroque gems.

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[3] Morello, Ted, Green Treasure of the Andes: Nature Mag., vol. 50, No. 10, December 1957, p. 515.

[4] Washington Evening Star, Woman Finds 3.11-Carat Diamond in Arkansas Mine: 105th Year, No. 140, May 20, 1957, p. A5.

TABLE 1.—Estimated production of gem stones in the United States, 1955–57, in thousand dollars

	1955	1956	1957		1955	1956	1957
Alaska	(2)	(2)	(2)				
Arizona	97	104	75	Nevada	(1)	50	100
Arkansas	4	25	(1)	New Hampshire	5	(2)	(2)
California	(1)	90	100	New Jersey	(2)	(2)	(2)
Colorado	48	30	35	New Mexico	25	30	30
Connecticut			(2)	New York	(2)	2	5
Florida		(2)	(2)	North Carolina	(2)	1	(2)
Georgia	(2)	(2)	(2)	North Dakota			(2)
Idaho	5	(1)	5	Oregon	150	250	200
Illinois			2	Pennsylvania	(2)	(2)	(2)
Iowa			(2)	South Dakota	7.4	10	15
Maine	5	(2)	(2)	Texas	115	115	100
Maryland		(2)	(2)	Utah	6	10	12
Michigan	(2)	(2)	(2)	Washington	65	75	75
Minnesota	(2)	(2)	(2)	Wyoming	57	75	55
Missouri			(2)	Other States and Territories	226	20	36
Montana	(1)	35	35				
Nebraska	2.4	3	2	Total	818	925	882

[1] Included with "Other States and Territories."
[2] Figures of less than $1,000 included with "Other States and Territories."

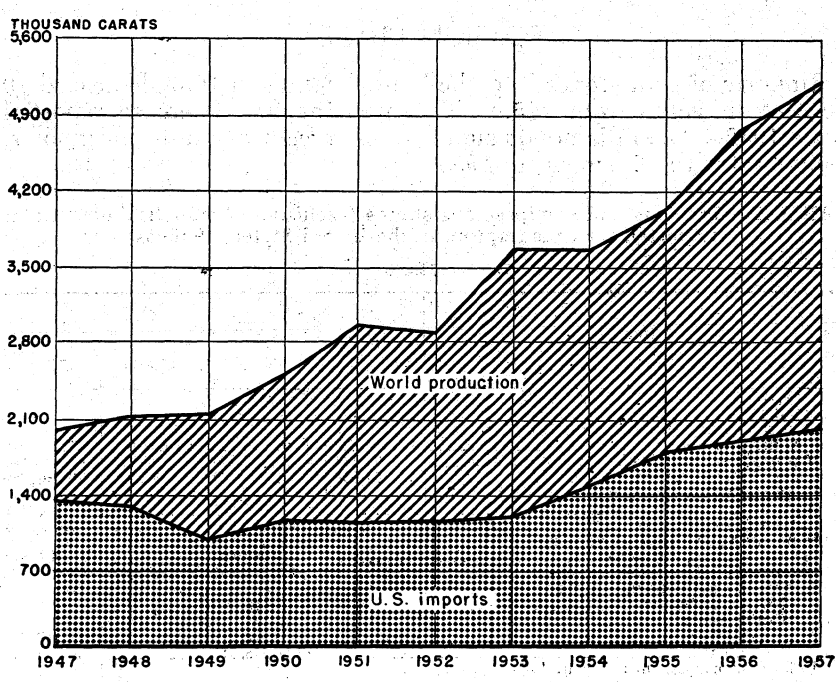

FIGURE 1.—World production and United States imports of gem diamonds, 1947–57.

CONSUMPTION

Sales of lapidary equipment and supplies, gem materials (excluding diamond), and mineral specimens were estimated at nearly $5 million. Synthetic gem-stone purchases from producers in the United States were estimated to be about $1 million; other countries supplied over

$10 million. Purchases of natural gem material, exclusive of diamond, from other sources was reported to be nearly $15 million.

The apparent consumption (domestic production plus imports minus exports) of gem stones in the United States in 1957 was over $142 million.

PRICES

In January 1957 the Diamond Trading Co. of London, England, announced price increases of 5 to 7½ percent on all qualities of rough diamonds used in manufacturing regular goods, tapered baguettes, and melee.[5]

The average diamond prices per carat imported into the United States were for cut, but unset, $107.28 and for rough or uncut, $76.93. The upward trend of prices paid for rough or uncut stones continued in 1957, with an average increase of $4.35 per carat; prices for cut but not set stones decreased $2.07 per carat.

Average prices paid for sapphire imported into the United States for consumption were $9.67 higher per carat in 1957 than in 1956.

FOREIGN TRADE[6]

Imports of gem stones into the United States in 1957 decreased 10 percent in value from 1956. This was the first decrease reported since 1952. Gem diamonds supplied 85 percent of the total imports, compared with 86 percent in 1956.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1956–57

[Bureau of the Census]

Item	1956		1957	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 1,176,832	[1] $86,216,172	1,002,696	$77,142,072
Cut but unset, suitable for jewelry, dutiable	693,142	[2] 75,795,826	609,775	65,418,387
Emeralds: Cut but not set, dutiable	50,931	[2] 1,688,429	37,245	1,594,789
Pearls and parts, not strung or set, dutiable:				
Natural		[2] 626,237		480,172
Cultured or cultivated		[2] 8,024,660		9,508,701
Other precious and semiprecious stones:				
Rough or uncut, duty-free		[2] 280,692		629,814
Cut but not set, dutiable		[2] 3,116,372		3,163,573
Imitation, except opaque, dutiable:				
Not cut or faceted		[2] 40,496		59,598
Cut or faceted:				
Synthetic		[2] 402,272		463,687
Other		[2] 11,448,744		10,061,841
Imitation, opaque, including imitation pearls, dutiable		[2] 30,410		23,054
Marcasites, dutiable: Real and imitation		38,911		26,413
Total		[1] [2] 187,709,221		168,572,101

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

[5] Jewelers' Circular-Keystone, The Diamond Industry, 1956: P. 2.
[6] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

The principal imported gem stones that showed decreases in value were imitation gems (25 percent), natural pearls (23 percent), and diamond (11 percent). Increases were noted in rough or uncut precious and semiprecious gems, excluding diamond and cultured pearls, 124 and 18 percent, respectively.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1956						
North America:						
Bermuda	498	$48,664	$97.72			
Canada	4,929	576,212	116.90	279	$22,304	$79.94
Mexico				57	23,467	411.70
Total	5,427	624,876	115.14	336	45,771	136.22
South America:						
Brazil	2,456	112,342	45.74	253	20,196	79.83
British Guiana	6,595	200,740	30.44			
Colombia	86	12,055	140.17			
Surinam				85	834	9.81
Uruguay				75	23,000	306.67
Venezuela	56,996	1,644,575	28.85	156	25,363	162.58
Total	66,133	1,969,712	29.78	569	69,393	121.96
Europe:						
Austria				480	52,800	110.00
Belgium-Luxembourg	139,965	16,579,867	118.46	422,002	46,810,415	110.92
Czechoslovakia				25	5,660	226.40
France	4,634	436,790	94.26	9,293	1,173,809	126.31
Germany, West	2,442	108,457	44.41	38,333	2,750,098	71.74
Italy				64	8,806	137.59
Netherlands	3,776	212,270	56.21	21,987	2,696,243	122.63
Switzerland	11,085	429,418	38.74	385	340,049	883.24
United Kingdom	810,591	60,991,614	75.24	3,526	536,427	152.13
Total	972,493	78,758,416	80.99	496,095	54,374,307	109.60
Asia:						
Ceylon				14	1,058	75.57
Hong Kong	76	1,662	21.87	4	419	104.75
India				1,424	121,254	85.15
Israel	2,556	51,011	19.96	145,950	13,169,447	90.23
Japan				1,050	88,242	84.04
Lebanon	89	7,666	86.13			
Malaya				111	15,670	141.17
Total	2,721	60,339	22.18	148,553	13,396,090	90.18
Africa:						
British East Africa	74	740	10.00			
Egypt				77	6,674	86.68
French Equatorial Africa	48,012	1,242,420	25.88			
Liberia	35,536	1,420,676	39.98	15	4,130	275.33
Southern British Africa				1	487	487.00
Union of South Africa	46,436	2,138,993	46.06	47,496	7,898,974	166.31
Total	[1] 130,058	[1] 4,802,829	[1] 36.93	47,589	7,910,265	166.22
Grand total	[1] 1,176,832	[1] 86,216,172	[1] 73.26	693,142	75,795,826	109.35

[1] Revised figure; Belgian Congo revised to none.

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TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1956–57, by countries—Continued

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1957						
North America: Canada	5,850	$567,531	$97.01	419	$52,190	$124.56
South America:						
Argentina	147	2,600	17.69	9	615	68.33
Brazil	3,426	135,503	39.55	778	75,620	97.20
British Guiana	4,782	135,938	28.43	236	24,011	101.74
Surinam	2,726	88,438	32.44			
Venezuela	61,890	2,057,533	33.24	4	493	123.25
Total	72,971	2,420,012	33.16	1,027	100,739	98.09
Europe:						
Belgium-Luxembourg	130,646	13,308,054	101.86	345,899	37,482,783	108.36
France	21,052	846,483	40.21	6,228	987,074	158.49
Germany, West	588	18,498	31.46	29,873	2,019,582	67.61
Hungary				105	3,500	33.33
Italy				147	21,839	148.56
Netherlands	4,248	319,044	75.10	22,686	2,914,262	128.46
Switzerland	917	27,160	29.62	134	107,905	805.26
United Kingdom	646,424	55,447,905	85.78	3,275	551,728	168.47
Total	803,875	69,967,144	87.04	408,347	44,088,673	107.97
Asia:						
Hong Kong				3	274	91.33
India	23	2,250	97.83	385	259,119	673.04
Iran				147	12,519	85.16
Israel	3,462	128,664	37.16	151,488	13,685,980	90.34
Japan	249	4,148	16.66	1,297	115,713	89.22
Malaya	300	43,655	145.52			
Thailand				152	1,283	8.44
Total	4,034	178,717	44.63	153,472	14,074,888	91.71
Africa:						
Belgian Congo	4,150	13,584	3.27			
British East Africa				1	515	515.00
French Equatorial Africa	23,690	633,920	26.76			
French West Africa	2,469	52,572	21.29			
Liberia	45,496	1,607,795	35.34			
Southern British Africa				42	3,250	77.38
Union of South Africa	40,161	1,700,797	42.35	46,284	7,063,491	152.61
Total	115,966	4,008,668	34.57	46,327	7,067,256	152.55
Oceania: Australia				183	34,641	189.30
Grand total	1,002,696	77,142,072	76.93	609,775	65,418,387	107.28

[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

WORLD REVIEW

In a historical world review of diamond discoveries, production, and sales it was estimated that, in 1955, nearly 22 thousand workers were engaged in cutting and polishing diamonds. Belgium led in number of workers, with 10,700, followed by Germany, 4,000; Israel, 2,500; and the United States, 2,000. The remaining workers were in 11 countries. Rough diamonds sold by the Diamond Syndicate during 1920–29, and the Central Selling Organization, 1930–56, were included. Sales in 1956 were nearly $210 million.[7]

[7] Leeper, Sir Reginald, The Development of the Diamond Industry: Optima (Johannesburg), vol. 7, No. 3, September 1957, pp. 125–129.

NORTH AMERICA

Canada.—An increased quantity of jade was produced from the Frazer River deposits of British Columbia, Canada, during 1957. These deposits were becoming more important as a source of good gem material as deposits in the United States and Alaska were being depleted.

Cuba.—The diamond cutting and polishing industry established during World War II was reported almost nonexistent in 1957. Over 12,000 carats were exported to the United States from 1947 to 1950, inclusive; none was exported from 1951 to 1956.[8]

Guatemala.—A study on jade and jade artifacts found in Guatemala gave the history of use; nomenclature; geologic occurrence; chemical, physical, and optical properties; and types of jade and other green minerals used in meso-American cultures.[9] After the study was published a jade deposit was found in place near Monzanal, Guatemala.

Mexico.—The quality, quantity, and location of agate, amethyst, apatite, beryl, danburite, garnet, obsidian, opal, orthoclase, scapolite, topaz, and tourmaline were reported. Many agate varieties, including iris, moss, flame, plume, and banded, were considered more valuable than other gem materials found. Agate was produced in large quantities.[10]

It was reported that a "lost" Mexican jade deposit was traced to an area near Taxco, Guerrero.[11]

SOUTH AMERICA

Surinam.—A diamond area near Rosebel and Sabanpassie, known since 1880, was investigated by the Geological and Mining Service. Diamond was found in eluvial conglomerate deposits. Mining would depend on the adaptability of large-scale equipment.[12]

Venezuela.—Over 19,000 carats of gem-quality diamonds was produced in 1956, equivalent to 20 percent of total diamond production. Only a small part was domestically cut and polished. Pearls sold in domestic jewelry came from local sources but were only a small part of the total production. Most of the pearls produced were exported.[13]

ASIA

India.—A total of 360 tons of ore from 20 sampling shafts, sunk at intersections of gridlines 250 feet apart, in the Panna diamond-mining area yielded 63 diamonds, equivalent to 12.5 carats per 100 tons.

Iran.—An estimated 15,000 pounds of turquois was mined in Nishapur during 1956. Production in 1957 was reported to be 30 percent less in quantity but 15 percent more in value. Sales to the United States were about $2,400.[14]

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[8] U. S. Embassy, Havana, Cuba, State Department Dispatch 412: Nov. 18, 1957, p. 1.
[9] Foshag, W. F., Mineralogical Studies on Guatemalian Jade: Smithsonian Miscellaneous Collections, vol. 135, No. 5, Dec. 3, 1957, 60 pp.
[10] Barron, E. M., Report on Mexican Gem Minerals: Unpublished.
[11] Science Newsletter, vol. 71, No. 13, Mar. 30, 1957, p. 198.
[12] U. S. Consulate, Paramaribo, Surinam, State Department Dispatch 115: Nov. 20, 1957, p. 3.
[13] U. S. Embassy, Caracas, Venezuela, State Department Dispatch 469: Jan. 7, 1958, pp. 39–40.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, pp. 28–29.

Israel.—Progress was reported by the Israel diamond-polishing industry, which anticipated exports valued at $31 million during 1957, compared with $24.5 million in 1956. According to spokesmen of the industry, employment rose to about 3,000. The average "added value" of the diamond increased from 17 to 20 percent.[15]

Japan.—The pearl industry overproduced in the spring during declining prices, cut production, increased exports, and stabilized prices in the last half of 1957. Production for the year was 45,469 pounds—4,134 pounds less than in 1956. Exports were 55,140 pounds valued at $14.3 million.[16]

U. S. S. R.—Diamond was discovered in an area of over 115 square miles near Yakutia. In an article describing the deposits, data were given on diamond properties and methods of prospecting, petrography, and mineralogy of the kimberlite. The largest diamond found weighed 32.5 carats; but in typical deposits, 70 to 90 percent of the diamonds were smaller than 1/10 carat. Because the stones were small, the field might be regarded principally as a source of industrial diamond.[17]

The Yakutia discoveries also were summarized and references to Russian publications describing the six separate diamond-bearing areas were given. It was indicated that about 19 percent of the diamonds were good industrial stones and gem stones.[18]

AFRICA

Angola.—The Portuguese Government was formulating plans to develop a diamond-cutting and polishing industry in Lisbon, utilizing diamond produced in Angola. Most of the Angola output was gem quality (60 percent), and was exported to the United Kingdom.[19]

Belgian Congo.—A decree effective August 1, 1957, was issued increasing the base value of Kasai diamonds, but reducing the export tax from 5 to 3 percent ad valorem.

French West Africa.—On February 20, 1957, at Kerouane, French Guinea, an African cooperation, Bakima, was created for diamond exploitation in the Famarodou area. This organization was established to protect the authorized miners and to help stop the illegal production and sale of diamond. The history of the area and methods of mining were related.[20]

Liberia.—Diamond exports in 1956 were over 1 million carats, more than 5 times the 1955 exports.[21]

A second diamond rush was reported in the Suehn-Bopolo district, northeast of Bomi Hills, about 75 miles from Monrovia.[22]

Rhodesia and Nyasaland, Federation of.—An emerald discovery near the Belingwe Native Reserve, Southern Rhodesia, was placed under Government control. Specimens were sent to the United States

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15 U. S. Embassy, Tel Aviv, Israel, State Department Dispatch 222: Oct. 15, 1957, p. 3.
16 U. S. Consulate, Nagoya, Japan, State Department Dispatch 43: Jan. 10, 1958, p. 1.
17 Davidson, C. F., The Diamond Fields of Yakutia: Min. Mag. (London), vol. 47, No. 6, December 1957, pp. 329–338.
18 Moyar, A., The Diamond Industry in 1956–57, Vlaams Economisch Verbond (Antwerp, Belgium), undated: Pp. 72–76.
19 U. S. Consulate, Luanda, Angola, State Department Dispatch 62: Nov. 26, 1957, pp. 1–2.
20 U. S. Consulate, Dakar, French West Africa, State Department Dispatch 241: Apr. 10, 1957, pp. 1-7.
21 U. S. Embassy, Monrovia, Liberia, State Department Dispatch 256: Apr. 10, 1957, pp. 2–3.
22 U. S. Embassy, Monrovia, Liberia, State Department Dispatch 206: Feb. 6, 1957, pp. 5–6.

for appraisal. The value and extent of deposits were not known.[23]

Tanganyika.—In 1957 production from the Williamson and Alamasi, Ltd., diamond mines exceeded that for 1956. Exports from the territory increased about 4 percent in weight and over 1 percent in value. Improvements made by Alamasi, Ltd., increased the output above the average of former years.[24] John T. Williamson, principal owner of the Williamson Diamond, Ltd., mine died January 8, 1958.[25]

Union of South Africa.—The Diamond Export Duty Act of 1957 was approved and adopted by the Government. This act, consolidating the export duty acts of 1917, 1919, 1947, 1950, and 1956, which were wholly or partly repealed, regulated the export duty of rough and uncut diamonds from the Union of South Africa.[26]

The DeBeers Consolidated Mines, on behalf of the Central Sales Organization, reported sales of gem diamond in 1957 totaling nearly $148 million, the highest on record and about $6 million over 1956.[27]

H. F. Oppenheimer became chairman of the board of DeBeers Consolidated Mines, Ltd., on the death of his father, Sir Ernest Oppenheimer, on November 25, 1957.[28]

OCEANIA

Australia.—Recovery of an additional 100 tons of oystershell by Japanese "pearlers" outside the 10-mile zone was approved by the Australian Government. The number of pearls recovered was not known.

A quantity of cultured pearls was produced by the Australian-Japanese-United States company described in the 1956 Gem Stones chapter.[29]

TECHNOLOGY

Scheelite crystals 7/16 inch in maximum dimensions were discovered in the Tyler Creek tungsten mine near Deer Creek, Calif. Crystals are rare, because most deposits contain only disseminated scheelite grains.[30]

A series of articles was published on gem materials, listing the properties that make them highly esteemed. Information on localities and facts about cutting and polishing were given.[31]

The properties of natural and artificial gem stones and methods of distinguishing between them were described.[32]

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[23] Rhodesia and Nyasaland Newsletter (Salisbury), Value of Rhodesian Emerald Find Still Unknown: Feb. 7, 1958, p. 3.
[24] U. S. Consulate, Dar es Salaam, Tanganyika, State Department Dispatch 157: Feb. 19, 1958, p. 4.
[25] Canadian Mining Journal, The Late John T. Williamson: Vol. 51, No. 550, February 1958, p. 120.
[26] U. S. Embassy, Pretoria, Union of South Africa, State Department Dispatch 76: Sept. 3, 1957, p. 1.
[27] DeBeers Consolidated Mines, Ltd., Annual Report, 1957: p. 18.
[28] DeBeers Consolidated Mines, Ltd., Annual Report, 1957: pp. 7-9, 11.
[29] U. S. Consulate, Perth, Australia, State Department Dispatch 3: Aug. 28, 1957, p. 4.
[30] California State Division of Mines, Mineral Information Service, Scheelite-Crystal Discovery: Vol. 10, No. 5, May 1, 1957, pp. 6-7.
[31] Owens, G. S., Gems: Rocks and Minerals, vol. 32, Nos. 1-2, January-February 1957, pp. 43-46; Report on Spinel: Nos. 7-8, July-August 1957, pp. 375-377; Beryl: Nos. 9-10, September-October 1957, pp. 469-472; Report on Chrysoberyl: Nos. 11-12, November-December 1957, pp. 582-585.
Cole, Bill, Tourmaline: Rocks and Minerals, vol. 32, Nos. 1-2, January-February 1957, pp. 47-48; Turquoise: Nos. 3-4, March-April 1957, pp. 146-147; Feldspar Gems: Nos. 5-6 May-June 1957, pp. 268-269; Quartz Gems (part I, The Crystalline Forms): Nos. 7-8, July-August 1957, pp. 400-401; Quartz Gems (part II, The Crysptocrystalline Forms): Nos. 9-10, September-October 1957, pp. 473-474.
[32] Blas, L. [Characteristics of Natural and Synthetic Gems]: Ion, vol. 16, No. 176, March 1956, pp. 147-152; Eng. Index Service No. 57-1879; Ind. Diamond Rev. Abs., vol. 17, No. 198, May 1957, p. B78.

A review of the gem-stone industry in California included mineralogy and geology, occurrences, locations of deposits, mining, utilization and treatment, markets, and a bibliography.[33]

A method of forming emerald crystals under high temperature and pressure was given.[34]

Sapphires grown in aqueous solutions—a process similar to that used to grow quartz crystals—appeared free from strain. The crystals might be useful in manufacturing optical items. The process might be used to make synthetic rubies and star sapphires under controlled conditions.[35]

A synthetic gem—strontium titanate—was made by the Verneuil process. It had an index of refraction higher than diamond and a hardness of 6 on the Mohs scale.[36]

Quality corundum crystals without strains and with minimum brittleness were grown by the Verneuil process.[37]

A report on gem stones and industrial crystals other than natural discussed the inadequacies of the terminology used in the trade to describe the finished products.[38]

Twelve mineral specimens were described, giving the synonyms, nomenclature, varieties, compositions, crystallography, physical and optical properties, tests, diagnoses, occurrence, and uses. Each mineral was illustrated in color. These mineral specimens were listed in chronological order: Beryl, sphalerite, chrysocolla, garnierite, pitchblende, chromite, quartz, corundum, fuller's earth, kyanite, pyrrhotite, and feldspar.[39]

A formula for calculating the weight of regular cuts of gem stones and pearls, particularly brilliant-cut diamonds, was given. Tables and graphs were included.[40]

A new instrument, the refractoscope, to determine the density and/or the index of refraction of gem stones, was introduced to jewelers and gemmologists.[41]

Laboratory methods to remove surface coatings from rough diamonds by chemical means were investigated. Present methods require a window cut into the stone to determine its quality.[42]

The color terminology and quality grades in diamond evaluation were discussed.[43]

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[33] Wright, L. A., Gem Stones: Chap. in Min. Commodities of California, California Div. Mines, Bull. 176, December 1957, pp. 205–214.

[34] Hurst, V. J., Mineralogical Notes: Georgia Mineral Newsletter, vol. 10, No. 3, Autumn 1957, p. 95.

[35] Chemical Engineering News, vol. 35, No. 38, Sept. 23, 1957, p. 62.

[36] Pough, R. H., Fabulite: Jewelers' Circ.-Keystone, vol. 127, No. 8, May 1957, pp. 78–83.

[37] Ikornikova, N. Yu., and Popova, A. A. [Preparation of Uniaxial Crystals of Synthetic Corundum]; Doklady Akad. Nauk (S. S. S. R.), vol. 106, No. 3, 1956, pp. 460–461; Ceram. Abs., vol. 40, No. 7, July 1957, column 172i.

[38] Pough, F. H., Reconstruction, Synthesis, Culture-or-What?: Jewelers' Circ.-Keystone, vol. 127, No. 10, July 1957, pp. 69–70, 87; No. 11, August 1957, pp. 160, 162, 188, 190; No. 12, September 1957, pp. 94, 96, 98, 114, 153; vol. 128, No. 1, October 1957, pp. 126, 128, 193–195.

[39] Mine and Quarry Engineering (London), Mineral Specimens No. 40–51: Vol. 23, No. 1, January 1957, pp. 14–15; No. 2, February 1957, pp. 58–59; No. 3, March 1957, pp. 102–103; No. 4, April 1957, pp. 144–145; No. 5, May 1957, pp. 190–191; No. 6, June 1957, pp. 238–239; No. 7, July 1957, pp. 288–289; No. 8, August 1957, pp. 334–335; No. 9, September 1957, pp. 380–381; No. 10, October 1957, pp. 428–429; No. 11, November 1957, pp. 472–473; No. 12, December 1957, pp. 516–517.

[40] Schiebel, W. [Formula for Calculating the Weight of Regular Cuts of Gemstones and Pearls, Particularly of the Brilliant Cut Diamond]: Deutsch. Gesell. Edelsteinkunde Ztschr., No. 18, Winter 1956–57, pp. 16–22; Ind. Diamond Rev. Abs., vol. 17, No. 196, March 1957, p. B53.

[41] Pough, F. H., Refractoscope: Jewelers' Circ.-Keystone, vol. 127, No. 9, June 1957, pp. 62, 64, 66, 111.

[42] International Cooperation Administration, Monthly Report, Bureau of Mines Metallurgist, Rio de Janeiro, Brazil, July 1957: July 31, 1957, 2-page airgram.

[43] Klippel, Robert, Modern Diamond Assorting: Jewelers' Circ.-Keystone, vol. 127, No. 11, August 1957, pp. 152, 154, 156, 158; No. 12, September 1957, pp. 90, 92, 123.

The properties of certain natural and synthetic colorless gem stones were described.[44]

Methods of determining the difference between true jade and artificially colored jade were given.[45]

Patents, suitable for use in lapidary processes, were obtained on a diamond bandsaw,[46] a diamond-filled-paste applicator,[47] an automatic feeder for cooling lapidary grinding tools,[48] a machine for grinding gem diamonds to selected shapes,[49] and an apparatus for cutting and polishing gem facets.[50]

Patents were also issued on a process of bonding diamond powder on a tool grinding face,[51] and a method of producing blue-white boules, which have gemlike properties.[52]

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[44] Pough, F. H., Colorless Stones: Jewelers' Circ.-Keystone, vol. 128, No. 2, November 1957, pp. 100, 102, 112–114.

[45] Wong, Edward, Be Sure It's Really Fine Jade: Jewelers' Circ.-Keystone, vol. 128, No. 3, December 1957, pp. 70, 84.

[46] Barron, J. H., Diamond Bandsaw: U. S. Patent 2,784,536, Mar. 12, 1957.

[47] Booth, S. M., Applicator for Applying a Diamond-Filled Paste to a Working Surface: U. S. Patent 2,775,851, Jan. 1, 1957.

[48] Loecy, J., Jr., Control Means for Cooling of Dressing Diamond or the Like: U. S. Patent 2,781,035, Feb. 12, 1957.

[49] Salzer, A., Automatic Diamond Cutting and Polishing Device: U. S. Patent 2,829,472, Apr. 8, 1958.

[50] Collar, L. H., Machine for Grinding and Polishing Gem Facets: U. S. Patent 2,779,138, Jan. 29, 1957.

[51] Keeleric, G. F., Process for Making Abrasive Article: U. S. Patent 2,785,060, Mar. 12, 1957.

[52] Merker, Leon (assigned to National Lead Co.), Synthetic Rutile Composition: U. S. Patent 2,801,182, July 30, 1957.

Gold

By J. P. Ryan [1] and Kathleen M. McBreen [2]

PRODUCTION of gold from domestic mines continued to decline in 1957 and, except for the war years 1943–46, reached the lowest peacetime level of production in more than 60 years. Output for 1957 of 1.8 million troy ounces valued at $62.8 million was 2 percent below that for 1956. World gold production rose for the fourth successive year in 1957, again owing almost entirely to the remarkable expansion of output in the Union of South Africa rather than to any general improvement in gold-mining conditions. Total world output for the year was valued at $1.39 billion—3 percent higher than in 1956. The decline in domestic production reflected the closing or curtailment of some straight gold-mining operations and reduction in the scale of operations at some base-metal mines where gold is recovered as a byproduct.

United States consumption of gold in the arts and industry increased nearly 4 percent in 1957 to 1.45 million ounces valued at $50.7 million, about 80 percent of domestic mine production.

United States Treasury gold stocks increased $831.7 million in 1957, and estimated gold reserves of the Free World gained about $720 million during the year. Prices of gold in the principal world markets remained close to the official United States price of $35 an ounce; but in some markets of the Far East, the United States dollar equivalent of the bar-gold price continued to range higher than the official price reflecting local conditions.

Sales of gold by the U. S. S. R. in 1957 were estimated by a leading bullion firm [3] to have aggregated 7.5 million ounces, nearly 75 percent higher than in 1956.

Of a total of 37 million ounces of new gold sold in 1957, the bullion firm estimated that 24 million ounces went to Central Bank reserves, about 9 million ounces to hoarders, and 4 million ounces for industrial consumption.

Several bills were introduced in the first session of the 85th Congress, which provided for: (1) Return of the United States to the gold standard, with free coinage of gold; and (2) unrestricted free trading of gold and limiting the use of gold held or acquired by the Treasury or Federal Reserve banks to monetary purposes exclusively. The bills were referred to the respective Committees on Banking and Currency of the House of Representatives and Senate, but no further action was taken. A joint resolution (S. J. Res. 16) was introduced

[1] Commodity specialist.
[2] Statistical assistant.
[3] Samuel Montagu & Co., Ltd.

TABLE 1.—Salient statistics of gold, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
United States:[1]						
Mine production___thousand ounces__	2,055	1,958	1,837	1,880	[2] 1,832	1,794
Value__________thousand dollars__	71,918	68,540	64,306	65,805	64,112	62,776
Ore (dry and siliceous) produced (thousand short tons):						
Gold ore____________________	3,033	2,199	2,249	2,234	2,255	2,359
Gold-silver ore_______________	404	82	46	120	245	116
Silver ore___________________	494	555	680	570	687	712
Percentage derived from—						
Dry and siliceous ores____________	41	40	43	41	42	43
Base-metal ores________________	33	39	34	37	39	38
Placers_____________________	26	21	23	22	19	19
Imports__________thousand ounces [3]__	21,083	1,344	1,083	2,930	3,730	7,701
Exports_____________________do____	8,074	854	494	162	734	4,806
Monetary stocks (end of year) million dollars [4]__	__________	22,030	21,713	21,690	21,949	22,781
Net consumption in industry and the arts____________thousand ounces__	2,386	2,143	1,270	1,300	1,400	1,450
Price, average, per fine troy ounce [5]___	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00
World: Production thousand ounces (estimated)	32,200	33,700	35,100	36,400	38,400	39,620

[1] Includes Alaska.
[2] Revised figure.
[3] Excludes coinage.
[4] Owned by Treasury Department; privately held coinage not included.
[5] Price under authority of Gold Reserve Act of Jan. 31, 1934.

in the Senate to establish a joint committee to investigate the gold mining industry and recommend enabling legislation to reestablish the industry as an integral part of the national economy. The resolution was referred to the Committee on Interior and Insular Affairs, but no further action was taken.

The Government's appeal of the Court of Claims ruling that a group of gold mines was entitled to recover compensation for losses suffered as a result of War Production Board Limitation Order L–208 was under review by the Supreme Court at the end of the year.

TABLE 2.—Gold produced in the United States,[1] 1948–52 (average) and 1953–57, according to mine and mint returns, in fine ounces of recoverable metal

	1948–52 (average)	1953	1954	1955	1956	1957
Mine_______________________	2,054,809	1,958,293	1,837,310	1,880,142	[2] 1,831,765	1,793,597
Mint_______________________	2,011,573	1,970,000	1,859,000	1,876,830	1,865,200	1,800,000

[1] Includes Alaska.
[2] Revised figure.

DOMESTIC PRODUCTION

United States mine production of recoverable gold declined 2 percent in 1957 to 1.8 million ounces valued at $62.8 million—the lowest output in 64 years, except for the period 1943–46 during World War

II. The production drop in 1957 was attributed chiefly to the lower output of byproduct gold from copper and zinc-lead-copper ores in Utah and lower recovery from gold ores in California and Colorado, which more than offset production gains from gold and copper ores in Washington and Arizona and lead ores in Nevada.

The continued rise in operating costs in relation to the fixed price for gold again brought about the closing or curtailment of some straight gold-mining operations as ore reserves became depleted. In addition, several base-metal mines recovering byproduct gold operated on a reduced scale as a result of the drop in prices of base metals. Of the total domestic production in 1957, 43 percent was recovered from precious metal ores, 19 percent from placers, and 38 percent as a byproduct of base-metal ores.

Units of measurement, classification of mines, and methods of calculating mine production are described in detail in the Gold chapter of Minerals Yearbook, 1954.

South Dakota continued to rank as the leading gold-producing State by a wide margin, followed by Utah, Alaska, and California, the same order as in 1956. These 3 States and 1 Territory again furnished about three-fourths of the total domestic production in 1957. Nearly all South Dakota's gold was from gold ore produced at the Homestake mine; Utah gold production was almost entirely as a byproduct of base-metal ores, chiefly copper ore at the Utah Copper mine; Alaska gold was recovered from many placer mines, chiefly by bucketline dredging; and California production was obtained almost exclusively from straight gold mines, both placer and lode. Again in 1957, about 39 percent of United States gold production was recovered by amalgamation and cyanidation, 19 percent by placer mining and recovery methods, and 42 percent in smelting ores and concentrates.

Lawrence County (Lead), S. Dak., continued to rank first among the leading gold-producing regions in the United States, a position it has held for many years. The West Mountain (Bingham) district, Utah, again was second, and the Fairbanks district in Alaska was third. The two leading districts continued to furnish about half the domestic gold output.

Of the 25 leading gold producers in the United States in 1957, 8 were lode mines, 5 were placer mines worked by bucketline dredges, 8 were copper mines, 1 was a lead-zinc mine, and 3 were copper-lead-zinc mines. The entire 25 mines supplied about 87 percent of the domestic output valued at $54.7 million.

Ore classification, methods of recovery, and metal yields, embracing all ores that yielded gold in the United States in 1957, are given in the following tables 7 to 11. The terminology used in classifying ores is described in detail in the 1954 Minerals Yearbook Gold chapter.

TABLE 3.—Mine production of gold in the United States[1] in 1957, by months

Month	Fine ounces	Month	Fine ounces
January	134,046	August	168,783
February	124,489	September	169,902
March	139,186	October	178,052
April	132,881	November	156,043
May	143,708	December	134,782
June	146,960		
July	164,765	Total	1,793,597

[1] Includes Alaska.

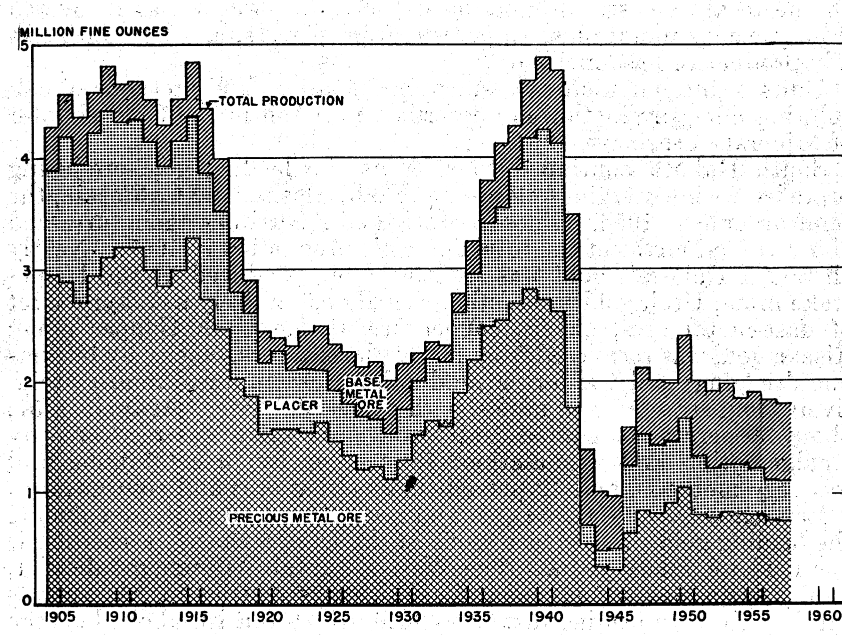

FIGURE 1.—Gold production in the United States, 1905–57.

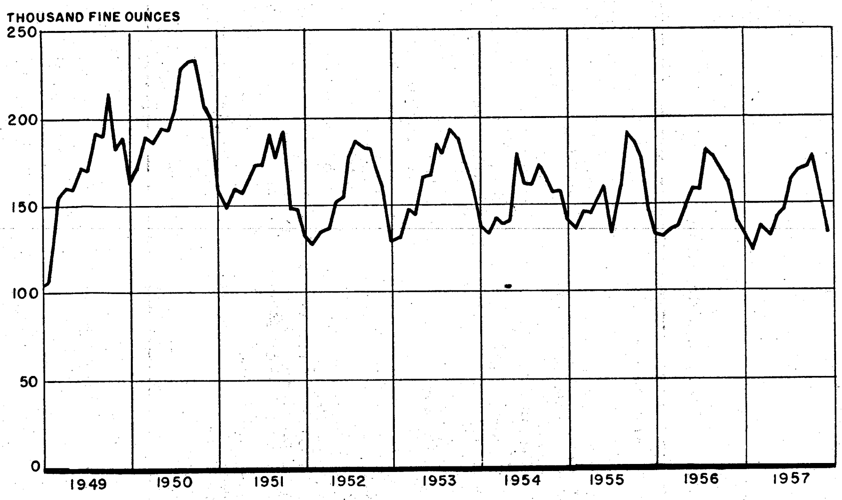

FIGURE 2.—Mine production of gold in the United States, 1949–57, by months, in terms of recoverable gold.

TABLE 4.—Mine production of recoverable gold in the United States, 1948–52 (average) and 1953–57, by districts that produced 10,000 fine ounces or more during any year (1953–57), in fine ounces [1]

District or region	State	1948–52 (average)	1953	1954	1955	1956	1957
Lawrence County	South Dakota	470,207	534,984	541,445	529,865	568,523	568,130
West Mountain (Bingham)	Utah	374,372	450,882	369,760	405,194	393,227	365,924
Fairbanks	Alaska	113,042	136,571	142,369	146,876	115,175	98,173
Chelan County	Washington	(2)	[3] 61,468	[3] 66,477	[3] 74,135	[3] 70,257	(2)
Ferry County	do	(2)	(3)	(3)	(3)	(3)	(2)
Yuba River	California	(2)	(2)	(2)	(2)	(2)	(2)
Warren (Bisbee)	Arizona	19,330	29,840	40,208	42,351	45,088	49,140
Robinson	Nevada	49,122	61,093	34,139	39,430	45,911	(2)
Cripple Creek	Colorado	29,807	51,559	48,935	47,171	52,544	45,323
Nome	Alaska	(2)	29,560	21,177	23,410	24,058	43,654
Ajo	Arizona	36,982	36,599	32,708	40,030	39,040	35,027
American River (Folsom)	California	90,825	65,275	61,885	55,794	49,651	(2)
Summit Valley (Butte)	Montana	18,118	19,871	17,325	22,262	31,132	27,165
Big Bug	Arizona	16,292	17,788	17,802	19,942	25,327	(2)
Upper San Miguel	Colorado	38,965	39,876	21,514	18,987	27,137	(2)
Aniak	Alaska	14,947	14,184	19,777	19,384	16,465	(2)
Klamath River	California	1,798	3,727	13,838	21,857	15,048	18,927
Bullion	Nevada	(2)	(2)	(2)	(2)	(2)	(2)
Old Hat	Arizona	1,842	2	32	----------	9,720	(2)
Pioneer	do	12,231	14,480	13,382	11,299	11,648	12,771
Park City	Utah	18,992	27,919	27,900	32,208	17,647	9,981
Downieville	California	(2)	(2)	(2)	(2)	(2)	9,344
Alleghany	do	(2)	13,112	8,483	5,769	(2)	(2)
Grass Valley-Nevada City	do	(2)	(2)	(2)	(2)	(2)	3,476
Red Cliff (Battle Mountain)	Colorado	2,837	3,750	10,121	8,416	2,031	(2)
Battle Mountain	Nevada	(2)	(2)	(2)	(2)	(2)	1,062

[1] Includes Alaska.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Chelan and Ferry Counties combined to avoid disclosing individual company confidential data.

TABLE 5.—Twenty-five leading gold-producing mines in the United States in 1957, in order of output

Rank	Mine	District or region	State	Operator	Source of gold
1	Homestake	Whitewood (Lead)	South Dakota	Homestake Mining Co.	Gold ore.
2	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp.	Copper ore.
3	Fairbanks Unit	Fairbanks	Alaska	U. S. Smelting, Refining & Mining Co.	Dredge.
4	Yuba Unit	Yuba River	California	Yuba Consolidated Gold Fields	Do.
5	Knob Hill	Republic	Washington	Knob Hill Mines, Inc.	Gold ore.
6	Copper Queen-Lavender Pit	Warren	Arizona	Phelps Dodge Corp.	Copper ore.
7	Nome Unit	Nome	Alaska	U. S. Smelting, Refining & Mining Co.	Dredge.
8	New Cornelia	Ajo	Arizona	Phelps Dodge Corp.	Gold-silver, copper ores.
9	Natomas	American River (Folsom)	California	The Natomas Co.	Dredge.
10	Iron King	Big Bug	Arizona	Shattuck Denn Mining Co.	Lead-zinc ore.
11	Gold King	Wenatchee River	Washington	Lovitt Mining Co., Inc.	Gold ore.
12	Treasury Tunnel-Black Bear-Smuggler Union.	Upper San Miguel	Colorado	Idarado Mining Co.	Copper-lead-zinc ore.
13	Ajax	Cripple Creek	do	Golden Cycle Corp.	Gold ore.
14	Nyac	Aniak	Alaska	New York-Alaska Gold Dredging Co.	Dredge.
15	Siskon	Klamath River	California	Siskon Corp.	Gold ore.
16	Tripp Pit	Robinson	Nevada	Consolidated Coppermines Corp.	Copper ore.
17	Liberty Pit	do	do	Kennecott Copper Corp.	Do.
18	Goldacres	Bullion	do	The London Extension Mining Co.	Gold ore.
19	San Manuel	Old Hat	Arizona	San Manuel Copper Corp.	Copper ore.
20	Cresson	Cripple Creek	Colorado	Cresson Consolidated Gold Mining & Milling Co.	Gold ore.
21	Clinton-Portland Group	Bald Mountain (Lead)	South Dakota	Bald Mountain Mining Co.	Do.
22	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co.	Silver, lead, lead-zinc ores.
23	Magma	Pioneer	Arizona	Magma Copper Co.	Copper ore.
24	Holden	Chelan Lake	Washington	Howe Sound Co.	Do.
25	Kelley	Summit Valley	Montana	The Anaconda Co.	Do.

TABLE 6.—Mine production of recoverable gold in the United States, 1948–52 (average) and 1953–57, by States, in fine ounces

State	1948–52 (average)	1953	1954	1955	1956	1957
Alaska	249,425	253,783	248,511	249,294	209,296	215,467
Arizona	113,048	112,824	114,809	127,616	146,110	152,449
California	369,746	234,591	237,886	251,737	193,816	170,885
Colorado	125,782	119,218	96,146	88,577	97,668	87,928
Idaho	58,799	17,630	13,245	10,572	[1] 9,210	12,301
Montana	46,448	24,768	23,660	28,123	38,121	32,766
Nevada	131,724	101,799	79,067	72,913	72,646	76,752
New Mexico	3,397	2,614	3,539	1,917	3,275	3,212
North Carolina	2	----------	214	190	882	1,373
Oregon	11,066	8,488	6,520	1,708	2,738	3,381
Pennsylvania	1,858	1,134	1,317	1,610	(2)	(3)
South Dakota	470,226	534,987	541,445	529,865	568,523	568,130
Tennessee	167	293	218	221	189	172
Texas	43	----------	----------	----------	----------	----------
Utah	401,551	483,430	403,401	441,206	416,031	378,438
Vermont	138	171	185	181	[4] 1,829	62
Washington	71,274	62,560	66,740	74,360	70,669	[5] 89,708
Wyoming	103	1	407	52	762	573
Total	[6] 2,054,809	[7] 1,958,293	1,837,310	1,880,142	[1] 1,831,765	1,793,597

[1] Revised figure.
[2] Included with Vermont.
[3] Included with Washington.
[4] Includes gold recovered from magnetite-pyrite-chalcopyrite ores in Pennsylvania.
[5] Includes production from Pennsylvania.
[6] Includes 8 ounces from Georgia and 4 ounces from Maryland.
[7] Includes 2 ounces from Georgia.

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 1957

State	Gold ore		Gold-silver ore		Silver ore		Copper ore		Lead ore		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	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton
Alaska	11,571	0.033	-----	-----	-----	-----	-----	-----	55	0.509	-----	-----	-----	-----	11,626	0.035
Arizona	5,059	.340	74,870	0.009	33,919	-----	59,621,032	0.002	9,920	.018	7,072	0.003	462,471	0.057	60,214,343	.003
California	126,114	.382	43	.093	37	0.216	8,242	[1] .085	1,609	.025	-----	-----	68,206	.006	204,251	[1] .241
Colorado	121,398	.378	4,966	.042	2,208	.019	32,138	.072	27,225	[2] .200	785	.290	922,172	.035	1,110,892	[2] .078
Idaho	2,938	.678	9	2.778	403,584	.003	282,855	.015	55,903	.001	[3] 88,427	-----	1,296,785	[1] .001	2,130,501	[1] .004
Montana	7,980	.317	13,791	.108	92,023	.022	9,576,968	.002	7,003	.101	[4] 1,059,177	.008	33,067	.010	[4] 10,790,009	.003
Nevada	161,902	.100	1,278	.491	4,243	.021	11,514,197	.004	26,740	.376	1,003	-----	60,471	.010	11,769,834	1.006
New Mexico	23	1.348	211	.185	13,434	-----	7,618,015	-----	35,799	.002	327,591	.003	82,582	.003	8,077,655	-----
Oregon	2,427	1.304	-----	-----	-----	-----	167	.228	-----	-----	-----	-----	-----	-----	2,594	1.234
South Dakota	1,778,583	.319	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,778,583	.319
Utah	236	.720	20,852	.035	162,011	.017	30,940,383	.011	35,848	.022	[5] 25,240	-----	543,621	.039	[5] 31,728,191	.012
Wyoming	2,000	.286	-----	-----	-----	-----	69	.029	-----	-----	-----	-----	-----	-----	2,069	.277
Undistributed [6]	138,839	.562	-----	-----	84	-----	492,735	.023	110	-----	1,714,582	-----	2,583,598	-----	[7] 4,929,948	[7] .018
Total	2,359,070	.325	116,020	.032	711,543	.008	120,086,801	.005	200,212	.087	3,223,877	.003	6,052,973	.014	132,750,496	.011

[1] Includes gold recovered from tungsten ore.
[2] Includes gold recovered from fluorspar ore.
[3] Zinc slag.
[4] Includes 51,888 tons of zinc slag.
[5] Includes 25,220 tons of zinc slag.
[6] Includes North Carolina, Tennessee, Vermont, and Washington.
[7] Excludes magnetite-pyrite-chalcopyrite ore and gold therefrom in Pennsylvania.

TABLE 8.—Mine production of gold in the United States,[1] 1948–52 (average) and 1953–57, 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
1948–52 (average)	25.9	41.2	24.3	0.6	0.2	7.8	2,054,809
1953	20.9	40.4	30.9	.3	.1	7.4	1,958,293
1954	22.8	42.8	28.6	.3	.1	5.4	1,837,310
1955	21.8	41.3	30.1	.2	.1	6.5	1,880,142
1956	19.0	42.5	31.8	.6	(2)	6.1	1,832,584
1957	19.1	43.3	31.5	1.0	.5	4.6	1,793,597

[1] Includes Alaska.
[2] Less than 0.1 percent.

TABLE 9.—Mine and refinery production of gold in the United States in 1957, by States and sources, in fine ounces of recoverable metals

State	Mine production							Refinery production [1]
	Placers	Dry ore	Copper ore	Lead ore	Zinc ore	Zinc-lead, zinc-copper, lead-copper, and zinc-lead-copper ores	Total	
Alaska	215,062	377	----	28	----	----	215,467	215,890
Arizona	60	2,358	123,463	179	23	26,366	152,449	158,000
California	121,617	48,131	[2] 702	40	----	395	170,885	173,000
Colorado	1,601	46,184	2,313	[3] 5,439	228	32,163	[3] 87,928	91,000
Idaho	2,965	3,102	4,288	41	----	[2] 1,905	[2] 12,301	12,900
Montana	802	6,000	16,964	706	7,957	337	32,766	39,600
Nevada	376	16,859	48,872	10,065	----	580	76,752	75,000
New Mexico	----	74	1,796	72	1,026	244	3,212	3,780
North Carolina	----	745	628	----	----	----	1,373	1,240
Oregon	179	3,164	38	----	----	----	3,381	3,600
Pennsylvania	----	----	----	----	----	----	(4)	1,930
South Dakota	----	568,130	----	----	----	----	568,130	560,000
Tennessee	----	----	----	----	----	172	172	170
Utah	11	3,663	352,737	789	10	21,228	378,438	384,370
Vermont	----	----	62	----	----	----	62	60
Washington	4	77,323	12,380	----	----	1	[5] 89,708	78,900
Wyoming	----	571	2	----	----	----	573	560
Total	342,677	776,681	564,245	17,359	9,244	83,391	1,793,597	1,800,000

[1] U. S. Bureau of the Mint.
[2] Includes gold recovered from tungsten ore.
[3] Includes gold recovered from fluorspar ore.
[4] Included with Washington.
[5] Includes gold recovered from magnetite-pyrite-chalcopyrite ores in Pennsylvania.

TABLE 10.—Gold produced in the United States from ore and old tailings, in 1957, by States and methods of recovery, in terms of recoverable metal

State	Total ore, old tailings, etc. treated (short tons)	Ore and old tailings to mills					Crude ore to smelters	
		Short tons	Recoverable in bullion		Concentrates smelted and recoverable metal			
			Amalgamation (fine ounces)	Cyanidation (fine ounces)	Concentrates (short tons)	Fine ounces	Short tons	Fine ounces
Alaska	11,626	11,571	353	----------	4	24	55	28
Arizona	60,214,343	59,423,329	12	3,971	1,906,661	110,549	791,014	37,857
California	204,251	194,219	20,993	18,877	13,479	8,934	10.032	464
Colorado	1,110,892	1,069,343	7,579	45,148	151.499	30,775	41,549	2,825
Idaho	2,130,501	2,005,330	832	----------	217,882	7,155	125,171	1,349
Montana	[1] 10,790,009	10,623,288	64	635	585,371	25,834	[1] 166,721	5,431
Nevada	11,769,834	11,647,126	209	15,507	283,008	48,133	122,708	12,527
New Mexico	8,077,655	7,974,647	4	----------	286,288	2,996	103,008	212
Oregon	2,594	2,371	147	----------	195	2,584	223	471
South Dakota	1,778,583	1,778,583	404,581	163,549	----------	----------	----------	----------
Utah	[2] 31,728,191	31,515,590	99	----------	926,537	374,298	212,601	4,030
Washington [3]	----------	----------	----------	----------	----------	----------	----------	----------
Wyoming	2,069	2,000	292	----------	25	279	69	2
Undistributed [4]	[5] 4,929,948	[5] 4,860,565	222	9,321	272,973	56,254	69,383	25,514
Total	132,750,496	131,107,962	435,387	257,008	4,643,922	667,815	1,642,534	90,710

[1] Includes 51,888 tons of zinc slag.
[2] Includes 25,220 tons of zinc slag.
[3] Included in "Undistributed."
[4] Includes North Carolina, Pennsylvania, Tennessee, Vermont, and Washington.
[5] Excludes magnetite-pyrite-chalcopyrite ore from Pennsylvania.

TABLE 11.—Gold produced at amalgamation and cyanidation mills in the United States and percentage of gold recoverable from all sources, 1948–52 (average) and 1953–57 [1]

	Bullion and precipitates recoverable (fine ounces)		Gold from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1948–52 (average)	448,776	270,343	21.8	13.2	39.1	25.9
1953	467,561	265,552	23.9	13.5	41.7	20.9
1954	429,558	286,989	23.4	15.6	38.1	22.9
1955	445,135	268,600	23.7	14.3	40.2	21.8
1956	439,180	270,785	24.0	14.8	42.2	19.0
1957	435,387	257,008	24.3	14.3	42.3	19.1

[1] Includes Alaska.
[2] Both crude ores and concentrates.

TABLE 12.—Gold production at placer mines in the United States, by class of mine and method of recovery, 1948–52 (average) and 1953–57 [1]

	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:						
1948–52 (average)	45	65	100,473,201	431,365	$15,097,789	$0.150
1953	21	41	65,313,835	343,132	12,009,620	.184
1954	22	44	62,082,120	356,018	12,460,630	.201
1955	25	20	53,351,709	348,131	12,184,585	.228
1956	19	32	48,955,036	294,585	10,310,475	.210
1957	18	33	45,489,183	297,204	10,402,140	.229
Dragline dredges:						
1948–52 (average)	28	26	3,742,005	18,521	648,228	.173
1953	14	13	659,600	2,453	85,855	.130
1954	15	15	554,460	4,184	146,440	.264
1955	19	7	479,885	2,939	102,865	.214
1956	16	7	774,324	2,502	87,570	.113
1957	13	14	[2] 377,798	1,562	54,670	.145
Suction dredges:						
1948–52 (average)	12	11	176,273	867	30,345	.172
1953	7	8	87,700	341	11,935	.136
1954	3	3	3,800	53	1,855	.488
1955	5	5	2,400	46	1,610	.671
1956	2	2	23,920	27	945	.040
1957	----	----	----	----	----	----
Nonfloating washing plants:						
1948–52 (average)	148	147	6,267,068	69,444	2,430,540	.388
1953	128	128	4,019,325	58,295	2,040,325	.508
1954	128	128	2,973,510	52,491	1,837,185	.618
1955	118	109	2,259,263	53,332	1,866,620	.826
1956	110	99	1,354,976	47,808	1,673,280	1.235
1957	94	111	[2] 2,188,105	39,456	1,380,960	.631
Gravel hydraulically handled:						
1948–52 (average)	78	----	703,247	6,642	232,477	.331
1953	48	----	440,290	1,923	67,305	.153
1954	48	----	258,100	2,079	72,765	.282
1955	44	----	200,001	1,528	53,480	.267
1956	36	----	49,652	1,438	50,330	1.014
1957	30	----	100,170	2,151	75,285	.752
Small-scale hand methods:						
Wet:						
1948–52 (average)	214	----	201,474	4,919	172,158	.854
1953	139	----	152,565	2,534	88,690	.581
1954	112	----	171,780	3,248	113,680	.662
1955	78	----	236,226	3,580	125,300	.530
1956	69	----	99,355	2,141	74,935	.754
1957	65	----	59,994	2,128	74,480	1.241
Dry:						
1948–52 (average)	7	----	1,904	86	3,003	1.577
1953	3	----	9,875	103	3,605	.365
1954	3	----	905	78	2,730	3.017
1955	2	----	420	75	2,625	6.250
1956	2	----	300	53	1,855	6.183
1957	1	----	360	49	1,715	4.764
Underground placers (drift):						
1948–52 (average)	27	----	9,051	443	15,512	1.714
1953	13	----	3,778	172	6,020	1.593
1954	23	----	9,130	304	10,640	1.165
1955	18	----	5,358	216	7,560	1.411
1956	12	----	3,886	166	5,810	1.495
1957	7	----	3,140	127	4,445	1.416
Grand total placers:						
1948–52 (average)	559	----	111,574,223	532,287	18,630,052	.167
1953	373	----	70,686,968	408,953	14,313,355	.202
1954	354	----	66,053,805	[3] 419,866	[3] 14,697,585	.223
1955	309	----	56,535,262	409,847	14,344,645	.254
1956	266	----	51,261,449	348,720	12,205,200	.238
1957	228	----	[2] 48,218,750	342,677	11,993,695	.249

[1] Includes Alaska.
[2] Does not include commercial sand and gravel operations recovering byproduct gold in Colorado.
[3] Includes 1,476 ounces of gold valued at $51,660 recovered from unclassified placers.

CONSUMPTION AND USES

Industry and the Arts.—Consumption of gold in domestic industry and the arts in 1957 rose nearly 4 percent to 1.45 million ounces, according to data furnished by the Bureau of the Mint. This was equivalent to about 80 percent of the domestic mine production for the year. Domestic consumption represents the net amount of gold issued by Government mints and assay offices and private refiners and dealers for industrial, professional, and artistic use after deduction of secondary materials returned to monetary use and old jewelry, plate, and other scrap returned for refining.

According to estimates of a leading bullion firm,[4] of 37 million ounces of new gold sold in 1957, 24 million ounces went into Central Bank reserves, 9 million to hoarders, and 4 million ounces for industrial consumption.

Most nonmonetary gold was used in manufacturing jewelry, watchcases, and utensils, for gold leaf and decorative finishes. Gold alloyed with platinum and palladium was used for spinnerets for making synthetic fibers and for dentures and orthodontic appliances, thermocouples, and electrical contacts. Because of its resistance to corrosion and oxidation, extreme ductility, and high conductivity, industrial application of gold continued to expand, despite its relatively high price.

New methods of applying gold to ceramic materials are expected to lead to broader uses in architectural panels and for other decorative purposes. Gold coating of engine shrouds was developed to help cool aircraft as they challenge the thermal barrier. The gold coating protects the metal shroud surrounding the engines from internal heat and corrosion. Gold plating of the outer surface of the Vanguard earth-satellite provided protection from the elements in outer space and facilitated optical tracking. Most of the internal parts and instrument housings also are gold-plated as a shield against friction heat and corrosion.

The heat-reflecting properties of gold were applied to protect steelworkers from heat rays emanating from molten steel or white-hot billets. Plastic face and eye protectors were sprayed with a thin film of gold that reflected 95 percent of the heat rays without impairing the transparency of the shield. Similarly, observation windows in smelting furnaces may be made heat reflecting by gold coating.

TABLE 13.—Net industrial[1] consumption of gold in the United States, 1948–52 (average) and 1953–57, in fine ounces

[U. S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1948–52 (average)	3,462,249	1,076,525	2,385,724
1953	3,210,829	1,067,969	2,142,860
1954	2,236,179	966,379	1,269,800
1955	1,964,500	664,500	1,300,000
1956	2,186,450	786,450	1,400,000
1957	2,241,892	791,892	1,450,000

[1] Including the arts.

[4] Samuel Montagu & Co., Ltd., Annual Bullion Review, 1957, p. 3.

Other new applications of gold reported during the year included the radioactive gold treatment of certain forms of cancer and the use of radioactive gold to increase the burning speed of fuel thus increasing efficiency and permitting substantial weight reduction in engines, especially in aircraft and guided missiles. Researchers also reported the development of improved gold-bond transistors with better uniformity and collector characteristics.

Gold continued to be the most widely used jewelry metal; approximately half of the total gold used in industry in 1957 was for jewelry. The unusual materials and processes used by the jewelry-manufacturing industry, the commercial standards and stamping-law requirements for composition of jewelry alloys, and their mechanical properties were described.[5]

Reports from producers to the Bureau of Mines indicate that about 800 ounces of gold was sold on the open market in the United States in 1957, most of which was used for jewelry. Prices were reported to be $3–$5 an ounce above the mint price of $35 an ounce.

Monetary.—Gold continued to be used chiefly for settling international transactions and to give stability of value to currency. Demand for gold coins continued strong and prices trended upward during the year.

An economic analysis of the present and future position of gold in the monetary system [6] discussed the effects of prevailing policies with respect to gold on prices, currency inflation, and international trade.

A study of the international function of gold, by an American economist,[7] points up the need for reestablishing a normal relationship between gold production and the production of goods, and outlines essential steps for restoring an international gold standard.

MONETARY STOCKS

United States Treasury gold stocks continued to increase in 1957 for the second successive year, with a gain of $831.7 million to $22,781 million. The estimated world gold reserve, excluding U. S. S. R. and other eastern European countries, was $38,930 million, according to the Federal Reserve Bulletin, a gain of $720 million for the year. United States Treasury stock thus was about 60 percent of the Free World monetary gold reserve.

Monetary gold reserves of the principal Free World central banks and governments outside of the United States at the end of the year,[8] in million dollars, were: Germany, 2,542; United Kingdom, 2,273; Switzerland, 1,706; Canada, 1,115; Belgium, 913; Netherlands, 744; France, 574; and International Monetary Fund, 1,180.

PRICES

The official United States price of gold, established under authority of the Gold Reserve Act of 1934 at $35 per fine troy ounce, remained unchanged. Virtually all domestic gold production was sold to Gov-

[5] Atkinson, Ralph H., Alloys for Precious Metal Jewelry: Metal Progress, vol. 72, No. 5, November 1957, pp. 107–111.
[6] Groseclose, Elgin, A Look Ahead at Gold and Silver: Mines Mag., vol. 48, No. 8, August 1957, pp. 31–37.
[7] Cortney, Philip, A New Gold Standard Could Restore Monetary Order: Optima, vol. 7, No. 2, June 1957, pp. 79–85.
[8] Federal Reserve Bulletin, vol. 44, No. 3, March 1958, p. 366.

ernment mint institutions or to licensed private dealers and refiners at the official price, less handling and refining charges. Sales for industrial and artistic uses also were made at the official price by the Government and private refiners.

The equivalent London market price of gold continued to remain close to the official United States price, fluctuating during the year within the narrow range of 17 cents an ounce between the United States buying and selling prices of $34.9125 and $35.0875, usually reflecting sterling/dollar exchange. This compares with a range of 23 cents an ounce in 1956 and 11 cents in 1955. In foreign markets other than London, the price at which gold was traded directly for United States dollars remained close to the London price but in several markets where gold was traded in local currencies, especially in the Far East, the dollar equivalent of the bar-gold price continued to range considerably higher than the official rate of $35 per ounce, reflecting local financial and political conditions.

It is significant that the prices in some foreign markets were quoted in local inconvertible currencies, which, when computed in United States dollars, are not always realistic.

Average price [1] of "free" gold bars (12.5 kg.) per fine troy ounce, in 1957 [2]

City:	*Price*	City:	*Price*
Manila	$36.37	Beirut	$35.10
Hong Kong	38.23	Paris	36.35
Bombay	56.73	Buenos Aires	35.75
Tangier	34.96		

[1] Prices are quoted at the "free" or black-market value of the U. S. dollar in the local markets.
[2] Engineering and Mining Journal, vol. 158, Nos. 2-12, February-December 1957, No. 1, January 1958 in the "Markets" section of each issue.

At the 12th annual meeting of the Board of Governors of the International Monetary Fund, Undersecretary of the Treasury, W. Randolph Burgess, stated with regard to the Government's gold policy:

> The United States is resolved to check inflationary pressures existing in its economy. We are equally resolved to preserve our international gold bullion standard. The dollar has traditionally been linked to gold, and it is our policy to keep it firmly linked to gold at $35.00 per ounce.

FOREIGN TRADE [9]

In the settlement of favorable trade balances in 1957, imports of gold again exceeded exports for the sixth successive year; however, the excess of imports over exports declined $1.8 million during the year to $104.3 million. Net imports of gold, plus domestic production, continued to exceed net consumption in the arts and industry by a wide margin, thus increasing monetary stocks. Canada furnished about 57 percent of gold imports in 1957 and Argentina, 31 percent. Nearly all of the gold exported by the United States went to Venezuela.

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

TABLE 14.—Value of gold imported into and exported from the United States, 1948–52 (average) and 1953–57, in thousand dollars

[Bureau of the Census]

Year	Imports	Exports	Excess of imports over exports
1948-52 (average)	$747,365	$321,258	$426,107
1953	47,025	44,992	2,033
1954	37,853	21,731	16,122
1955	104,592	7,257	97,335
1956	132,667	26,562	106,105
1957	272,641	168,332	104,309

TABLE 15.—Gold imported into the United States in 1957, by countries of origin

[Bureau of the Census]

Country of origin	Ore and base bullion		Bullion, refined	
	Troy ounces	Value	Troy ounces	Value
North America:				
Canada	730,857	$25,544,215	3,678,256	$128,728,046
Costa Rica			705	24,663
Cuba	915	32,020		
Dominican Republic	325	10,136		
El Salvador	2,466	86,376		
Honduras	1,878	65,862		
Mexico	74,774	2,605,548		
Nicaragua	125,703	4,393,462		
Panama	61	2,135		
Total	936,979	32,739,754	3,678,961	128,752,709
South America:				
Argentina	436	15,217	2,423,943	84,847,124
Bolivia	467	16,220	34,594	1,210,797
Brazil	494	16,795		
British Guiana	4,197	147,002		
Chile	49,277	1,798,041		
Colombia	463	16,183		
Ecuador	16,354	567,978		
Peru	75,799	2,626,458	218,823	7,658,821
Venezuela	175	6,000		
Total	147,662	5,209,894	2,677,360	93,716,742
Europe:				
France	21	723		
Malta, Gozo, and Cyprus	2,591	90,459		
Portugal	21,189	726,422		
United Kingdom	10,604	371,968	88	3,094
Total	34,405	1,189,572	88	3,094
Asia:				
Korea, Republic of	14	509		
Philippines	51,113	1,785,768	156,100	8,599,820
Turkey	1,759	59,847		
Total	52,886	1,846,124	156,100	8,599,820
Africa:				
Rhodesia and Nyasaland, Federation of	1,926	67,338		
Union of South Africa	113	3,973		
Total	2,039	71,311		
Oceania: Australia	11,946	417,605	2,744	94,270
Grand total	1,185,917	41,474,260	6,515,253	231,166,635

TABLE 16.—Gold exported from the United States in 1957, by countries of destination

[Bureau of the Census]

Country of destination	Ore and base bullion		Bullion, refined	
	Troy ounces	Value	Troy ounces	Value
North America:				
Canada			197	$6,905
Cuba			169	6,362
El Salvador			3,335	117,160
Mexico	14,448	$505,680	1,109	38,964
Total	14,448	505,680	4,810	169,391
South America:				
Brazil			229	7,524
Chile			1,382	48,423
Venezuela			4,748,753	166,208,535
Total			4,750,364	166,264,482
Europe:				
Portugal			20,039	702,044
United Kingdom	9,505	328,675		
Total	9,505	328,675	20,039	702,044
Asia:				
Ceylon			26	950
India			92	3,215
Israel			2	73
Philippines			4,744	298,109
Turkey			1,703	59,637
Total			6,567	361,984
Grand total	23,953	834,355	4,781,780	167,497,901

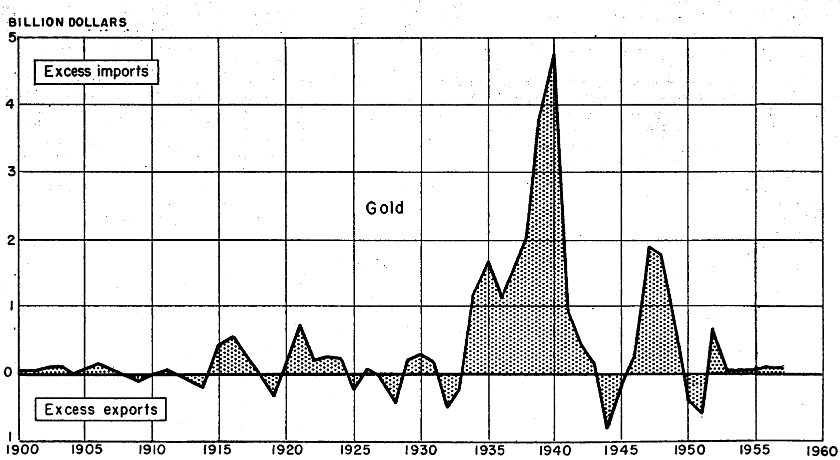

FIGURE 3.—Net imports or exports of gold, 1900–57.

WORLD REVIEW

World output of gold rose 3 percent in 1957 to 39.6 million ounces valued at $1.39 billion, again reaching the highest production level since 1941 and only 6 percent below the alltime peak production of 42.3 million ounces in 1940. Again, the gain in world production resulted almost entirely from increased output in South Africa, which more than offset lower output from Colombia, the Philippines, India, and the United States. Mining costs continued to rise during the year in most of the principal gold-producing countries, and several countries outside of the United States continued to grant financial assistance to the industry by subsidies or tax concessions. Notwithstanding financial aid by the foreign governments, some mines were forced to close owing to rising costs and depletion of economically recoverable reserves.

Australia.—The output of gold from Australia rose slightly in 1957 to 1.08 million ounces. Western Australia was again the leading gold-producing state, contributing about 80 percent of the total output. The Commonwealth subsidy to gold producers was increased to a maximum of £A2–15s an ounce from £A2–0s, equivalent to $6.19 and $4.50, respectively. In addition, premium sales during the year, on the open market through the Gold Producers Association, averaged 9.83d per ounce above the standard price.

Western Australian mines were able to maintain ore reserves, despite increased costs and ore extraction, through economies effected by greater mechanization.

Canada.—Gold production in Canada in 1957 was 4.42 million ounces, valued at $148.27 million—a slight gain over the 1956 output. Because of a decline in the premium on the Canadian dollar in relation to the United States dollar, the value of the 1957 gold output, in Canadian dollars, declined slightly. Gold continued to rank fifth in value among minerals produced in Canada. The average price re-

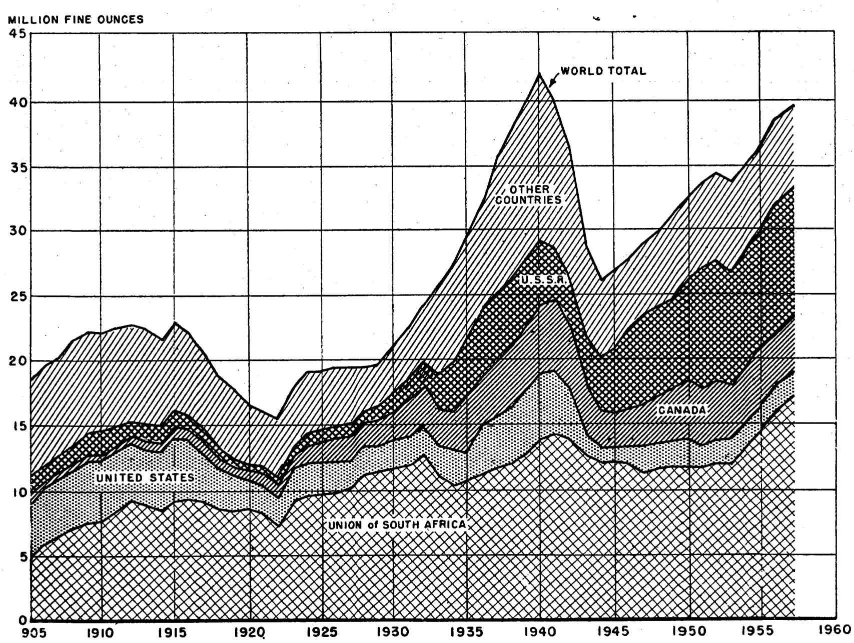

FIGURE 4.—World production of gold, 1905–57.

TABLE 17.—World production of gold, 1948–52 (average) and 1953–57, by countries,[1] in fine ounces [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	4,191,766	4,055,723	4,366,440	4,541,962	4,383,863	4,419,383
Central America and West Indies:						
Costa Rica [3]	299	----------	----------	----------	535	705
Cuba [3]	2,931	1,181	677	2,024	1,008	915
Dominican Republic	448	----------	----------	----------	290	286
Guatemala	[3] 86	[4] 300	[4] 300	[4] 300	[4] 360	[4] 360
Honduras	27,839	47,523	20,429	817	1,611	[4] 1,878
Nicaragua	[5] 234,440	261,899	232,212	237,376	217,140	203,636
Panama	2,934	----------	----------	----------	----------	----------
Salvador	[5] 26,340	19,934	5,326	3,818	2,983	2,508
Mexico	406,932	483,483	386,870	382,883	350,218	357,369
United States (incl. Alaska) [6]	2,011,573	1,970,000	1,859,000	1,876,830	1,865,200	1,800,000
Total	6,906,000	6,840,000	6,871,000	7,046,000	6,823,000	6,787,000
South America:						
Argentina	7,530	5,048	7,202	7,330	11,414	9,645
Bolivia	12,381	22,923	28,614	31,508	35,549	27,685
Brazil [4]	179,180	147,000	153,000	145,000	162,000	[4] 150,000
British Guiana	17,132	20,966	26,938	23,766	15,815	16,490
Chile	176,830	130,693	124,970	141,978	94,459	103,587
Colombia	385,420	437,297	377,466	380,824	438,349	325,114
Ecuador	62,194	29,239	18,942	15,289	15,076	16,247
French Guiana	12,185	2,576	1,512	8,713	[4] 7,500	[5] 9,549
Peru	125,617	141,193	147,424	170,747	159,074	165,052
Surinam	5,029	6,482	6,771	7,204	6,736	6,516
Venezuela	30,646	27,304	56,074	61,140	69,826	89,654
Total [4]	1,014,000	971,000	949,000	993,000	1,016,000	920,000
Europe:						
Finland	14,382	19,483	16,976	18,840	18,229	21,895
France	60,735	64,687	15,947	30,286	24,800	[4] 25,000
Germany, West	[4] 1,591	6,398	4,665	3,839	[4] 4,500	[4] 4,500
Greece	----------	2,048	7,620	6,655	3,504	[4] 3,500
Italy	13,285	12,153	5,208	5,562	5,337	5,691
Portugal	14,789	14,854	18,583	28,807	22,120	[4] 23,000
Spain	15,326	8,263	9,677	10,449	11,510	[4] 10,000
Sweden	73,477	88,254	110,277	98,767	95,745	[4] 100,000
U. S. S. R.[4 7]	8,200,000	[8] 9,000,000	9,000,000	9,000,000	10,000,000	10,000,000
Yugoslavia	32,266	36,620	44,785	41,635	47,808	[4] 53,000
Total [4]	8,500,000	9,400,000	9,400,000	9,400,000	10,400,000	10,400,000
Asia:						
Burma	158	647	170	124	179	104
Cambodia	----------	----------	----------	----------	482	1,608
China	[4] 91,200	[4] 100,000	(9)	(9)	(9)	(9)
India	204,237	223,376	239,168	210,880	209,251	179,182
Indonesia	[4] 44,000	(9)	(9)	(9)	(9)	(9)
Japan	133,724	228,255	243,149	240,732	241,422	251,290
Korea:						
North	[4] 240,000	(9)	(9)	(9)	(9)	(9)
Republic of	10,011	15,882	52,406	47,037	49,903	66,578
Malaya	15,818	18,283	20,955	22,838	20,253	11,157
Philippines	338,814	480,625	416,052	419,112	406,163	379,982
Sarawak	1,067	442	531	463	599	883
Saudi Arabia	69,907	81,566	34,298	----------	----------	----------
Taiwan	26,922	27,200	25,010	28,100	33,131	20,548
Total [4 7]	1,182,000	1,440,000	1,440,000	1,380,000	1,420,000	1,370,000
Africa:						
Angola	213	20	36	57	34	[4] 30
Bechuanaland	752	1,109	1,216	560	590	190
Belgian Congo [10]	338,817	371,020	365,490	369,926	373,840	374,235
Egypt	11,030	14,234	17,387	6,524	7,697	[4] 7,500
Eritrea	1,380	1,363	1,484	161	3,215	4,501
Ethiopa	38,090	26,696	33,894	22,058	25,700	[4] 25,000
French Cameroon	6,968	1,022	686	518	463	10,899

See footnotes at end of table.

TABLE 17.—World production of gold, 1948–52 (average) and 1953–57, by countries,[1] in fine ounces [2]—Continued

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Africa—Continued						
French Equatorial Africa	56,097	54,180	45,307	46,548	40,703	30,768
French West Africa	50,040	1,608	675	579	431	331
Ghana	685,780	730,963	787,075	687,151	599,316	790,381
Kenya	19,284	9,603	6,607	9,528	13,843	7,388
Liberia	10,047	863	1,135	672	500	381
Madagascar	1,886	1,640	1,363	1,074	894	842
Morocco: Southern zone	1,537	2,533	3,566	4,270	265	----------
Mozambique	1,978	1,034	2,027	1,248	1,247	1,080
Nigeria	2,113	689	730	681	439	389
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [11]	1,436	3,107	2,648	2,234	3,243	3,296
Southern Rhodesia	507,484	501,057	535,852	524,701	536,392	536,849
Sierra Leone	2,824	1,451	2,254	474	[5] 452	----------
South-West Africa	104	----------	----------	7	----------	----------
Sudan	2,847	2,175	1,554	1,526	[4] 2,000	[4] 2,000
Swaziland	1,614	----------	----------	----------	252	7
Tanganyika	64,390	69,886	71,447	68,892	59,293	54,088
Uganda (exports)	548	511	568	450	293	213
Union of South Africa	11,657,748	11,940,616	13,237,119	14,602,267	15,896,693	17,031,690
Total	13,465,000	13,740,000	15,120,000	16,350,000	17,570,000	18,880,000
Oceania:						
Australia	903,907	1,075,181	1,117,742	1,049,039	1,029,821	1,084,079
Fiji	94,487	76,970	72,200	70,100	67,475	75,150
New Guinea	95,243	120,568	86,195	73,980	79,085	68,564
New Zealand	77,914	38,656	41,713	26,443	26,063	30,195
Papua	360	141	318	873	391	466
Total	1,171,911	1,311,516	1,318,168	1,220,435	1,202,835	1,258,454
World total (estimate)	32,200,000	33,700,000	35,100,000	36,400,000	38,400,000	39,620,000

1 In addition to countries listed, gold is also produced in Austria, Bulgaria, Czechoslovakia, East Germany, Hungary, Rumania, and Thailand, but production data are not available; estimates are included in total. Figures were derived in part from American Bureau of Metal Statistics. For some countries accurate figures are not possible to obtain owing to clandestine trade in gold (as for example, French West Africa).

2 This table incorporates a number of revisions of data published in previous Gold chapters. Data do not add to totals shown because of rounding where estimated figures are included in detail.

3 Imports into United States.

4 Estimate.

5 Exports.

6 Refinery production. Excludes production of the Philippines.

7 Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.

8 Production is believed to have decreased because of a probable diversion of forced labor into other activities.

9 Data not available; estimate included in total.

10 Includes Ruanda-Urundi.

11 Included is yield from Nkana mine refinery slimes; 1948–52 (average), 1,803 ounces; 1952, 2,503; 1953, 2,820; 1954, 2,470; 1955, 2,203; 1956, 3,243; and 1957, not yet available.

ceived for gold dropped from $34.45 per ounce in 1956 to $33.55 in 1957. This adverse price situation, combined with increased production costs, was partly offset at some mines by milling higher grade ore. Except for a few mines with low costs, straight-gold mines continued to receive cost aid under the Emergency Gold Mine Assistance Act, which was extended through 1960.

Subsidy payments under the Emergency Gold Mining Assistance Act to high cost mines, aggregated over $106 million since the act came into force in 1948 to the end of 1957. The Minister of Mines announced early in 1958 that the Government intended to extend the operation of the act beyond the end of 1958 to the end of 1960.

Ontario continued as the leading gold-producing Province, accounting for 58 percent of the total; Quebec was second, with 23 percent, followed by the Northwest Territories, with 8, and British Columbia, with 5 percent. Lode- and placer-gold mines again furnished 86 percent of the gold output; the remainder was recovered as a byproduct of base-metal ores. No gold mines closed during 1957 and no new mines came into production.

Production of gold in Canada in 1956 and 1957 was distributed as follows:[10]

	Fine ounces	
Province or Territory:	*1956*	*1957*
British Columbia	196, 692	221, 392
Manitoba	120, 232	119, 595
Northwest Territories	352, 669	338, 721
Ontario	2, 513, 910	2, 569, 110
Quebec	1, 036, 059	1, 013, 347
Saskatchewan	82, 687	77, 052
Yukon	72, 001	66, 429
Others[1]	9, 611	12, 704
Total	4, 383, 863	4, 418, 350

[1] Alberta, Nova Scotia, and Newfoundland.

Operating costs were reduced significantly by consolidation of milling facilities of the adjoining Lake Shore and Wright-Hargreaves mines in the Kirkland Lake district. The merging of surface facilities and closer coordination of the operations of the two companies resulted in reducing the production cost of gold.

Colombia.—Gold production in Colombia dropped about 26 percent during 1957 to 325,100 ounces. Most of the output was from placer mines and was recovered by bucketline dredging. The Department of Antioquia accounted for about three-quarters of the total output. A 15-percent export tax imposed by the Colombian Government in 1957 hindered the sale of bullion.

A special statute was drafted for the precious metal industry, under which all gold, silver, and platinum metals are to be sold to the Banco de la Republica, which will become the sole exporter.

Germany, West.—Restrictions on gold trading in West Germany were relaxed further in 1957. German residents were permitted to import gold from countries affiliated with the European Payments Union, provided that payment was made in Bedo marks of limited convertibility. However, gold for industrial uses was still purchased against dollars. Permits to export gold still were required.

India.—India's gold production declined 14 percent in 1957 to 179,200 ounces valued at $10.72 million. Kolar gold mines in Mysore State supplied 92 percent of the total output; the remainder came from the Hutti Gold Mines Co. operations in Mysore. The average price paid for gold was about Rs 285.75 equivalent to $60 per troy ounce.

Philippines.—Output of gold in the Philippines declined 6 percent in 1957 to 380,000 ounces—the lowest output since 1950. However, due to the higher free-market price, the value of the gold produced was 2 percent higher in 1957 than in 1956. The average price on the Manila market was ₱120.24 per ounce, compared with an average of ₱109.76 in 1956, equivalent to $60.12 and $54.88, respectively.

[10] Department of Mines and Technical Surveys, Ottawa, Canada, Gold in Canada, 1957.

The Emergency Gold Mining Assistance Act by which the Central Bank purchased gold from producers at a subsidy price averaging ₱39.07 an ounce above the official price of ₱70.00 expired in July 1957; however, the producers were permitted to sell part of their gold to holders of blocked pesos at the free market price.

Two mines, Benguet and Balatoc, which were under 1 management, furnished over 50 percent of the total gold production. One small mine (Benguet Exploration) was brought into production during the year.

Union of South Africa.—Gold output rose about 7 percent in 1957 to 17 million ounces, the highest ever recorded in the Union and the sixth successive annual increase. As in preceding years since 1953, the 1957 gain reflected increased output from new mines in the Orange Free State, the Klerksdorp district, and the Far Western Rand in the Transvaal.

Working profits from gold increased from £48.5 million to £57.8 million, and average grade increased from 4.5 dwts. to 5.0 dwts. per ton milled. Three mines closed during the year bringing the total number of working mines to 54. The improvement in grade reflected both higher grade ore and more extensive sorting.

A historical review of the South African gold mining industry published in a trade journal [11] traced the growth and development of the industry and the financial organizations that brought about the remarkable record of production over 73 years.

Some of the older marginal mines on the Witwatersrand, where the cost of producing gold is close to the price realized for it, were expected to close in 1958, as their ore reserves will be exhausted.

TABLE 18.—Salient statistics of gold mining in the Union of South Africa, 1948–52 (average) and 1953–57

[Transvaal Chamber of Mines]

	1948–52 (average)	1953	1954	1955	1956	1957
Ore milled (tons)	58,165,650	58,772,000	62,534,500	65,950,700	67,524,700	66,114,400
Gold recovered (fine ounces)[1]	11,656,346	11,440,830	12,682,328	14,093,668	15,373,680	16,540,817
Gold recovered (dwt. per ton)	3.847	3.893	4.068	4.274	4.553	5.000
Working revenue (gold) £	[2] 125,010,806	142,198,156	158,630,787	177,414,094	193,214,230	207,705,565
Working revenue per ton milled	42s. 11d.	48s. 5d.	50s. 11d.	53s. 10d.	57s. 3d.	62s. 10d.
Working cost £	86,605,617	107,306,956	120,435,001	133,161,104	144,763,823	149,871,972
Working cost per ton	29s. 9d.	36s. 6d.	38s. 8d.	40s. 5d.	42s. 11d.	45s. 4d.
Working cost per ounce of gold	155s. 1d.	187s. 7d.	189s. 11d.	189s. 0d.	188s. 4d.	181s. 3d.
Estimated working profit from gold £	38,435,591	34,891,200	38,195,786	44,252,990	48,450,407	57,833,593
Estimated working profit per ton from gold	13s. 2d.	11s. 11d.	12s. 3d.	13s. 5d.	14s. 4d.	17s. 6d.
Premium gold sales £	----------	1,934,421	12,999	233,942	882,368	----------
Uranium and thorium exports £	----------	3,873,029	14,835,344	29,959,589	38,571,195	49,859,496
Estimated uranium profits £	----------	1,828,067	8,105,744	17,558,208	24,662,054	53,308,195
Dividends £	19,621,153	18,994,307	19,127,166	22,361,887	28,177,343	36,699,373

[1] Excludes gold produced by nonmembers of Chambers of Mines.
[2] 1 £ valued at $4.03 (approx. average) from Jan. 1, 1948, to Sept. 19, 1949; after that date, 1 £ valued at $2.80.

[11] Waspe, L. A., The South African Mining Industry and the Growth of Finance Institutions–II: Mining Mag. (London), vol. 97, No. 5, November 1957, pp. 273–277.

TECHNOLOGY

Methods of reducing gold losses in cyanide mills treating ores containing mercury and the chemical effects of using mercury salts in cyanide solutions to improve recovery were discussed in a technical journal [12] and some practical suggestions made to increase efficiency.

The adoption of FluoSolids roasting combined with flotation, cyanidation, and tailings-scavenging treatment of a refractory arsenical gold ore made it possible to operate profitably at a Southern Rhodesia mine. Metallurgical techniques and equipment used in developing the treatment process were described and detailed technical and cost data given.[13]

Gold Plating without electrodes was accomplished with Baker & Company's Atomex process, by which 24-carat gold can be deposited by ionic displacement on metals and alloys, such as copper, steel, diecast metals, and nickel. The base metals, under chemical attack by the electrolyte, sheds atoms and dissolves into the electrolyte, while gold atoms come out of solution and plate onto the base-metal surface. The deposits were reported to be unusually dense and uniform.[14]

New developments in research by the Atomic Energy Commission Oak Ridge Laboratories on the transmutation of gold into mercury by neutron bombardment indicate possible important commercial uses of the isotope produced—mercury 198—in such scientific equipment as supersensitive measuring instruments and superior optical devices. A patent was issued for a method of recovering gold [15] and other minerals from colloidal clays by spraying the material with an alkaline solution, such as a complex phosphate or a mixture of crude tannic acid and hydrated lime or caustic soda to disperse sticky hydrophilic clay and enable effective recovery of minerals.

A patent was issued for an improved method of electrolytically depositing gold by subjecting an aqueous solution containing an alkali metal-gold-cyanide complex to electrolysis in the presence of a buffer sufficient to maintain a pH of 6.5 to 7.5 during electrolytic deposition.[16] A method was developed for removing gold and silver cyanides from adsorption on certain ion-exchange resins [17] by treatment with an eluting solution of a complex base-metal cyanide. A new brazing alloy composed of 60 percent gold, 35 percent copper, and 5 percent indium was developed for use under conditions of elevated temperature and high vacuum.[18]

Several other significant articles pertaining to the technology of gold were published in 1957.[19]

[12] Allingham, John, How to Reduce Gold Losses in Cyanide Mills: Eng. Min. Jour., vol. 158, No. 6, June 1957, pp. 101–102.

[13] Rabone, Philip, How FluoSolids Roasting Aids Gold Recovery at Dalny Mine: Eng. and Min. Jour., vol. 158, No. 5, May 1957, pp. 98–104.

[14] E&MJ Metal and Mineral Markets, vol. 28, No. 38, Sept. 19, 1957, p. 7.

[15] Morrison, R. P., Method and Apparatus for Recovering Valuable Minerals: U. S. Patent 2,801,003, July 30, 1957.

[16] Pforzheim, Fritz Volk (assigned to Birle & Co.), Electrolytic Deposition of Gold and Gold Alloys: U. S. Patent 2,812,299, Nov. 5, 1957.

[17] Hazen, Wayne C., Methods of Eluting Adsorbed Complex Cyanides of Gold and Silver: U. S. Patent 2,810,638, Oct. 22, 1957.

[18] Hack, Walter L. (assigned to Western Gold & Platinum Co.), Gold-copper-Indium Brazing Alloy: U. S. Patent 2,813,790, Nov. 19, 1957.

[19] Findlay, R. E., Sill Pillar Recovery at Aunor: Canadian Min. and Met. Bull., vol. 50, No. 546, October 1957, pp. 626–628.

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Graphite

By Donald R. Irving[1] and Betty Ann Brett[2]

AN ALLTIME high was recorded for world production of natural graphite in 1957 because the output of amorphous graphite in the Republic of Korea increased sharply. Most other countries produced about the same or moderately less than in 1956.

Late in 1957, General Services Administration sold, at public auction, the Government-owned Benjamin Franklin graphite mine and mill near Chester Springs, Pa. When national stockpile objectives for all grades of graphite were complete, the Department of Defense ruled that there was no need to retain the property in the National Industrial Reserve.

Also, during 1957 Crescent Carbon Corp. began to produce manufactured (artificial) graphite at Rosamond, Calif.—the first such plant west of Tennessee.

TABLE 1.—Salient statistics of graphite in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Natural graphite consumed:						
Short tons	24,600	34,900	33,000	45,200	40,400	41,000
Value	$3,451,600	$4,779,000	$4,386,800	$6,289,400	$5,920,300	$5,568,000
Imports:						
Short tons	45,000	51,300	40,800	48,800	47,900	41,500
Value	$2,251,500	$2,809,200	$2,281,300	$2,386,600	$2,593,700	$2,106,800
Exports:						
Short tons	1,400	1,800	800	1,400	1,100	1,300
Value	$173,500	$200,100	$105,600	$199,400	$159,800	$225,500
World: Production (estimated):						
Short tons	195,000	200,000	185,000	290,000	270,000	320,000

DOMESTIC PRODUCTION

Southwestern Graphite Co., Burnet, Tex., continued to be the only producer of crystalline flake graphite in North America in 1957. Graphite Mines, Inc., Cranston, R. I., was the only producer of amorphous graphite in the United States.

The output of manufactured (artificial) graphite powder and products came from plants of the following companies: National Carbon Co., Division of Union Carbide Corp. (formerly Union Carbide & Carbon Corp.), Niagara Falls, N. Y., Clarksburg, W. Va., and Columbia, Tenn.; Great Lakes Carbon Corp., Niagara Falls, N. Y., and Morganton, N. C.; International Graphite & Electrode Division, Speer

[1] Assistant chief, Branch of Ceramic and Fertilizer Materials.
[2] Statistical clerk.

Carbon Co., St. Marys, Pa., and Niagara Falls, N. Y.; Stackpole Carbon Co., St. Marys, Pa.; and Crescent Carbon Corp., Rosamond, Calif. The Dow Chemical Co. produced graphite electrodes for its own use at Midland, Mich.

TABLE 2.—Production and shipments of natural graphite in the United States, 1948–52 (average) and 1953–57

Year	Production (short tons)	Shipments	
		Short tons	Value
1948–52 (average)	6,779	6,516	$543,997
1953	6,281	4,850	488,008
1954–57	(1)	(1)	(1)

[1] Figures withheld to avoid disclosing individual company confidential data.

CONSUMPTION AND USES

In 1957 domestic consumption of natural graphite increased 2 percent in quantity but decreased 6 percent in value compared with 1956. Greater quantities were consumed only for bearings (22 percent) and foundry facings (17 percent). Steelmaking, lubricants, and brake linings consumed virtually the same quantity as in 1956. Other uses decreased from 14 to 46 percent.

TABLE 3.—Consumption of natural graphite in the United States, 1948–52 (average) and 1953–57

Year	Consumption		Year	Consumption	
	Short tons	Value		Short tons	Value
1948–52 (average)	24,636	$3,451,586	1955	45,245	$6,289,416
1953	34,884	4,778,981	1956	40,401	5,920,298
1954	33,038	4,386,760	1957	41,029	5,567,952

TABLE 4.—Consumption of natural graphite in the United States in 1957, by uses

Use	Crystalline flake		Ceylon amorphous		Other amorphous [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Batteries	80	$26,282			1,266	$87,235	1,346	$113,517
Bearings	6	3,615	61	$33,957	57	16,565	124	54,137
Brake linings	363	148,310	251	69,836	157	55,163	771	273,309
Carbon brushes	141	60,482	331	171,313	150	19,742	622	251,537
Crucibles, retorts, stoppers, sleeves, and nozzles	3,136	621,208	27	5,712	5	605	3,168	627,525
Foundry facings	423	66,402	372	64,916	15,645	1,125,797	16,440	1,257,115
Lubricants	2,731	618,302	2,137	423,514	2,557	313,442	7,425	1,355,258
Packings	212	114,165	49	25,226	112	20,511	373	159,902
Paints and polishes	3	789	9	1,680	406	47,614	418	50,083
Pencils	265	101,759	576	200,850	778	113,815	1,619	416,424
Rubber	14	4,372	1	643	97	12,351	112	17,366
Steelmaking	293	48,356	1	750	7,983	763,891	8,277	812,997
Other [2]	114	38,250	58	41,501	162	99,031	334	178,782
Total	7,781	1,852,292	3,873	1,039,898	29,375	2,675,762	41,029	5,567,952

[1] Includes small quantity of mixtures of natural and manufactured graphite.
[2] Includes adhesives, carbon resistors, catalyst manufacture, chemical equipment and processes, copper refining, electrodes, electronic products, insulation, plastics, powdered metal parts, refractory materials, roofing granules, specialties, and other uses not specified.

PRICES

Quoted prices for graphite merely indicate the range of prices; actual prices are negotiated between buyer and seller on the basis of a wide range of specifications.

Quotations in E&MJ Metal and Mineral Markets were as follows per pound, carlots, f. o. b. shipping point (United States): Crystalline flake, natural, 85–88 percent carbon, crucible grade, 13 cents; 96 percent carbon, special and dry usage, 22 cents; 94 percent carbon, normal and wire drawing, 19 cents; 98 percent carbon, special for brushes, etc., 26½ cents. Amorphous, natural, for foundry facings, etc., up to 85 percent carbon, 9 cents: Madagascar, c. i. f. New York, "standard grades, 85–88 percent carbon," $235 per short ton; special mesh, $260; special grade, 99 percent carbon, nominal. All of these prices remained unchanged during the year. The quotation for Mexican amorphous graphite, f. o. b. point of shipment, per metric ton, was $9 to $18 until December 5, when it was increased to $12 to $18.

FOREIGN TRADE [3]

Graphite imports for consumption in the United States decreased 13 percent in quantity and 19 percent in value in 1957, compared with 1956. Of the major suppliers, Hong Kong (39 percent) and Norway (38 percent) reported quantity increases and Madagascar and West Germany (26 percent each), Ceylon (17 percent), and Mexico (16 percent) quantity decreases. Small quantities were imported from Denmark, India, and Turkey in 1957 but not in 1956.

Total exports of natural graphite, 1953–55, were: 1953, 1,760 tons, $200,110; 1954, 798 tons, $105,598; 1955, 1,394 tons, $199,383.

TABLE 5.—Graphite (natural and artificial) imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

	Crystalline				Amorphous				Total	
	Flake		Lump, chip, or dust		Natural		Artificial			
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	6,192	$863,680	258	$31,576	38,407	$1,347,474	154	$8,798	45,011	$2,251,528
1953	10,579	1,608,960	79	7,958	40,382	1,176,613	283	15,647	51,323	2,809,178
1954	8,464	1,198,665	653	100,191	31,510	970,771	212	[1] 11,629	40,839	[1] 2,281,256
1955	7,706	1,018,600	195	28,703	40,663	1,328,197	236	11,130	48,800	2,386,630
1956										
North America:										
Canada	------	--------	------	--------	229	10,847	50	1,012	279	11,859
Mexico	------	--------	------	--------	30,866	648,395	------	--------	30,866	648,395
Total	------	--------	------	--------	31,095	659,242	50	1,012	31,145	660,254

See footnote at end of table.

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

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TABLE 5.—Graphite (natural and artificial) imported for consumption in the United States, 1948–52(average) and 1953–57—Continued

	Crystalline				Amorphous				Total	
	Flake		Lump, chip, or dust		Natural		Artificial			
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1956—Continued										
Europe:										
Austria	-	-	-	-	1	$252	-	-	1	$252
France	48	$19,741	-	-	2	915	-	-	50	20,656
Germany, West	530	96,242	132	$30,295	1,026	121,084	-	-	1,688	247,621
Italy	33	5,909	-	-	-	-	3	$980	36	6,889
Norway	-	-	-	-	1,814	154,338	27	2,455	1,841	156,793
Switzerland	-	-	-	-	-	-	3	980	3	980
Total	611	121,892	132	30,295	2,843	276,589	33	4,415	3,619	433,191
Asia:										
Ceylon	-	-	39	4,412	3,964	562,321	-	-	4,003	566,733
Hong Kong	-	-	-	-	2,386	51,464	-	-	2,386	51,464
Total	-	-	39	4,412	6,350	613,785	-	-	6,389	618,197
Africa:										
British East Africa	61	9,915	-	-	82	6,212	-	-	143	16,127
Madagascar	6,564	861,859	-	-	-	-	-	-	6,564	861,859
Madeira Islands	28	4,080	-	-	-	-	-	-	28	4,080
Total	6,653	875,854	-	-	82	6,212	-	-	6,735	882,066
Grand total, 1956	7,264	997,746	171	34,707	40,370	[1]1,555,828	83	5,427	47,888	[1]2,593,708
1957										
North America:										
Canada	-	-	-	-	-	-	3	263	3	263
Mexico	-	-	-	-	25,789	562,836	-	-	25,789	562,836
Total	-	-	-	-	25,789	562,836	3	263	25,792	563,099
Europe:										
Denmark	-	-	-	-	110	9,757	-	-	110	9,757
France	43	18,408	-	-	-	-	-	-	43	18,408
Germany, West	332	64,052	19	10,814	904	112,584	-	-	1,255	187,450
Italy	-	-	-	-	-	-	5	1,934	5	1,934
Norway	-	-	-	-	2,538	210,086	-	-	2,538	210,086
Total	375	82,460	19	10,814	3,552	332,427	5	1,934	3,951	427,635
Asia:										
Ceylon	-	-	28	4,056	3,304	476,579	-	-	3,332	480,635
Hong Kong	-	-	-	-	3,318	72,059	-	-	3,318	72,059
India	-	-	-	-	56	9,150	-	-	56	9,150
Turkey	55	7,161	-	-	-	-	-	-	55	7,161
Total	55	7,161	28	4,056	6,678	557,788	-	-	6,761	569,005
Africa:										
British East Africa	168	19,081	-	-	-	-	-	-	168	19,081
Madagascar	4,858	527,982	-	-	-	-	-	-	4,858	527,982
Total	5,026	547,063	-	-	-	-	-	-	5,026	547,063
Grand total, 1957	5,456	636,684	47	14,870	36,019	1,453,051	8	2,197	41,530	2,106,802

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable to earlier years.

TABLE 6.—Graphite exported from the United States, 1956–57, by countries of destination

[Bureau of the Census]

Country	Amorphous		Crystalline flake, lump, or chip		Natural, n. e. c.	
	Short tons	Value	Short tons	Value	Short tons	Value
1956						
North America:						
Canada	546	$49,223	21	$13,258	36	$4,828
Cuba			14	2,316		
Mexico	10	1,150	8	3,966	12	3,425
Total	556	50,373	43	19,540	48	8,253
South America:						
Brazil					1	580
Colombia			11	2,666		
Ecuador			10	1,900		
Venezuela			1	1,360		
Total			22	5,926	1	580
Europe:						
Belgium-Luxembourg			2	980		
Denmark			2	1,240	11	1,813
France	11	2,750				
Netherlands			(1)	549		
Switzerland	8	1,311				
United Kingdom	205	32,532			23	3,544
Total	224	36,593	4	2,769	34	5,357
Asia:						
India			3	1,935	34	5,493
Pakistan			75	16,500		
Philippines	10	2,590			4	1,294
Total	10	2,590	78	18,435	38	6,787
Africa:						
Egypt					(1)	1,145
Libya					4	1,444
Total					4	2,589
Grand total, 1956	790	89,556	147	46,670	125	23,566
1957						
North America:						
Canada	706	62,884	66	26,964	109	14,910
Cuba			30	7,775	11	1,700
Mexico	20	2,000	17	7,530		
Total	726	64,884	113	42,269	120	16,610
South America:						
Chile			4	2,498		
Colombia			5	2,771	19	4,109
Peru			1	754	(1)	140
Venezuela	7	1,282	10	2,500	64	14,470
Total	7	1,282	20	8,523	83	18,719
Europe:						
Denmark	11	1,813				
France	6	1,400				
Netherlands			(1)	630		
United Kingdom	128	20,005			18	2,804
Total	145	23,218	(1)	630	18	2,804
Asia:						
India	8	1,318	4	1,140	28	6,807
Japan					1	1,746
Philippines	16	2,763	30	4,600		
Taiwan					30	28,223
Total	24	4,081	34	5,740	59	36,776
Grand total, 1957	902	93,465	167	57,162	280	74,909

[1] Less than 1 ton.

WORLD REVIEW

World production of natural graphite, at an alltime high of 320,000 short tons in 1957, exceeded the previous record 299,000 tons for 1943, because the output reported from the Republic of Korea increased 142 percent. During 1957 exportation of anthracite from the Republic of Korea was banned, but exportation of amorphous graphite was permitted; and it appeared likely, as reported in the Korean press, that sizable quantities of anthracite were exported as "amorphous graphite."

Production in most other countries remained about the same or decreased moderately.

TABLE 7.—World production of natural graphite, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	2,376	3,466	2,463			
Mexico	31,115	33,433	24,013	32,342	32,655	25,938
United States	6,779	6,281	(3)	(3)	(3)	(3)
South America:						
Argentina	[4] 330	(5)	(5)	2	572	[4] 550
Brazil	752	648	1,008	855	579	[4] 550
Europe:						
Austria	15,182	16,185	19,184	19,637	20,597	20,860
Czechoslovakia	[4] 16,500	(5)	(5)	(5)	(5)	(5)
Germany, West	8,210	8,222	10,448	11,556	12,878	[4] 13,200
Italy	5,581	5,731	4,165	2,595	3,262	3,649
Norway	2,948	3,255	3,993	5,970	5,562	[4] 5,500
Spain	411	352	451	349	331	304
Sweden	39			309	440	[4] 440
U. S. S. R.	(5)	(5)	(5)	(5)	(5)	[4] 50,000
Yugoslavia	151			1,033		
Asia:						
Ceylon (exports)	13,293	8,084	8,655	11,064	10,312	9,172
Hong Kong		220	2,061	1,722	2,734	3,703
India	1,812	859	1,657	1,807	[4] 1,650	[4] 1,650
Japan	6,242	4,488	4,515	3,441	3,757	5,278
Korea, Republic of	24,520	21,416	15,344	99,228	67,367	162,703
Taiwan (Formosa)	154				2,285	(5)
Africa:						
Egypt	11					
Kenya	8	205	347	241	619	1,056
Madagascar	14,915	14,847	13,284	17,443	17,451	[4] 17,600
Morocco:						
Northern Zone	13			129	137	
Southern Zone	130	108				
Mozambique	97					
South-West Africa	2,002		115	1,011		
Tanganyika	6	21			26	
Union of South Africa	266	413	1,396	1,829	1,862	1,750
Oceania: Australia	140	17	78	24	11	(5)
World total (estimate) [1 2]	195,000	200,000	185,000	290,000	270,000	320,000

[1] In addition to countries listed, graphite has been produced in China and North Korea, but production data are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Graphite chapters. Data do not add to totals shown, owing to rounding where estimated figures are included in the detail.
[3] Production included in total; Bureau of Mines not at liberty to publish.
[4] Estimate.
[5] Data not available; estimate by senior author of chapter included in total.

Austria.—In 1956, 74 percent of the graphite produced was exported. Major countries of destination, in descending order of importance, were West Germany, Italy, Belgium, Poland, Switzerland, Yugoslavia, and France.[4]

[4] Engineering and Mining Journal, Austria: Vol. 158, No. 8, August 1957, p. 214.

Brazil.—The Compagnie de Produits Chimiques et Électrométallurgiques, Paris, and Industrias Reunidas Francisco Matarazzo Co. announced plans for building a plant to produce 4,000 tons of graphite electrodes a year. The proposed plant would be the first manufactured-graphite plant in Brazil.[5]

Ceylon.—The number of mines producing graphite at the end of 1956 was 34, compared with 44 at the end of 1955.[6]

TABLE 8.—Graphite exported from Ceylon, 1953–57, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
North America:					
Canada	112	196	453	207	185
United States	1,938	2,054	4,234	3,782	3,175
Europe:					
France	83	163	198	207	160
Germany, West	77	20	95	110	348
Italy		8	8	8	7
Netherlands		11	40	11	34
United Kingdom	3,429	4,172	3,624	3,076	1,698
Asia:					
Hong Kong		8	7	9	2
India	417	274	535	422	385
Japan	1,588	1,219	1,306	2,237	2,759
Pakistan		91	118	87	99
Thailand	9				11
Oceania: Australia	303	437	444	385	360
Other countries	128	1	2		
Total	8,084	8,654	11,064	10,541	9,223

[1] Compiled from Ceylon Customs Returns.
[2] This table incorporates a number of revisions of data published in previous Graphite chapters.

TABLE 9.—Exports of graphite from Ceylon to the United States, by grades, 1957[1]

Grade	Short tons	Percent of total	Value per ton
97 percent C or higher	1,383	43.6	$161.56
90–96 percent C	1,618	51.1	128.36
Less than 90 percent C	168	5.3	100.00
Total	3,169	100.0	141.34

[1] U. S. Embassy, Colombo, Ceylon, State Department Dispatch 38: July 15, 1957, 2 pp.; Dispatch 73, July 25, 1957, 2 pp.; Dispatch 360, Oct. 18, 1957, 2 pp.; Dispatch 667, Jan. 21, 1958, 2 pp.

Egypt.—Graphite was discovered at Baremia, near Jebel Abu Selim. Other deposits are in the Bint Abu Garria district and in the Wadi Sitra zone at Um Gheig.[7]

Korea, Republic of.—United Nations Korean Reconstruction Agency (UNKRA) announced plans to finance construction of a modern graphite mill at the Sihung graphite mine in Kyonggi Do. The mill will have a capacity of 2,400 tons of crystalline graphite a year and will supplement production from the existing mill, which has a capacity of 800 tons a year. Deposits at Sihung contain an estimated 20 million tons of ore.[8]

[5] Chemical Week, Graphite/Brazil: Vol. 80, No. 26, June 29, 1957, p. 26.
[6] Industrial and Mining Standard (Melbourne), Mining in Ceylon in 1956: Vol. 112, No. 2839, Aug. 1. 1957, p. 14.
[7] U. S. Embassy, Cairo, Egypt, State Department Dispatch 632: Dec. 21, 1957, enclosure 2, p. 23.
[8] Mining World, Korea: Vol. 19, No. 3, March 1957, p. 112.

Companies exporting graphite included the following:[9]

Choong-ku, Seoul, Korea

Dongchang Commercial Co., Ltd., 51–2, 1–ka, Choongmu-ro.
Dongseong Moolsan Co., Ltd., 34, 1-ka, Myung-dong.
Kumjeng Industrial Co., Ltd., 40, 1-ka, Wheihyun-dong.
Kumsaing Trading Co., Ltd., 95, 3-ka, Namdaemun-ro.
Samduk Trading Co., Ltd., Dong Shin Bldg., 70, Sokong-dong.
Sekai Mulsan Co., Ltd., 82–13, 2-ka, Myung-dong.
Sungha Commercial Co., Ltd., 51, 1-ka, Choongmu-ro.
Washin Industrial Co., Ltd., 187, 1-ka, Sinmun-ro.

Pusan, Korea

Dongan Moolsan Co., Ltd., 20, 2-ka, Taikyo-ro.

Madagascar.—The ratio of coarse flake (flake) to fine flake (fines) produced in Madagascar continued to decline and was 54:46 in the first 9 months of 1957 compared with 60:40 in 1956 and 66:34 in 1955.[10]

TABLE 10.—Exports of graphite from Madagascar, 1952–56, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1952	1953	1954	1955	1956
North America: United States	8,236	10,152	8,465	7,510	6,300
Europe:					
Belgium-Luxembourg	149	39	(3)	44	(3)
France	4,055	2,457	2,862	7,837	5,505
Germany, West	42	72	63	476	995
Italy	2,441	797	661	1,099	2,199
Netherlands				20	
United Kingdom	3,983	1,272	1,675	1,312	1,278
Asia: Japan	110	110	27	(3)	(3)
Oceania: Australia	220	99	55	160	(3)
Other countries	31	2	235	30	700
Total	19,267	15,000	14,043	18,488	16,977

[1] Compiled from Customs Returns of Madagascar.
[2] This table incorporates a number of revisions of data published in previous Graphite chapters.
[3] Data not available.

Mexico.—A graphite electrode plant, being built near Monterrey by Electrodos Nacionales, S. A., an affiliate of Union Carbide Corp., New York, N. Y., was scheduled to begin production in 1958. The plant was to supply electrodes to the electric-furnace steel, ferroalloy, and electrochemical industries, as well as provide manufactured-graphite materials essential to the nuclear-power development of Mexico. It was anticipated that part of the output would be exported.[11]

Sweden.—According to a press announcement of December 12, 1957, the Norrbottems Järnverk AB (the Government-owned steel mill at Lulea) and the Institute of Technology, Stockholm, were investigating the possibility of recovering graphite from large deposits

[9] U. S. Embassy, Seoul, Korea, State Department Dispatch 481: Jan. 28, 1958, 5 pp.
[10] U. S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 1: July 2, 1957, p. 1; Dispatch 54, Sept. 19, 1957, p. 1; Dispatch 161, Jan. 23, 1958, p. 1.
[11] Engineering and Mining Journal, Union Carbide Plans Mexican Graphite Plant: Vol. 158, No. 11, November 1957, p. 158.

of graphite-bearing shales in Lapland. It was estimated that Lapland shale deposits contain 70 to 80 million tons of crude graphite.[12]

Tanganyika.—Discovery of a deposit of good-quality graphite was reported near Masasi in the Southern Province.[13]

United Kingdom.—Anglo-Great Lakes Corp., Ltd., organized by the Electrode Division of Great Lakes Carbon Corp., New York, N. Y., and four British companies, began constructing a plant at Newcastle, England, to produce manufactured graphite for nuclear and other commercial applications. The plant was to have an initial capacity of 15,000 long tons a year and was scheduled for production in late 1958.[14]

TECHNOLOGY

Graphite occurrences in California,[15] Canada,[16] Hong Kong,[17] and India [18] were noted, and several articles on the beneficiation of graphite ores were published.[19]

A bibliography of methods of purifying graphite, covering 1926 to 1955, was published in 1957.[20]

The covering capacity, particle thickness, and specific surface of natural graphite samples from different sources and in particle-size ranges usually used in crucible manufacture were determined.[21] The influence of the graphite-silicon carbide ratio, effect of varying proportions of fire-clay grog, and conditions for binder carbonization in manufacturing carbon-bonded graphite crucibles were discussed and two suitable body compositions were suggested.[22]

The lubricating properties of graphite in reactors [23] and internal-combustion motors were described.[24]

The Society of Chemical Industry (London) sponsored a conference on "Industrial Carbon and Graphite," attended by delegates from Australia, France, Germany, Italy, Japan, Netherlands, Norway,

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[12] U. S. Embassy, Stockholm, Sweden, State Department Dispatch 674: Dec. 13, 1957, p. 1.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 30.
[14] Chemical Engineering Progress, vol. 53, No. 1, January 1957, p. 120.
[15] Oakeshott, G. B., Graphite: Chap. in Mineral Commodities of Calif., California Div. Mines Bull. 176, 1957, pp. 227–229.
[16] Geological Survey of Canada, Geological and Economic Minerals of Canada: Dept. Mines and Tech. Surveys, Econ. Geol., Ser. 1, 4th ed. (Ottawa), 1957, pp. 120, 439.
[17] Ruxton, B. P., Graphite Seams in Hong Kong: Colonial Geol. and Miner. Res. (London), vol. 6, No. 4, 1957, pp. 429–441.
[18] Majumdar, K. K., India's Industrial Minerals: Indian Min. Jour. (Calcutta), vol. 5, No. 2, February 1957, pp. 5–8.
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[19] Deco Trefoil, Flowsheet Study, Recovery of Graphite: Vol. 21, No. 4, July–August 1957, pp. 15–16.
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[21] Marathe, B. R., and Joglekar, G. D., Measurement of the Specific Surface and Covering Capacity of Graphite Powders: Jour. Sci. Ind. Res. (New Delhi, India), vol. 16A, No. 1, January 1957, pp. 23–28.
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[23] Braithwaite, E. R., Graphite and Molybdenum Disulphide: Nuclear Eng. (London), vol. 2, No. 12, March 1957, pp. 107–110.
[24] Augustin, J. U., and D'Ans, A. M., [Colloidal Graphite and Its Effect on Friction and Lubrication, Especially in Internal Combustion Motors]: Ztschr. Ver. deut. Ing. (Düsseldorf, Germany), vol. 99, March 1957, pp. 274–279; May 1957, pp. 624–632; Battelle Tech. Rev., vol. 6, No. 6, June 1957, p. 394a; No. 9, September 1957, p. 615a.

Poland, Sweden, United States, and U. S. S. R., in addition to the United Kingdom. The use of manufactured graphite in nuclear-energy applications heightened interest in the proceedings. A total of 66 papers was given in groups, covering the following topics: Physical properties, manufacture, crystal structure, surface chemical properties and reactivity, electrical behavior and applications, graphite in the nuclear-power industry, and mechanical, chemical, and metallurgical applications.[25]

Manufactured graphite has been widely used in nuclear reactors since the beginning of the atomic-energy program.[26] By far the major atomic-energy use has been as a neutron moderator, but manufactured graphite also has been used or proposed for tubes to contain reactor coolants, neutron filters and attenuators for experimental purposes, and containers for irradiating samples of materials.

Graphite molds and crucibles, with high alumina and magnesia coatings, are employed in casting and melting uranium and uranium alloys.[27] The performance of graphite parts was said to be improved by a new technique for placing a hard, refractory, wear-resistant coating on machined graphite parts.[28]

A manufactured graphite body bonded by silicon carbide, with physical properties superior to graphite alone, was developed.[29]

A statistical analysis was made of the effect of electrode length, diameter, and surface area on graphite-electrode consumption in electric-arc furnaces.[30]

Interest in manufactured graphite for use in nuclear and missile applications resulted in publication of a large number of technical papers on its properties.[31]

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[25] Chemistry and Industry (London), S. C. I. Conference on Industrial Carbon and Graphite: No. 44, Nov. 2, 1957, pp. 1442–1447.

[26] Fletcher, J. F., and Snyder, W. A., Use of Graphite in the Atomic-Energy Program: Bull. Am. Ceram. Soc., vol. 36, No. 3, March 1957, pp. 101–104.

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[34] Hummers, W. S., Jr. (assigned to National Lead Co.), Preparation of Graphitic Acid: U. S. Patent 2,79[illegible],878, July 9, 1957.

graphite in packings,[35] in a protective coating for salt-bath brazing,[36] in electrically conductive coating compositions,[37] and to reduce the octane requirement in internal-combustion engines.[38] Patents were issued for preparing impervious manufactured graphite,[39] and its use in making a magnetic sound tape.[40]

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Gypsum

By Leonard P. Larson [1] and Nan C. Jensen [2]

PARALLELING the reduced level of residential construction, the domestic gypsum industry during 1957 experienced a further decline in production.

TABLE 1.—Salient statistics of the gypsum industry in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Active establishments [1]	89	94	86	83	88	84
Crude gypsum: [2]						
Mined .... short tons	7,827,222	8,292,876	8,995,960	10,683,733	10,316,483	9,194,580
Imported .... do	3,039,330	3,184,292	3,368,133	3,977,105	[3] 4,346,135	4,334,467
Apparent supply ... do	10,866,552	11,477,168	12,364,093	14,660,838	[3] 14,662,618	13,529,047
Calcined gypsum produced:						
Short tons	6,736,185	7,166,005	7,617,617	8,848,029	8,608,378	7,801,050
Value	$55,907,448	$66,668,981	$76,170,562	$88,575,600	$91,335,989	$83,454,677
Gypsum products sold: [4]						
Uncalcined uses:						
Short tons	2,334,062	2,656,446	2,745,571	2,938,108	3,259,312	3,138,786
Value	$8,399,326	$9,844,330	$10,592,392	$11,435,694	$13,173,189	$13,120,432
Industrial uses:						
Short tons	247,646	254,148	250,088	299,119	334,382	318,642
Value	$4,458,249	$5,260,875	$5,383,874	$6,337,055	$7,309,336	$6,998,102
Building uses:						
Value	$187,353,699	$229,948,261	$256,176,655	$301,550,728	$301,169,171	$280,976,226
Total value	$200,211,274	$245,053,466	$272,152,921	$319,323,477	$321,651,696	$301,094,760
Gypsum and gypsum products:						
Imported for consumption	$3,411,814	$4,792,191	[5] $5,377,710	[5] $7,275,615	[5] $8,546,119	$8,514,497
Exported	$1,420,086	$1,993,671	$1,600,477	$1,348,068	$1,214,847	$1,344,053

[1] Each mine, plant, or combination mine and plant is counted as 1 establishment.
[2] Excludes byproduct gypsum.
[3] Revised figure.
[4] Made from domestic, imported, and byproduct gypsum.
[5] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with previous years.

DOMESTIC PRODUCTION

Crude.—The rate of output of domestically mined crude gypsum reached a 3-year low when production declined to 2 million short tons in the first quarter of 1957. This tonnage was 23 percent below the first-quarter figure for 1956 and 15 percent below that for 1955. During the second and third quarters the output of crude gypsum increased steadily, with production in the third quarter exceeding the output

[1] Commodity specialist.
[2] Supervisory statistical assistant.

in the corresponding period of the previous year. The output of crude gypsum for the year totaled 9.2 million short tons—11 percent below 1956. Compared with 1956, nearly all States reported lower production. The five leading States mining crude gypsum were California, Iowa, Michigan, New York, and Texas; together they furnished about 62 percent of the United States total. Mining was discontinued at 3 mines in Colorado and 1 each in Arizona and Wyoming; 2 properties

TABLE 2.—Crude gypsum mined in the United States, 1956–57, by States

State	1956			1957		
	Active mines	Short tons	Value	Active mines	Short tons	Value
Arizona	3	95,666	$366,115	(1)	(1)	(1)
California	12	1,399,390	3,401,606	12	1,268,021	$2,995,106
Colorado	6	88,026	352,761	(1)	(1)	(1)
Iowa	4	1,177,488	3,919,032	4	1,123,468	3,773,251
Louisiana	1	275,984	598,000	(1)	(1)	(1)
Michigan	4	1,715,832	5,861,152	4	1,385,952	4,822,810
Nevada	3	790,356	2,700,708	(1)	(1)	(1)
New York	5	1,140,187	4,817,353	5	863,963	3,749,243
South Dakota	1	15,794	63,176	1	13,303	53,212
Texas	5	1,156,956	3,623,005	7	1,043,236	3,343,217
Washington	(1)	(1)	(1)	1	6,000	18,000
Wyoming	2	11,380	45,521	(1)	(1)	(1)
Other States [2]	17	2,449,424	8,351,016	27	3,490,637	11,116,607
Total	63	10,316,483	34,099,445	61	9,194,580	29,871,446

[1] Included with "Other States."
[2] Includes the following States to avoid disclosing individual company confidential data: Arkansas, Idaho (1957 only), Louisiana (1957), Virginia, Washington (1956), and Wyoming (1957), 1 mine each; Arizona (1957), Indiana, Kansas, Montana, Ohio, and Utah, 2 mines each; Colorado (1957) and Nevada (1957), 3 mines each; and Oklahoma, 4 mines.

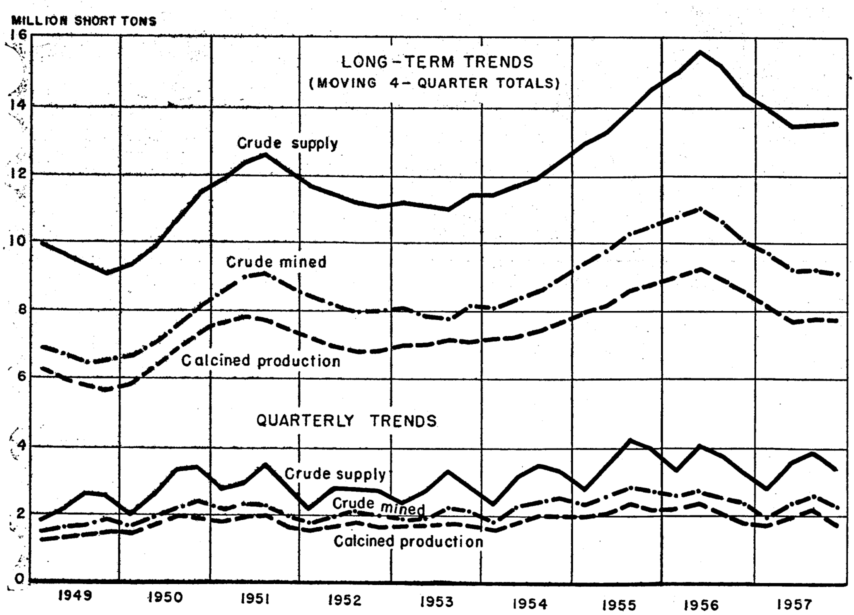

FIGURE 1.—Trends of new crude supply, domestic crude mined, and production of calcined gypsum, 1949–57, by quarters.

were opened in Texas and 1 in Idaho. Of the 61 mines producing in 1957, 43 were open pit, 15 underground, and 3 combinations of the 2 types.

Calcined.—Production of calcined gypsum from domestic and imported ores in 1957 dropped 9 percent below kettle and kiln output in 1956. Calcined gypsum was produced from domestic and imported ore by 57 plants having 210 kettles and 63 pieces of other calcining equipment. Oil, natural gas, propane, and coal were the fuels used to supply the heat necessary for converting crude gypsum to the calcined form in which most gypsum is used. The average mill value, which in most instances is the transfer value assigned by the producers who also mine crude, was $10.70 per ton, an increase of $0.09 above the value in 1956.

Mine and Products-Plant Development.—Kaiser Gypsum Co., which recently entered the insulation-board market through the purchase of Fir-Tex Insulation Board, Inc., completed constructing its new wallboard and plaster plant at Antioch, Calif.[3]

TABLE 3.—Calcined gypsum produced in the United States, 1956–57, by districts

District	1956		1957	
	Short tons	Value	Short tons	Value
New Hampshire, Massachusetts, and Connecticut	295,926	$3,191,498	268,519	$2,808,503
Eastern New York, New Jersey, Pennsylvania, Georgia, and Florida	1,640,531	17,347,710	1,626,072	17,811,873
Ohio, Virginia, Indiana, and Maryland	1,547,171	17,404,918	1,438,622	16,208,680
Western New York	708,447	7,731,126	550,895	6,046,012
Michigan	673,890	6,673,743	518,314	5,189,702
Iowa	803,137	8,484,783	714,708	7,340,587
Kansas and Oklahoma	517,598	4,410,150	473,681	3,980,045
Louisiana and Texas	902,046	10,169,270	847,412	9,763,173
Colorado, Montana, Utah, and Washington	308,641	3,958,335	279,372	3,691,518
Arizona, California, and Nevada	1,210,991	11,964,456	1,083,455	10,614,584
Total	8,608,378	91,335,989	7,801,050	83,454,677

TABLE 4.—Active calcining plants and equipment in the United States, 1955–57, by States

State	1955			1956			1957		
	Calcining plants	Equipment		Calcining plants	Equipment		Calcining plants	Equipment	
		Kettles	Other calciners [1]		Kettles	Other calciners [1]		Kettles	Other calciners [1]
California	5	12	9	6	13	12	6	18	12
Iowa	4	21	4	4	21	4	4	21	4
Michigan	4	20		4	20	3	4	20	3
New York	7	21	6	8	24	6	7	24	5
Texas	4	29		4	29		5	30	
Other States [2]	26	94	32	31	102	38	31	97	39
Total	50	197	51	57	209	63	57	210	63

[1] Includes rotary and beehive kilns, grinding-calcining units, and hydrocal cylinders.
[2] Comprises calcining plants in 1955–57 as follows: 1 each in Arizona (1956–57), Connecticut, Florida, Georgia, Maryland, Massachusetts, Montana, New Hampshire, Oklahoma, Pennsylvania, and Washington; 2 each in Kansas, Louisiana (1956–57), Nevada, New Jersey (1 in 1955), Ohio, Utah, and Virginia; 3 in Colorado (2 in 1955) and Indiana.

[3] Chemical Engineering, vol. 64, No. 2, February 1957, p. 352.

It was reported that the Flintkote Co. of East Rutherford, N. J., was constructing a new plant at North Judson, Ind., for manufacturing building material for combination roof decks and ceilings, floor slabs, structural insulation, interior sheathing, stucco, and interior plaster base.[4]

United States Gypsum Co., Chicago, Ill., announced plans in December for constructing a multimillion-dollar gypsum plant near Houston, Tex.[5]

National Gypsum Co., Buffalo, N. Y., purchased the gypsum-products plant of Connecticut Adamant Plaster Co. at New Haven, Conn.

The company planned to expand plant operations to include other building products, such as sheathing and roof deck.

The Allied Chemical and Dye Corp. Barrett Division began manufacturing gypsum board products at its plant in Edgewater, N. J. This plant was reported to be fully automatic and to have a daily capacity of 800,000 square feet of gypsum board. The annual production goal for the plant has been set at a quarter billion square feet.[6]

Cheekako Development Corp. was reported to have begun mining gypsum on the Wind River Indian Reservation, 27 miles northwest of Riverton, Wyo.[7]

New facilities were acquired at Des Plaines, Ill., by the Celotex Corp., Chicago, as a major step in expanding its research facilities. The existing company research facilities in other parts of the country will be maintained.[8]

CONSUMPTION AND USES

Outlays for new construction in 1957 reached a record high as public construction increased. Total private building was almost unchanged, as the increase in nonresidential construction offset the decline in residential building. Activity in the industry reached a low in the first quarter, when the seasonally adjusted annual rate was reported as 940,000, a decrease of almost one-third from the peak reached in the second quarter of 1955. By late spring the seasonally

[4] Pit and Quarry, Flintkote Co. Constructing $1,000,000 Insulation Plant at 30-Acre Indiana Site: Vol. 49, No. 7, January 1957, p. 26.
[5] Pit and Quarry, United States Gypsum Plans Big Plant at Texas Site: Vol. 50, No. 5, November 1957, p. 30.
[6] Oil, Paint and Drug Reporter, Gypsum-Board Unit Opened in New Jersey by Barrett Division: Vol. 173, No. 2, Jan. 13, 1958, p. 55.
[7] Engineering and Mining Journal, vol. 158, No. 4, April 1957, p. 165.
[8] Pit and Quarry, Celotex Buys Des Plaines Site to Expand Research Facilities: Vol. 49, No. 7, January 1957, p. 137.

adjusted rate had risen to about 1 million units and remained close to it for the remainder of the year.

Consumption of most gypsum building products, particularly the high-value prefabricated materials used in residential construction, followed the trends of the residential building industry. Sales of uncalcined gypsum products were 4 percent lower than in the previous year, due primarily to the decline in the production of portland-cement retarder. Industrial and building plasters declined 5 and 6 percent respectively.

STOCKS

Producers reported stocks of crude gypsum totaling 2,313,000 short tons on hand December 31, 1957, compared with 2,265,000 tons on the same date of the preceding year and 1,894,000 tons at the end of 1955.

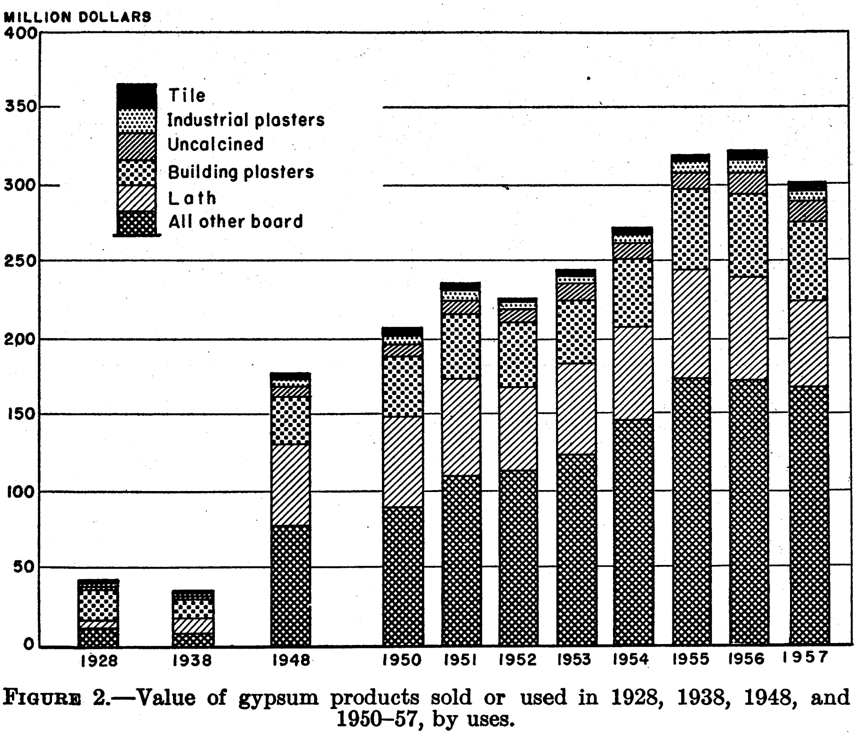

FIGURE 2.—Value of gypsum products sold or used in 1928, 1938, 1948, and 1950–57, by uses.

TABLE 5.—Gypsum products (made from domestic, imported, and byproduct crude gypsum) sold or used in the United States, 1956–57, by uses

Use	1956			1957			Percent of change in—	
	Short tons	Value		Short tons	Value			
		Total	Average		Total	Average	Tonnage	Average value
Uncalcined:								
Portland-cement retarder	2,393,502	$9,616,456	$4.02	2,272,809	$9,574,240	$4.21	−5	+5
Agricultural gypsum	830,337	3,131,822	3.77	831,249	3,121,429	3.76	(1)	(1)
Other uses [2]	35,473	424,911	11.98	34,728	424,763	12.23	−2	+2
Total uncalcined uses	3,259,312	13,173,189	4.04	3,138,786	13,120,432	4.18	−4	+3
Industrial:								
Plate-glass and terra-cotta plasters	67,751	1,007,896	14.88	66,663	986,077	14.79	−2	−1
Pottery plasters	51,296	1,056,465	20.60	46,263	951,597	20.57	−10	(1)
Orthopedic and dental plasters	10,112	360,045	35.61	10,656	400,185	37.55	+5	+5
Industrial molding, art, and casting plasters	91,111	1,789,975	19.65	84,795	1,675,546	19.76	−7	+1
Other industrial uses [3]	114,112	3,094,955	27.12	110,265	2,984,697	27.07	−3	(1)
Total industrial uses	334,382	7,309,336	21.86	318,642	6,998,102	21.96	−5	(1)
Building:								
Cementitious:								
Plasters:								
Base-coat	1,566,574	25,028,412	15.98	1,412,223	22,781,424	16.13	−10	+1
Sanded	656,551	15,224,222	23.19	616,845	14,464,858	23.45	−6	+1
To mixing plants	4,817	66,738	13.85	3,157	42,802	13.56	−34	−2
Gaging and molding	152,521	2,819,216	18.48	141,616	2,637,580	18.62	−7	+1
Prepared finishes	12,862	950,459	73.90	12,741	1,011,754	79.41	−1	+7
Roof-deck	432,139	6,707,468	15.52	468,654	7,362,848	15.71	+8	+1
Other [4]	21,920	2,124,817	96.94	21,816	2,002,020	91.77	(1)	−5
Keene's cement	46,889	1,156,867	24.67	41,311	1,045,045	25.30	−12	+3
Total cementitious	2,894,273	54,078,199	18.68	2,718,363	51,348,331	18.89	−6	+1
Prefabricated:								
Lath	2,021,469	67,819,914	[5] 25.35	1,697,662	57,410,171	[5] 25.47	[6] −16	(1)
Wallboard	4,184,636	167,055,985	[5] 36.32	3,917,180	160,323,998	[5] 37.26	[6] −6	+3
Sheathing board	145,493	5,458,631	[5] 39.37	138,334	5,345,332	[5] 40.60	[6] −5	+3
Laminated board	1,394	66,806	[5] 53.53	1,564	83,898	[5] 64.59	[6] +4	+21
Formboard for poured-in-place gypsum roof deck	56,176	2,205,911	[5] 41.29	52,727	2,151,900	[5] 42.61	[6] −5	+3
Tile	181,710	4,483,725	[7] 93.20	174,172	4,312,596	[7] 94.48	[6] −3	+1
Total prefabricated	6,590,878	247,090,972	37.49	5,981,639	229,627,895	38.39	[6] −10	+2
Total building uses		301,169,171			280,976,226			
Grand total value		321,651,696			301,094,760			

[1] Less than 1 percent.
[2] Includes uncalcined gypsum for use as filler and rock dust, in brewer's fixe, in color manufacture, and for unspecified uses.
[3] Includes dead-burned filler, granite polishing, and miscellaneous uses.
[4] Includes joint filler, patching, painter's, insulating, and unclassified building plasters.
[5] Average value per thousand square feet.
[6] Percent of change in square footage.
[7] Average value per thousand square feet of partition tile only.

TABLE 6.—Gypsum board and tile sold or used in the United States, 1948–52 (average) and 1953–57, by types

Year	Lath			Wallboard			Sheathing		
	Thousand square feet	Value		Thousand square feet	Value		Thousand square feet	Value	
		Total	Average[1]		Total	Average[1]		Total	Average[1]
1948–52 (average)	2,477,492	[2] $55,246,583	[2] $22.30	[2] 2,883,416	[2] $87,702,909	$30.42	114,748	$4,014,420	$34.98
1953	2,437,481	58,396,664	23.96	3,564,427	119,967,024	33.66	119,560	4,366,801	36.52
1954	2,489,665	60,744,726	24.40	4,006,951	139,010,481	34.69	135,027	5,010,992	37.11
1955	2,939,914	71,340,593	24.27	4,732,331	165,899,184	35.06	125,921	4,671,953	37.10
1956	2,675,184	67,819,914	25.35	4,598,927	167,055,985	36.32	138,644	5,458,631	39.37
1957	2,253,806	57,410,171	25.47	4,303,387	160,323,998	37.26	131,655	5,345,332	40.60

Year	Laminated board			Formboard			Tile[3]		
	Thousand square feet[4]	Value		Thousand square feet	Value		Thousand square feet	Value	
		Total	Average[1]		Total	Average[1]		Total	Average[5]
1948–52 (average)	2,415	$169,308	$70.11	(2)	(2)	(2)	33,127	$3,943,537	$75.50
1953	2,922	144,050	49.30	39,519	$1,519,180	$38.44	26,649	3,769,157	84.20
1954	1,808	94,522	52.28	42,213	1,666,178	39.47	31,059	4,295,133	86.20
1955	1,765	100,479	56.93	50,190	2,001,467	39.88	35,734	4,690,950	87.13
1956	1,248	66,806	53.53	53,429	2,205,911	41.29	32,285	4,483,725	93.20
1957	1,299	83,898	64.59	50,498	2,151,900	42.61	31,244	4,312,596	94.48

[1] Per thousand square feet, f. o. b. producing plant.
[2] Formboard included with wallboard. Separate data not available.
[3] Includes partition, roof, floor, soffit, shoe, and all other gypsum tiles and planks.
[4] Area of component board and not of finished product.
[5] Per thousand square feet, f. o. b. producing plant, of partition tile only.

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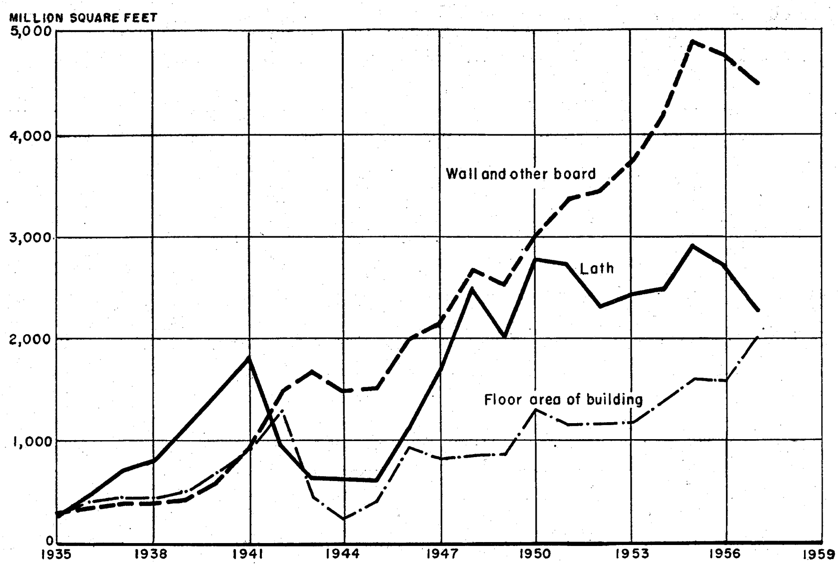

FIGURE 3. —Trends in sales of gypsum lath and wallboard and other boards (including wallboard, laminated board in terms of component board, formboard, and sheathing), compared with Dodge Corp. figures on combined floor area of residential and nonresidential buildings, 1935–57.

TABLE 7.—Gypsum lath and wallboard sold or used in the United States, 1956–57, by thickness

	1956				1957			
	Thousand square feet	Short tons	Value		Thousand square feet	Short tons	Value	
			Total	Average [1]			Total	Average [1]
Lath:								
⅜-inch [2]	2,654,641	2,000,176	$67,193,429	$25.31	2,231,799	1,674,990	$56,738,263	$25.42
½-inch	20,543	21,293	626,485	30.50	22,007	22,672	671,908	30.53
Total	2,675,184	2,021,469	67,819,914	25.35	2,253,806	1,697,662	57,410,171	25.47
Wallboard:								
¼-inch	120,848	69,018	3,554,065	29.41	199,498	129,636	6,249,713	31.33
⅜-inch [3]	2,074,722	1,617,682	69,612,368	33.55	1,836,752	1,436,105	62,433,052	33.99
½-inch	2,310,303	2,370,611	88,994,890	38.52	2,157,610	2,203,811	85,638,759	39.69
⅝-inch	93,054	127,325	4,894,662	52.60	109,527	147,628	6,002,474	54.80
Total	4,598,927	4,184,636	167,055,985	36.32	4,303,387	3,917,180	160,323,998	37.26

[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.

PRICES

Producers reported that the average value of crude gypsum mined was $3.25 per short ton ($3.31 in 1956); among the uncalcined uses, the unit values of portland-cement retarder and agricultural gypsum products were $4.21 and $3.76, respectively. The values of industrial gypsum products, except orthopedic and dental plasters (which increased 5 percent), varied within 1 percent. All prefabricated products increased in value, particularly laminated board, which increased 21 percent.

FOREIGN TRADE [9]

As in the previous year, import of crude gypsum into the United States totaled 4.3 million short tons. Canada supplied 85 percent of the total quantity imported and approximately 27 percent of the total United States supply. Imports of crude gypsum from Canada, United Kingdom, and Italy declined.

TABLE 8.—Gypsum and gypsum products imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Crude (including anhydrite)		Ground or calcined		Keene's cement		Alabaster manufactures [1] (value)	Other manufactures, n. e. s. (value)	Total value
	Short tons	Value	Short tons	Value	Short tons	Value			
1948–52 (average)	3,039,330	$3,146,046	784	$24,388	4	$307	$97,519	$143,554	$3,411,814
1953	3,184,292	4,288,589	888	31,108	(2)	2	181,421	291,071	4,792,191
1954	3,368,133	[3] 4,878,405	684	[3] 25,438	11	433	[3] 210,503	[3] 262,931	[3] 5,377,710
1955	3,977,105	[3] 6,298,410	937	32,674	1	834	[3] 346,357	[3] 597,340	[3] 7,275,615
1956	[4] 4,346,135	[3] 7,814,223	1,146	39,333			[3] 415,973	[3] 276,590	[3] 8,546,119
1957	4,334,467	7,570,671	870	33,043			577,273	333,510	8,514,497

[1] Includes imports of jet manufactures, which are believed to be negligible.
[2] Less than 1 ton.
[3] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.
[4] Revised figure.

TABLE 9.—Crude gypsum (including anhydrite) imported for consumption in the United States, 1955–57, by countries

[Bureau of the Census]

Country	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	3,483,179	$5,770,040	[1] 3,771,282	$6,986,334	3,686,237	$6,500,085
Dominican Republic	45,472	96,807	38,923	93,943	57,089	152,375
Jamaica	68,294	80,990	135,441	357,985	167,203	536,888
Mexico	380,160	350,573	388,839	348,563	419,304	373,473
Total	3,977,105	6,298,410	[1] 4,334,485	7,786,825	4,329,833	7,562,821
Europe:						
Italy			2	268		
United Kingdom			11,648	27,130	4,634	7,850
Total			11,650	27,398	4,634	7,850
Grand total	3,977,105	[2] 6,298,410	[1] 4,346,135	[2] 7,814,223	4,334,467	7,570,671

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

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

TABLE 10.—Gypsum and gypsum products exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Crude, crushed, or calcined [1]		Plasterboard, wallboard, and tile		Other manufactures, n. e. s. (value)	Total value
	Short tons	Value	Square feet	Value		
1948–52 (average)	19,394	$466,860	25,713,073	$761,444	$191,782	$1,420,086
1953	23,690	693,632	45,767,496	1,195,168	104,871	1,993,671
1954	22,384	761,524	20,968,956	688,820	150,133	1,600,477
1955	22,539	737,531	8,686,854	412,397	198,140	1,348,068
1956	20,757	710,564	7,026,932	363,648	140,635	1,214,847
1957	24,447	762,687	8,866,572	519,668	61,698	1,344,053

[1] Effective Jan. 1, 1949, calcined gypsum not separable from crude, crushed, or calcined.

WORLD REVIEW

NORTH AMERICA

Canada.—Western Gypsum Products, Ltd., Winnipeg, a wholly-owned subsidiary of British Plaster Board (Holding), Ltd., of London, acquired extensive deposits of gypsum at Windermere in East Kootenay, British Columbia, through the purchase of Westroc Industries, Ltd., and Columbia Gypsum Co. of Vancouver. Reported sales price of the 2 companies was $2 million.[10]

Preliminary investigations of a number of gypsum deposits in the southern portion of Cape Breton Island, Nova Scotia, was begun by the Bestwall Gypsum Co. (Canada), Ltd.[11]

Jamaica.—Exports of gypsum from Jamaica in 1956 totaled 135,053 short tons, compared with 92,014 tons in 1955 and 179,062 tons in 1954. Exports were discontinued during the latter half of 1955, while Jamaica Gypsum, Ltd., a subsidiary of United States Gypsum Co., installed a new crushing plant at the quarry. In 1956 about 90 workers were employed by Jamaica Gypsum in its mining operations.[12]

EUROPE

United Kingdom.—Solvay Chemicals, Ltd., a subsidiary of Marchon Products, Ltd., White-haven, Cumberland, England, is supplying approximately 7,000 tons of anhydrite per week to its chemical plant. The plant produces 1 ton of portland cement for each ton of sulfuric acid resulting from the anhydrite process.[13]

ASIA

U. S. S. R.—It was reported that large deposits of gypsum have been found in the Angara Steppe area. Deposits containing more than 10 million tons have been made ready for exploitation. When operated at full capacity the mines are expected to produce in excess of 300,000 tons per year.[14]

[10] Pit and Quarry, Western Gypsum Products Acquires Two B. C. Companies: Vol. 50, No. 2, August 1957, p. 34.
[11] Wall Street Journal, Bestwall Gypsum Developing Properties in Nova Scotia: Vol. 149, No. 54, Mar. 19, 1957, p. 22.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 26.
[13] Rock Products, Anhydrite Mine: Vol. 60, No. 2, February 1957, p. 66.
[14] Engineering and Mining Journal, vol. 158, No. 10, October 1957, p. 200.

AFRICA

Tanganyika.—According to a report contained in the April 1956 issue of The East African Trade and Industry, plans are being made by Gypsum Products, Ltd., to develop the extensive deposits of gypsum at Mkomasi. Reserves at this property have been conservatively estimated to contain 1 million tons, but may exceed this figure by 100 percent when the ore deposit is proved. Gypsum obtained from this property will be processed by the Bellrock system of continuous calcination into a plaster.[15]

Union of South Africa.—According to the Union of South Africa Department of Mines (Pretoria) Quarterly Reports, 1956, the output of gypsum increased 17 percent in 1956 compared with 1955. The following nine companies were listed as producers of gypsum in 1956:

Daroba Gypsum Co. (Pty.), Ltd., Vanrhynsdorp, Cape Province.
Fincham's Base Mineral Mines (Pty.), Ltd., Postmasburg, Cape Province.
Kimberley Gypsum Supplies (Pty.), Ltd., Kimberley, Cape Province.
Nantwich Salt Works, Ltd., Riverton, Cape Province.
National Portland Cement Co., Ltd., Claremont, Cape Province.
Dr. J. Nortje and J. Gauche, Vredendal, Cape Province.
P. J. Theophilus, Barroe, Cape Province.
Permanent Gypsum and Allied Minerals (Pty.), Ltd., Longlands, Barkly West, Cape Province.
Potgieter's Gypsum Operations (Pty.), Ltd., Kimberley, Cape Province.

OCEANIA

Australia.—Large-scale mining operations were planned on Kangaroo Island, Australia, by Fred Ingham Co. The company was recently granted a 500-acre lease on an area known as Salt Lake, which was estimated to contain 2.5 million tons of gypsum. Gypsum mined at this property will supply a new plaster plant to be constructed at Port Adelaide.[16]

TABLE 11.—World production of gypsum, by countries,[1] 1948–52 (average) and 1953–57, in thousand short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada [3]	3,580	3,839	4,184	4,540	4,900	4,501
Cuba	[4] 23	[4] 33	[4] 33	[4] 35	24	[4] 45
Dominican Republic	13	20	29	64	84	[4] 77
Guatemala	------	------	------	------	------	7
Jamaica	25	83	186	92	140	212
United States	7,827	8,293	8,996	10,684	10,316	9,195
Total [1 4]	11,516	12,378	13,538	15,525	15,574	14,147
South America:						
Argentina	146	[4] 138	164	141	193	[4] 198
Brazil	[4] 34	82	83	178	170	[4] 165
Chile	66	77	[4] 83	[4] 83	[4] 77	[4] 77
Colombia	4	9	17	24	55	[4] 66
Peru	39	[4] 81	[4] 65	[4] 91	[4] 94	[4] 96
Venezuela	2	------	------	------	------	------
Total [1 4]	291	387	412	517	589	602

See footnotes at end of table.

[15] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 38.
[16] Chemical Age (London), Gypsum Project: Vol. 77, No. 1956, Jan. 5, 1957, p. 15.

TABLE 11.—World production of gypsum, by countries,[1] 1948–52 (average) and 1953–57, in thousand short tons[2]—Continued

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Europe:						
Austria [3]	123	331	404	455	499	579
Finland	[4] 1	---	---	---	---	---
France (saleable) [3]	2,337	3,193	3,513	4,018	3,967	[4] 3,860
Germany, West [5]	709	857	932	999	1,046	982
Greece	13	28	22	17	19	[4] 19
Ireland	82	102	124	139	121	149
Italy	565	739	785	817	870	[4] 880
Luxembourg	13	10	2	3	6	[4] 6
Poland	[4] 46	(6)	(6)	(6)	(6)	(6)
Portugal	42	51	64	52	61	[4] 60
Spain	1,849	1,154	957	1,067	1,245	851
Switzerland	[4] 125	138	165	[4] 220	266	259
U. S. S. R.	1,851	2,635	2,799	3,164	[4] 3,300	[4] 3,300
United Kingdom [3]	2,482	2,995	3,093	3,266	3,734	3,721
Yugoslavia	14	49	99	74	[4] 77	[4] 77
Total [1] [4]	10,341	12,490	13,200	14,550	15,500	15,050
Asia:						
Ceylon	(7)	(7)	(7)	(7)	1	1
China [4]	70	110	220	280	330	330
Cyprus [4]	100	210	220	180	140	165
India	233	656	686	773	952	1,024
Iran [4] [8]	275	180	220	740	380	390
Iraq [4]	275	275	275	275	385	440
Israel [4]	22	25	31	56	55	24
Japan	165	299	372	374	417	524
Pakistan	20	31	35	31	41	[4] 40
Philippines	2	---	---	---	---	---
Syria [9]	4	1	1	1	2	[4] 2
Taiwan	4	2	4	11	14	7
Thailand	(7)	---	---	---	---	2
Total [1] [4]	1,170	1,790	2,060	2,720	2,720	2,950
Africa:						
Algeria	54	100	80	132	84	[4] 84
Angola	5	6	10	3	22	[4] 22
Belgian Congo	3	7	10	11	11	[4] 11
Egypt	113	205	157	432	225	[4] 220
Kenya	1	1	1	1	2	5
Morocco: Southern Zone	18	16	23	16	28	[4] 28
Sudan	3	8	4	3	2	[4] 2
Tanganyika	(7)	2	5	9	11	11
Tunisia	25	25	33	38	15	[4] 17
Union of South Africa	121	168	174	178	209	180
Total	343	538	497	823	609	[4] 580
Oceania:						
Australia	367	370	492	526	524	538
New Caledonia	12	21	3	---	---	---
Total	379	391	495	526	524	538
World total (estimate) [1] [2]	24,040	27,970	30,200	34,660	35,520	33,900

[1] In addition to the countries listed, gypsum is produced in Bulgaria, Ecuador, Korea, Mexico, and Rumania, but production data are not available. Estimates for these countries are included in the totals.
[2] This table incorporates a number of revisions of data published in previous Gypsum chapters. Data do not add to totals shown, because of rounding where estimated figures are included in the detail.
[3] Includes anhydrite.
[4] Estimate.
[5] Crude production estimates based on calcined figures.
[6] Data not available; estimate by senior author of chapter included in total.
[7] Less than 500 tons.
[8] Year ended March 20 of year following that stated.
[9] Some pure, some 80 percent gypsum and 20 percent limestone.

TECHNOLOGY

A rapid hydration process for converting anhydrite was developed as a result of a study conducted to determine natural conversion of anhydrite to gypsum. Conditions were determined from laboratory data on the effects of particle size, seeding, ratio of solid to liquid, activation, temperature, agitation, time, and washing conditions. A slurry of 10 to 50 percent pulverized anhydrite with minor gypsum in a solution of sodium sulfate or potassium sulfate (also saturated with calcium sulfate) is agitated below 30° C. for 1 to 7 hours; after filtration, the solids are washed with water or saturated calcium sulfate solution. The alkali sulfate activator may be recycled.[17]

A report on the control of mine roofs at United States Gypsum Co. property at Oakfield, Calif., through the use of roof bolts was described in the trade press. The elimination of timber supports, roof-bolt type and pattern used, testing of bolts, roof-bolting equipment, bit life, and the advantages of roof bolting were discussed.[18]

Two substantial deposits of gypsum, varying in thickness from 120 to 125 feet and averaging 75-percent-pure gypsum, were reported found in the Ottumwa and Hendrick areas of Iowa. The deposits were discovered by testing rock samples obtained during well drilling. Depths extend from 825 to 950 feet at Ottumwa and 935 to 1,055 feet at Hendrick. It is now believed that the gypsum beds are continuous between Ottumwa and Hendrick, a distance of 15 miles.[19]

The feasibility of producing ammonium sulfate commercially from gypsum and ammonium carbonate has attracted interest both in the United States and abroad, especially in areas where sulfuric acid is made from imported sulfur. A brief description of the process and cost involved are contained in a trade press article.[20]

An article in the trade press discussed the basic factors in an economic appraisal of gypsum deposit. Among the factors discussed were available markets, efficient operating, high quality, and adequate tonnage.[21]

A report was published on a modernization program at the Ruberoid Co. mine and mill at Wheatland, N. Y. Mining method, roof bolting, and mine and mill equipment were discussed.[22]

A report was made of the scrape stripping operations at United States Gypsum Co. Fort Dodge, Iowa, plant. A new method of stripping, geology of the ore body, mining system employed, drilling, blasting, and crushing were discussed.[23]

Patents.—An apparatus and method were patented for machine application on walls of mortars formed by the use of binders. Water requirements are held to a minimum with this method, which is especially useful for rapid, high-quality plastering of walls, using a lightweight aggregate and gypsum plaster.[24]

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[17] Leininger, R. K., Conley, R. F., and Bundy, W. M., Rapid Conversion of Anhydrite to Gypsum: Ind. Eng. Chem., vol. 49, No. 5, May 1957, p. 13A.

[18] Ernst, E., and Runuik, R., Control of Mine Roof at Oakfield: Min. Eng., vol. 9, No. 6, June 1957, pp. 646–647.

[19] Rock Products, Promotes Iowa Gypsum: Vol. 60, No. 3, March 1957, p. 44.

[20] Industrial and Engineering Chemistry, Ammonium Sulfate by the Gypsum Process: Vol. 49, No. 2, February 1957, pp. 57A–58A.

[21] Harvard, J. F., What Makes a Gypsum Deposit Economic: Min. Cong. Jour., vol. 43, No. 3, March 1957, pp. 56–58.

[22] Rock Products, Modernizing a Gypsum Plant: Vol. 60, No. 2, pp. 98–102, 128.

[23] Rock Products, Scraper Stripping Steps Up Output: Vol. 60, No. 2, February 1957, pp. 94–97.

[24] Hubson, L. H., Method of Emplacing Mortar: U. S. Patent 2,770,560, Nov. 13, 1956.

A new molding composition was disclosed in a recent patent. The composition comprises gypsum plaster, asbestos fiber or ground pumice, wood flour, powdered cork, castor oil, and a solution of nitrocellulose in ethyl acetate.[25]

A patent disclosed an apparatus designed for gravity removal of contaminants, such as tramp iron from a moving stream of fine, dry material.[26]

[25] Petersilie, H. H., and Zimmermann, E. O., Hardened Molded Article and Method of Forming Same: U. S. Patent 2,770,026, Nov. 13, 1956.

[26] Morrow, U. H., Material Trap: U. S. Patent 2,769,544, Nov. 6, 1956.

Iodine

By Henry E. Stipp[1] and James M. Foley[2]

INCREASED imports and the reduced price of crude iodine were problems confronting the domestic iodine industry during 1957. New uses for iodine and iodine compounds in sanitation and medicine, industry, and agriculture were reported.

DOMESTIC PRODUCTION

Iodine was produced from waste oil-well brines in 1957 by the Dow Chemical Co., with plants at Seal Beach, Venice, and Inglewood, Calif., and the Deepwater Chemical Co., Ltd., with a plant at Compton, Calif. Domestic producers supplied a substantial part of national requirements. In addition to the 2 California producers, approximately 19 firms processed crude iodine and produced refined iodine and iodine compounds.

CONSUMPTION AND USES

Consumption of iodine compounds during 1957 increased substantially over that in 1956. The increase was due partly to expansion of the Bureau of Mines canvass. The 1957 data include 152,113 pounds of iodine reported by firms not previously canvassed.

TABLE 1.—Crude iodine consumed in the United States, 1956–57

Compound manufactured	1956			1957		
	Number of plants	Crude iodine consumed		Number of plants	Crude iodine consumed	
		Pounds	Percent of total		Pounds	Percent of total
Resublimed iodine	5	142,647	11	6	203,062	9
Potassium iodide	9	622,889	49	12	1,091,009	49
Sodium iodide	5	123,493	10	8	213,095	10
Other inorganic compounds	10	86,172	7	12	322,699	15
Organic compounds	15	300,459	23	18	379,868	17
Total	[1] 22	1,275,660	100	[1] 27	2,209,733	100

[1] A plant producing over 1 product is counted but once in arriving at total.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

Iodine and iodine compounds found numerous and varied uses in medicine and sanitation, agriculture, and industry during 1957. A large part of the iodine consumed was used in medicines and antiseptics. Probably the best known use for iodine is the household antiseptic, "tincture of iodine." Increased use was made of iodophors as antiseptics and disinfecting agents. Iodine was also employed for disinfecting drinking water. Potassium or sodium iodide, potassium iodate, or cuprous iodide was added to livestock feed. Iodized proteins in stock and fowl feeds prevented various diseases and increased the yield of milk and eggs. The use of silver iodide crystals to seed clouds, thereby inducing rainfall, was small; however, this use has great potential for expansion. Radioactive iodine 131 was used in medicine and industry in increasing quantities. It was used in medicine for physical therapy and examinations of the human body. Industrially it was used for process control and research. A new expanding use in metallurgy was in producing such high-purity metals as titanium, silicon, hafnium, and zirconium. In addition, iodine was used in photography, metallurgy, rubber, dyes, and analytical reagents and as catalysts.

STOCKS

Some stocks of iodine were maintained at St. Louis, Mo., and New York, N. Y., by domestic producers. In addition large stocks were held in Chile and at Staten Island, N. Y., by Chilean Nitrate Sales Corp. These stocks are replenished at irregular intervals as they become depleted. Iodine was also stockpiled by the United States Government.

PRICES AND SPECIFICATIONS

According to the Oil, Paint and Drug Reporter the prices of iodine and iodine compounds during 1957 were as follows: Crude iodine, in kegs, $1.10 per pound throughout the year; resublimed iodine, U. S. P., bottles, drums, $2.30–$2.32 per pound throughout the year; potassium iodide, drums, $1.90–$1.95 per pound throughout the year; sodium iodide, U. S. P., bottles, drums, $2.55 per pound from January to mid-October and $2.42–$2.54 per pound for the remainder of the year; ammonium iodide, N. F., drums, bottles, $4.26–$4.38 per pound throughout the year.

National stockpile purchase specifications for crude iodine to supersede those of May 23, 1956, were issued December 27, 1957.

FOREIGN TRADE [3]

Imports of crude iodine from Chile increased 114 percent in 1957; however, imports from Japan decreased 23.7 percent from the 1956 high. Total imports of crude iodine in 1957 increased 58 percent to a new high. The increase in imports resulted from a reduction in the price of crude iodine in October 1956. Increased output by Chile was reported to be responsible for the price decrease.

Exports of iodine and iodine compounds in 1957 decreased 54 percent to a total of 232,973 pounds.

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

TABLE 2.—Crude iodine imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries

[Bureau of the Census]

Country	1948–52 (average)		1953		1954	
	Pounds	Value	Pounds	Value	Pounds	Value
South America: Chile	528,970	$822,681	681,484	$1,197,379	615,744	$667,088
Europe: France					110	493
Asia: Japan	161,092	238,658	276,154	408,645	330,131	366,354
Grand total	690,062	1,061,339	957,638	1,606,024	945,985	1,033,935

Country	1955		1956		1957	
	Pounds	Value	Pounds	Value	Pounds	Value
South America: Chile	868,040	$1,034,834	1,001,701	$1,225,849	2,149,065	$2,048,594
Europe: France						
Asia: Japan	363,954	477,673	703,167	954,008	536,424	720,284
Grand total	1,231,994	1,512,507	1,704,868	2,179,857	2,685,489	2,768,878

TABLE 3.—Iodine, iodide, and iodates exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Pounds	Value	Year	Pounds	Value
1948–52 (average)	287,637	$542,727	1955	243,686	$356,531
1953	274,690	452,387	1956	505,274	750,140
1954	338,258	487,633	1957	232,973	335,075

WORLD REVIEW

SOUTH AMERICA

Chile.—Exports of iodine totaled 792.4 metric tons in the 1955–56 crop year (July 1, 1955, through June 30, 1956) compared with 1,163 tons for the preceding year.[4]

TABLE 4.—Exports of iodine from Chile, crop year, 1955–56

Country of destination	Metric tons	Country of destination	Metric tons
Argentina	25.9	Peru	0.4
Australia	3.3	Portugal	.5
Belgium	27.0	Spain	35.1
Brazil	4.6	Sweden	2.1
Czechoslovakia	5.1	Switzerland	1.0
France	108.7	United Kingdom	139.6
Germany	71.0	United States	359.8
India	2.2		
Ireland	.1	Total	792.4
Netherlands	6.0		

Chile produced 1,000 metric tons of iodine during the 1956 calendar year.[5]

[4] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 29.
[5] U. S. Embassy, Santiago, Chile, State Department Dispatch 430: Oct. 30, 1957, 4 pp.

EUROPE

Italy.—Production of iodine totaled 14,158 kilograms in 1955.[6] In 1956 production totaled 13,415 kilograms of iodine.[7]

United Kingdom.—Imports of iodine in 1956 were valued at £237,507, compared with £592,124 in 1955.[8]

ASIA

Japan.—Production of elemental iodine in Japan during 1956 totaled 597 metric tons.[9]

TECHNOLOGY

Properties of iodophors, their advantages over aqueous iodine solutions, formulation problems, and the speed with which iodine acts were reviewed by chemists of the American Chemical Society.[10] An iodophor was described as a mixture of iodine and a carrier, in which the carrier increased the solubility of iodine in water and stabilized the iodine solution. Iodophors are less toxic but have all the germicidal activity of iodine. They are stable in solution due to lowering of the iodine vapor pressure. Iodophors do not stain and do not irritate the skin and eyes. Hard water does not interfere with their germicidal action. Interference of high bicarbonate content with germicidal action is corrected by proper formulation. Formulas have three basic ingredients—iodine, surfactant, and acid. Ingredients are varied to obtain different characteristics, such as storage stability, viscosity, foaming, and solubility. In tests of various iodine solutions, iodophors were effective against germs, as little as 10 p. p. m. iodine acting for 10 seconds. Iodine was more effective than chlorine or quarternary compounds.

Silicon suitable for semiconductor devices was produced from silicon tetraiodide by crystallization, sublimation, zone purification, and decomposition in vacuum.[11]

Cuprous iodide was said to have strong anti-inflammatory action in animals.[12] The compound and its effects on people were being studied. Data suggested that it may give action equal to that of corticosteroids at lower cost.

The United States Naval Ordnance Laboratory introduced an electrochemical device, termed a "solion," that may replace vacuum tubes and transistors for some applications.[13] In the device ions move through a solution in a small sectionalized cylinder containing electrodes and a chemical solution. Potassium iodide and iodine were among the chemicals used. A low-voltage battery starts the current flow; and changes in condition, such as sound, temperature, pressure, and acceleration, influence the flow rate of iodide ions, and thus vary-

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6 Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 3, March 1957, p. 23.
7 U. S. Embassy, Rome, Italy, State Department Dispatch 1505: May 14, 1957, 5 pp.
8 U. S. Embassy, London, England, State Department Dispatch 2486: Apr. 3, 1957, 13 pp.
9 U. S. Embassy, Tokyo, Japan, State Department Dispatch 1191: May 6, 1957, 7 pp.
10 Chemical and Engineering News, Enhancing Iodine: Vol. 35, No. 15, Apr. 15, 1957, p. 80.
11 Chemical and Engineering News, Second Route to Pure Si: Vol. 34, No. 42, Oct. 15, 1956, pp. 5007-5008.
12 Chemical and Engineering News, Cuprous Iodide May Compete With Corticosteroids: Vol. 35, No. 42, Oct. 21, 1957, p. 21.
13 Chemical and Engineering News, New Jobs for Ions: Vol. 35, No. 27, July 8, 1957, pp. 24, 26.

ing the current. The change in current is used to set off control devices.

The minimum cost for isotopes that could be expected under the largest volume uses was estimated by Willard F. Libby.[14] The cost for iodine 131 was estimated as $0.0004 per curie as compared with the present selling price of $550 per curie.

Milk from farms within 200 miles of Britain's Windscale plutonium plant was discarded because of possible contamination by radioactive iodine.[15] Plant filters contained most of the harmful material that escaped. Air, vented to the atmosphere after filtering, was thought to contain some radioactive material.

Iodine pentoxide was used in a field apparatus for determining the concentration of saturated hydrocarbons in air, developed by Stanford Research Institute.[16] It will determine the concentration of aliphatic or alicyclic hydrocarbons in the range 0 to 5,000 p. p. m., with a maximum error of plus or minus 20 percent. The apparatus consists of a squeeze-bulb assembly fitted with a special calibration scale. A tube containing I_2O_5 and 65 percent fuming H_2SO_4 on silica gel is alongside the scale. The I_2O_5 oxidizes hydrocarbons in the air sample drawn through the tube and is reduced to elemental iodine. The hydrocarbon concentration is read directly from the scale and is proportional to the length of the brown iodine stain in the tube.

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[14] Chemical and Engineering News, Price of Isotopes Drops With Use: Vol. 35, No. 20, May 20, 1957, p. 19.
[15] Chemical and Engineering News, vol. 35, No. 42, Oct. 21, 1957, p. 21.
[16] Chemical and Engineering News, Analyzing for Hydrocarbons: Vol. 35, No. 21, May 27, 1957, p. 82.

Iron Ore

By Horace T. Reno [1] and Helen E. Lewis [2]

IRON-ORE exploration was continued vigorously in 1957, and iron ore was produced for export at a record rate throughout the world despite the decline in business activity in the last half of the year. Iron ore imported for consumption in the United States comprised one-fourth of the total domestic supply.

TABLE 1.—Salient statistics of iron ore in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Iron ore (usable;[1] less than 5 percent Mn):						
Production by districts:						
Lake Superior long tons	80,358,720	95,655,105	60,993,927	83,255,400	77,817,113	83,531,001
Southeastern do	7,937,181	7,691,745	6,150,260	7,105,706	6,034,638	6,804,825
Northeastern do	4,473,795	5,161,813	4,083,608	4,649,566	4,867,098	4,961,470
Western do	6,323,785	8,868,658	6,064,947	[2] 6,958,070	[2] 8,073,272	10,040,744
Undistributed (byproduct ore) long tons	[3] 588,314	617,448	836,052	1,034,002	1,085,210	810,379
Total do	99,681,795	117,994,769	78,128,794	[2] 103,002,744	[2] 97,877,331	106,148,419
Production by types of product:						
Direct long tons	73,360,419	82,163,882	49,105,976	66,746,189	[2] 59,895,222	63,885,256
Concentrates do	21,204,952	29,161,642	23,172,948	[2] 28,775,735	[2] 27,342,720	29,106,481
Agglomerates do	4,563,677	6,051,797	5,013,818	6,446,818	9,554,179	12,346,303
Byproduct material (pyrites cinder and sinter) long tons	552,747	617,448	836,052	1,034,002	1,085,210	810,379
Total do	99,681,795	117,994,769	78,128,794	[2] 103,002,744	[2] 97,877,331	106,148,419
Production by types of ore:						
Hematite long tons	87,830,293	102,553,404	66,384,324	92,957,669	81,143,609	86,135,918
Brown ore do	2,416,286	2,238,236	2,315,407	[2] 2,461,011	[2] 3,202,450	3,403,979
Magnetite do	8,882,469	12,585,681	8,593,011	6,550,062	[2] 12,446,062	15,798,143
Byproduct material (pyrites cinder and sinter) long tons	552,747	617,448	836,052	1,034,002	1,085,210	810,379
Total do	99,681,795	117,994,769	78,128,794	[2] 103,002,744	[2] 97,877,331	106,148,419
Shipments do	99,495,207	117,821,981	76,954,081	[2] 106,257,579	[2] 97,924,400	104,969,871
Value	$499,000,484	$796,732,998	$541,193,051	[2] $756,852,687	[2] $759,727,907	$874,884,972
Average value per ton at mine	$5.02	$6.76	$6.99	$7.12	[2] $7.76	$8.33
Stocks at mines Dec. 31 long tons	5,694,353	5,706,430	7,077,651	4,280,782	[2] 5,465,340	6,718,263
Imports do	8,332,902	11,074,035	15,792,450	23,471,956	[2] 30,410,652	33,653,048
Value	$50,064,439	$96,788,218	$119,458,945	$177,457,281	[2] $250,490,199	$285,060,340
Exports long tons	3,501,547	4,251,955	3,145,714	4,516,828	[2] 5,508,296	5,002,153
Value	$22,503,212	$32,421,637	$24,783,997	$36,992,523	[2] $48,804,583	$49,301,960
Consumption long tons	102,361,015	122,124,661	94,229,135	[4] 125,028,306	125,170,702	129,375,234
Manganiferous iron ore (5 to 35 percent Mn):						
Shipments long tons	1,024,918	1,106,598	498,511	813,961	565,999	865,127
Value	$3,830,512	$6,946,862	$3,079,380	$5,128,255	([5])	$5,413,352

[1] Direct shipping ore, washed ore, concentrates, agglomerates, and byproduct pyrites cinder and agglomerates.
[2] Revised figure.
[3] Includes Puerto Rican ore—39,212 tons in 1951 and 138,613 tons in 1952.
[4] Includes 1,119,704 gross tons of manganiferous iron ore.
[5] Bureau of Mines not at liberty to publish figure.

[1] Assistant chief, Branch of Ferrous Metals and Ferroalloys.
[2] Statistical assistant.

TABLE 2.—Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man in 1956, by districts and States

District and State	Employment					Production									
	Average number of men employed	Time employed				Crude ore (long tons)	Usable ore			Average per man (long tons)					
		Average number of days	Total man-shifts	Man-hours			Long tons	Iron contained		Crude ore		Usable ore			
				Average per shift	Total			Long tons	Natural (percent)	Per shift	Per hour	Per shift	Per hour	Iron contained: Per shift	Iron contained: Per hour
Lake Superior:[1]															
Michigan	6,909	234	1,616,360	8.00	12,930,852	13,985,951	13,043,264	6,745,976	51.72	8.653	1.082	8.070	1.009	4.174	0.522
Minnesota	11,973	251	3,002,403	8.00	24,023,246	95,571,251	63,818,412	32,781,346	51.36	31.832	3.978	21.256	2.657	10.918	1.365
Wisconsin	1,164	229	266,206	8.00	2,129,658	1,551,894	1,551,438	814,504	52.50	5.830	.729	5.828	.728	3.060	.382
Total	20,046	244	4,884,969	8.00	39,083,756	111,109,096	78,413,114	40,341,826	51.45	22.745	2.843	16.052	2.006	8.258	1.032
Southeastern States:															
Alabama and Georgia	3,214	175	562,384	8.18	4,601,800	11,042,699	5,983,327	2,336,297	39.05	19.636	2.400	10.639	1.300	4.154	.508
Northeastern States:															
New Jersey	511	247	126,018	8.00	1,008,147	1,831,391	933,565	590,013	63.20	14.533	1.817	7.408	.926	4.682	.585
New York and Pennsylvania	1,657	244	403,980	8.01	3,236,583	9,791,869	3,933,533	2,430,136	61.78	24.238	3.025	9.737	1.215	6.015	.751
Total	2,168	244	529,998	8.00	4,244,730	11,623,260	4,867,098	3,020,149	62.05	21.931	2.738	9.183	1.147	5.698	.712
Western States:															
Utah and Wyoming	649	227	147,569	8.00	1,180,549	4,776,804	4,776,804	2,471,908	51.75	32.370	4.046	32.370	4.046	16.751	2.094
Other[2]	740	212	156,533	8.08	1,265,443	8,536,069	3,272,693	1,681,203	51.81	54.532	6.746	20.907	2.586	10.740	1.329
Total	1,389	219	304,102	8.04	2,445,992	13,312,873	8,049,497	4,153,111	51.77	43.778	5.443	26.469	3.291	13.657	1.698
Total[3]	26,817	234	6,281,453	8.02	50,376,278	147,087,928	97,313,036	49,851,383	51.24	23.416	2.920	15.492	1.932	7.936	.990

[1] Includes manganese-bearing ore in the Lake Superior district.
[2] California, Nevada, Colorado, Missouri, New Mexico, Texas, Washington, Montana, Arkansas, and Kentucky.
[3] Man-hour data for Idaho, Mississippi, Oregon, South Dakota, and Tennessee not available; therefore, production data for these States are excluded from all totals.

On the Mesabi range iron-ore beneficiation marked its 50th anniversary, flotation was applied commercially for the first time, and the Nation's largest iron-ore-beneficiation plant produced its first agglomerate. Direct reduction of iron ore was the item of principal technical interest in 1957.

EMPLOYMENT

Employment statistics for 1956 show that the average number of men employed in iron mines and beneficiating plants in all districts except those in the Southeastern States increased 8 percent in 1956 compared with 1955, although the quantity of usable iron ore and contained iron produced in these districts decreased in 1956. Complete employment data for the Southeastern and Western States could not be published for 1955, but their omission has no significance in comparing employment statistics of one year with another. The apparent decrease in labor efficiency in 1956 was due to increased output of low-grade ore in the Lake Superior district, where usable iron-ore output per man-shift dropped from 18.3 tons in 1955 to 16.0 tons in 1956.

DOMESTIC PRODUCTION

Domestic iron-ore production continued throughout 1957 at a near record rate; however, consumption declined in the last quarter, following a decline in steel production. Consequently, iron-ore stocks at mines, at United States docks, and at consuming plants were much above normal by the end of the year. Throughout the iron-mining industry, beneficiation and agglomeration of ore to obtain a product of higher grade and better structure was the principal concern. Reserve Mining Co. E. W. Davis plant at Silver Bay, Minn., produced taconite concentrate and agglomerate at capacity. Erie Mining Co. taconite concentration and agglomeration plant near Aurora, Minn., began operating late in 1957, and the company shipped iron-ore agglomerates from its new dock at Taconite Harbor, Minn., on Lake Superior. Jones & Laughlin Steel Corp. Hill-Annex tailings-reclamation plant at Calumet, Minn., used froth flotation to concentrate iron ore—the first commercial application of this process to ores of the Mesabi range.

Output of crude ore (mine product before it is treated to remove waste constituents) increased 10 percent in 1957 compared with 1956, principally owing to increased production from the taconite and jaspilite deposits of the Lake Superior district. Minnesota continued as the principal producer of crude ore, with 66 percent of the total; Michigan ranked second with 9 percent and Alabama third with 6 percent. Hematite ore comprised 71 percent, magnetite ore 22 percent, and brown ore 7 percent of the total crude iron ore produced in the United States in 1957. Most iron ores contain more than one iron mineral; therefore, this division among mineral types is made according to the mineral that predominates and is not precise. Underground iron mines in 1957 regained about 1 percentage point of their share of total crude-ore output in 1957, after reaching a low of 18 percent in 1956. The output of crude ore from underground iron mines does not fluctuate as much as the output from open-pit mines, but underground mines have been losing an average of 0.75

percentage point of the total production to open-pit mines each year since 1950. The continuing trend toward beneficiation of all iron ores, begun in 1940, resulted in an increase in crude-ore shipments to beneficiation plants from 60 percent of the total in 1956 to 69 percent in 1957.

TABLE 3.—Crude iron ore mined in the United States, 1956–57, by States and varieties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	Number of mines	Hematite	Brown ore	Magnetite	Total	Rank
1956						
Alabama	[1] 48	4,506,076	5,164,863		9,670,939	4
Arkansas, Colorado, and Mississippi	[2] 6		[2] 49,155		[2] 49,155	13
California	3	(3)		[3, 4] 3,451,902	3,451,902	7
Georgia	[1] 25		1,371,760		1,371,760	10
Idaho	1			714	714	20
Kentucky	1		1,796		1,796	18
Michigan	37	13,985,951			13,985,951	2
Minnesota	152	80,214,840	613,499	13,684,035	94,512,374	1
Missouri, Tennessee, and Texas	27	449,303	3,764,748		4,214,051	5
Montana	2	3,358		8,285	11,643	15
Nevada	10	30,122		842,466	872,588	11
New Jersey	4	768,095		1,063,296	1,831,391	8
New Mexico	2			5,899	5,899	16
New York and Pennsylvania	6			9,791,869	9,791,869	3
Oregon	1		893		893	19
South Dakota	1	22,146			22,146	13
Utah	10	[5] 3,247,967		878,844	4,126,811	6
Washington	1	2,201			2,201	17
Wisconsin	3	1,551,894			1,551,894	9
Wyoming	2	647,762		2,231	649,993	12
Total	[2] 342	105,429,715	[2] 10,966,714	[2] 29,729,541	[2] 146,125,970	
Percent of total		72.1	7.5	20.4	100.0	
1957						
Alabama	[1] 47	4,916,430	5,447,849		10,364,279	4
Arkansas	1		6,973		6,973	16
California	6	(6)		(6)	(6)	7
Colorado	2		(6)		(6)	17
Georgia	23		1,704,019		1,704,019	9
Idaho	1			(6)	(6)	19
Michigan	33	15,022,408			15,022,408	2
Minnesota	143	87,611,491	(7)	[7] 18,516,801	106,128,292	1
Mississippi	1		160		160	23
Missouri	42	439,852	281,427		721,279	13
Montana	2	26,297		9,241	35,538	15
Nevada	11	205,319		765,193	970,512	11
New Jersey	4	(7)		[7] 1,710,246	1,710,246	8
New Mexico	2			650	650	21
New York and Pennsylvania	6			10,406,036	10,406,036	3
Oregon	1		(6)		(6)	22
South Dakota	1	(6)			(6)	20
Tennessee	3	(6)	(6)		(6)	14
Texas	4		(6)		(6)	6
Utah	10	[7] 4,245,038		(7)	4,245,038	5
Washington	1	3,591			3,591	18
Wisconsin	3	1,618,347			1,618,347	10
Wyoming	2	702,277		33,857	736,134	12
Undistributed		61,236	3,967,818	3,122,738	7,151,792	
Total	349	114,852,286	11,408,246	34,564,762	160,825,294	
Percent of total		71.4	7.1	21.5	100.0	

[1] Excludes an undetermined number of small pits. Output of these pits included with tonnage given.
[2] Revised figure.
[3] Semialtered magnetite containing various proportions of hematite.
[4] Small amount of hematite included with magnetite.
[5] Hematite mixed with a small quantity of magnetite.
[6] Included with "Undistributed" to avoid disclosing confidential company data.
[7] Varieties of ore not shown separately (quantities are small) are combined with other varieties mined in the same State.

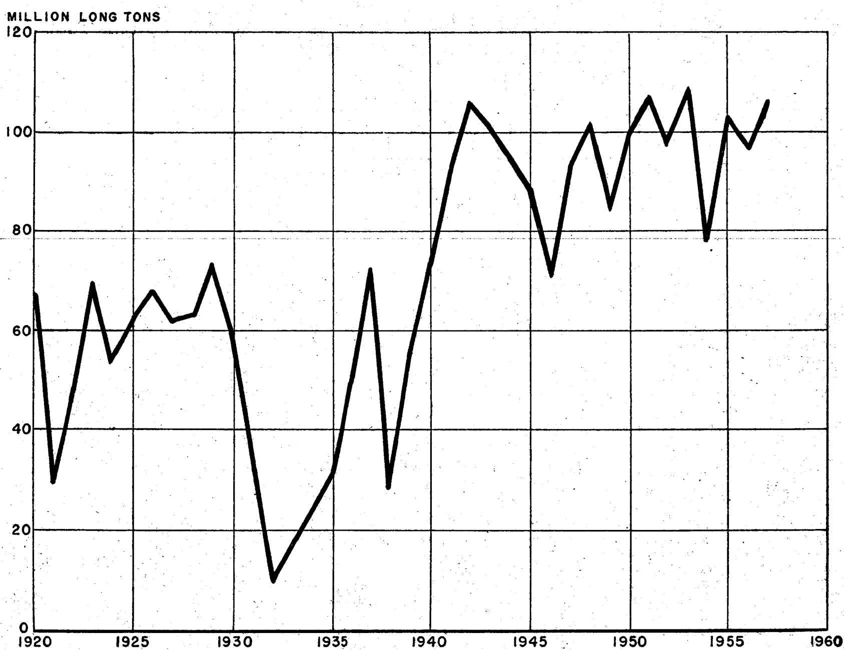

FIGURE 1.—Production of iron ore in the United States, 1920–57.

TABLE 4.—Crude iron ore mined in the United States, 1956–57, by States and mining methods, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1956			1957		
	Open pit	Underground	Total	Open pit	Underground	Total
Alabama	5,274,327	4,396,612	9,670,939	5,548,782	4,815,497	10,364,279
Arkansas	[1 2] 49,155		[1 2] 49,155	6,973		6,973
California	3,451,902		3,451,902	([3] [4])	([4])	([3])
Colorado	([1])		([1])	([3])		([3])
Georgia	1,371,760		1,371,760	1,704,019		1,704,019
Idaho	714		714	([3])		([3])
Kentucky	1,796		1,796			
Michigan	2,269,608	11,716,343	13,985,951	([5])	15,022,408	15,022,408
Minnesota	92,338,296	2,174,078	94,512,374	103,529,263	2,599,029	106,128,292
Mississippi	([1])		([1])	160		160
Missouri	[6] 3,808,731	405,320	[6] 4,214,051	282,944	438,335	721,279
Montana	11,643		11,643	35,538		35,538
Nevada	872,588		872,588	970,512		970,512
New Jersey		1,831,391	1,831,391		1,710,246	1,710,246
New Mexico	5,899		5,899	650		650
New York and Pennsylvania	6,057,197	3,734,672	9,791,869	6,709,116	3,696,920	10,406,036
Oregon	893		893	([3])		([3])
South Dakota	22,146		22,146	([3])		([3])
Tennessee	([6])		([6])	([3])		([3])
Texas	([6])		([6])	([3])		([3])
Utah	4,126,811		4,126,811	4,245,038		4,245,038
Washington	2,201		2,201	3,591		3,591
Wisconsin	84,732	1,467,162	1,551,894	([5])	1,618,347	1,618,347
Wyoming	2,231	647,762	649,993	33,857	702,277	736,134
Undistributed [3]				7,151,792		7,151,792
Total	[2] 119,752,630	26,373,340	[2] 146,125,970	130,222,235	30,603,059	160,825,294
Percent of total	81.9	18.1	100.0	81.0	19.0	100.0

[1] Mississippi and Colorado included with Arkansas.
[2] Revised figure.
[3] Included with "Undistributed" to avoid disclosing individual company data.
[4] Included with open pit.
[5] Included with underground.
[6] Tennessee and Texas included with Missouri.

TABLE 5.—Crude iron ore shipped from mines in the United States, 1956–57, by States and disposition, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1956			1957		
	Direct to consumers	To beneficiation plants	Total	Direct to consumers	To beneficiation plants	Total
Alabama	2,825,867	6,817,750	9,643,617	3,564,447	6,769,937	10,334,384
Arkansas	------------	[1] [2] 49,155	[1] [2] 49,155	------------	6,973	6,973
California	1,063,523	2,396,599	3,460,122	(3)	(3)	(3)
Colorado	(1)	------------	(1)	(3)	------------	(3)
Georgia	18,060	1,353,700	1,371,760	(4)	[4] 1,704,019	1,704,019
Idaho	714	------------	714	(3)	------------	(3)
Kentucky	------------	1,796	1,796	------------	------------	------------
Michigan	12,031,612	1,435,884	13,467,496	(4)	14,546,637	14,546,637
Minnesota	35,380,111	59,425,280	94,805,391	37,281,090	68,439,410	105,720,500
Mississippi	------------	(1)	(1)	------------	120	120
Missouri	[5] 85,403	[5] 4,128,648	[5] 4,214,051	------------	721,279	721,279
Montana	11,643	------------	11,643	35,538	------------	35,538
Nevada	916,592	------------	916,592	539,133	427,065	966,198
New Jersey	144,663	1,698,960	1,843,623	(4)	1,790,978	1,790,978
New Mexico	3,120	2,779	5,899	150	------------	150
New York and Pennsylvania	39,151	9,739,262	9,778,413	(4)	10,520,054	10,520,054
Oregon	893	------------	893	(3)	------------	(3)
South Dakota	22,146	------------	22,146	(3)	------------	(3)
Tennessee	(5)	(5)	(5)	(3)	(3)	(3)
Texas	(5)	(5)	(5)	------------	(3)	(3)
Utah	4,001,739	------------	4,001,739	4,155,988	------------	4,155,988
Washington	2,201	------------	2,201	3,591	------------	3,591
Wisconsin	1,488,067	750	1,488,817	1,576,057	------------	1,576,057
Wyoming	647,762	2,231	649,993	702,277	33,857	736,134
Undistributed [3]	------------	------------	------------	1,586,347	5,562,752	7,149,099
Total	[2] 58,683,267	[2] 87,052,794	[2] 145,736,061	49,444,618	110,523,081	159,967,699
Percent of total	40.0	60.0	100.0	30.9	69.1	100.0

[1] Mississippi and Colorado included with Arkansas.
[2] Revised figure.
[3] Included with "Undistributed" to avoid disclosing confidential company data.
[4] Included with ore shipped to beneficiation plants.
[5] Tennessee and Texas included with Missouri.

Usable ore is that produced by both mines and beneficiating plants, measured in the form shipped to the consumer. Heretofore, the forms of usable ore have been called either direct-shipping ore, concentrate, or sinter. The term "sinter" covered all material that had been treated to form lump, including material called nodules, pellets, or briquets by the iron-ore industry. The practice has caused misunderstanding, because most fine iron-bearing material treated at steel mills before smelting is sintered and this product is also known as sinter. To avoid further misunderstanding, usable ore that previously was classified as "sinter" is now classified as "agglomerate." This broader term includes not only sinter produced by sintering but also nodules, pellets, briquets, and any other glomerule made from fine-grained ore or concentrate. Frequently, agglomerating facilities are part of the beneficiating plants, and the usable ore shipped from these plants is measured in the form of agglomerates. The product of beneficiation plants that do not have agglomerating facilities will continue to be measured in the form of concentrate. Usable ore, then, will comprise direct-shipping ore, iron-ore concentrate, and iron-ore agglomerate. Agglomerate made at consuming plants will continue to be excluded from usable-iron-ore tables.

Production of usable iron ore in 1957 increased 9 percent compared with 1956. The Lake Superior district, as usual, was the principal producing district with 80 percent of the total, increasing production 7 percent over 1956. The Western States produced 9 percent of the total, and increased their output 25 percent over 1956. California, Missouri, Utah, Wyoming, Montana, and Nevada (in the order named) increased their output significantly, contributing to the big increase in usable-iron-ore production in the Western States. The Southeastern States produced 6 percent of the total domestic output of usable iron ore in 1957 and increased their production 13 percent over 1956. The Northeastern States produced 5 percent of the total and increased their output only 2 percent, owing to the preponderance of iron ore produced from underground mines. Usable-iron-ore production in all mining districts was affected by reduced steel production in the last half of the year. Small mine operators in the South and Southwest and a few independent mines in the Lake Superior district cut production early in the fall. As a large part of the output of iron ore is sold under annual contracts and demand for ore in the North and West did not decrease much until October, usable-iron-ore output was not much below that in a year of normal industrial activity.

TABLE 6.—Iron ore mined in the United States, 1956–57, by mining districts and varieties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

Variety of ore	Lake Superior district	South-eastern States	North-eastern States	Western States	Total
1956					
Crude ore:					
Hematite	95,752,685	4,469,272	768,095	4,358,876	105,348,928
Brown ore	[1] 613,499	6,648,206	------------	[2] 3,785,796	[2] 11,047,501
Magnetite	13,684,035	------------	10,855,165	[2] 5,190,341	[2] 29,729,541
Total	110,050,219	11,117,478	11,623,260	[2] 13,335,013	[2] 146,125,970
Usable iron ore:					
Hematite	72,376,985	4,323,140	252,063	4,191,421	81,143,609
Brown ore	[1] 395,026	1,711,498	------------	[2] 1,095,926	[2] 3,202,450
Magnetite	5,045,102	------------	4,615,035	[2] 2,785,925	[2] 12,446,062
Total	77,817,113	6,034,638	4,867,098	[2] 8,073,272	[2] 96,792,121
1957					
Crude ore:					
Hematite	104,252,246	4,956,452	(3)	4,657,366	113,866,064
Brown ore	(3)	7,216,868	------------	4,191,378	11,408,246
Magnetite	[1 3] 18,516,801	------------	[3] 12,116,282	4,917,901	35,550,984
Total	122,769,047	12,173,320	12,116,282	13,766,645	160,825,294
Usable ore:					
Hematic	76,537,631	4,890,673	(3)	4,466,076	85,894,380
Brown ore	(3)	1,914,152	------------	1,352,212	3,266,364
Magnetite	[1 3] 6,993,370	------------	[3] 4,961,470	4,222,456	16,177,296
Total	83,531,001	6,804,825	4,961,470	10,040,744	105,338,040

[1] Includes brown ore produced in Fillmore County, Minn., not in the true Lake Superior district.
[2] Revised figure.
[3] Included with magnetite to avoid disclosing confidential company data.

TABLE 7.—Iron ore produced in the United States, 1956–57, by States and types of product, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1956					1957				
	Direct shipping ore	Agglomerates [1]	Concentrates	Total	Iron content, natural (percent)	Direct shipping ore	Agglomerates [1]	Concentrates	Total	Iron content, natural (percent)
Mined ore:										
Alabama	2,847,650	551,000	2,227,942	5,626,592	38.89	4,122,733	725,000	1,443,230	6,290,963	38.10
Arkansas			[2 3] 49,155	[2 3] 49,155	[2] 43.38			6,973	6,973	42.06
California	1,047,486			1,047,486	49.92	(4)		(4)	(4)	(4)
Colorado	(3)		(3)	(3)	(2)	(4)			(4)	(4)
Georgia	18,060		338,675	356,735	41.52	(5)		[5] 457,672	457,672	42.01
Idaho	714			714	66.0	(4)			(4)	
Kentucky			161	161	38.26					
Michigan	12,544,598	55,757	442,909	13,043,264	51.72	[5] 13,626,313	(5)	(5)	13,626,313	52.16
Minnesota	35,299,467	5,539,107	22,383,837	63,222,411	51.49	37,996,598	7,272,385	23,017,358	68,286,341	52.49
Mississippi			(2)	(2)				160	160	39.38
Missouri	[6] 85,403	(6)	[6] 1,249,490	[6] 1,334,893	[6] 48.29			529,989	529,989	49.36
Montana	11,643			11,643	49.90	35,538			35,538	59.62
Nevada	872,588			872,588	58.61	543,447		365,858	909,305	60.15
New Jersey	769,375		164,190	933,565	63.20	(5)		[5] 885,248	885,248	65.21
New Mexico	5,899			5,899		650			650	60.92
New York and Pennsylvania	39,151	3,408,315	486,067	3,933,533	61.78	(5)	3,582,206	[5] 494,016	4,076,222	61.79
Oregon	893			893	60.00	(4)			(4)	
South Dakota	22,146			22,146	39.50	(4)			(4)	(4)
Tennessee	(6)		(6)	(6)	(6)	(4)		(4)	(4)	(4)
Texas	(6)	(6)	(6)	(6)	(6)	(4)	(5)	(4 5)	(4)	(4)
Utah	4,126,811			4,126,811	52.37	4,245,038			4,245,038	52.08
Washington	2,201			2,201		3,591			3,591	
Wisconsin	1,551,144		294	1,551,438	52.50	1,618,347			1,618,347	52.32
Wyoming	649,993			649,993	47.80	702,277		33,857	736,134	46.27
Undistributed						[4] 1,608,490		2,021,066	3,629,556	37.41
Total	[3] 59,895,222	9,554,179	[3] 27,342,720	[3] 96,792,121	51.31	64,503,022	11,579,591	29,255,427	105,338,040	51.27
Byproduct ore [7]		1,085,210		1,085,210	66.14		810,379		810,379	66.77
Grand total	[3] 59,895,222	10,639,389	[3] 27,342,720	[3] 97,877,331	51.47	64,503,022	12,389,970	29,255,427	106,148,419	51.39

[1] Exclusive of agglomerates produced at consuming plants. Small quantity of agglomerates included with concentrates in 1956 to avoid disclosing confidential company data.
[2] Mississippi and Colorado included with Arkansas. Also includes small quantity of direct shipping ore.
[3] Revised figure.
[4] State totals not shown separately are combined under "Undistributed."
[5] Types of ore not shown separately are combined with other types produced in the same State.
[6] Tennessee and Texas included with Missouri.
[7] Cinder and sinter obtained from treating pyrites.

TABLE 8.—Iron ore produced in the United States, 1956–57, by States and varieties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1956				1957			
	Hematite	Brown ore	Magnetite	Total	Hematite	Brown ore	Magnetite	Total
Alabama	4, 279, 157	1, 347, 435		5, 626, 592	4, 850, 651	1, 440, 312		6, 290, 963
Arkansas		[1] [2] 49, 155		[1] [2] 49, 155		6, 973		6, 973
California	(3)		[3] 1, 047, 486	1, 047, 486	(4)		(4)	(4)
Colorado		(1)		(1)		(4)		(4)
Georgia		356, 735		356, 735		457, 672		457, 672
Idaho			714	714			(4)	(4)
Kentucky		161		161				
Michigan	13, 043, 264			13, 043, 264	13. 626, 313			13, 626, 313
Minnesota	57, 782, 283	395, 026	5, 045, 102	63, 222, 411	61, 292, 971	(5)	[5] 6, 993, 370	68, 286, 341
Mississippi		(1)		(1)		160		160
Missouri	[6] 281, 848	[6] 1, 053, 045		[6] 1, 334, 893	245, 562	281, 427		529, 989
Montana	3, 358		8, 285	11, 643	26, 297		9, 241	35, 538
Nevada	30, 122		842, 466	872, 588	205, 319		703, 986	909, 305
New Jersey	252, 063		681, 502	933, 565	(5)		[5] 885. 248	885, 248
New Mexico			5, 899	5, 899			650	650
New York and Pennsylvania			3, 933, 533	3, 933, 533			4, 076, 222	4, 076, 222
Oregon		893		893		(4)		(4)
South Dakota	22, 146			22, 146	(4)			(4)
Tennessee	(6)	(6)		(6)	(4)	(4)		(4)
Texas	(6)	(6)		(6)		(4)		(4)
Utah	3, 247, 967		878, 844	4, 126, 811	[5] 4, 245, 038		(5)	4, 245, 038
Washington	2, 201			2, 201	3, 591			3, 591
Wisconsin	1, 551, 438			1, 551, 438	1, 618, 347			1, 618, 347
Wyoming	647, 762		2, 231	649, 993	702, 277		33, 857	736, 134
Undistributed [3]					61, 236	1, 079, 820	2, 488, 500	3, 629, 556
Total	81, 143, 609	[2] 3, 202, 450	[2] 12, 446, 062	[2] 96, 792, 121	86, 877, 602	3, 266, 364	15, 191, 074	105, 338, 040
Byproduct ore [7]				1, 085, 210				810, 379
Grand total	81, 143, 609	[2] 3, 202, 450	[2] 12, 446, 062	[2] 97, 887, 331	86, 877, 602	3, 266, 364	15, 191, 074	106, 148, 419

[1] Mississippi and Colorado included with Arkansas to avoid disclosing confidential company data.
[2] Revised figure.
[3] Small tonnage of hematite included with magnetite.
[4] State totals not shown separately are combined under "Undistributed."
[5] Varieties of ore not shown separately are combined with other varieties produced in the same State.
[6] Tennessee and Texas included with Missouri.
[7] Cinder and sinter obtained from treating pyrites.

Direct-shipping ore comprised 61 percent of the usable-iron-ore output, exclusive of byproduct ore; iron-ore concentrate comprised 28 percent and iron-ore agglomerates 11 percent. The proportion of agglomerate to total output in 1957 rose only 1 percent compared with 1956, but agglomerate production was 2 million long tons more in 1957 than in 1956 (an increase of 21 percent) and 5 million tons more than in 1955 (an increase of 79 percent in 2 years). Most of this increase resulted from newly opened taconite mines in Minnesota and jaspilite mines in Michigan.

The principal States producing usable iron ore ranked in the same order and had the same percentages of the total output in 1957 as in 1956. Minnesota ranked first, with 65 percent of the total; Michigan ranked second, with 13 percent; Alabama was third, with 6 percent; Utah was fourth, with 4 percent; and New York and Pennsylvania together ranked fifth, with 4 percent. Domestic output of usable iron ore in 1957 contained an average of 51.4 percent iron, compared with 51.5 percent in 1956, 51.2 percent in 1955, 50.9 percent in 1954, and 50.4 percent in 1953. More extensive use of beneficiation was responsible for maintaining the high average iron content and the high rate of production in 1957.

TABLE 9.—Shipments of iron ore in the United States in 1957, by States and uses, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	Iron and steel			Cement	Paint	Miscellaneous	Total	
	Direct-shipping ore	Agglomerates [1]	Concentrates				Quantity	Value
Mined ore:								
Alabama	3,564,447	(2)	[2] 2,658,437				6,222,884	$40,518,329
Arkansas			6,973				6,973	34,560
California	(2 3)		(2)	(2)			(3)	(3)
Colorado	(2 3)				(2)	(2)	(3)	(3)
Georgia	(2)		[2] 442,672				442,672	2,109,352
Idaho	(2 3)					(2)	(3)	(3)
Michigan	[2] 13,122,875	(2)	(2)		(2)		13,122,875	111,483,808
Minnesota	37,281,090	6,835,830	23,539,120				67,656,040	541,473,783
Mississippi			120				120	720
Missouri			529,989				529,989	4,625,209
Montana	35,538						35,538	(3)
Nevada	539,133		365,322				904,455	5,340,639
New Jersey	(2)		[2] 876,605				876,605	16,667,716
New Mexico	150						150	1,055
New York	(2)	2,878,999	[2] 449,905	(2)		(2)	3,328,904	44,567,403
Oregon	(2 3)					(2)	(3)	(3)
Pennsylvania		(3)	(3)				(3)	(3)
South Dakota	(2 3)			(2)			(3)	(3)
Tennessee	(3)		(3)				(3)	(3)
Texas		(3)	(2 3)	(2)			(3)	(3)
Utah	[2] 4,155,988			(2)			4,155,988	30,383,465
Washington				3,591			3,591	(3)
Wisconsin	[2] 1,576,057					(2)	1,576,057	(3)
Wyoming	702,277					33,857	736,134	(3)
Undistributed [3]	2,554,612	1,047,583	955,752				4,557,947	68,496,891
Total	63,532,167	10,762,412	29,824,895	3,591		33,857	104,156,922	865,702,930
Byproduct ore [4]							812,949	9,182,042
Grand total	63,532,167	10,762,412	29,824,895	3,591		33,857	104,969,871	874,884,972

[1] Exclusive of agglomerates produced at consuming plants.
[2] Iron-ore uses not shown separately are combined with other uses in the same State to avoid disclosing individual company confidential data.
[3] Tonnages and values not shown separately are combined with "Undistributed."
[4] Cinder and sinter obtained from treating pyrites.

The values of iron-ore shipment shown in table 9 are those reported by producers at the mines, exclusive of transportation costs but including all costs of mining, concentration, and agglomeration. The average value at the mines in 1957 was $8.33 per long ton. Shipments are classified by uses according to data submitted by the producer; therefore, the classification may not be precise because the shipper does not control the end use.

Active iron-ore mines in the United States, exclusive of many small open-pit mines that operated intermittently, totaled 349 in 1957. Forty mines each produced more than 1 million long tons of crude ore; 44 mines produced ½ to 1 million tons; 82 mines produced 100 thousand to ½ million tons; and the remaining 183 mines each produced less than 100 thousand long tons of crude ore. The forty 1-million-ton mines produced 64 percent of the crude ore and 61 percent of the usable ore; the forty-four ½- to 1-million-ton mines produced 19 percent of the crude and 22 percent of the usable ore; the eighty-two 100-thousand- to ½-million-ton mines produced 14 percent of the crude and 15 percent of the usable ore; and the 183 small mines produced 3 percent of the crude ore and only 2 percent of the usable iron ore.

TABLE 10.—Iron ore mined in the United States in 1957, by States and counties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State and county	Active mines	Crude ore	Usable ore
Alabama:			
Barbour	2	445,000	111,069
Bibb	1	903,000	225,563
Blount	1		
Butler	9	987,800	246,811
Calhoun	4	17,205	4,277
Conecuh	1	1,085,900	271,649
Crenshaw	2		
Etowah	2	1,371,415	422,762
Franklin	5		
Jefferson	9	4,851,713	4,785,934
Pike	6	590,682	148,970
St. Clair	2		
Shelby	1	111,564	73,928
Talladega	1		
Tuscaloosa	1		
Total	47	10,364,279	6,290,963
Arkansas: Fulton	1	6,973	6,973
California:			
Riverside	1	(1)	(1)
San Bernardino	5		
Total	6	(1)	(1)
Colorado: San Miguel	2	(1)	(1)
Georgia:			
Bartow	8	731,019	213,880
Polk	7	513,000	128,521
Stewart	6	460,000	115,271
Webster	2		
Total	23	1,704,019	457,672
Idaho: Washington	1	(1)	(1)
Michigan:			
Baraga	1	321,924	142,775
Dickinson	1		
Gogebic	6	14,700,484	13,483,538
Iron	11		
Marquette	14		
Total	33	15,022,408	13,626,313
Minnesota:			
Crow Wing	14	3,436,590	2,400,255
Fillmore [2]	2		
Itasca	28	35,456,644	16,393,437
St. Louis	99	67,235,058	49,492,649
Total	143	106,128,292	68,286,341
Mississippi: Webster	1	160	160
Missouri:			
Crawford	1	5,211	5,211
Dent	1		
Douglas	2		
Greene	1		
Howell	23	137,670	137,670
Miller	1	105,086	105,086
Oregon	5		
Ozark	1	447,265	255,975
Reynolds	1		
Ripley	1		
St. Francois	1		
Wayne	4	26,047	26,047
Total	42	721,279	529,989
Montana:			
Broadwater	1	35,538	35,538
Judith Basin	1		
Total	2	35,538	35,538
Nevada:			
Churchill	1	501,325	464,638
Douglas	1		
Humboldt	3		
Nye	1	469,187	444,667
Pershing	5		
Total	11	970,512	909,305
New Jersey:			
Morris	3	1,710,246	885,248
Warren	1		
Total	4	1,710,246	885,248
New Mexico:			
Grant	1	650	650
Socorro	1		
Total	2	650	650
New York:			
Clinton	1	[3] 10,406,036	[3] 4,076,222
Essex	3		
St. Lawrence	1		
Total	5	[3] 10,406,036	[3] 4,076,222
Oregon: Columbia	1	(1)	(1)
Pennsylvania: Lebanon	1	(3)	(3)
South Dakota: Lawrence	1	(1)	(1)
Tennessee:			
Blount	1	(1)	(1)
McMinn	1		
Roane	1		
Total	3	(1)	(1)
Texas:			
Cass	1	(1)	(1)
Cherokee	2		
Morris	1		
Total	4	(1)	(1)
Utah: Iron	10	4,245,038	4,245,038
Washington: Stevens	1	3,591	3,591
Wisconsin:			
Florence	1	1,618,347	1,618,347
Iron	2		
Total	3	1,618,347	1,618,347
Wyoming:			
Albany	1	736,134	736,134
Platte	1		
Undistributed [1]	------	7,151,792	3,629,556
Grand total	349	160,825,294	105,338,040

[1] State totals not shown separately are included under "Undistributed."
[2] Not in the true Lake Superior district.
[3] Pennsylvania included with New York.

TABLE 11.—Iron ore produced in the Lake Superior district, 1854–1957, by ranges, in long tons

(Exclusive after 1905 of ore containing 5 percent or more manganese)

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1952	267, 560, 381	237, 124, 941	280, 904, 750	87, 812, 079	1, 850, 244, 021	49, 431, 025	2, 773, 077, 197
1953	5, 785, 118	4, 604, 765	5, 179, 608	1, 643, 039	75, 324, 236	2, 900, 579	95, 437, 345
1954	4, 670, 603	3, 640, 320	3, 931, 233	1, 371, 967	45, 724, 827	1, 497, 296	60, 836, 246
1955	5, 412, 956	4, 126, 417	4, 359, 761	1, 454, 365	64, 860, 493	2, 770, 738	82, 984, 730
1956	5, 869, 171	4, 348, 683	4, 376, 848	1, 284, 536	59, 346, 091	2, 242, 216	77, 467, 545
1957	6, 557, 010	4, 250, 269	4, 437, 381	(1)	[1] 65, 886, 086	[2] 2, 400, 255	83, 531, 001
Total	295, 855, 239	258, 095, 395	303, 189, 581	93, 565, 986	2, 161, 385, 754	61, 242, 109	3, 173, 334, 064

[1] Included with Mesabi range to avoid disclosing individual company data.
[2] Includes production from Spring Valley district not in the true Lake Superior district.

TABLE 12.—Average analyses of total tonnages (bill-of-lading weights) of all grades of iron ore from all ranges of Lake Superior district, 1948–52 (average) and 1953–57

[Lake Superior Iron Ore Association]

Year	Long tons	Content (natural), percent				
		Iron	Phosphorus	Silica	Manganese	Moisture
1948–52 (average)	80, 222, 546	50. 40	0. 096	9. 76	0. 76	11. 12
1953	95, 438, 743	50. 37	. 090	10. 25	. 75	10. 90
1954	59, 585, 720	50. 86	. 095	10. 22	. 70	10. 47
1955	85, 404, 796	50. 63	. 099	10. 11	. 72	10. 81
1956	76, 407, 170	51. 34	. 090	9. 78	. 67	10. 39
1957						

TABLE 13.—Beneficiated iron ore shipped from mines in the United States, 1948–52 (average) and 1953–57, in long tons

(Exclusive of ore containing 5 percent or more manganese)

Year	Beneficiated	Total	Proportion of beneficiated to total (percent)
1948–52 (average)	25, 738, 811	98, 927, 170	26. 0
1953	35, 895, 529	117, 197, 537	30. 6
1954	27, 756, 129	76, 125, 664	36. 5
1955 [1]	36, 181, 983	105, 240, 644	34. 4
1956 [1]	38, 259, 926	96, 945, 017	39. 4
1957	42, 027, 130	104, 156, 922	40. 3

[1] Revised figures.

CONSUMPTION AND USES

Sixty-eight percent of the usable iron ore consumed in the United States in 1957 was used in blast furnaces, 26 percent in agglomerating plants, 6 percent in steel furnaces, and less than 1 percent in ferroalloy furnaces and for nonmetallurgical uses. Total consumption of iron ore increased 3 percent over 1956. Consumption in agglomerating plants increased 21 percent, but consumption in ferroalloy furnaces decreased 40 percent. The increase in ore consumed in agglomerating plants was due to more extensive use of beneficiation at the mines and increased use of sintering to agglomerate fine ore at the steel mills. The 40-percent decline in ferroalloy-furnace consumption was more the result of timing than of an actual decrease in ferroalloy output. Most ferroalloy furnaces were operated intermittently, depending on demand and producers' inventories. This practice results in wide fluctuations in reported annual consumption of iron ore.

TABLE 14.—Consumption of iron ore in the United States in 1957, by States and uses, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	Metallurgical uses				Miscellaneous uses			Total
	Iron blast furnaces	Steel furnaces	Agglomerating plants	Ferroalloy furnaces	Cement	Paint	Other	
Alabama				(1)	27,551	------	------	
Kentucky	9,119,355	420,785	2,808,734	------	------	------	------	12,427,228
Tennessee				------	(1)	------	------	
Texas				------	50,803	------	------	
California				------	37,181	------	------	
Colorado	3,687,500	562,337	2,720,837	------	------	------	(1)	7,007,855
Utah				------	(1)	------	------	
Delaware				------	------	------	------	9,740,243
Maryland	5,148,895	704,694	3,886,654	------	(1)	------	------	
West Virginia				------	(1)	------	------	
Illinois	8,891,920	520,971	521,875	------	(1)	------	------	9,934,766
Indiana	12,164,145	846,513	1,024,620		------	------	------	14,035,278
Massachusetts	5,114,330	561,596	4,460,166	------	------	------	------	10,234,452
New York				80,670	17,690	------	(1)	
Michigan	5,443,673	322,277	8,978,894	------	------	(1)	------	14,744,844
Minnesota				------	------	(1)	------	
Oregon	------	------	------	(1)	(1)	------	(1)	
Ohio	17,107,599	1,400,274	2,755,871	180,784	(1)	------	------	21,444,528
Pennsylvania	20,746,509	2,185,784	6,604,904	2,086	27,629	------	------	29,566,912
Undistributed [2]	------	------	------	1,052	97,306	25,882	114,888	239,128
Total	87,423,926	7,525,231	33,762,555	264,592	258,160	25,882	114,888	129,375,234

[1] Included with "Undistributed."
[2] Includes States indicated by footnote 1 plus the following: For cement, Arkansas, Florida, Georgia, Idaho, Iowa, Kansas, Louisiana, Missouri, Montana, Oregon, South Dakota, Virginia, and Washington; for other uses, New Jersey, Wisconsin, Wyoming, and Idaho.

Agglomerate (Sinter)—In previous Iron-Ore chapters of the Minerals Yearbook all iron-bearing fine-grained material that had been massed or gathered together to form lumps was called sinter, as sintering formerly was the principal method used to make the lumps. This sinter included some material that properly could have been classified as either nodules, pellets, or briquets. The statistical data on production and consumption of nodules, pellets, and briquets were not accurate enough nor were the quantities involved large enough to warrant changing past practice. In 1957, however, production and consumption data on sinter, nodules, pellets, and briquets were essentially complete and precise, and the term "agglomerate" is used in this issue to describe these items as a group. Individually, the materials are designated by their industry names.

TABLE 15.—Production and consumption of agglomerate in the United States in 1957, by States, in long tons

State	Agglomerate produced	Agglomerate consumed [1]	
		In blast furnaces	In steel furnaces
Alabama, Kentucky, Tennessee, Texas	2,789,815	2,862,625	55,998
California, Colorado, Utah	2,626,192	2,632,802	----------
Delaware, Maryland, West Virginia	3,827,688	4,163,744	---------- (Delaware, Maryland); (2) (West Virginia)
Illinois	1,019,629	1,137,703	742,801 (Illinois and Indiana)
Indiana	2,300,258	2,282,696	
New York	4,532,337	3,037,925	(3)
Michigan, Minnesota	8,656,456	1,204,645	(2)
Ohio	3,702,446	4,937,729	[2] 435,068
Pennsylvania	8,282,476	9,553,340	[3] 492,952
Total	37,737,297	31,813,209	1,726,819

[1] Includes 1,208,582 long tons of agglomerate produced in foreign countries.
[2] West Virginia, Michigan, and Minnesota included with Ohio.
[3] New York included with Pennsylvania.

In table 15, the 37,737,297 long tons of agglomerate produced included 6,575,498 tons of pellets, 221,145 tons of briquets, 29,356,169 tons of sinter, and 1,584,487 tons of unclassified agglomerate. The 31,813,209 long tons of agglomerate consumed in blast furnaces included 57 tons of nodules, 1,300,015 tons of pellets, 213,217 tons of briquets, 28,206,478 tons of sinter, 980,041 tons of unclassified agglomerate, and 1,113,402 tons of agglomerate produced in foreign countries. The 1,726,819 tons of agglomerate consumed in steel furnaces included 91,991 tons of pellets, 402,207 tons of nodules, 11,285 tons of briquets, 35,174 tons of unclassified agglomerate, and 95,180 tons of agglomerate produced in foreign countries.

STOCKS

Usable iron-ore stocks at mines on December 31, 1957, totaled 6.7 million long tons, about 1 million tons more than normal and 23 percent more than at the same time in 1956. The increase in mine stocks was the result of decreasing shipments from the Lake Superior district in the latter part of the year.

TABLE 16.—Stocks of usable iron ore at mines, Dec. 31, 1956–57, by States, in long tons

State	1956	1957	State	1956	1957
Alabama	28,453	96,532	New Jersey	31,789	40,262
California	47,958	(1)	New Mexico	----------	1,000
Colorado	365	----------	New York	217,855	164,681
Georgia	----------	15,000	Pennsylvania	8,703	(1)
Idaho	179	----------	Texas	145,868	(1)
Michigan	2,155,060	2,658,498	Utah	383,176	472,226
Minnesota	2,273,577	2,903,878	Wisconsin	162,507	204,797
Mississippi	----------	40			
Nevada	9,850	(1)	Total	[2] 5,465,340	6,718,263

[1] Included in United States total.
[2] Revised figure.

According to the American Iron Ore Association, stocks of ore at United States docks (principally Lake Erie docks) totaled 5.2 million long tons on Dec. 31, 1957. Consuming-plant inventories of iron ore plus agglomerates (including manganiferous ore) totaled 54.0 million tons. Thus, United States stock of iron ore and agglomerates at the end of the year totaled 65.9 million long tons.

PRICES

The average value of domestically produced iron ore per long ton, f. o. b. mines, was $8.33 in 1957 compared with $7.76 in 1956, $7.12 in 1955, and $6.99 in 1954. These data are taken from producers' statements and probably approximate the commercial selling price less the cost of mine-to-market transportation. In all instances, the reported value includes all expense of mining and beneficiating the ore. In the Lake Superior district the mine value is the Lake Erie price less freight from mines to lower Lake ports.

E&MJ Metal and Mineral Markets quoted Lake Superior iron ore, 51.5 percent iron, per long ton, lower Lake ports, in 1957 as follows: Mesabi Non-Bessemer $11.45, Old Range Non-Bessemer $11.70, Mesabi Bessemer $11.60, Old Range Bessemer $11.85. The same

TABLE 17.—Average value per long ton of iron ore at mines in the United States, 1956–57

(Exclusive of ore containing 5 percent or more manganese)

State	1956							1957						
	Direct			Concentrates				Direct			Concentrates			
	Hematite	Brown ore	Magnetite	Hematite	Brown ore	Magnetite	Sinter	Hematite	Brown ore	Magnetite	Hematite	Brown ore	Magnetite	Sinter
Alabama	$5.97	$6.38	--	$7.20	$5.23	--	(1)	$6.61	$6.20	--	$8.07	$5.40	--	(2)
Arkansas	--	--	--	--	(2)	--	--	--	--	--	--	(2)	--	--
California	(2)	--	(2)	(2)	--	--	--	(2)	--	(2)	--	--	(2)	--
Colorado	--	(1)	--	--	--	--	--	--	(2)	--	--	--	--	--
Georgia	--	2.96	--	--	4.59	--	--	--	(2)	--	--	4.96	--	--
Idaho	--	--	--	--	--	--	--	--	--	(2)	--	--	--	--
Kentucky	--	--	--	--	(2)	--	--	--	--	--	--	--	--	--
Michigan	7.80	--	--	8.36	--	--	(1)	8.02	--	--	8.81	--	--	(2)
Minnesota	6.92	6.80	--	7.54	6.67	--	(1)	7.64	--	--	7.97	(2)	(2)	(2)
Mississippi	--	--	--	--	(2)	--	--	--	--	--	--	6.01	--	--
Missouri	--	--	--	(2)	(2)	--	--	--	--	--	(2)	(2)	--	--
Montana	--	--	(1)	--	--	--	--	(2)	--	(2)	--	--	--	--
Nevada	(2)	--	(2)	--	--	--	--	6.47	--	$6.51	--	--	$5.03	--
New Jersey	--	--	(1)	(1)	--	$16.84	--	--	--	14.64	(2)	--	17.46	--
New Mexico	--	--	(2)	--	--	(2)	--	--	--	7.03	--	--	--	--
New York	--	--	(1)	--	--	10.75	$13.18	--	--	14.40	--	--	11.09	$13.69
Oregon	--	(2)	--	--	--	--	--	--	(2)	--	--	--	--	--
Pennsylvania	--	--	--	--	--	(1)	(1)	--	--	--	--	--	(2)	(2)
South Dakota	(2)	--	--	--	--	--	--	(2)	--	--	--	--	--	--
Tennessee	(2)	--	--	--	(2)	--	--	(2)	--	--	--	(2)	--	--
Texas	--	(2)	--	--	(2)	--	(2)	--	(2)	--	--	(2)	--	(2)
Utah	6.81	--	$6.90	--	--	--	--	7.31	--	7.32	--	--	--	--
Washington	(2)	--	--	--	--	--	--	(2)	--	--	--	--	--	--
Wisconsin	(2)	--	--	(2)	--	--	--	(2)	--	--	--	--	--	--
Wyoming	(2)	--	--	--	--	(2)	--	7.31	--	--	--	--	6.00	--
Undistributed [2]	7.92	5.57	2.70	10.47	10.46	5.00	10.12	7.49	3.95	9.17	18.01	8.73	9.82	10.64
Average all States [1]	7.12	5.52	5.80	7.89	6.70	13.74	11.00	7.64	4.05	8.52	8.19	6.71	10.97	11.39
Byproduct ore [3]	--	--	--	--	--	--	9.57	--	--	--	--	--	--	11.29

[1] Included with average for all States to avoid disclosing individual company data.
[2] Combined and shown under "Undistributed."
[3] Cinder and sinter obtained from treating pyrites.

publication quoted Eastern ores, foundry and basic, at 17 and 18 cents per long ton delivered at the furnaces; Swedish ore, 60 to 68 percent, contracts, at 25 cents plus per short ton, depending on grade; Brazilian ore per long ton, 68.5 percent iron, f. o. b. port of shipment, $14.60, premium for low-phosphorus ore.

Freight Rates.—Total freight charges from the Mesabi range to the Pittsburgh-Wheeling district via the Great Lakes were $5.98 per long ton in 1957 compared with $5.64 per ton in the last half of 1956. Component charges were: $1.31 Mesabi range to Duluth, including $0.17 dock-handling charge; $2.26 Duluth to Lake Erie ports, including $0.26 handling charge from hold to rail of vessel; and $2.41 Lake Erie ports to the Pittsburgh-Wheeling district, including $0.17 handling charge from vessel rail to car.

TRANSPORTATION

Iron ore continued to move at record rates over most of the waterways of the world throughout 1957, but in August the Japanese asked their suppliers to cut shipments 15 percent, and in October and November Great Lakes shipments were much below normal.

Great Lakes.—Iron-ore shipments on the Great Lakes in 1957 began on April 1, when the first ship was loaded at Escanaba, Mich., and ended on December 3, when the last ship was loaded at Superior, Wis.

A list of Canadian and United States Lake ports that serve the Lake Superior district, arranged in order of the quantity of iron ore handled in 1957,[3] follows:

Port	*Iron ore handled, long tons*
Superior, Wis	27, 415, 536
Duluth, Minn	17, 430, 495
Two Harbors, Minn	17, 143, 168
Escanaba, Mich	5, 907, 580
Silver Bay, Minn	5, 121, 172
Marquette, Mich	4, 620, 331
Ashland, Wis	3, 483, 740
Port Arthur, Ontario	2, 347, 692
Michipicoten, Ontario	1, 032, 483
Taconite Harbor, Minn	112, 537
Total	84, 614, 734

RESOURCES AND RESERVES

The iron-ore resources of the United States in 1957 were estimated to be about 75 billion long tons of crude ore.[4] About 10 of the 75 billion tons was classed as reserves; direct-shipping ore and concentrate obtainable from low-grade ore totaled 5½ billion long tons. The remaining 65 billion tons probably could yield approximately 25 billion tons of concentrate.

Iron-ore reserves of Michigan and Minnesota, given in tables 18 and 19, represent only taxable and State-owned reserves and not the total that may become available; taconite and jaspilite reserves are excluded. These reserves are recalculated each year as deposits are explored and mined; since 1944 they have been decreasing.

[3] Skillings' Mining Review, Lake Superior Iron Ore Shipments From Upper Lake Ports, 1957: Vol. 46, No. 37, Dec. 14, 1957, pp. 2, 25.

[4] U. S. Department of the Interior, Geological Survey Estimates United States Iron-Ore Resources: Inf. Service Release, July 15, 1957, 6 pp.

TABLE 18.—Iron-ore reserves in Michigan, Jan. 1, 1949–53 (average) and 1954–58, in thousand long tons

[Michigan Department of Conservation]

Range	1949–53 (average)	1954	1955	1956	1957	1958
Gogebic	31,742	28,607	31,326	30,810	26,209	25,187
Marquette	66,120	65,364	69,549	63,820	64,464	64,027
Menominee	59,355	60,086	59,322	58,284	63,536	60,877
Total Michigan	157,217	154,057	160,197	152,914	154,209	150,091

TABLE 19.—Unmined iron-ore reserves in Minnesota, May 1, 1948–52 (average) and 1953–57, in thousand long tons

[Minnesota Department of Taxation]

	1948–52 (average)	1953	1954	1955	1956	1957
Mesabi	895,139	839,733	825,292	787,992	739,971	697,267
Vermilion	11,836	12,989	12,063	11,307	10,449	9,641
Cuyuna	40,643	43,983	58,903	58,859	54,518	52,337
Total Lake Superior district (taxable)	947,618	896,705	896,258	858,158	804,938	759,245
Fillmore County	602	608	573	666	926	1,125
Morrison County	29					
Aitkin County	170	850	870	870	825	825
Mower County			118	118	118	118
State ore (not taxable)	3,040	117	117	117	2,352	2,629
Total Minnesota	951,459	898,280	897,936	859,929	809,159	763,942

FOREIGN TRADE

Iron ore imported for consumption in the United States in 1957 comprised almost one-fourth of the total domestic supply, establishing new import records in both tonnage and value. The total tonnage of imported iron ore was 11 percent more and the total value 14 percent more than the previous record of 1956.

Canada continued as the principal supplier of iron ore to the United States but by a narrow margin, as imports from Venezuela continued to increase whereas Canadian imports decreased slightly. Of the total quantity of iron ore imported, Canada and Venezuela each supplied 37 percent, Chile supplied 8 percent, Peru 7 percent, Brazil 4 percent, Liberia 3 percent, and 9 other countries together supplied the remaining 4 percent.

Most of the iron ore exported from the United States went to Canada. The Western States, principally Nevada, continued to export iron ore to Japan; the total value of these exports exceeded $10 million for the first time in history.

World iron-ore export-import statistics are given for 1955, because the statistical pattern of iron-ore transactions in international trade does not emerge with acceptable accuracy for at least 2 years. Preliminary data indicate that world trade in iron ore in 1957 was similar to that in 1955, except that 1957 was marked by increased imports into European Coal and Steel Community countries and by initial imports of high-grade Asian iron ore into Soviet satellite countries in Europe.

TABLE 20.—Iron ore imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries, in long tons

[Bureau of the Census]

Country	1948–52 (average)		1953		1954		1955		1956		1957	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
North America:												
Canada	1,644,222	$11,506,689	1,840,983	$16,050,131	3,537,489	$28,622,647	10,077,238	$79,058,021	[1] 13,722,656	[1] $117,665,974	12,536,809	$111,783,124
Costa Rica	90	201	3,076	4,588								
Cuba	33,370	220,184	196,676	1,853,187	32,165	313,563	42,697	328,586	93,041	909,733	33,166	346,199
Dominican Republic	3,682	39,589	80,401	947,442	89,160	1,066,861	101,934	1,173,494	162,612	2,043,397	149,295	2,024,795
Mexico	161,560	391,526	241,636	1,048,617	140,863	417,539	176,293	573,867	132,934	446,461	235,910	746,107
Panama									268	2,679		
Total	1,842,924	12,158,189	2,362,772	19,903,965	3,799,677	30,420,610	10,398,162	81,133,968	[1] 14,111,511	[1] 121,068,244	12,955,180	114,900,225
South America:												
Argentina	4	4,962										
Brazil	679,427	6,479,725	458,282	6,386,308	595,907	7,016,488	1,010,579	11,215,864	1,223,047	15,415,573	1,430,880	20,275,179
Chile	2,498,869	7,613,578	2,363,401	12,347,510	1,664,300	7,865,692	1,035,399	5,379,900	1,563,783	10,813,219	2,740,709	20,641,331
Peru			844,481	5,955,545	1,931,929	15,594,978	1,558,629	13,691,003	1,840,320	[1] 16,405,089	2,358,886	20,713,054
Venezuela	496,239	3,678,313	1,949,618	17,026,862	5,209,812	36,034,782	7,159,832	45,549,052	[1] 9,254,404	[1] 61,929,331	12,293,271	87,713,863
Total	3,674,539	17,776,578	5,615,782	41,716,225	9,401,948	66,511,940	10,764,439	75,835,819	[1] 13,881,554	[1] 104,563,212	18,823,746	149,343,427
Europe:												
Denmark			123	4,408					169	4,072	98	2,182
France	1,908	12,970										
Germany, West											29	2,080
Italy	1,890	12,988										
Netherlands	1,423	12,805										
Norway	21,723	126,920										
Spain	18,911	155,663	10,690	124,779	235	5,291						
Sweden	2,013,296	15,229,476	2,097,522	27,207,210	1,543,753	14,241,188	1,221,334	12,334,640	999,124	11,914,183	676,929	9,575,270
United Kingdom	508	24,676	444	24,011	354	30,129	2,079	58,461	599	39,102	496	35,049
Total	2,059,659	15,575,498	2,108,779	27,360,408	1,544,342	14,276,608	1,223,413	12,393,101	999,892	11,957,357	677,552	9,614,581
Asia:												
Iran	2,394	131,551	2,953	205,053	2,953	200,858			3,937	266,238		
Philippines	2,602	23,339							23,500	381,000		
Total	4,996	154,890	2,953	205,053	2,953	200,858			27,437	647,238		

Africa:												
Algeria	365,470	2,154,521	21,150	273,888	20,100	339,550	20,255	245,176	10,600	85,893		
British West Africa	148,864	975,391	231,600	1,305,910	250,820	1,404,547	137,699	800,426	161,698	1,052,993	169,646	1,252,812
Egypt	1,500	17,730										
Liberia	136,528	741,899	710,290	5,764,548	763,610	6,304,832	927,988	7,048,791	1,217,960	11,115,262	1,012,626	9,783,452
Morocco	1,738	12,166										
Spanish Africa	11,386	72,385										
Tunisia	82,448	409,416	19,700	231,243								
Union of South Africa	2,850	15,776	1,009	26,978							14,298	165,843
Total	750,784	4,399,284	983,749	7,602,567	1,043,530	8,048,929	1,085,942	8,094,393	1,390,258	12,254,148	1,196,570	11,202,107
Grand total	8,332,902	50,064,439	11,074,035	96,788,218	15,792,450	[2]119,458,945	23,471,956	177,457,281	[1]30,410,652	[1]250,490,199	33,653,048	285,060,340

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable to years before 1954.

TABLE 21.—Pyrites cinder[1] imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries, in long tons

[Bureau of the Census]

Country	1948–52 (average)		1953		1954		1955		1956		1957	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
North America: Canada	12,045	$45,471	12,053	$54,172	898	$3,556	3,879	$15,801	1,430	$5,972	567	$2,222
Europe:												
Belgium-Luxembourg	(2)	17										
Italy	(2)	2										
Total	(2)	19										
Grand total	12,045	45,490	12,053	54,172	898	3,556	3,879	[3] 15,801	1,430	5,972	567	2,222

[1] Byproduct iron ore.
[2] Less than 1 ton.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable to years before 1954.

TABLE 22.—Iron ore exported from the United States, 1948–52 (average) and 1953–57, by countries of destination, in long tons

[Bureau of the Census]

Destination	1948–52 (average)		1953		1954		1955		1956		1957	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
North America:												
Canada	2,973,916	$17,491,543	3,853,580	$28,094,069	2,812,367	$21,669,146	4,231,806	$34,076,880	[1] 4,528,751	[1] $39,271,565	3,957,685	$38,629,492
Canal Zone	4	110										
Mexico	9	25			88	2,379			3,188	41,486	714	7,960
Total	2,973,929	17,491,678	3,853,580	28,094,069	2,812,455	21,671,525	4,231,806	34,076,880	[1] 4,531,939	[1] 39,313,051	3,958,399	38,637,452
South America:												
Brazil	1	65										
Chile									273	26,674		
Colombia					46	1,700	18	680				
Surinam									89	6,094		
Total	1	65			46	1,700	18	680	362	32,768		
Europe:												
Germany, West									206	1,960	237	6,102
Netherlands	18	1,365							47	708		
Norway	186	2,383										
United Kingdom	5	1,280										
Total	209	5,028							253	2,668	237	6,102
Asia:												
Japan	526,571	4,995,905	398,374	4,327,448	332,231	3,065,285	284,602	2,874,243	973,862	9,313,164	1,041,144	10,532,106
Philippines	812	7,610	1	120			400	40,000				
Total	527,383	5,003,515	398,375	4,327,568	332,231	3,065,285	285,002	2,914,243	973,862	9,313,164	1,041,144	10,532,106
Africa:												
French Morocco	20	990										
Gold Coast	(2)	93										
Union of South Africa					978	43,808			1,880	142,932	2,371	125,445
Total	20	1,083			978	43,808			1,880	142,932	2,371	125,445
Oceania: Australia	5	1,843			4	1,679	2	720			2	855
Grand total	3,501,547	22,503,212	4,251,955	32,421,637	3,145,714	24,783,997	4,516,828	36,992,523	[1] 5,508,296	[1] 48,804,583	5,002,153	49,301,960

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

TABLE 23.—World trade in iron ore, iron-ore concentrates, and iron-ore agglomerates, in thousand long tons, in 1955

[Compiled by Corra A. Barry]

Exports by countries of origin	Fe (percent)	Production	Exports	Exports by countries of destination: North America: Canada	North America: United States	Europe: Austria	Europe: Belgium-Luxembourg	Europe: Czechoslovakia	Europe: Finland	Europe: France	Europe: Germany, West	Europe: Italy	Europe: Netherlands	Europe: Poland	Europe: Saar	Europe: Spain	Europe: Switzerland	Europe: United Kingdom	Asia: Japan	Other countries
North America:																				
Canada	55	14,539	13,008		9,984						1,036		160					1,343	485	(1)
Cuba	62	129	121	9	68						7	18	14					1		4
Dominican Republic	66	99	99		99															
Mexico	68	705	183		183															
United States	49	103,003	4,517	4,232															285	(1)
South America:																				
Brazil	68	4,084	2,525	30	1,091	22		233		14	391	46	50	95				544	9	
Chile	64	1,693	1,218	10	1,056						110	42								
Peru	62	1,703	1,711		1,711															
Venezuela	64	8,306	8,305		7,823						314	17						151	(1)	
Europe:																				
Austria	32	2,793	39					39		(1)							(1)			
Belgium-Luxembourg	28	7,195	416							35	380									1
Finland	36	181	278					10			56	3		141				67		1
France	33	49,517	20,751				12,350				350		139	10	7,262			640		(1)
Germany, West	27	15,436	304			274	1			2		2	3		22		(1)			(1)
Greece	49	189	206			77					113							16		
Italy	29	1,328	47			12					35									
Norway	65	1,236	1,164			121	54	24	10	1	710		10	120				112		2
Portugal	50	187	165								51	26						88		(1)
Spain	45	3,709	2,102			27				29	956	7	109				73	713		188
Sweden	60	17,080	15,407		1,204	134	2,432	26	93	182	6,315	218	248	462				4,068		25
Switzerland	40	127	109							2	107									
U. S. S. R.	55	70,800	[2] 8,661					[2] 2,657						[2] 3,474						[2] 2,530
United Kingdom	30	16,175	1		(1)		(1)													1
Yugoslavia	45	1,376																		

Asia:																				
China	50+	[2] 8,600																	(1)	
Hong Kong	45	115	124																122	2
India	53	4,653	1,287			59	24	153			148								903	
Malaya	45	1,466	1,592																1,585	7
Philippines	54	1,410	1,401		232														1,156	13
Portuguese India	55	2,176	1,424			63					705	276							380	
Turkey	60	860	337			1		5		2	95	178	4	2						50
Africa:																				
Algeria	52	3,541	3,568		30	23	111			89	699	141	276	17				2,182		
French Guiana	53	640	666				13			18	65			50				520		
Liberia	68	1,870	1,716	60	857						286	11	294					208		
Morocco:																				
Northern zone	67	1,017	1,003				25			81	155	8	124			369		241		
Southern zone	45	305	283		17	3				6	22							235		
Sierra Leone	60	1,235	1,332		167						423		10					732		
Tunisia	53	1,122	1,124							40	106	44	72	9				853		
Union of South Africa	62	1,967	4								4									
Oceania: Australia	60	3,573																		
Other countries		[2] 9,581	(3)																	
Total		365,721	97,198	4,341	24,522	816	15,010	3,147	103	501	13,639	1,037	1,513	4,380	7,284	369	73	12,714	4,925	2,824

[1] Less than 500 tons.
[2] Estimate.
[3] Data not available.

WORLD REVIEW

NORTH AMERICA

Canada.—Canada produced about the same quantity of iron ore in 1957 as in 1956, but the average grade of ore was lower, and the value of shipments in 1957 was about $5 million less than in 1956. Seven companies in Canada shipped iron ore from properties operated solely for the production of iron. Of these 2 produced direct-shipping ore, 2 magnetite concentrate, 1 sinter, 1 pelletized concentrate, and 1 heavy-medium concentrate.

British Columbia.—The Provincial Government of British Columbia amended its Mineral Act to abolish the system of crown-granted mineral claims, as had been the practice throughout the history of the Province. The Government also imposed a maximum and minimum tax of 50 and 25 cents per ton on iron-ore exports. The British Columbian Minister of Mines was given authority to decide the tax rate within the maximum and minimum based on his department's evalution of exploration and development done at each deposit.[5]

TABLE 24.—World production of iron ore, iron-ore concentrates, and iron-ore agglomerates, by countries,[1] 1948–52 (average) and 1953–57, in thousand long tons [2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	3,610	5,813	6,573	14,539	19,954	19,988
Cuba	32	197	25	129	135	105
Dominican Republic	[3] 19	91	105	99	161	[4] 180
Guatemala	[4] 1	[4] 3	[4] 2	[4] 3	[4] 3	4
Mexico	413	538	514	705	801	[4] 935
United States	99,681	117,995	78,129	103,003	97,877	106,148
Total	103,756	124,637	85,348	118,478	118,931	127,360
South America:						
Argentina	[4] 44	72	60	74	64	69
Brazil	2,168	3,560	3,023	4,084	4,765	3,937
Chile	2,669	2,893	2,164	1,693	2,955	2,165
Colombia	------	------	82	344	388	[4] 590
Peru	------	985	2,188	1,703	2,604	3,522
Venezuela	[5] 1,128	2,260	5,335	8,306	10,930	15,054
Total	6,009	9,770	12,852	16,204	21,706	25,337
Europe:						
Austria	1,883	2,713	2,678	2,793	3,207	3,441
Belgium	77	98	81	104	144	136
Bulgaria	[4] 30	113	116	111	232	295
Czechoslovakia	1,612	1,700	1,650	1,955	2,050	2,756
Finland	------	17	132	181	203	412
France	31,595	41,777	43,134	49,517	51,858	56,854
Germany:						
East	[4] 450	1,338	1,447	1,638	1,583	1,624
West	10,944	14,388	12,830	15,436	16,661	18,031
Greece	56	87	76	189	394	[4] 200
Hungary	325	353	421	347	[4] 295	[4] 255
Italy	580	975	1,074	1,328	1,629	1,540
Luxembourg	4,773	7,057	5,794	7,091	7,474	7,719
Norway	369	1,167	1,078	1,236	1,526	1,476
Poland	797	1,288	1,550	1,827	1,942	1,963
Portugal	[6] 54	143	110	187	233	280
Rumania	[4] 400	675	685	627	683	634
Spain	2,135	2,976	2,869	3,709	4,410	5,291

See footnotes at end of table.

[5] U. S. Consulate General, Vancouver, Canada, State Department Dispatch 27: Nov. 12, 1957. Northern Miner (Toronto), B. C. Iron-Ore Miners Shocked by Confiscatory Taxation Bill: Vol. 43, No. 2, Apr. 4, 1957, pp. 1, 9.

TABLE 24.—World production of iron ore, iron-ore concentrates, and iron-ore agglomerates, by countries,[1] 1948–52 (average) and 1953–57, in thousand long tons [2]—Continued

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Europe—Continued						
Sweden	14,362	16,715	15,083	17,080	18,648	19,665
Switzerland	78	103	100	127	129	114
U. S. S. R.[7]	[4] 38,900	[4] 59,000	63,300	70,800	76,900	82,900
United Kingdom	14,092	15,818	15,557	16,175	16,245	16,902
Yugoslavia	728	782	1,093	1,376	1,698	1,846
Total	[4] 124,240	[4] 169,283	170,858	193,834	208,144	224,334
Asia:						
Burma	—	—	3	4	2	4
China [4]	2,095	5,600	7,200	8,600	10,800	11,800
Hong Kong	103	123	91	115	123	94
India	3,130	3,855	4,308	4,653	4,830	5,066
Iran [8]	[6] 12	[4] 10	10	[4] 10	5	[4] 5
Japan [9]	954	1,517	1,605	1,492	1,882	2,208
Korea, Republic of	[6] 35	19	31	29	62	182
Lebanon	[3] 7	30	49	42	41	[4] 39
Malaya	482	1,063	1,213	1,466	2,445	2,972
Philippines	602	1,199	1,402	1,410	1,417	1,325
Portuguese India	238	929	1,359	2,176	[4] 2,100	[10] 2,360
Thailand	[5] 4	8	4	5	6	9
Turkey	265	489	577	860	915	1,220
Total [1 4 7]	8,000	14,900	18,350	21,850	25,600	28,300
Africa:						
Algeria	2,538	3,335	2,881	3,541	2,543	2,746
Egypt	—	—	—	—	130	[4] 395
French Guinea	—	393	583	640	840	1,072
Liberia	[6] 530	1,264	1,238	1,870	2,108	1,935
Morocco:						
Northern Zone	905	970	916	1,017	1,356	[10] 1,378
Southern Zone	430	501	329	305	482	461
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	2	2	1	2	—	—
Southern Rhodesia	50	62	63	83	114	133
Sierra Leone	1,102	1,368	817	1,235	1,307	1,445
Tunisia	799	1,040	935	1,122	1,151	1,156
Union of South Africa	1,334	1,940	1,863	1,967	2,031	2,047
Total	7,690	10,875	9,626	11,782	12,062	12,768
Oceania:						
Australia	2,198	3,299	3,519	3,573	3,924	3,806
New Caledonia	[5] 5	—	—	—	28	230
Total	2,203	3,299	3,519	3,573	3,952	4,036
World total (estimate) [1]	251,898	332,764	300,553	365,717	390,367	422,135

[1] In addition to countries listed, North Korea reports production of iron ore, but data are not available; esimate by author of chapter included in the total.
[2] This table incorporates a number of revisions of data published in previous Iron Ore chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Average for 1 year only, as 1952 was the first year of commercial production.
[4] Estimate.
[5] Average for 1950–52.
[6] Average for 1951–52.
[7] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[8] Year ending March 31 of year following that stated.
[9] Includes iron-sand production as follows: 1948–52 (average), 140,398 tons; 1953, 430,954 tons; 1954, 501,439 tons; 1955, 541,890 tons; 1956, 846,953 tons; and 1957, 1,079,667 tons.
[10] Exports.

Newfoundland-Quebec.—On June 7, 1957, the Newfoundland House of Assembly approved agreements with the Canadian Javelin, Pickands Mather, and other companies for developing iron-ore deposits in Labrador. These companies will produce iron ore for sale to the steel industries in the United States, Canada, Great Britain, and Germany at an estimated rate of 25 million long tons per year.

Newfoundland will collect 22 cents royalty for each ton of ore shipped.[6]

The Iron Ore Co. of Canada produced about 1/2 million tons more iron ore in 1957 than in 1956; to provide better service for its European and United Kingdom customers, the company began building a 1/2-million-ton storage-transfer dock at Rotterdam, Holland.

Ontario.—Steep Rock Iron Mines, Ltd., continued to dredge the silt overlying its middle (G) ore body but produced about 1 million tons less iron ore from the Hogarth pit and Errington mine in 1957 than in 1956.

The Canadian National Railroad Co. completed a 4.5-mile spur from Milnet to the Moose Mountain property of the Lowphos Ore, Ltd. Lowphos Ore, Ltd., continued construction of a mining plant and concentrator, which will have annual capacity of about a half million tons of 65-percent iron concentrate when completed.[7]

The Anaconda Company (Canada), Ltd., subsidiary of The Anaconda Company, New York, N. Y., exercised options to purchase the iron-ore properties of the Lake Superior Iron Ore Co., Ltd., of Montreal. The claims are 32 miles north of Nakina on the Canadian National Railway in the Kowash mining division of the district of Thunder Bay, Ontario.

SOUTH AMERICA

Brazil.—Iron-ore resources of the Congonhas District, Minas Gerais, Brazil, were estimated at 39 billion metric tons of 40 percent iron. The high-grade hematite reserve, averaging 68 percent iron, was estimated at 250 million metric tons.[8]

Chile.—Chile produced about 1 million tons more iron ore in 1957 than in 1956. Technicians of the Chilean Production Development Corporation discovered an iron-ore deposit in the coastal range, Nahuelbuta, about 200 kilometers south of Concepcion. The deposit was estimated to contain over 100 million tons of ore.[9]

Peru.—Peru produced about 1/2 million tons more iron ore in 1957 than in 1956. The Marcona Mining Co. succeeded in enlarging its market to include the interior of the United States when it sold a small cargo of iron ore to the Granite City Steel Co. of East St. Louis, Ill. The ore was loaded on ocean freighters at San Juan, Peru, and routed through the Panama Canal and the Gulf of Mexico to Mobile, Ala., where it was transferred to railroad cars and shipped to St. Louis, Mo.[10]

Venezuela.—Mineroferroviaria de Venezuela, C. A., a new iron-ore mining company in 1957, planned to invest $52 million to develop the El Trueno deposit southwest of Ciudad Bolivar, Venezuela. The company will operate under a profit-splitting agreement on concessions owned by Trans Western de Venezuela, C. A., a United States-Venezuelan company.

Iron ore was mined in Venezuela in 1957 by Iron Mines Co. of Venezuela, subsidiary of Bethlehem Steel Co., and Orinoco Mining

[6] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, p. 6.
[7] Northern Miner (Toronto), Pushed Construction at Ontario Iron Mine of Lowphos Ore: Vol. 43, No. 14, June 27, 1957, pp. 1, 4.
[8] Guild, P. W., Geology and Mineral Resources of the Congonhas District, Minas Gerais, Brazil: Geol. Survey Prof. Paper 290, 1957, 90 pp.
[9] Mining World, vol. 19, No. 13, December 1957, p. 83.
[10] Skillings' Mining Review, Granite City Steel Receives Shipment of Peruvian Iron Ore: Vol. 46, No. 3, Apr. 20, 1957, p. 6.

Co., subsidiary of United States Steel Corp. Iron-ore-mining companies pay normal corporate taxes ranging up to 26 percent on annual profits of $8.4 million and a production royalty of 1 percent to the Venezuelan Government. If company profits exceed 15 percent on net worth in any tax year, the law provides for a special surtax to equalize the Government's tax revenue and the company's net profits.[11]

EUROPE

France.—According to the Federation of French Iron Mines current 5-year plan, which began on January 1, 1957, iron-ore output will be increased 32 percent to 70 million tons annually within the next 5 years. French iron-ore reserves have been estimated to total 8 billion tons—6 billion tons in Lorraine and 2 billion in western France and the Pyrenees.[12]

Germany, West.—The German iron and steel industry made long-term contracts to buy iron ore from recently reopened mines in Labrador and Venezuela. In 1957 the industry imported 30 percent of its iron-ore requirements.[13]

German steel companies participated in exploring and evaluating iron-ore deposits in eastern Quebec and the Ungava Bay area of Canada, in French North Africa, and in Minas Gerais, Brazil. Three West German steel companies contracted to take 350,000 tons of iron ore from Chile in 1957.[14]

Sweden.—On September 30, 1957, the Government of Sweden made the first of five equal installment payments to Trafik a.-b. Grängesberg-Oxelösund to acquire that company's stock in the iron-ore-mining corporation Luossavaara-Kiirunavaara, a.-b. Through this action the Swedish Government acquired what has been reported to be the world's largest mine and ore-dressing plant and control of about 75 percent of Sweden's iron-ore output.[15]

U. S. S. R.—Iron-ore resources of the Soviet Union and the iron and steel industry of that country were described in three publications issued by agencies of the Soviet Government. A summary of the context of these three publications was presented in English.[16]

ASIA

India.—The Indian Government contracted with Hewitt-Robins, Inc., to build a $5.5-million material-handling and crushing and screening facility for a new iron-ore mine at Barsua, Orissa Province, 225 miles southwest of Calcutta. The deposit, said to contain 150 million tons of 54- to 65-percent iron, is owned by Hindustan Steel Private, Ltd.[17]

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11 Engineering and Mining Journal, Mivenca Plans $52-Million Iron Mine: Vol. 158, No. 11, November 1957, pp. 144, 148.

12 South African Mining and Engineering Journal, vol. 68, pt. I, No. 3355, May 31, 1957, p. 1053.
Skillings' Mining Review, French Iron Ore Production: Vol. 46, No. 11, June 15, 1957, p. 29.

13 U. S. Consulate General, Duesseldorf, Germany, State Department Dispatch 187: June 24, 1957, 4 pp.

14 Foreign Commerce Weekly, German Firms Active in Joint Iron Mining: Vol. 57, No. 11, Mar. 18, 1957, p. 42.
Mining World, vol. 19, No. 9, August 1957, p. 93.
Mining Journal (London), vol. 248, No. 6354, May 31, 1957, p. 691.

15 U. S. Embassy, Stockholm, Sweden, State Department Dispatch 383: Oct. 4, 1957.
Mining Engineering, Arctic Iron-Ore Plant Starts Operation: Vol. 9, No. 4, April 1957, p. 407.

16 Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, pp. 3-12; vol. 45, No. 4, October 1957, pp. 11-23.

17 Metal Bulletin, Indian Mine Equipment Order: No. 4256; Dec. 24, 1957, p. 25.

Japan.—The Japanese iron and steel industry continued to seek new sources of iron ore in the first half of 1957. In August, however, it was reported that the steel industry was negotiating with its iron-ore suppliers temporarily to reduce shipments by about 15 percent.[18] Two special-purpose ore-cement carriers to transport cement from Japan to southeast Asian countries and return with iron ore to Japan were being constructed by a leading Japanese cement manufacturer.[19]

Malaya.—Iron-ore output in Malaya in 1957 established a new record.

The Endau Iron Mining Co., 51 percent owned by Malayans and 49 percent by Japanese, was formed to reopen mines obtained from the Federation's Custodian of Enemy Property. The mines were operated by Japanese before the war. Malayan Enterprises, Ltd., another newly formed company, was granted mining rights near Kota Tinggi in Johore. Malayan Enterprises is owned by Malayans, but the Japanese assisted in prospecting the property, and when iron ore is produced it will be sold to the Fuji Steel Co. in Japan.[20]

AFRICA

Liberia.—The Liberia Mining Co. built a beneficiation plant to increase its iron-ore output by about 40 percent—from 2.2 million tons to 3 to 4 million tons annually.[21]

The Liberian-American-Swedish Minerals Co. began intensive geological and engineering studies of an iron-ore deposit in the Nimba Mountains, about 20 miles from Sanniquelle on the Liberia-French Guinea frontier. The company plans to begin mining in 1960 and produce at the rate of 10 million tons annually by 1962.[22]

TECHNOLOGY

Hydraulic mining with a suction dredge and use of froth flotation at the Jones & Laughlin Steel Corp.'s Hill Annex tailings reclamation plant at Calumet, Minn., were significant "firsts" in applying standard mining and beneficiating techniques to recover iron commercially on the Mesabi Range.[23]

The world's largest walking dragline was installed at the United Steel Companies, Ltd., iron mine at Exton Park, Rutland, England. The machine weighs 1,676 tons, has a 282-foot boom and a 20-cubic-yard bucket, and will move 10,000 tons of overburden a day, digging at 90 feet.[24]

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[18] Skillings' Mining Review, Defer Iron Ore Shipments to Japan: Vol. 56, No. 22, Aug. 31, 1957, p. 14.
[19] Metal Bulletin (London), Japanese Cement-Ore Ships: No. 4168, Feb. 8, 1957, p. 25.
[20] U. S. Consulate General, Singapore Malaya, State, Department Dispatch, 151: Oct. 8, 1957, pp. 9-10.
[21] Foreign Commerce Weekly, Growth in Liberian Economy Continues: Vol. 58, No. 24, Dec. 9, 1957, p. 15.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 5, May 1957, p. 9.
[23] Livingston, R. W., Flotation Starts on the Mesabi: Eng. Min. Jour., vol. 159, No. 1, January 1958, pp. 90-93.
[24] Metal Bulletin (London), World's Largest Walking Dragline: No. 4213, July 23, 1957, pp. 20-21.

Dry magnetic concentration and a fluidized-solids technique for converting nonmagnetic iron minerals to magnetite and subsequent magnetic concentration were suggested as possible methods of exploiting low-grade iron-ore deposits.[25] The Ontario Research Foundation operated a pilot plant in the summer of 1956 at Lakefield, Ontario, and a new plant at Rexdale near Toronto in 1957 to evaluate dry grinding and magnetic concentration of iron ore. Dry-concentration results were comparable to those on the same ore concentrated by wet methods. Economic studies of the fluidized-solids system for reducing hematite in low-grade deposits to magnetite indicated operating costs per long ton of feed (5 percent H_2O) of $0.76, using coal for fuel, and $0.66, using gas for fuel.

Worldwide interest in iron-ore direct-reduction processes continued in 1957. In most foreign countries this interest was instigated by desire for a local steel industry and by lack of coking coal. In the United States continuing interest was supported by successful pilot-plant operations, indicating that most of the technical obstacles to commercial operation had been overcome.[26]

Research and development to produce additional iron from blast furnaces through improved practice included use of oxygen, beneficiated iron ore, agglomeration, moisture in the blast, higher blast heats, and improved coke quality.[27]

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[25] Cavanagh, F. E., and Williams, E. W., Dry Magnetic Concentration: The Canadian Min. and Met. Bull., vol. 50, No. 545, September 1957, pp. 558–564.
Priestley, Robert J., Magnetic Conversion of Iron Ores: Ind. Eng. Chem., vol. 49, No. 1, January 1957, pp. 62–64.

[26] Squires, A. M., and Johnson, C. A., The H-Iron Process: Jour. Metals, vol. 9, No. 4, April 1957, pp. 586–590.
Turner, H. S., Research in the Direct Reduction of Iron Ore: Min. Cong. Jour., vol. 43, No. 12, December 1957, pp. 59–63.
Franklin, James W., Industry Looks at Direct Reduction: Eng. Min. Jour., vol. 158, No. 12, December 1957, pp. 84–93.

[27] Steel, Getting More Iron From Blast Furnaces: Vol. 141, No. 24, Dec. 9, 1957, pp. 164–176.

Iron and Steel

By James C. O. Harris[1] and J. Kay Myers[2]

THE DOMESTIC steel industry celebrated its 100th anniversary in 1957 commemorating the Kelley and Bessemer converters, which made possible the manufacture of large quantities of steel economically. In observance of this historic event a special stamp was issued by the Post Office Department. Production was the third highest on record, totaling 112.7 million short tons compared with 115.2 million in 1956 and the alltime record of 117.0 million tons in 1955. In the second half of 1957 steel production dropped 14 percent below the high rate of the first half of the year. Improved blast-furnace and operating techniques and a drop in scrap consumption contributed to a new record in pig-iron production of 78.4 million short tons. Scrap prices dropped sharply during the last 4 months, but blast-furnace output did not drop substantially until November. At the end of the year 94 furnaces were out of blast compared with 13 on January 1. The ratio of scrap to pig iron consumed was 49 to 51 in 1957 compared with 52 to 48 in 1956.

At the end of 1957 blast- and steel-furnace capacities reached new highs of 91.0 and 140.7 million short tons, respectively. Steelmaking capacity increased 7.2 million tons—the second highest annual gain; capacity for blast furnaces increased 4.2 million—the highest gain on record. More than half of the blast-furnace capacity was increased through the enlargement and modernization of existing furnaces; three new furnaces were blown in—one each at Morrisville, Pa., Sparrows Point, Md., and Fontana, Calif. The 2-million-ton increase in steelmaking capacity at Bethlehem Steel's Sparrows Point plant makes this the world's largest steelworks, with a capacity of 8.2 million tons.

The American steel industry continued to improve existing iron- and steel-making facilities, develop new direct iron-reduction processes, and expand vacuum-melting facilities. The use of oxygen and humidification of blast-furnace blast received further attention, and more than half a dozen direct-iron processes were active. According to a survey conducted at the end of 1957, domestic capacity of vacuum-

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

melting facilities was 20 million pounds of the induction melting and 50 million pounds of the consumable-electrode type.

The use of oxygen in steel furnaces received further attention; Jones & Laughlin Steel Corp. constructed the Nation's second oxygen steelmaking plant at Aliquippa, Pa., and Inland Steel used oxygen and made steel in an open-hearth furnace without fuel. In 1957, for every ton of steel ingots made, more than 200 cubic feet of oxygen was used.

Domestic shipments of steel products, including exports, in 1957 totaled 79.9 million short tons,—the fourth highest on record—6 percent below the record year 1955. Receipts by the automotive industry, again the Nation's leading consumer, was 14 million tons or 19 percent of domestic shipments, slightly higher than in 1956. Exports of iron and steel products in 1957 were the highest since 1947, and pig-iron exports were the highest on record.

Weekly hours worked per employee in the steel industry during 1957 averaged 39.1, compared with 40.4 in 1956. The number of employees for the year averaged 538,000 compared with 534,000, and the hourly wage averaged $2.68 in 1957 compared with $2.52 for the previous year. The average composite price of finished steel, as published by Iron Age, was 5.800 cents per pound compared with 5.358 in 1956.

TABLE 1.—Salient statistics of iron and steel in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Pig iron:						
Production	61,896,525	74,853,319	57,947,551	76,848,509	75,030,249	78,404,266
Shipments	61,816,337	74,162,829	57,782,686	77,300,681	75,109,714	76,886,551
Imports	514,114	589,825	290,716	283,559	326,700	225,387
Exports	23,159	18,837	10,247	34,989	[1] 269,477	882,342
Steel: [2]						
Production of ingots and castings:						
Open-hearth:						
Basic	81,729,892	99,827,729	80,019,628	104,804,570	102,167,989	101,027,725
Acid	642,993	646,094	307,866	554,847	672,596	630,051
Bessemer	4,227,802	3,855,705	2,548,104	3,319,517	3,227,997	2,475,138
Electric [3]	5,763,835	7,280,191	5,436,054	8,357,151	9,147,567	8,582,082
Total	92,364,522	111,609,719	88,311,652	117,036,085	115,216,149	112,714,996
Capacity, annual on Jan. 1	100,512,902	117,547,470	124,330,410	125,828,310	128,363,090	133,459,150
Percent of capacity	91.9	94.9	71.0	93.0	89.8	84.5
Production of alloy steel:						
Stainless	756,332	1,054,113	852,021	1,222,316	1,255,725	1,046,919
Other	7,685,293	9,274,081	6,340,842	9,437,775	9,072,343	7,864,904
Total	8,441,625	10,328,194	7,192,863	10,660,091	10,328,068	8,911,823
Shipments of steel products:						
For domestic consumption	65,575,412	77,472,162	60,618,843	81,134,367	79,628,741	75,325,782
For export	3,072,988	2,679,731	2,533,883	3,583,077	3,622,427	4,568,795
Total	68,648,400	80,151,893	63,152,726	84,717,444	83,251,168	79,894,577

[1] Revised figure.
[2] American Iron and Steel Institute.
[3] Includes a very small quantity of crucible steel and oxygen converter steel for 1954–57.

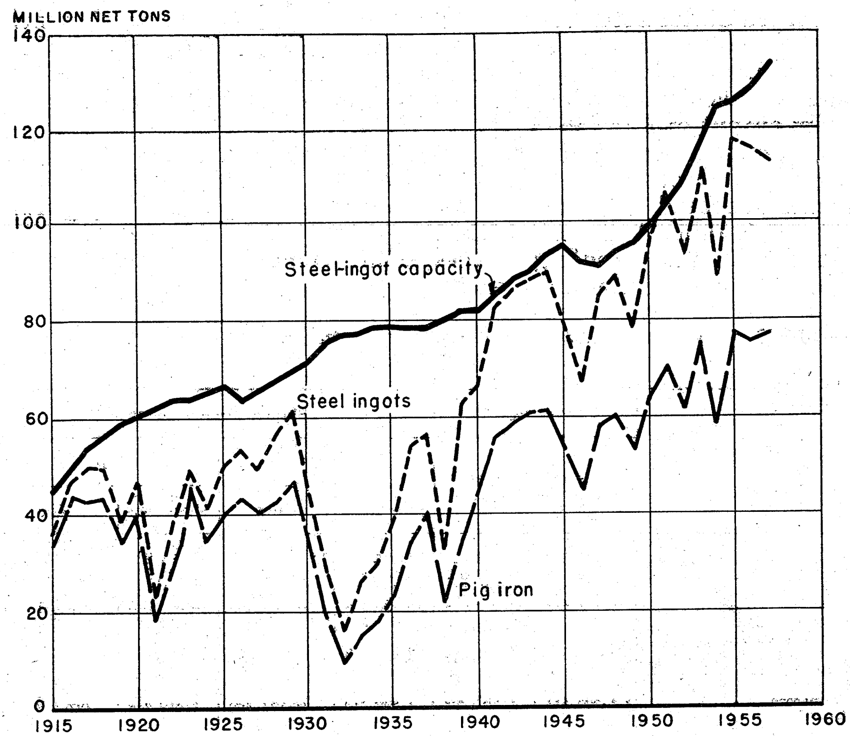

FIGURE 1.—Trends in production of pig iron and steel ingots and steel-ingot capacity in United States (1915–57).

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron, exclusive of ferroalloys, reached a record high of 78.4 million short tons, a 5-percent increase over 1956 and a 2-percent increase over the previous record year 1955. Blast furnaces operated at 90 to 100 percent of capacity for the first 9 months of the year but dropped sharply from 88.4 percent in October to 71.6 percent in December. Pig-iron production increased in 13 States but decreased in California, Illinois, Ohio, and West Virginia. Pennsylvania, Ohio, and Indiana ranked first, second, and third in pig-iron production, supplying 27, 19, and 11 percent, respectively, compared with 27, 20, and 11 percent in 1956.

Other products of the blast furnace were 40.9 million short tons of blast-furnace slag or 1,040 pounds per ton of pig iron and 8 million tons of flue dust recovered or 204 pounds per ton of pig iron, virtually unchanged from 1956.

The combined capacity of the new blast furnaces, installed by Bethlehem Steel Co., Kaiser Steel Corp., and United States Steel Corp., was 1.9 million short tons; modernization and enlargement of 8 furnaces added 2.3 million tons to the annual capacity.

United States Steel Corp. reported what might be the record month for the Nation in blast-furnace output. During the month of May the United States Steel Corp. Fairless Works Pennsylvania, No. 2 blast furnace produced 66,395 short tons of pig iron or an average daily output of 2,142 tons.

Shipments of pig iron (including onsite transfers) were the second highest on record and 2 percent greater than in 1956. Value of shipments increased 12 percent. The average values per ton of pig iron shown in table 4 are lower than market prices published in trade journals because handling charges, selling commissions, freight costs, and other related items are excluded.

TABLE 2.—Pig iron produced and shipped in the United States, 1956–57, by States

State	Produced		Shipped from furnaces			
	1956 (short tons)	1957 (short tons)	1956		1957	
			Short tons	Value	Short tons	Value
Alabama	4,166,593	4,903,627	4,326,511	$217,314,687	4,693,224	$253,160,817
Illinois	6,515,852	6,308,891	6,537,451	356,432,770	6,195,023	359,569,030
Indiana	8,245,756	9,007,611	8,203,198	435,543,342	8,991,482	524,510,587
Ohio	15,127,518	14,979,958	15,086,354	790,897,903	14,683,645	820,587,336
Pennsylvania	20,618,260	21,031,230	20,651,381	1,135,945,127	20,610,846	1,221,274,798
California, Colorado, Utah	3,869,003	3,941,135	3,819,248	193,503,622	3,929,547	225,701,696
Kentucky, Tennessee, Texas	1,505,111	1,967,259	1,495,815	73,617,998	1,915,912	104,179,069
Maryland, West Virginia	6,087,184	6,669,910	6,078,044	336,066,425	6,538,592	415,751,270
Michigan, Minnesota	3,998,520	4,197,654	4,004,081	217,446,898	4,118,061	239,156,672
New York, Massachusetts	4,896,452	5,396,991	4,907,631	267,908,584	5,210,219	328,408,630
Total	75,030,249	78,404,266	75,109,714	4,024,677,356	76,886,551	4,492,299,905

TABLE 3.—Foreign iron ore and manganiferous iron ore consumed in manufacturing pig iron in the United States, 1956–57, by sources of ore, in short tons

Source	1956	1957	Source	1956	1957
Africa	137,699	50,438	Peru	1,548,032	1,385,199
Brazil	17,583	2,488	Sweden	290,200	169,038
Canada	8,196,055	8,311,912	Venezuela	6,482,917	5,464,336
Chile	188,423	122,790	Unclassified	346,403	222,552
Cuba	74,691	35,330			
India	1,954	784	Total	17,405,794	15,977,881
Mexico	121,837	213,014			

TABLE 4.—Pig iron shipped from blast furnaces in the United States, 1956–57, by grades [1]

Grade	1956			1957		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Foundry	2,502,265	$129,841,696	$51.89	2,077,003	$117,301,167	$56.48
Basic	62,012,160	3,325,547,674	53.63	64,197,669	3,762,500,726	58.61
Bessemer	6,625,236	358,447,652	54.10	6,204,829	362,538,961	58.43
Low-phosphorus	346,924	20,603,109	59.39	814,399	47,490,482	58.31
Malleable	3,471,100	182,801,123	52.66	3,239,745	182,082,365	56.20
All other (not ferroalloys)	152,029	7,436,102	48.91	352,096	20,386,204	57.90
Total	75,109,714	4,024,677,356	53.58	76,886,551	4,492,299,905	58.43

[1] Includes pig iron transferred directly to steel furnaces at same site.

Metalliferous Materials Used.—The production of pig iron in 1957, excluding coke and fluxes, required 135.1 million short tons of iron and manganiferous ores and agglomerates, 4.1 million tons of scrap, 0.4 million tons of flue dust, and 9.8 million tons of miscellaneous materials or 1.905 tons of material per ton of pig iron made. The scrap charge consisted of 1,733,645 short tons of purchased scrap and 2,407,697 tons of home scrap, including 560,124 tons of home-slag scrap. Miscellaneous materials consumed included 3.9 million tons of mill cinder and scale, 5.8 million tons of open-hearth and Bessemer slag, 65,000 tons of other metalliferous materials, and 97,000 tons of nonmetalliferous materials. Net totals shown in table 6 were computed by deducting 8 million tons of flue dust recovered and 1 million tons of scrap produced at blast furnaces.

The agglomerate charge consisted of 32,505,806 tons of sinter, 1,788,476 tons of pellets, and 1,336,513 tons of other agglomerates; 1,247,010 tons of the total was of foreign origin. Canada, Venezuela, and Peru supplied 52, 37, and 9 percent, respectively, of foreign iron and manganiferous ores used in blast furnaces.

Alabama furnaces consumed hematite from the Birmingham district, brown ores from Alabama and Georgia, and byproduct ore from Tennessee; imported iron ores from Brazil, Labrador, Peru, Sweden, and Venezuela; and a small quantity of foreign manganese-bearing ores from Brazil, India, and South Africa.

Blast furnaces at Fontana, Calif., were supplied with iron ore from California and Nevada.

Pueblo, Colo., furnaces (Colorado Fuel & Iron Corp.) used iron ores from Wyoming and Utah.

Over 97 percent of the iron ores consumed at Sparrows Point, Md., was of foreign origin—Labrador, Venezuela, Chile, Peru, Cuba, and Liberia. A small quantity of manganiferous ore from Labrador and Egypt was used.

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The Lake Superior region was the principal source of iron ores for Pennsylvania blast furnaces. The major foreign sources (20 percent of total ore) were Venezuela, Canada, and Peru; manganiferous ores came from Labrador, Africa, and Egypt.

Eighty-eight percent of the iron ore used in Illinois, Indiana, Ohio, and West Virginia was of domestic origin, largely from the Lake Superior region; Canada was the major foreign source.

The Everett, Mass., blast furnace used iron ore from Canada, Peru, and Venezuela and iron and manganiferous ores from Labrador. Less than 15 percent of the iron ore used was of domestic origin.

New York furnaces used ores from the Lake Superior region, Mineville area, and eastern New York, and iron and manganiferous ores from Canada. Canadian ores furnished 12 percent of the total, excluding agglomerating ores.

Texas furnaces consumed brown ores from east Texas and iron ores from Mexico and Peru.

Utah furnaces used iron ore from Iron County, Utah, and manganese ore from Mexico.

TABLE 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States, December 31, 1956–57

[American Iron and Steel Institute]

State	Dec. 31, 1956			Dec. 31, 1957		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	17	4	21	15	6	21
California	3		3	3	1	4
Colorado	4		4	2	2	4
Illinois	22		22	11	11	22
Indiana	23		23	17	6	23
Kentucky	3		3	2	1	3
Maryland	9		9	9	1	10
Massachusetts	1		1	1		1
Michigan	8		8	7	1	8
Minnesota	3		3	2	1	3
New York	16	1	17	13	4	17
Ohio	49	4	53	28	25	53
Pennsylvania	75	3	78	49	30	79
Tennessee	3		3	1	2	3
Texas	2		2	2		2
Utah	5		5	4	1	5
Virginia	1	1	2	1	1	2
West Virginia	5		5	4	1	5
Total	249	13	262	171	94	265

TABLE 6.—Iron ore and other metallic materials, coke, and fluxes consumed and pig iron produced in the United States, 1956–57, by States, in short tons

State	Metalliferous materials consumed							Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made				Coke and fluxes consumed per ton of pig iron	
	Iron and manganiferous ores		Agglomerates	Net ores and agglomerates [1]	Net scrap [2]	Miscellaneous [3]	Net total				Net ores and agglomerates [1]	Net scrap [2]	Miscellaneous [3]	Total	Net coke	Fluxes
	Domestic	Foreign														
1956																
Alabama	5,576,001	1,737,475	1,587,088	8,539,544	209,451	95,674	8,844,669	4,017,769	1,354,483	4,166,593	2.050	0.050	0.023	2.123	0.964	0.325
Illinois	10,476,328	43,695	1,072,769	10,918,626	342,215	1,239,443	12,500,284	5,463,493	2,090,416	6,515,852	1.676	.052	.190	1.918	.839	.321
Indiana	12,062,650	562,333	2,117,134	13,545,127	141,918	1,282,186	14,969,231	6,982,306	2,864,803	8,245,756	1.642	.017	.156	1.815	.847	.347
Ohio	16,557,639	4,352,219	4,568,354	24,103,208	790,730	1,974,032	26,867,970	13,107,138	5,728,531	15,127,518	1.593	.052	.131	1.776	.866	.379
Pennsylvania	19,886,545	4,834,121	9,014,233	31,717,368	1,221,819	3,250,308	36,189,495	17,027,748	8,006,628	20,618,260	1.538	.059	.158	1.755	.826	.388
California, Colorado, Utah	3,890,869	6,694	2,886,940	6,607,934	74,364	184,503	6,866,801	2,973,585	1,145,112	3,869,003	1.708	.019	.048	1.775	.769	.296
Kentucky, Tennessee, Texas	1,792,590	289,114	349,882	2,391,268	122,222	202,512	2,716,002	1,323,013	653,882	1,505,111	1.589	.081	.135	1.805	.879	.434
Maryland, West Virginia	2,033,815	4,833,797	2,882,752	9,069,939	101,374	705,236	9,876,549	4,716,103	1,867,778	6,087,184	1.490	.017	.116	1.623	.775	.307
Michigan, Minnesota	6,025,652	238,134	1,262,273	6,992,676	197,732	334,135	7,524,543	3,630,196	1,664,135	3,998,520	1.749	.049	.084	1.882	.908	.416
New York, Massachusetts	5,447,276	508,212	2,444,528	8,027,440	229,915	512,894	8,770,249	4,148,579	1,755,794	4,896,452	1.639	.047	.105	1.791	.847	.359
Total	83,749,365	17,405,794	28,185,953	121,913,130	3,431,740	9,780,923	135,125,793	63,389,930	27,131,562	75,030,249	1.625	.046	.130	1.801	.845	.362
1957																
Alabama	7,231,358	528,019	2,694,339	10,029,637	239,040	136,319	10,404,996	4,685,961	1,513,711	4,903,627	2.045	.049	.028	2.122	.956	.309
Illinois	9,959,732	56,160	1,274,227	10,701,072	213,258	854,510	11,768,840	5,094,445	2,044,922	6,308,891	1.696	.034	.135	1.865	.808	.324
Indiana	13,232,090	433,662	2,556,620	14,932,632	168,467	1,300,667	16,401,766	7,537,155	2,962,601	9,007,611	1.658	.019	.144	1.821	.837	.329
Ohio	15,153,482	4,400,024	5,530,256	23,926,159	705,155	1,859,495	26,490,809	12,735,191	5,430,148	14,979,958	1.597	.047	.124	1.768	.850	.362
Pennsylvania	18,719,669	4,732,731	10,699,741	32,150,441	1,096,647	3,523,224	36,770,312	17,478,623	7,827,163	21,031,230	1.529	.052	.167	1.748	.831	.372
California, Colorado, Utah	4,140,071	3,599	2,948,739	6,924,260	70,120	202,465	7,196,845	3,101,464	1,117,244	3,941,135	1.757	.018	.051	1.826	.787	.283
Kentucky, Tennessee, Texas	2,046,388	466,715	511,801	2,962,078	150,072	283,411	3,395,561	1,588,947	781,360	1,967,259	1.506	.076	.144	1.726	.808	.397
Maryland, West Virginia	1,921,589	4,074,857	4,663,394	9,980,006	153,993	781,170	10,915,169	5,075,212	2,106,378	6,669,910	1.496	.023	.117	1.636	.761	.316
Michigan, Minnesota	5,920,503	330,392	1,349,202	7,028,041	239,262	326,418	7,593,721	3,715,964	1,641,055	4,197,654	1.674	.057	.078	1.809	.885	.391
New York, Massachusetts	5,134,430	951,722	3,402,476	8,800,663	161,614	531,450	9,493,727	4,619,740	1,932,288	5,306,991	1.631	.030	.098	1.759	.856	.358
Total	83,459,312	15,977,881	35,630,796	127,434,989	3,197,628	9,799,129	140,431,746	65,632,702	27,356,870	78,404,266	1.625	.041	.125	1.791	.837	.349

[1] Net ores and agglomerates=ores+agglomerates+flue dust used—flue dust recovered. [2] Excludes home scrap produced at blast furnaces. [3] Does not include recycled material.

PRODUCTION AND SHIPMENTS OF STEEL

Domestic steel production in 1957 was 112.7 million short tons, or 84.5 percent of capacity; the AISI index was 134.6 (1947–49=100). The corresponding figures for 1956 were 115.2, 89.8, and 137.2, respectively. Production was above 90 percent of capacity for the first quarter; the second highest monthly output—11 million tons—was recorded for January and was only 40,000 tons below the record month of October 1956. As the year progressed the demand for steel continued to decrease, and the operating rate dropped to 65.5 percent of capacity in December. The percentages of total steel made by the several processes were as follows: Open hearth, 90; electric, 8 (oxygen-converter output and operating rate are included with the electric furnace); and Bessemer, 2. Corresponding figures for 1956 were 89, 8, and 3, respectively.

Thirty-three percent of domestic steel was produced in the Pittsburgh-Youngstown district, 22 percent in both the Chicago and Eastern districts, 11 percent in the Cleveland-Detroit district, and 6 percent in both the Western and Southern districts. These figures compare with 35, 22, 22, 10, 6, and 5 percent, respectively, in 1956. The above districts are those designated by AISI.

During the year open-hearth capacity increased 5.4 million short tons to 122.3 million tons; electric furnace, 1.8 million tons to 13.3 million; oxygen converter, 541,000 to 1.1 million tons. Bessemer furnace capacity decreased 478,000 to 4 million tons.

Figures for steelmaking capacity represent net-steel capacity after the producers deducted an average of 8.8 percent for operating time lost for rebuilding, relining, repairing, and holiday shutdowns (AISI). The output from steel foundries that did not produce steel ingots are not included in the production data.

The Bethlehem Steel Sparrows Point plant became the largest steel plant in the world with the addition in 1957 of 2 million tons of new open-hearth capacity; this brought total capacity to 8.2 million tons compared with 7.2 million tons for the United States Steel, Gary, Ind., plant, formerly the world's largest. On December 10, 1957, the Nation's second oxygen-steelmaking plant started operating in Pennsylvania at the Aliquippa Works of Jones & Laughlin Steel Corp. Annual capacity of this installation totaled 492,000 tons. The capacity of the McLouth Steel Corp. oxygen-steelmaking plant in Trenton, Mich., built in 1954, was increased to 589,000 tons. Three other steel companies were building or planning oxygen-steelmaking plants.

Shipments of steel products, given in table 11, decreased 3.4 million tons. Although most categories decreased, shipments for construction and maintenance increased 2.1 million tons.

Alloy Steel.[3]—Domestic alloy-steel production in 1957 was 8,911,823 short tons, a decrease of 14 percent from 1956; it furnished 8 percent of total steel output compared with 9 percent in 1956 and 1955.

Stainless-steel ingot [3a] production (12 percent of the 1957 alloy-steel output) was 1,043,719 tons. Output for the year was 16 percent below 1956 and 14 percent below 1955. The production of austenitic stainless steel AISI 300 (nickel-bearing) and 200 series (manganese-nickel bearing), representing 60 percent of total stainless-steel production, was 17 percent below 1956; the ferritic and martensitic, straight chromium types, AISI 400 series, decreased 16 percent. Production of AISI 200 series (25,528 short tons) increased 31 percent. The output of type 501, 502, and other high-chromium, heat-resisting steels included in the stainless-steel-production figure decreased 7 percent. Production of all grades of alloy steel, other than stainless, decreased 14 percent. Production of molybdenum, manganese-molybdenum, and nickel-chromium steels increased. All others decreased, with silico-manganese and manganese steels showing the greatest decline. Silicon sheet steel (1 million short tons) decreased 21 percent. The percentages of alloy steel produced in the basic open-hearth, acid open-hearth, and electric furnaces were 64, 2, and 34 percent, respectively, compared with 61, 2, and 37 percent, respectively, in 1956.

TABLE 7.—Steel capacity, production, and percentage of operations, in the United States, 1948–52 (average) and 1953–57, in short tons [1]

[American Iron and Steel Institute]

Year	Annual capacity as of Jan. 1	Production				
		Open hearth	Bessemer	Electric [2]	Total	Percent of capacity
1948–52 (average)	100,512,902	82,372,885	4,227,802	5,763,835	92,364,522	91.9
1953	117,547,470	100,473,823	3,855,705	7,280,191	111,609,719	94.9
1954	124,330,410	80,327,494	2,548,104	5,436,054	88,311,652	71.0
1955	125,828,310	105,359,417	3,319,517	8,357,151	117,036,085	93.0
1956	128,363,090	102,840,585	3,227,997	9,147,567	115,216,149	89.8
1957	133,459,150	101,657,776	2,475,138	8,582,082	112,714,996	84.5

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. Omitted portion is about 2 percent of total steel production.
[2] Includes a very small quantity of crucible steel and oxygen-converter steel for 1954–57.

[3] The Bureau of Mines uses the American Iron and Steel Institute specifications for alloy steels, which include stainless and any other steel containing one or more of the following elements in the designated quantities: Manganese in excess of 1.65 percent, silicon in excess of 0.60 percent, and copper in excess of 0.60 percent. These specifications also include steel containing the following elements in any quantity specified or known to have been added to obtain a desired alloying effect: Aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, and other alloying elements.
[3a] All figures in this paragraph refer to ingots only except the last two sentences.

TABLE 8.—Open-hearth steel ingots and castings manufactured in the United States, 1948–52 (average) and 1953–57, by States, in short tons [1]

[American Iron and Steel Institute]

States	1948–52 (average)	1953	1954	1955	1956	1957
Mass., R. I., Conn.	458, 660	489, 967	327, 108	468, 893	378, 626	238, 748
New York	4, 459, 285	5, 771, 684	4, 596, 359	6, 304, 168	6, 045, 209	6, 224, 629
Pennsylvania	23, 844, 103	28, 805, 249	20, 549, 346	29, 357, 878	29, 218, 214	28, 646, 151
N. J., Del., Md.	4, 900, 377	5, 687, 465	5, 582, 382	6, 350, 784	5, 986, 771	6, 471, 163
West Virginia, Kentucky	3, 198, 435	3, 648, 235	3, 069, 339	3, 810, 285	3, 935, 260	3, 738, 042
Georgia, Alabama	3, 664, 957	4, 321, 489	3, 451, 696	4, 265, 487	3, 439, 887	4, 103, 289
Ohio	14, 612, 762	17, 570, 814	13, 661, 994	18, 446, 670	18, 240, 360	16, 722, 719
Indiana	10, 582, 300	13, 818, 187	12, 330, 815	15, 032, 809	14, 323, 470	14, 856, 378
Illinois	6, 553, 536	7, 735, 397	5, 963, 127	8, 025, 030	8, 065, 262	7, 352, 766
Michigan, Minnesota	4, 094, 029	4, 979, 415	4, 247, 700	5, 463, 778	5, 318, 570	5, 055, 911
Mo., Okla., Colo., Texas	2, 420, 765	3, 088, 318	2, 868, 874	3, 480, 238	3, 250, 580	3, 360, 551
Utah, Wash., Calif.	3, 583, 676	4, 557, 603	3, 678, 754	4, 353, 397	4, 638, 376	4, 887, 429
Total	82, 372, 885	100, 473, 823	80, 327, 494	105, 359, 417	102, 840, 585	101, 657, 776

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. Omitted portion is about 2 percent of total steel production.

TABLE 9.—Bessemer-steel ingots and castings manufactured in the United States, 1948–52 (average) and 1953–57, by States, in short tons [1]

[American Iron and Steel Institute]

State	1948–52 (average)	1953	1954	1955	1956	1957
Ohio	1, 965, 681	2, 326, 983	1, 658, 176	2, 268, 715	2, 210, 386	1, 735, 526
Pennsylvania	1, 184, 228	689, 814	451, 845	589, 249	593, 208	739, 612
Other States	1, 077, 893	838, 908	438, 083	461, 553	424, 403	
Total	4, 227, 802	3, 855, 705	2, 548, 104	3, 319, 517	3, 227, 997	2, 475, 138

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.

TABLE 10.—Steel electrically manufactured in the United States, 1948–52 (average) and 1953–57, in short tons [1]

[American Iron and Steel Institute]

Year	Ingots	Castings	Total [2]	Year	Ingots	Castings	Total [2]
1948–52 (average)	5, 667, 060	96, 775	5, 763, 835	1955	8, 307, 138	50, 013	8, 357, 151
1953	7, 229, 340	50, 851	7, 280, 191	1956	9, 090, 264	57, 303	9, 147, 567
1954	5, 381, 762	54, 292	5, 436, 054	1957	8, 513, 659	68, 423	8, 582, 082

[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 and oxygen-converter steel for 1954–57.

TABLE 11.—Shipments of steel products by market classifications, all grades, including carbon, alloy, and stainless

[American Iron and Steel Institute]

Market classification	1955		1956		1957	
	Shipments, short tons	Percent of total	Shipments, short tons	Percent of total	Shipments, short tons	Percent of total
Steel for converting and processing [1]	3,753,381	4.6	3,776,559	4.7	3,396,529	4.5
Forgings	1,266,032	1.6	1,473,186	1.8	1,056,036	1.4
Bolts, nuts, rivets, and screws	1,475,340	1.8	1,485,087	1.9	1,149,545	1.5
Warehouses and distributors:						
Oil and gas industry	2,196,491	2.7	2,247,184	2.8	2,323,742	3.1
All other	13,561,514	16.7	14,505,049	18.2	12,183,566	16.2
Total	15,758,005	19.4	16,752,233	21.0	14,507,308	19.3
Construction, including maintenance:						
Rail transportation	74,937	.1	65,959	.1	71,097	.1
Oil and gas	2,447,430	3.0	2,556,036	3.2	3,469,507	4.6
All other	7,159,411	8.8	7,819,131	9.8	8,982,681	11.9
Total	9,681,778	11.9	10,441,126	13.1	12,523,285	16.6
Contractor's products	3,982,161	4.9	4,074,577	5.1	3,403,580	4.5
Automotive:						
Passenger cars, trucks, parts, etc	18,203,409	22.4	13,744,303	17.3	13,895,315	18.5
Forgings	518,471	.7	397,584	.5	331,781	.4
Total	18,721,880	23.1	14,141,887	17.8	14,227,096	18.9
Rail transportation:						
Railroad rails, trackwork, and equipment	1,580,155	1.9	1,590,013	2.0	1,406,157	1.9
Freight cars, passenger cars, and locomotives	1,900,686	2.3	2,604,447	3.3	2,703,006	3.6
Street railways and rapid-transit systems	40,008	.1	32,194	-------	39,911	-------
Total	3,520,849	4.3	4,226,654	5.3	4,149,074	5.5
Shipbuilding and marine equipment	601,234	.8	760,306	1.0	1,277,772	1.7
Aircraft	96,892	.1	134,721	.2	99,561	.1
Oil and gas drilling	792,767	1.0	778,714	1.0	700,501	.9
Mining, quarrying, and lumbering	268,987	.3	349,508	.4	328,803	.4
Agricultural:						
Agricultural machinery	1,112,354	1.4	818,731	1.0	915,151	1.2
All other agricultural	224,532	.3	263,728	.3	182,951	.3
Total	1,336,886	1.7	1,082,459	1.3	1,098,102	1.5
Machinery, industrial equipment, and tools	4,699,024	5.8	5,031,599	6.3	4,512,298	6.0
Electrical machinery and equipment	2,291,866	2.8	2,437,804	3.1	2,085,675	2.8
Appliances, utensils, and cutlery	2,199,114	2.7	2,129,115	2.7	1,558,569	2.1
Other domestic and commercial equipment	2,189,416	2.7	2,263,775	2.8	1,837,940	2.4
Containers:						
Cans and closures	4,946,829	6.1	5,025,825	6.3	4,830,538	6.4
Barrels, drums, and shipping pails	982,651	1.2	1,018,873	1.3	817,533	1.1
All other containers	793,594	1.0	773,663	1.0	589,512	.8
Total	6,723,074	8.3	6,818,361	8.6	6,237,583	8.3
Ordnance and other military	856,527	1.1	523,890	.7	356,406	.5
Shipments of nonreporting companies	919,154	1.1	947,180	1.2	820,119	1.1
Total domestic	81,134,367	100.0	79,628,741	100.0	75,325,782	100.0
Export	3,583,077	-------	3,622,427	-------	4,568,795	-------
Total shipments	84,717,444	-------	83,251,168	-------	79,894,577	-------

[1] Net total after deducting shipments to reporting companies for conversion or resale.

TABLE 12.—Alloy-steel ingots and castings manufactured in the United States, 1948–52 (average) and 1953–57, by processes, in short tons [1]

[American Iron and Steel Institute]

Process	1948–52 (average)	1953	1954	1955	1956	1957
Open hearth:						
Basic	5,721,658	6,599,038	4,528,336	6,735,450	6,288,648	5,745,682
Acid	162,924	185,341	130,559	185,473	201,377	169,898
Electric [2]	2,557,043	3,543,815	2,533,968	3,739,168	3,838,043	2,996,243
Total	8,441,625	10,328,194	7,192,863	10,660,091	10,328,068	8,911,823

[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 and oxygen-converter steel for 1954–57.

Metalliferous Materials Used in Steelmaking.—Pig iron and scrap consumed in steelmaking furnaces in 1957 totaled 125.5 million short tons; the percentage of each was 55 and 45, respectively, compared with 52 and 48 percent in 1956 and 1955 (see table 13). The increase in the proportion of pig iron to scrap in 1957 resulted in an alltime record consumption of pig iron in steel furnaces. Consumption of foreign iron ore and agglomerates, including sinter, also reached a record high.

For the fourth consecutive year consumption of foreign iron ore in steelmaking furnaces exceeded that from domestic sources. The principal sources of foreign ore consumed were: Chile, 34 percent (18 percent in 1956); Brazil, 22 percent; Liberia, 16 percent; Venezuela, 14 percent; and Sweden, 6 percent.

CONSUMPTION OF PIG IRON

Although all the States used some pig iron, consumption was concentrated largely in steelmaking centers in the East North Central, Middle Atlantic, South Atlantic, and East South Central States. These areas in 1957 consumed 93 percent of the pig iron. Pennsylvania (the leading consumer) used 27 percent of the total, Ohio (second) 18 percent, and Indiana (third) 13 percent; corresponding figures for 1956 were 27, 20, and 12, respectively.

TABLE 13.—Metalliferous materials consumed in steel furnaces in the United States, 1948–52 (average) and 1953–57, in short tons

Year	Iron ore [1]		Agglomerates [1] [2]	Pig iron	Ferroalloys [2]	Iron and steel scrap
	Domestic	Foreign				
1948–52 (average)	3,548,561	1,723,252	1,358,433	54,038,403	1,300,000	49,680,857
1953	4,178,398	3,459,075	1,817,722	65,839,018	1,650,000	59,100,900
1954	2,619,871	3,640,771	1,143,160	51,658,482	1,270,000	46,064,651
1955	3,352,182	4,615,966	1,751,663	67,957,207	1,620,000	61,774,897
1956	3,398,359	4,741,062	1,516,936	66,437,573	1,630,000	62,276,019
1957	2,836,650	5,592,024	[3] 1,934,038	68,767,530	1,530,000	56,764,655

[1] Excludes consumption in steelmaking furnaces at plants that do not have blast furnaces.
[2] Includes ferromanganese, speigeleisen, silicomanganese, manganese briquets, ferrosilicon, and ferrochromium alloys.
[3] Includes 1,255,048 tons of sinter, 120,538 tons of pellets, 450,472 tons of nodules, and 107,980 tons of agglomerates. (106,602 tons of foreign origin).

TABLE 14.—Consumption of pig iron in the United States, 1954–57, by type of furnace

Type of furnace or equipment	1954		1955		1956		1957	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Open hearth	48, 632, 261	82. 9	63, 750, 490	82. 6	62, 165, 807	82. 9	64, 997, 545	85. 1
Bessemer [1]	2, 848, 691	4. 9	3, 932, 920	5. 1	4, 038, 845	5. 4	3, 494, 883	4. 6
Electric	177, 530	. 3	273, 797	. 3	232, 921	. 3	275, 102	. 4
Cupola	4, 896, 703	8. 3	5, 961, 861	7. 7	5, 349, 402	7. 1	4, 660, 016	6. 1
Air	232, 422	. 4	295, 209	. 4	292, 717	. 4	244, 552	. 3
Crucible	42	(2)	38	(2)	36	(2)	22	(2)
Direct castings	1, 874, 400	3. 2	3, 002, 020	3. 9	2, 915, 751	3. 9	2, 681, 006	3. 5
Total	58, 662, 049	100. 0	77, 216, 335	100. 0	74, 995, 479	100. 0	76, 353, 126	100. 0

[1] Includes pig iron used in oxygen-converter steel process.
[2] Less than 0.05 percent.

TABLE 15.—Consumption of pig iron in the United States, 1953–57, by States and districts, in short tons

District and State	1953	1954	1955	1956	1957
New England:					
Connecticut	63, 436	48, 981	50, 126	54, 104	41, 506
Maine	5, 928	3, 057	3, 357	4, 556	3, 171
Massachusetts	174, 513	140, 194	160, 664	170, 658	135, 025
New Hampshire	3, 503	3, 731	3, 731	4, 059	3, 710
Rhode Island	49, 432	38, 583	53, 316	52, 875	38, 381
Vermont	8, 974	9, 033	10, 626	13, 053	8, 961
Total	305, 786	243, 579	281, 820	299, 305	230, 754
Middle Atlantic:					
New Jersey [1]	200, 572	207, 610	234, 153	245, 524	168, 947
New York	3, 689, 763	2, 984, 809	3, 891, 870	3, 710, 751	4, 000, 712
Pennsylvania [1]	20, 608, 854	14, 601, 423	20, 600, 273	20, 450, 118	20, 450, 516
Total	24, 499, 189	17, 793, 842	24, 726, 296	24, 406, 393	24, 620, 175
East North Central:					
Illinois [1]	6, 055, 031	4, 320, 164	5, 877, 830	5, 942, 389	5, 771, 407
Indiana [1]	8, 928, 835	7, 713, 815	9, 411, 067	9, 015, 531	9, 589, 218
Michigan	3, 811, 411	3, 140, 805	4, 642, 449	4, 401, 778	4, 333, 789
Ohio [1]	14, 641, 399	11, 117, 854	15, 203, 917	14, 818, 433	14, 101, 850
Wisconsin	258, 786	206, 221	259, 552	275, 984	232, 338
Total	33, 695, 462	26, 498, 859	35, 394, 815	34, 454, 115	34, 028, 602
West North Central:					
Iowa	89, 467	71, 868	88, 072	73, 814	70, 060
Kansas, Nebraska	12, 378	6, 559	7, 322	5, 769	3, 959
Minnesota, North Dakota, South Dakota	518, 930	486, 718	601, 199	532, 391	500, 217
Missouri	77, 075	36, 002	51, 864	45, 722	51, 932
Total	697, 850	601, 147	748, 457	657, 696	626, 168
South Atlantic:					
Delaware, District of Columbia, Maryland	3, 919, 420	3, 877, 686	4, 260, 786	4, 050, 142	4, 642, 440
Florida, Georgia	65, 111	24, 600	45, 371	23, 245	19, 448
North Carolina	22, 644	17, 886	23, 456	22, 109	25, 061
South Carolina	10, 501	13, 107	14, 165	13, 777	13, 297
Virginia, West Virginia	1, 933, 541	1, 706, 519	2, 006, 306	2, 098, 515	2, 133, 902
Total	5, 951, 217	5, 639, 798	6, 350, 084	6, 207, 788	6, 834, 148

See footnote at end of table.

TABLE 15.—Consumption of pig iron in the United States, 1953–57, by States and districts, in short tons—Continued

District and State	1953	1954	1955	1956	1957
East South Central:					
Alabama	4,163,931	3,554,765	4,319,869	3,674,477	4,168,930
Kentucky [1], Mississippi, Tennessee	1,055,604	764,232	1,137,360	958,142	1,017,233
Total	5,219,535	4,318,997	5,457,229	4,632,619	5,186,163
West South Central:					
Arkansas, Louisiana, Oklahoma	12,464	8,673	10,229	9,132	7,972
Texas	568,161	661,821	749,298	675,432	913,087
Total	580,625	670,494	759,527	684,564	921,059
Mountain:					
Arizona, Nevada, New Mexico	195	266	82	184	195
Utah and Colorado	2,506,885	1,889,089	2,259,694	2,199,915	2,448,029
Montana, Idaho, Wyoming	478	324	180	318	542
Total	2,507,558	1,889,679	2,259,956	2,200,417	2,448,766
Pacific:					
California [1]	1,233,898	1,000,576	1,223,264	1,430,737	1,436,691
Oregon, Washington	15,357	5,078	14,887	21,845	20,600
Total	1,249,255	1,005,654	1,238,151	1,452,582	1,457,291
Undistributed [1]	1,267				
Total United States	74,707,744	58,662,049	77,216,335	74,995,479	76,353,126

[1] Small tonnages of pig iron, not separable, shown as "Undistributed."

PRICES

The major price increases for pig iron and steel were effective July 1 and were generally attributed to the 3-year contract between the steel industry and labor calling for wage increases on July 1 of each year.

TABLE 16.—Average value of pig iron at blast furnaces in the United States, 1948–52 (average) and 1953–57, by States, per short ton

State	1948–52 (average)	1953	1954	1955	1956	1957
Alabama	$40.21	$46.63	$46.97	$47.89	$50.23	$53.94
California, Colorado, Utah	45.98	51.14	51.08	53.82	50.67	57.44
Illinois	43.15	49.85	50.09	51.21	54.52	58.04
Indiana	43.41	49.29	50.16	50.79	53.09	58.33
New York	43.55	50.46	50.60	51.54	54.54	63.09
Ohio	43.03	49.44	48.92	49.35	52.42	55.88
Pennsylvania	43.87	50.69	50.52	51.30	55.01	59.25
Other States [1]	45.19	49.66	50.61	50.78	54.19	60.37
Average	43.60	49.83	49.93	50.68	53.58	58.43

[1] Comprises Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Tennessee, Texas, Virginia, and West Virginia.

The weighted average annual price of pig iron, as published by Iron Age, was $58.17 per short ton compared with $54.60 in 1956. The Iron Age composite price of finished steel for 1957 was 5.800 cents per pound, compared with 5.358 cents per pound in 1956. Prices increased in February, March, and July. Prices of hot-, cold-rolled, and galvanized sheets, strip, bars, structural shapes, bright wire, and stainless sheets increased on July 1. Tinplate prices increased on May 1 and tool steel on October 1.

TABLE 17.—Average monthly prices per short ton of chief grades of pig iron, 1956–57

[Metal Statistics]

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	
	1956	1957	1956	1957	1956	1957	1956	1957
January			$52.68	$56.25	$53.13	$56.70	$52.23	$55.80
February								
March	$49.11	$52.68	52.94	57.87	53.38	58.31	52.49	57.42
April								
May			54.02	58.04	54.46	58.48	53.57	57.59
June								
July	52.51	55.23		58.64		59.09		58.20
August								
September								
October	52.68	55.80	56.25	59.38	56.70	59.82	55.80	58.93
November								
December								
Average	50.88	54.20	54.63	58.33	55.08	58.78	54.19	57.88

TABLE 18.—F. o. b. value of steel mill products in the United States, 1956–57, in cents per pound [1]

Product	1956				1957			
	Carbon	Alloy	Stainless	Average	Carbon	Alloy	Stainless	Average
Ingots	4.307	8.361	31.559	5.398	4.216	9.012	37.063	9.505
Semifinished shapes and forms	5.081	8.446	29.487	5.846	5.447	9.160	36.135	6.151
Plates	5.717	9.471	54.791	6.241	6.244	11.772	63.630	6.781
Sheets and strips	6.474	13.252	50.991	7.413	6.868	14.579	54.238	7.919
Tin-mill products	8.449			8.449	8.879			8.879
Structural shapes and piling	5.540	6.986		5.551	6.074	7.595		6.087
Bars	6.642	12.848	55.923	8.158	7.190	13.428	64.399	8.707
Rails and railway-track material	6.328			6.328	6.987			6.987
Pipes and tubes	9.099	16.614	142.899	10.071	10.564	17.955	158.624	11.564
Wire and wire products	10.938	34.396	75.215	11.909	12.025	35.087	84.714	13.023
Other rolled and drawn products	7.882	32.343	60.530	11.081	8.904	35.844	59.985	12.155
Average total steel	6.915	12.770	53.587	7.731	7.497	13.862	60.218	8.328

[1] Computed from figures supplied by the U. S. Department of Commerce, Bureau of the Census.

FOREIGN TRADE [4]

Exports of pig iron (882,342 short tons valued at $57,202,035) in 1957 reached a record high, exceeding the previous record year, 1937, by 6,014 tons. Japan and India received 68 and 22 percent, respectively, of pig iron exported. The remaining 10 percent went to 14 other countries. Imports of pig iron were 31 percent below 1956; Canada supplied 98 percent of the total.

Exports of iron and steel products were the highest since 1947. Exports of railway track material and plates were 150 and 102 percent, respectively, greater than 1956. Tubular products and structural steel increased 45 to 50 percent. Hot- and cold-rolled strip and wire-mill products decreased. Overall imports decreased 12 percent. Imports of barbed wire increased and exceeded domestic production. Total exports of pig iron, iron and steel scrap, ferroalloys, and iron and steel products, exceeding 13.5 million short tons, were at an alltime high.

TABLE 19.—Pig iron imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries, in net tons

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America: Canada	144,525	305,256	203,303	260,741	303,121	221,166
South America:						
Argentina	(1)					
Brazil	6,897				19,621	
Chile	13,480					
Total	20,377				19,621	
Europe:						
Austria	34,925					
Belgium-Luxembourg	15,314					
Finland		168				
France	18,705					
Germany	119,904	[2] 3,539	[2] 31,854			[2] 34
Italy	1,025					
Netherlands	84,181	18,475	7,914	1,232	112	
Norway	10,230	2,692	3,482	224	339	
Spain	11,855	4,665	11,704	3,000		
Sweden	12,491	56,633	1,203	2,466	1,852	3,135
United Kingdom	1,393					
Total	310,023	86,172	56,157	6,922	2,303	3,169
Asia:						
India	16,101	12,659	7,470	11,217	336	
Turkey	7,442					
Total	23,543	12,659	7,470	11,217	336	
Africa:						
Rhodesia and Nyasaland, Federation of		[3] 6,606	[4] 1,944	241		
Union of South Africa	4,108		5,517	1,425	128	
Total	4,108	6,606	7,461	1,666	128	
Oceania: Australia	11,538	179,132	16,325	3,013	1,191	1,052
Grand total: Net tons	514,114	589,825	290,716	283,559	326,700	225,387
Value	$22,331,329	$25,967,435	$13,315,255	$14,563,612	$17,842,357	$13,527,813

[1] Less than 1 ton.
[2] West Germany.
[3] Southern Rhodesia.
[4] Southern Rhodesia not separately classified after July 1, 1954; 1,562 net tons January to June.

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

TABLE 20.—Major iron and steel products imported for consumption in the United States, 1955–57

[Bureau of the Census]

Products	1955		1956		1957	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel bars:						
Concrete reinforcement bars	158,973	[1] $13,559,126	173,302	[1] $17,314,051	160,374	$15,903,262
Solid and hollow, n. e. s.	33,225	3,664,784	47,372	[1] 5,794,523	26,369	3,879,629
Hollow and hollow drill steel	592	183,256	954	251,145	1,466	385,582
Bar iron, iron slabs, blooms, or other forms	79	17,909	93	[1] 21,842	113	35,559
Wire rods, nail rods, and flat rods up to 6 inches in width	47,761	[1] 5,699,167	64,193	7,823,521	54,371	6,712,135
Boiler and other plate iron and steel, n. e. s.	3,964	469,571	[2] 62,493	8,414,026	29,798	4,905,157
Steel ingots, blooms, and slabs; billets, solid or hollow	146,103	[1] 10,635,444	26,142	3,069,702	7,787	1,145,998
Die blocks or blanks, shafting, etc.	285	46,464	487	143,478	243	94,595
Circular saw plates	24	18,688	41	34,125	50	51,140
Sheets of iron or steel, common or black and boiler or other plate iron or steel	2,571	348,957	[2] 6,798	[1] 870,834	1,430	216,997
Sheets and plates and steel, n. s. p. f.	298	90,287	223	119,018	784	276,673
Tinplate, terneplate, and taggers' tin	44	16,826	656	[1] 148,235	45	17,352
Total semimanufactures	393,919	[1] 34,750,479	[2] 382,754	[1] 44,004,500	282,830	33,624,079
Manufactures:						
Structural iron and steel	266,161	[1] 28,963,223	[2] 615,983	[2] 76,936,436	437,400	61,495,142
Rails for railways	6,278	362,469	7,437	662,853	4,853	442,706
Rail braces, bars, fishplates, or splice bars and tie plates	772	[1] 36,323	112	[1] 13,709	193	23,194
Pipes and tubes:						
Cast-iron pipe and fittings	9,219	[1] 1,383,590	[2] 10,820	[2] 2,141,929	8,765	1,891,397
Other pipes and tubes	77,105	[1] 10,990,257	140,365	[1] 22,486,171	190,837	36,298,717
Wire:						
Barbed	60,084	7,695,229	62,296	[1] 8,416,191	63,109	9,361,129
Round wire, n. e. s.	40,495	[1] 5,627,152	49,921	[1] 7,790,678	70,763	11,555,551
Telegraph, telephone, etc., except copper, covered with cotton jute, etc.	635	[1] 582,963	1,747	[1] 1,378,254	1,667	1,289,843
Flat wire and iron and steel strips	24,765	[1] 7,043,253	18,394	[1] 8,035,028	16,208	8,433,649
Rope and strand	5,537	[1] 2,933,517	9,662	[1] 5,445,568	10,815	5,803,283
Galvanized fencing wire and wire fencing	13,460	[1] 1,709,300	21,988	[1] 2,922,962	30,157	4,369,296
Iron and steel used in card clothing	(3)	409,196	(3)	[1] 609,678	(3)	743,344
Hoop and band iron and steel, for baling	6,261	726,812	13,595	1,876,792	13,866	1,906,046
Hoop, band and strips, or scroll iron or steel, n. s. p. f.	24,549	2,243,672	[2] 20,272	2,434,121	15,472	1,985,972
Nails	132,838	[1] 18,093,133	113,480	[1] 16,860,733	137,558	21,816,051
Castings and forgings, n. e. s.	8,011	2,242,451	10,005	[1] 3,221,773	9,729	3,450,616
Total manufactures	676,170	[1] 91,042,540	[2] 1,096,077	[1,2] 161,232,876	1,011,392	170,865,936
Advanced manufactures:						
Bolts, nuts, and rivets	21,643	[1] 5,402,242	23,102	[1] 7,072,721	26,779	8,666,612
Chains and parts	1,556	[1] 974,561	3,201	[1] 1,816,388	2,985	1,830,899
Hardware, builders'		[1] 341,011		[1] 578,734		553,733
Hinges and hinge blanks		[1] 1,363,490		[1] 1,495,571		1,065,794
Screws (wholly or chiefly of iron or steel)		[1] 1,328,502		[1] 1,507,455		1,225,666
Tools		[1] 8,198,468		[1,2] 8,890,498		10,494,579
Other advanced manufactures		[1] 25,672		[1] 83,558		208,955
Total advanced manufactures		[1] 17,633,946		[1,2] 21,444,925		24,046,238
Grand total		[1] 143,426,965		[1,2] 226,682,301		228,536,253

1 Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.
2 Revised figure.
3 Weight not recorded.

TABLE 21.—Major iron and steel products exported from the United States, 1955–57

[Bureau of the Census]

Products	1955		1956		1957	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel ingots, blooms, billets, slabs, and sheet bars	621,333	$51,350,303	362,724	$35,719,065	510,350	$55,364,534
Iron and steel bars and rods:						
Iron bars	408	89,559	1,151	204,186	548	183,185
Concrete reinforcement bars	73,969	8,018,949	97,301	11,927,535	84,720	11,129,096
Other steel bars	131,276	21,424,479	199,599	34,287,859	129,361	26,010,215
Wire rods	30,930	3,227,968	17,514	2,056,656	13,696	1,743,632
Iron and steel plates, sheets, skelp, and strips:						
Plates, including boiler plate, not fabricated	215,391	28,803,072	298,664	46,369,238	604,093	92,699,415
Skelp iron and steel	88,329	8,455,238	148,520	15,704,087	197,120	23,697,814
Iron and steel sheets, galvanized	157,036	28,102,680	154,598	30,187,805	126,285	26,068,989
Steel sheets, black, ungalvanized	1,067,085	164,614,295	[1] 929,837	[1] 158,057,731	968,868	178,737,374
Strip, hoop, band, and scroll iron and steel:						
Cold-rolled	54,149	19,063,245	49,921	20,676,172	33,846	18,421,917
Hot-rolled	38,373	7,022,547	40,733	7,002,004	25,511	6,662,679
Tin plate and terneplate	837,404	143,195,161	[1] 726,339	[1] 134,495,400	700,720	133,829,273
Total semimanufactures	3,315,683	483,367,496	[1] 3,026,901	[1] 496,687,738	3,395,118	574,548,123
Manufactures—steel-mill products:						
Structural iron and steel:						
Water, oil, gas, and other storage tanks complete and knockdown material	41,781	11,294,219	75,453	19,482,217	81,566	24,114,277
Structural shapes:						
Not fabricated	279,487	32,198,998	363,400	46,954,245	452,544	62,003,769
Fabricated	87,619	22,080,038	84,315	26,206,978	220,256	33,905,305
Plates, sheets, fabricated, punched, or shaped	16,653	4,209,725	21,158	4,773,832	37,184	8,976,266
Metal lath	2,452	829,066	2,689	875,109	2,343	838,067
Frames, sashes, and sheet piling	11,035	2,116,256	11,013	2,294,154	20,596	4,410,352
Railway-track material:						
Rails for railways	57,825	4,579,185	68,319	7,559,764	196,950	23,441,927
Rail joints, splice bars, fishplates, and tie plates	11,279	2,316,702	17,549	3,557,549	33,957	6,961,875
Switches, frogs, and crossings	3,000	932,772	6,104	1,921,048	5,359	2,205,961
Railroad spikes	1,930	369,962	2,850	559,894	2,035	458,611
Railroad bolts, nuts, washers, and nut locks	818	317,480	1,081	480,344	1,168	459,111
Tubular products:						
Boiler tubes	26,683	7,679,501	26,375	9,739,104	31,168	13,183,912
Casing and line pipe	216,049	44,613,066	[1] 603,520	[1] 116,082,009	991,196	222,326,839
Seamless black and galvanized pipe and tubes, except casing, line and boiler, and other pipes and tubes	22,140	4,977,734	45,658	[1] 10,194,135	52,822	13,330,529
Welded black pipe	27,929	5,351,135	30,770	6,554,216	31,782	7,528,116
Welded galvanized pipe	12,125	2,449,004	11,254	2,548,844	13,054	3,187,784
Malleable-iron screwed pipe fittings	1,857	1,652,137	1,983	1,849,679	1,927	1,835,139
Cast-iron pressure pipe and fittings	21,021	3,077,033	27,345	4,661,595	38,608	6,165,829
Cast-iron soil pipe and fittings	9,243	1,695,536	9,329	1,907,159	13,517	2,674,944
Iron and steel pipe, fittings, and tubing, n. e. c.	48,928	27,422,795	71,102	42,107,628	70,678	53,028,415

See footnotes at end of table.

TABLE 21.—Major iron and steel products exported from the United States, 1955–57—Continued

Products	1955		1956		1957	
	Net tons	Value	Net tons	Value	Net tons	Value
Wire and manufactures:						
Barbed wire	1,641	$285,576	1,085	$216,188	1,340	$256,767
Galvanized wire	10,668	2,175,877	10,677	2,448,957	7,490	2,085,275
Iron and steel wire, uncoated	23,299	5,670,926	30,551	7,531,831	17,992	5,078,252
Spring wire	4,696	2,444,793	4,714	2,577,276	3,803	2,432,133
Wire rope and strand	14,166	7,263,861	18,350	9,748,332	19,063	10,816,919
Woven-wire fencing and screen cloth	4,174	[2] 2,265,921	3,905	[2] 2,274,819	3,107	[2] 2,042,013
All other	30,576	10,816,808	34,328	13,385,891	32,179	14,197,186
Nails and bolts, iron and steel, n. e. c.:						
Wire nails, staples, and spikes	3,090	2,022,481	3,273	2,347,621	3,737	2,659,596
All other nails, staples, spikes, and tacks	2,733	1,401,259	2,208	1,232,351	2,048	1,256,815
Bolts, screws, nuts, rivets, and washers, n. e. c	19,868	15,445,666	21,751	17,462,012	19,813	17,765,012
Castings and forgings: Iron and steel, including car wheels, tires, and axles	109,534	25,323,043	109,745	25,858,696	112,340	29,608,891
Total manufactures	1,124,299	255,278,495	[1] 1,721,854	[1] 395,393,477	2,521,622	579,235,887
Advanced manufactures:						
Buildings (prefabricated and knockdown)		7,083,068		[1] 11,126,174		6,108,034
Chains and parts	8,206	7,936,142	11,211	10,480,268	8,896	9,793,130
Construction material	8,012	4,727,559	10,648	5,958,982	8,544	5,500,752
Hardware and parts		17,123,664		20,533,440		22,298,745
House-heating boilers and radiators		7,896,943		9,491,538		8,611,624
Oil burners and parts		10,134,831		11,030,717		8,916,897
Plumbing fixtures and fittings		7,407,358		6,917,669		7,358,955
Tools		48,183,073		54,161,771		55,924,783
Utensils and parts (cooking, kitchen, and hospital)	1,531	4,569,769	1,540	4,687,746	1,533	4,815,857
Other advanced manufactures		29,410,460		32,622,941		39,811,170
Total advanced manufactures		144,472,867		[1] 167,011,246		169,139,947
Grand total		883,118,858		[1] 1,059,092,461		1,322,923,957

[1] Revised figure.
[2] Includes wire cloth as follows—1955: $1,163,185 (6,950,825 square feet); 1956: $1,104,737 (6,713,660 square feet); 1957: $1,168,144 (6,601,139 square feet).

WORLD REVIEW

World production of pig iron, including ferroalloys, and steel in 1957 reached a new high with a 5-percent increase in pig iron and a 3-percent increase in steel. The United States, the European Coal and Steel Community, and the Soviet Union ranked first, second, and third in both pig-iron and steel production. The United States produced 35 percent of both world pig iron and steel compared with 35 and 37 percent, respectively, in 1956.

TABLE 22.—World production of pig iron, (including ferroalloys), by countries,[1] 1948–52 (average) and 1953–57, in thousand short tons [2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	2,589	3,166	2,327	3,380	3,810	3,948
Mexico [3]	260	271	297	356	455	[4] 485
United States	63,814	77,201	59,752	79,263	77,667	81,144
Total	66,663	80,638	62,376	82,999	81,932	85,577
South America:						
Argentina	[4] 24	39	30	40	32	37
Brazil	736	985	1,222	1,198	1,291	[4] 1,320
Chile	143	315	336	282	368	[4] 420
Colombia	---------	---------	97	109	128	139
Total	903	1,339	1,685	1,629	1,819	[4] 1,916
Europe:						
Austria	1,006	1,456	1,493	1,660	1,915	2,161
Belgium	4,636	4,641	5,098	5,941	6,350	6,158
Bulgaria	[5] 12	6	7	8	8	[4] 44
Czechoslovakia	[4] 2,180	3,065	3,075	3,287	3,618	3,968
Denmark	42	40	44	61	62	[4] 66
Finland	103	87	82	126	114	142
France	9,173	9,678	9,868	12,198	12,833	13,314
Germany:						
East	405	1,188	1,453	1,672	1,735	[4] 1,820
West	9,888	12,846	13,792	18,168	19,375	20,236
Hungary	514	777	904	942	820	[4] 770
Italy	892	1,536	1,484	1,911	2,200	2,431
Luxembourg	3,027	3,000	3,086	3,401	3,652	3,713
Netherlands	528	654	672	739	730	773
Norway	263	305	271	392	492	614
Poland	1,658	2,600	2,935	3,430	3,865	4,059
Rumania [4]	340	500	480	630	650	[4] 660
Saar	2,055	2,626	2,752	3,174	3,341	3,492
Spain	731	911	1,004	1,093	1,100	1,030
Sweden	996	1,165	1,103	1,375	1,552	1,548
Switzerland	40	45	39	60	45	50
U. S. S. R. [6]	21,230	30,200	33,100	36,700	39,500	40,800
United Kingdom	10,947	12,516	13,309	13,966	14,750	16,024
Yugoslavia	257	310	406	585	713	812
Total [6]	70,923	90,152	96,457	111,519	119,420	[4] 124,685
Asia:						
China	[4] 1,050	[4] 3,300	3,340	4,057	5,616	[4] 6,060
India	1,884	1,990	2,197	2,122	2,194	2,147
Japan	2,546	5,129	5,237	5,981	6,905	7,864
Korea, North [4]	32	---------	---------	125	200	300
Taiwan (Formosa)	6	8	10	11	18	[4] 22
Thailand	[7] 7	6	2	2	4	[4] 4
Turkey	153	239	216	223	243	[4] 243
Total [6]	5,678	[4] 10,672	11,002	12,521	15,180	[4] 16,640
Africa:						
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	33	40	15	22	29	[4] 72
Union of South Africa	887	1,348	1,319	1,433	1,495	1,574
Total	920	1,388	1,334	1,455	1,524	1,646
Oceania: Australia	1,424	2,064	2,079	2,013	2,309	2,484
World total (estimate)	146,500	186,300	174,900	212,100	222,200	232,900

[1] Pig iron is also produced in Belgian Congo and Indonesia, but quantity produced is believed too small to affect estimate of world total.
[2] This table incorporates a number of revisions of data published in previous Iron and Steel chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Excluding ferroalloy production, for which data are not yet available; but estimates have been included in total.
[4] Estimate.
[5] Average for 1 year only, as 1952 was the first year of commercial production.
[6] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[7] Average for 1950–52.

TABLE 23.—World production of steel ingots and castings, by countries, 1948–52 (average) and 1953–57, in thousand short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	3,409	4,116	3,194	4,529	5,305	5,038
Mexico	452	579	686	838	970	1,136
United States [2]	92,364	111,610	88,312	117,036	115,216	112,715
Total	96,225	116,305	92,192	122,403	121,491	118,889
South America:						
Argentina [3]	140	190	205	240	[4] 340	[4] 400
Brazil	799	1,120	1,265	1,380	1,626	[3] 1,760
Chile	119	345	354	320	420	[3] 440
Colombia	11			85	99	130
Total	1,069	1,655	1,824	2,025	2,485	[3] 2,730
Europe:						
Austria	995	1,415	1,822	2,010	2,291	2,766
Belgium	4,776	4,957	5,462	6,504	7,035	6,917
Bulgaria		14	68	82	143	[3] 190
Czechoslovakia	3,471	4,813	4,707	4,932	5,381	[3] 5,680
Denmark	134	198	219	261	265	298
Finland	132	162	195	206	217	230
France	10,078	10,951	11,627	13,831	14,770	15,540
Germany:						
East	1,193	2,384	2,569	2,765	3,020	3,191
West	12,379	16,998	19,218	23,519	25,561	27,014
Greece	28	[3] 45	62	73	83	[3] 83
Hungary	1,188	1,701	1,644	1,796	1,571	1,653
Ireland [3]	19	22	33	33	33	28
Italy	2,899	3,858	4,637	5,947	6,512	7,481
Luxembourg	2,922	2,931	3,117	3,555	3,810	3,850
Netherlands	549	956	1,030	1,080	1,157	1,306
Norway	93	122	133	183	316	380
Poland	2,811	3,973	4,353	4,879	5,527	5,847
Rumania	595	793	693	844	859	945
Saar	2,273	2,959	3,092	3,489	3,719	3,791
Spain	883	1,063	1,296	1,427	1,365	1,526
Sweden	1,595	1,939	2,028	2,342	2,644	2,696
Switzerland [5]	149	173	165	183	188	247
U. S. S. R. [6]	29,784	41,998	45,636	49,935	53,572	56,218
United Kingdom	17,647	19,723	20,742	22,165	23,137	24,303
Yugoslavia	465	580	692	903	993	1,173
Total [5]	97,058	124,728	135,240	152,944	164,169	173,353
Asia:						
China	646	1,955	2,453	3,145	4,922	5,497
India	1,591	1,688	1,887	1,909	1,947	1,916
Japan	5,105	8,446	8,543	10,371	12,242	13,856
Korea:						
North [3]	34	11	60	150	210	310
Republic of	4	1	1	12	11	19
Philippines						63
Taiwan (Formosa)	11	22	28	44	68	96
Thailand	[7] 8	1	2	4	4	6
Turkey	130	187	187	207	213	194
Total [6]	7,529	12,311	13,161	15,842	19,617	21,957
Africa:						
Egypt [3]	11	22	78	95	117	110
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	25	28	36	55	64	77
Union of South Africa	912	1,368	1,577	1,742	1,769	1,915
Total	948	1,418	1,691	1,892	1,950	2,102
Oceania: Australia	1,559	2,288	2,476	2,465	2,915	3,260
World total (estimate)	204,400	258,700	246,600	297,600	312,600	322,300

[1] This table incorporates a number of revisions of data published in previous Iron and Steel chapters. Data do not exactly add to totals shown because of rounding where estimated figures are included in the detail.
[2] Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingots.
[3] Estimate.
[4] Including castings.
[5] Including secondary.
[6] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[7] Average for 1950–52.

NORTH AMERICA

Canada.—The Canadian steel industry increased its ingot capacity from 3.7 million short tons in 1948 to 6.0 million tons by the end of 1957. At the end of the year, plant capacity was adequate to supply over 60 percent of Canadian steel requirements, and further expansion was under way or planned. There was enough tinplate capacity to meet all Canadian needs. In recent years mill capacity has been increased for hot strip (continuous), electrolytic tinplate, galvanizing (continuous), and annealing (continuous). New plate mills and cold reduction mills have also been installed.

In 1957 the Steel Company of Canada, Ltd. (Stelco), added a new blooming mill capable of handling 30-ton ingots and having an annual capacity of 2.8 million tons. A new electrolytic tinning line was expected to be completed in early 1959. In the Hamilton area Stelco planned to spend $179,000 to reduce air pollution. At Algoma the following facilities were added: An iron foundry for making ingot molds, equipment to recover flue dust at the blast-furnace department, and a new coke-oven battery with 57 ovens. Construction of the oxygen-steelmaking plant and expansion of the bar and strip mill were scheduled for completion in 1958. A 27-foot-diameter hearth blast furnace to boost pig-iron capacity to 1.5 million tons and a new blooming and plate mill were scheduled for 1959. Dominion Steel & Coal Co. lit a new open hearth and installed new soaking pits. Several firms were investigating the economic feasibility of constructing an integrated steel mill in the Montreal area and steel plants in British Columbia and at Quebec City.[5]

SOUTH AMERICA

Venezuela.—The Venezuelan Government increased the investment for its new steel plant at Puerto Ordaz from $200 to $343 million, which called for increasing annual steelmaking capacity to 1.3 million tons. Nine 220-ton-capacity, low-shaft, electric pig-iron furnaces and four 305-ton open hearths will be installed. Power will be furnished from a Government hydroelectric project under construction on the Caroni River. The major part of the plant reportedly will be completed, and tubes will be produced by March 1958. All units should be operating by 1960. Other products will include rails, reinforcing rods, bars, shapes, and wire products.[6]

EUROPE

Portugal.—In the spring of 1956 the Economic Committee of the Portuguese Government declared itself in favor of building an iron and steel works. Bids for equipment were presented in Germany, England, France, United States, and Belgium. Late in 1957 a contract was signed with a German-Belgium combine to build the steelworks at Seixal, south of Lisbon; the plant was scheduled for completion in 3 years. It will include a blast-furnace plant (675 short tons of pig iron a day), a sintering plant (750 to 900 tons per day), a coking plant, a 40-ton electric-arc furnace, a 35-ton oxygen converter,

[5] U. S. Consul, Toronto, Canada, State Department Dispatch 84: Mar. 26, 1958.
[6] Metalworking Weekly, vol. 141, No. 5, July 29, 1957, p. 81.
American Metal Market, vol. 64, No. 114, June 14, 1957, p. 1.
Foreign Commerce Weekly, vol. 58, No. 5, July 29, 1957, p. 25.

a blooming and billet mill, and a merchant mill (165,000 tons per year). Initial ingot capacity will be 275,000 tons per year. Port facilities for handling iron ore and coal were to be built.[7]

U. S. S. R.—Having reached an alltime high output of 40.8 million short tons of pig iron and 56.2 million tons of steel in 1957, the U. S. S. R. announced plans to increase production of these commodities by 5 to 6 percent in 1958. It appeared that original Five-Year Plan objectives for 1960 calling for an output of 58 and 75 million short tons, respectively, of pig iron and steel would fall short by 8 to 10 million tons.[8] The plan was revised as the industry did not fulfill its capital construction program for 1957. However, 3 blast furnaces, 7 open-hearth furnaces, 5 rolling stands, 5 coke-oven batteries, 7 sintering strands, and several open-pit and shaft mines were put into operation (total investment—8.8 billion rubles).[9]

A book on U. S. S. R. iron ore resources also described plans for development of the Soviet iron and steel industry. Information on iron and steel in this book and from other Soviet sources was reviewed.[10]

The European Coal and Steel Community.—The European Coal and Steel Community celebrated its fifth anniversary with new record production of pig iron and steel. Pig-iron production for the year was 50.1 million short tons (including ferroalloys) compared with 48.5 million tons in 1956 and 38.6 million tons in 1952. The corresponding production figures for steel were 65.7, 62.6, and 46.0 million, respectively. With the exception of Belgium, all countries in the Community reached new record production in 1957. Belgian production decreased 0.5 million short tons because of a strike. Italy ranked third as a producer of steel in the Community, surpassing Belgium. The Community planned to increase its pig iron to steel ratio to lessen its dependence on foreign scrap. In 1957 the quantity of pig iron consumed per short ton of steel was 1,510 pounds, compared with 1,535 pounds in 1956 and 1,660 pounds in 1952. The objective for 1960 was 1,570 pounds. Although the operating rate of the iron and steel industry was slightly below 1956, pig-iron and steel production increased because of expanding facilities. Pig-iron and steel capacities increased 4.5 and 7.2 percent, respectively. Of the total tonnage of steel produced in 1957, 50.4 percent was produced in the basic Bessemer, 39.5 percent in the open hearth, and 10.1 percent in the electric furnace, virtually the same as 1956.

Production of rolled-steel products in 1957 was 46.5 million short tons, compared with 43.2 million in 1956 and 31.5 million in 1952. In 1957 the increase was 5.3 percent over 1956, essentially the same as in raw-steel production. However, in 1952 to 1957 expansion of rolled steel exceeded this rate—44.4 percent compared with 42.7 percent. The production of finished and special steels increased

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[7] Metal Bulletin (London), No. 4264, Jan. 24, 1958, p. 21.
U. S. Embassy, Lisbon, Portugal, State Department Dispatch 372: Jan. 23, 1958.
Iron and Steel Works of the World, 2d ed., 1956–57, p. 624.

[8] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, pp. 11–12.

[9] Stal, No. 1, January 1958, pp. 1–3.

[10] Academy of Sciences of the U. S. S. R., The Iron Ore Base of the U. S. S. R., I. P. Bardin, Editor in Chief, Moscow, 1957, 560 pp.
The Industry of the U. S. S. R., statistical handbook, Central Statistical Administration, Council of Ministers of the U. S. S. R., Moscow, 1957.
Planovoye Khozyaistvo, The Outlook for the Development of a Ferrous Metallurgy in Eastern Areas of the U. S. S. R., February 1957.
Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, pp. 3–16; vol. 45, No. 4, October 1957, pp. 11–23.

slightly over 1956. Production in France, the Saar, and Italy increased, while production in Germany and the Benelux countries decreased.

Investments at blast-furnace and steel plants in 1957 were $798 million, compared with $573 million in 1956. Investments for pig iron, steelmaking furnaces, rolling mills, and auxiliary service in 1957 were $233 million, $127 million, $294 million, and $144 million, respectively.

Information on technical developments is given for the European Coal and Steel Community under Technologic Developments.

ASIA

India.—India's iron- and steel-expansion plan was on schedule in private industry but lagging in Government-supported industry except for the Durgapur plant. The Tata Iron and Steel Co. began operating 3 of the seven 225-ton open-hearth furnaces, a battery of 26 coke ovens, and a roughing stand and finishing equipment at the plate mill; a plant for recovering scrap from slag was nearing completion. Indian Iron & Steel Co. completed a battery of 78 coke ovens, a 1,350-ton-per-day blast furnace and a 335-ton open hearth. At the Durgapur steel project where construction was progressing on schedule, two-thirds of the site's preparation had been accomplished, and foundations for the coke-oven and blast-furnace plant were completed or in progress. A 500-house town also was built. Only at the coke-oven plant of the Rourkela steel project was noticeable progress made. At the Soviet Bhilai steel project construction had been delayed because of the lack of raw steel for fabricating certain structures. Two-thirds of the steel needed for construction is supplied by the U. S. S. R., and the rest must be fabricated in India. Construction of the coal washery for this plant was also delayed because of the difficulty with building the foundation and late delivery of machinery from abroad.[11]

Main features of Indian steel plants in the Government-supported sector [1]

	Rourkela	Bhilai	Durgapur
Coke ovens	3 batteries of 70 ovens each.	3 batteries of 65 ovens each.	3 batteries of 78 ovens each.
Blast furnaces	3 of 1,000 tons capacity each.	3 of 1,135 tons capacity each.	3 of 1,250 tons capacity each.
Steel melting	2 mixers of 1,100 tons each. 3 L.D. converters of 40 tons each. 4 basic stationery open-hearth furnaces of 80 tons each.	1 mixer. 6 open-hearth furnaces of 250 tons each.	2 mixers. 7 open-hearth furnaces of 200 tons capacity each. 1 open-hearth furnace of 100 tons capacity.
Rolling mills	1 blooming and slabbing mill. 1 heavy-plate mill. 1 continuous strip mill. 1 cold-rolling mill with 2 sets of stands.	1 blooming mill, 45.2-inch. 1 rail and structural mill. 1 merchant mill. 1 continuous billet mill.	1 blooming mill. 1 intermediate mill. 1 medium structural mill. 1 merchant mill. 1 continuous billet mill. 1 wheel, tire, and axle plant.
Power plant	75,000 kw.	24,000 kw.	15,000 kw.

[1] Figures in long tons.

Japan.—The Japanese iron and steel industry reached another record in 1957 in production, shipments, and earnings. Pig-iron production was 14 percent higher than in the preceding year, steel-ingot

[11] U. S. Consul, Calcutta, India, State Department Dispatch 372: Mar. 27, 1958.

production was 13 percent higher, and production of ordinary rolled-steel products increased by 14 percent. Gross sales during the 12-month period ending in September 1957 were 30 percent higher than during the preceding year, and net earnings increased 82 percent. Exports were 22 percent below 1956. Imports of raw materials and finished steel products were exceptionally high because it had been anticipated that domestic production would not be enough to meet the rapidly growing demand.

Japan expanded its blast-furnace capacity during the year and improved blast-furnace efficiency. New furnaces were built by Amagasaki Iron & Steel Co. and Nakayama Steel Works, Ltd. The quantities of sintered ore and coke used per short ton of pig iron made, in pounds, are as follows:

	1956 average	*1957 January–June*	*1957 July–December*
Sintered ore	1,262	1,272	1,326
Coke	1,470	1,452	1,422

In steelmaking Japan's first 2 surface-blowing oxygen converters each with a capacity of 50 tons, were completed at Yawata Steel Corp. and produced 40,000 short tons in December. The Government and the steel industry emphasized construction of oxygen converters because of their negligible use of ferrous scrap.

Several new rolling mills were completed. The chief of these was a 160-inch, 4-high plate mill by Yawata Iron & Steel Co. In September Fuji Iron & Steel Co. began operating a new 6-stand hot-strip mill with an annual capacity of 800,000 tons, and Japan Steel & Tube Corp. completed a new seamless-tube mill with an annual capacity of 130,000 tons.[12]

Philippines.—The National Shipyards & Steel Corp. (NASSCO), P. I., announced a steel-development program calling for 200,000 tons of finished steel by 1961. The proposed pig-iron and steel-converter plants will be installed in Panganiban (Southern Luzon), and a rolling mill with a capacity of 200,000 tons will be constructed at Iligan in Mindanao. NASSCO has purchased two 18,000 kv.-a. electric-smelting furnaces with a combined capacity of 300 tons per day from Elektrokjemisk of Oslo, Norway. The plant was scheduled for delivery in the fall of 1958.[13]

Turkey.—Expansion plans of the Karabuk Iron & Steel Works, Turkey's only integrated steel plant, called for more than doubling existing capacity. A new 165-short ton open hearth was added during 1957, and a new contract for constructing a blast furnace with an annual capacity of 330,000 tons was signed. Three of the four existing 82.5-ton open-hearth furnaces were to be enlarged to 165 tons, and a new 165-ton open hearth was to be added. When the entire expansion program is completed, the plant can produce 660,000 tons of pig iron and 600,000 tons of steel per year.[14]

OCEANIA

New Zealand.—Plans were announced for building a £25-million iron and steel industry utilizing iron sands from the western Taranaki

[12] U. S. Embassy, Tokyo, Japan, State Department Dispatch 1365: May 13, 1958.
[13] Metal Bulletin (London), No. 4198, May 28, 1957, p. 17.
[14] U. S. Embassy, Ankara, Turkey, State Department Dispatch 620: Apr. 8, 1957.

area at Port Chalmers, Dunedin. Coal and power are available, and further large-scale power developments were planned. Because the iron sands contain titanium, a new type of electric-smelting furnaces will be used.[15]

TECHNOLOGIC DEVELOPMENTS

During 1957 the American steel industry continued to improve iron- and steel-making facilities, develop new direct iron-reduction processes, and expand vacuum-melting facilities. The use of oxygen and humidification of blast-furnace blast received further attention. In an experiment at the National Steel, Weirton, W. Va., plant, pig-iron output was increased 19 percent by using a blast enriched with 4 percent of oxygen. Oxygen enrichment with humidification of blast increases carbon monoxide and hydrogen content of the bosh gas and reduces the amount of nitrogen. By increasing the proportion of reducing gases to nitrogen and carbon dioxide, more of these reducing gases are available for shaft reduction, which decreases overall smelting time. The time required for reduction with hydrogen is about one-fourth of that required with carbon monoxide.[16]

The use of oxygen in steelmaking increased during the year, and new oxygen plants were under construction. Jones & Laughlin Steel Corp. constructed the Nation's second oxygen-steelmaking plant at Aliquippa, Pa. Inland Steel used oxygen and made steel in an open-hearth furnace without fuel.

In 1957, for every ton of steel ingots made, more than 200 cubic feet of oxygen was used.[17] One oxygen-steelmaking plant was under construction by Acme Steel. The company will use oxygen converters to make steel from molten iron produced in two hot-blast cupolas, a new practice in the United States.

A summary of oxygen usage in various steel-mill operations follows:

1. Open-hearth lancing—150 to 300 cubic feet per ton of ingots.
2. Open-hearth jets through roof—100 to 500 cubic feet per ton of ingots.
3. Open-hearth combustion—125 to 500 cubic feet per ton of ingots.
4. Bessemer—400 to 500 cubic feet of oxygen per ton of ingots.
5. Top-blown oxygen converter—1,800 to 2,200 cubic feet per ton of ingots.
6. Hot scarfers—100 to 150 cubic feet per ton of slabs.
7. Blast furnaces—1,200 to 4,500 cubic feet per ton of pig iron at 1 to 4 percent enrichment.[18]

Inland Steel Co. produced steel in an open hearth without fuel, using lance injection of oxygen at the slag-metal interface. A 125-ton heat of steel was made in about half the time compared with conventional practice.

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[15] Mining World, vol. 19, No. 13, December 1957, p. 79.

[16] Strassburger, J. H., The Use of Oxygen in Iron and Steel Production: Pres. at AISE meeting, Pittsburgh, Pa., July 15, 1957.

[17] American Iron and Steel Institute, Annual Statistical Report: May 1958, p. 23.

[18] Work cited in footnote 16.

Inland's test showed that high-carbon, low-phosphorous steel can be made from pig iron containing 0.7 percent or more phosphorous without external heat. The steel produced is identical with basic open-hearth steel.[19]

A new method developed for deoxidizing and alloying steel with aluminum employs an aluminum bar, which is wired in place in the mold before the steel ingot is poured. This method reportedly increases product yield, reduces aluminum requirement, and improves mixing.

Battelle Memorial Institute announced a new process for desulfurizing pig iron with caustic soda. Molten iron and caustic soda are fed continuously into an apparatus in which desulfurization occurs as the materials are mixed. Slag and desulfurized metal flow continuously from the apparatus into molds or ladles. Under laboratory conditions the process has been used to reduce the sulfur content from 0.1 to less than 0.02 percent.[20]

Direct-iron processes, discussed in technical journals and under investigation during the year, are summarized below. These were studied in pilot plants at virtually every major steel plant in the United States. Between $10 and $12 million was estimated as spent in research on direct-iron processes.[21]

Another development—casting steel ingots that are free from surface imperfections—was accomplished by using a 0.040-inch fiber-glass-mold lining. The liner prevents splashed molten steel from sticking to the mold wall and forming scabs and other defects on the ingot. The fiber-glass liner melts at the metal-contact surface.

Armco Steel Corp. tried an unconventional system for charging scrap into open-hearth furnaces. Scrap was transported to the open-hearth charging floor in gondola cars and transferred by magnet hoist to a charging hopper. Three charging pans were under the hopper; I received the charge, and 2 others took any spillage. As soon as the pans were full, the charging machine moved the pan containing scrap directly into the furnace. This system speeded charging of scrap by about 15 percent and eliminated long trains of charging-pan railroad cars, which frequently cause delay in charging adjacent furnaces.

The increased demand for superior steel and alloys led to expansion in vacuum-melting-furnace capacity in the United States. At the end of 1957 capacity of facilities totaled about 20 million pounds of induction vacuum melting and 50 million pounds by consumable-electrode, vacuum-arc melting. Allegheny Ludlum Steel Corp. began operating probably the world's largest vacuum furnace for making high-purity superalloys at its Watervliet, N. Y., plant. This unit uses the consumable-electrode remelting process and can produce 26-inch-diameter ingots weighing up to 6 tons. This new furnace brings Allegheny Ludlum's capacity for producing these special alloys to 2 million pounds a month.

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[19] Luerssen, F. W., Halley, J. W., and Tenenbaum, Michael, Inland Steel Co., An Oxygen Steelmaking Process for American Raw Materials: Pres. at AIME annual meeting, New Orleans, La., Feb. 28, 1957.
[20] Battelle Technical Review, vol. 6, No. 8, August 1957, p. 15.
[21] Madsen, I. E., Developments in the Iron and Steel Industry During 1957: Iron & Steel Eng., vol. 35, No. 10, January 1958, pp. 139-189.

World direct-iron processes [1]

Process	Its nature	Location	Reducing agent	Type product	Status	Remarks
Tysland-Hole	Electric-arc furnace	Several in Scandinavia	Low-grade coal with arc heat source.	Pig iron	Production	Requires cheap electric power. Siemens furnace is similar.
Lubatti	Electric-resistance furnace.	Forni Lubatti Co., Turin, Italy.	Coal	do	(?)	Fine ore reduced by coal fines in slag maintained molten by resistance heating.
Krupp-Renn (Johannsen)	Rotary kiln	Several in Europe, Asia, Africa.	Low-grade coal or coke breeze.	Iron nodules, sponge iron.	Production	Product likely to be high in sulfur, silica, gangue. Basset kiln is similar.
R-N (Republic Steel-National Lead).	do	Birmingham, Ala	Low-grade carbon fuel.	Iron-flake compacts.	Semiproduction	Employs a highly beneficiated charge.
Madaras	Fluidized bed	Longview, Tex	Cracked natural gas	Sponge iron	do	A modified Madaras plant is making charge metal for a small Mexican steel company.
Nu-Iron (U. S. Steel)	do	South Works, Chicago, Ill.	Hydrogen and carbon monoxide.	Iron-powder compacts.	Pilot	Continuous process using natural gas for reducing gases.
Esso-Little (Arthur D. Little)	do	Arthur D. Little, Inc., Cambridge, Mass.	do	do	do	Do.
H-Iron (Hydrocarbon Research).	do	Hydrocarbon Research Inc., Trenton, N. J.	Hydrogen	do	Semiproduction	Alan Wood Steel Co. has ordered full-scale plant.
Hoganas (Sieurin)	Tunnel kiln	Hoganas, Sweden; Riverton, N. J.	Coke or coal	Sponge iron	Production	Used mainly for iron-powder production.
Domnarfvet	Rotary furnace	Domnarfvet, Sweden	do	do	Experimental	Operating problems similar to Krupp-Renn.
Diamond Alkali	Rotating drum	Battelle Memorial Institute, Columbus, Ohio.	Coal	Liquid iron or steel.	do	Application to direct reduction still theoretical.
Demag-Humbolt	Low-shaft blast furnace.	Germany	do	Pig iron	Production	One of many low-shaft designs. Not competitive with coke blast furnace.
DLM (Dwight-Lloyd-McWane).	Sintering machine and shaft furnace.	McDowell Co., Inc., Cleveland, Ohio.	Cheap coal or coke breeze.	do	Experimental	Primarily a pellet-roasting process.
Cyclosteel	Slagging cyclone with fluidized bed preheater.	British Iron & Steel Research Association, London.	Cheap coal or natural gas and oxygen.	Steel	do	Several stage reduction with liquid end product.

[1] Steel: The Case for Direct Reduction, vol. 141, No. 18, Oct. 28, 1957, p. 185.

Greater automation was introduced in rolling mills to speed up operations. One mill used a punch-card system on a roughing mill for controlling 15 programmed passes from a single card at accuracies of 0.01 inch. Another mill used a trailing-end tension compensator, which reduced the amount of overgage on the tail end of strip steel; strip produced from one steel slab is frequently ½ mile long. Although it is rolled at speeds of 2,500 feet per minute, the temperature drop in the back end of the bar is great enough to cause overgage. Another unit is being planned to obtain the same results by installing automatic machines for changing mill-gage settings and speeds to give uniform gage at the end of the bars.[22]

The Bureau of Mines made a number of significant contributions to iron and steel technology during 1957. In a unique experiment at Pittsburgh the composition and constitution of a blast-furnace charge column was determined by quenching the Bureau's experimental blast furnace with nitrogen during normal operation. Examination of sections of the unfused part of the charge column held together with plastic and of the fused part by core drilling revealed many heretofore unknown phenomena. A spherical cavity or raceway at the mouth of each tuyère, heretofore a matter of conjecture, was clearly defined. Other outstanding accomplishments in blast-furnace research were the development of factors for applying experimental data to industrial-scale blast furnaces and the production of commercial-grade pig iron from green (unfired) taconite pellets.

In Bureau steel research vapor-pressure studies of solid and liquid manganese and of manganese in liquid iron-manganese alloys provided useful data in predicting the behavior of the metal in high-temperature reactions. Low-nickel manganese-austenitic stainless steels, substitutes for the 8-percent-nickel type, were made from offgrade western ores. High-silicon iron (possibly a substitute for silvery pig iron) was made from pyrite cinders and nonferrous smelter slag in an open-top electric furnace using coke and wood chips as reductants.

In continuing the search for methods to conserve manganese and improve the quality of steel the Bureau installed equipment for the safe employment of radioactive isotopes to identify trace inclusions in steel. Mischmetal was found experimentally effective in desulfurizing steel.

The low-shaft blast furnace employing low-rank coals continued to be used in Europe. A 100-ton-per-day low-shaft furnace was under construction at Klockner Mannstaedt-Werke at Troisdorf, near Bonn, West Germany. At Cologne, Germany, an experimental pilot plant, in operation since 1954, produced all types of pig iron, including Bessemer, foundry, and the basic open-hearth grades with normal composition except for perhaps the generally lower sulfur grades. Coal requirements, about 4,400 pounds per ton of pig iron, may be reduced in larger units to as low as 2,100 to 2,400 pounds per short ton of pig iron.[23]

At the beginning of the current Five-Year Plan in the U. S. S. R., the average blast-furnace working volume was 26,240 cubic feet.

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[22] Madsen, I. E., Developments in the Iron and Steel Industry During 1957: Iron & Steel Eng., vol. 35, No. 10, January 1958, pp. 139–189.

[23] Chatterjea, A. B., Low-Shaft Furnaces as an Alternative to the Blast Furnace: Iron and Coal Trades Rev., Nov. 23, 1956, pp. 1255–1261.

Some old furnaces were being reconstructed in 1957, and most of the new ones were to range from 53,400 to 60,700 cubic feet in size.[24]

Of the 7 blast furnaces, construction of which is to begin in 1958, 5 will have working volumes of 60,700 cubic feet each. Blast furnaces with working volumes of 70,600 cubic feet and a daily output of 3,700 short tons of pig iron were on the drawing board.

Many Soviet blast furnaces used a high proportion of self-fluxing sinter (90 percent at Magnitogorsk), humidified blast, high-top pressure (70 percent of total pig iron produced), hot-blast temperatures of 1,500°–1,700° F., and were blowing 100,000 c. f. m. of wind. While modernization continued, the industry was plagued by decreasing iron content in the Krivoi Rog basin (from 55.4 to 54.5 percent during the year). The ores and sinter fed to the Chelyabinsk and Nizhne-Tagil blast furnaces dropped 1.5 to 2.5 percent in iron content during the first 9 months of the year; and the ash content in the coke used by the eastern plants increased an average of 0.67 percent.[25]

Most of the large open-hearth furnaces in operation had a capacity per heat of 200 to 400 tons; some of the new ones will be up to 550 short tons. Oxygen-enriched flames, vacuum melting and teeming of steel, centrifugal and semicontinuous pipe casting are being adopted. Continuous casting machines were to be introduced at the Magnitogorsk and Kuznetsk plants.

Visitors returning from the U. S. S. R. report that open-hearth roofs made of basic brick last for 650 heats.[26] This compares with about 350 heats for silica-brick roofs.

The main features of the European Coal and Steel Community research program were: (1) Reducing the quantity of coke per ton of pig iron by employing unusual blast-furnace innovations; (2) agglomerating iron ore without a binder; (3) producing direct iron as a substitute for scrap; (4) improving and increasing the life of furnace refractories; and (5) increasing emphasis on process control during rolling of steel to improve quality.

For the first problem (reducing metallurgical coke per ton of metal produced) the High Authority made an $850,000 grant to the International Low-Shaft Blast Furnace Group at Liege, Belgium, to study for a 3-year period the different factors influencing coke consumption. The first problem of this experiment was making the Liege furnace operate like a commercial blast furnace on a reduced scale. One experiment was reducing the blowing rate which decreased direct reduction and daily coke rate. In this phase of the study the movement of the furnace charge down the shaft was more uniform, and the problem of local fusion and the formation of channels in the charge column were not apparent. Paralleling the decrease in blowing rate, the use of high-top pressure, screened coke and ore, and increased hot-blast temperature were employed. Finally studies were made or in process to determine whether a circular hearth or an elliptical one was preferable and to find the optimum height of the stack. The 1958 program

[24] Sominskiy, V. S., O Tekhnicheskom Progresse Promyshlennosti SSSR (about the Technical Progress in USSR Industry), Moscow, 1957, pp. 62–70.
[25] Work cited in footnote 13.
[26] Business Week: Russia Crowds the U. S., Dec. 7, 1957, No. 1475, pp. 110, 111.

called for addition of water vapor to the hot blast, injection of liquid fuels through the tuyères, enrichment of the blast with oxygen, and use of greater proportions of sinter.

In 1957 a $250,000 grant was devoted to completing studies particularly directed to agglomerated materials produced without a binder in an extruding press operating in vacuum. Three direct-iron processes (rotary kiln, shaft furnace, and fluidized bed) were studied to produce a material that can be substituted for scrap in open-hearth and electric furnaces. Service tests of refractories in four open-hearth furnaces were conducted. In an effort to improve steel quality, an electronic computer was used to study experimental results relating irregularities that occur during heating and rolling of steel to the finished steel products.[27]

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27 European Iron and Steel Community [Sixth General Report on the Activities of the Community] (in French): Pub. Dept., vol. II, Apr. 13, 1958, 425 pp. (Translated by Percy H. Royster and Bernadetta Michalski.)

Iron and Steel Scrap

By James E. Larkin [1]

DURING 1957, prices and demand were uncertain in the iron and steel scrap industry. The price of No. 1 Heavy-Melting scrap at Pittsburgh was at a yearly high of $60.70 per gross ton in January. In April its price dropped to $42.00 but by July had increased to $56.25. The price then declined to $32.50 (estimate) per ton in December—the lowest price since December 1954.

Domestic demand for scrap was high during the first quarter of 1957, when steel mills were producing at 96 percent of the annual rated capacity, during which time they were able to obtain an ample supply of scrap. During January scrap consumption totaled 7.4

TABLE 1.—Salient statistics of ferrous scrap and pig iron in the United States, 1956–57

	1956 (short tons)	1957 (short tons)	Change from 1956 (percent)
Stocks, December 31: Ferrous scrap and pig iron at consumers' plants:			
Total scrap	7,416,055	8,949,386	+21
Pig iron	2,354,796	3,816,699	+62
Total	9,770,851	12,766,085	+31
Consumption: Ferrous scrap and pig iron charged to:			
Steel furnaces: [1]			
Total scrap	62,276,019	56,764,655	−9
Pig iron	66,437,573	68,767,530	+4
Total	128,713,592	125,532,185	−3
Iron furnaces: [2]			
Total scrap	16,698,026	15,647,960	−6
Pig iron	8,557,906	7,585,596	−11
Total	25,255,932	23,233,556	−8
Miscellaneous uses [3] and ferroalloy production: Total scrap	1,341,125	1,136,208	−15
All uses:			
Total ferrous scrap	80,315,170	73,548,823	−8
Pig iron	74,995,479	76,353,126	+2
Grand total	155,310,649	149,901,949	−4
Imports of scrap (including tinplate scrap)	255,569	238,610	−7
Exports of scrap:			
Iron and steel	[4] 6,340,261	6,655,963	+5
Tinplate, circles, strips, cobbles, etc	[4] 24,481	21,875	−11
Average prices per gross ton:			
Scrap:			
No. 1 Heavy Melting, Pittsburgh [5]	[4] $54.14	[6] $47.53	−12
No. 1 Cast Cupola, Chicago [5]	[6] $55.05	(7)	
For export	[4] $51.88	$54.14	+4
Pig iron, f. o. b. Valley furnaces: [5]			
Basic	$60.67	$64.92	+7
No. 2 Foundry	$61.17	$65.42	+7

[1] Includes open-hearth, Bessemer, electric furnaces, and oxygen-steel process.
[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.
[6] Estimate.
[7] No longer quoted in Iron Age.

[1] Commodity specialist.

million short tons, highest for the year; but, as the year progressed, scrap requirements fluctuated each month and dropped to a low of 4.8 million short tons during December.

A 2-percent drop in steel output and an increase in the ratio of pig iron to scrap in 1957 as compared with 1956 resulted in a 9-percent decrease in the use of scrap in steelmaking furnaces. Consumption of pig iron in these furnaces was at an alltime high—4 percent above 1956—but the use of ferrous materials, scrap and pig iron, decreased 3 percent. The decline in the use of materials for manufacturing steel ingots and castings was attributed to scattered work stoppages in the steel industry and a lack of demand resulting from a general business recession in the third and fourth quarters.

LEGISLATION AND GOVERNMENT PROGRAM

On February 1, 1957, the United States Department of Commerce transmitted a report on the supply and availability of iron and steel scrap to the Speaker of the House of Representatives. The report was prepared in accordance with section 2 of Public Law 631, 84th Congress. It concerned a study of the Nation's mobilization base in ferrous metallics for the Office of Defense Mobilization and was in response to a request from the Congress to the Secretary of Commerce for a comprehensive survey of the national ferrous scrap situation. This report was based on a special survey of obsolete scrap by the Battelle Memorial Institute of Columbus, Ohio, and from records of the Federal Bureau of Mines.

In summarization, the report indicated that future requirements for obsolete Heavy-Melting grades would exceed the rate at which these grades will return to the Nation's scrap supply. Alleviating this drain upon Heavy-Melting grades of scrap would require a change in the pattern of domestic and foreign scrap consumption and less dependence on these grades of scrap for steelmaking.

Regulations governing licensing of scrap for export were temporarily suspended by the Bureau of Foreign Commerce, United States Department of Commerce, to permit a review of the domestic supply situation and because of the heavy volume of export applications received in February. The suspension was rescinded within a short time and permitted resumption of scrap licensing of all grades, other than Heavy-Melting scrap to Japan, the United Kingdom, and the European Coal and Steel Community. These countries agreed to limit their imports of Heavy-Melting grades of scrap to approximately 13 percent of the quantity imported in 1956.

AVAILABLE SUPPLY

Consumers of iron and steel scrap had a net available supply at their plants of 75.1 million short tons during 1957—a 7-percent decrease from the net available supply held during the previous year. Home scrap produced by consumers was slightly higher than during 1956, but scrap received from dealers and other sources decreased 14 percent. The net available supply decreased 26 percent in the New England district; however, the Rocky Mountain district supply increased 11 percent.

TABLE 2.—Iron and steel scrap, net available supply [1] for consumption in 1957, by districts and States, in short tons

District and State	Home production	Receipts from dealers and all others	Total available supply	Shipments [2]	Net available supply for consumption
New England:					
Connecticut	96,669	113,178	209,847	10,128	199,719
Maine	3,788	7,787	11,575	4,165	7,410
Massachusetts	180,008	234,968	414,976	23,085	391,891
New Hampshire	8,023	8,424	16,447	769	15,678
Rhode Island	35,981	36,265	72,246	2,713	69,533
Vermont	10,478	11,111	21,589	67	21,522
Total: 1957	334,947	411,733	746,680	40,927	705,753
1956	429,794	571,431	1,001,225	43,045	958,180
Middle Atlantic:					
New Jersey	178,409	492,371	670,780	27,422	643,358
New York	2,137,451	2,002,132	4,139,583	68,799	4,070,784
Pennsylvania	11,601,899	6,963,182	18,565,081	1,031,260	17,533,821
Total: 1957	13,917,759	9,457,685	23,375,444	1,127,481	22,247,963
1956	13,503,537	11,111,531	24,615,068	933,585	23,681,483
East North Central:					
Illinois	3,670,943	3,357,564	7,028,507	227,984	6,800,523
Indiana	5,212,778	3,390,251	8,603,029	150,401	8,452,628
Michigan	3,097,291	3,167,331	6,264,622	96,758	6,167,864
Ohio	7,790,071	4,593,598	12,383,669	421,824	11,961,845
Wisconsin	453,426	429,962	883,388	90,912	792,476
Total: 1957	20,224,509	14,938,706	35,163,215	987,879	34,175,336
1956	20,861,974	17,783,820	38,645,794	1,027,393	37,618,401
West North Central:					
Iowa	119,789	244,432	364,221	3,573	360,648
Kansas and Nebraska	25,355	81,448	106,803	3,035	103,768
Minnesota, North Dakota, and South Dakota	273,364	219,952	493,316	2,757	490,559
Missouri	191,469	764,692	956,161	25,644	930,517
Total: 1957	609,977	1,310,524	1,920,501	35,009	1,885,492
1956	665,106	1,570,865	2,235,971	16,305	2,219,666
South Atlantic:					
Delaware, District of Columbia, and Maryland	2,420,743	451,685	2,872,428	18,479	2,853,949
Florida and Georgia	69,580	221,253	290,833	1,500	289,333
North Carolina	29,482	33,354	62,836	8,237	54,599
South Carolina	10,564	11,609	22,173	864	21,309
Virginia and West Virginia	765,465	776,094	1,541,559	53,078	1,488,481
Total: 1957	3,295,834	1,493,995	4,789,829	82,158	4,707,671
1956	3,051,997	1,980,559	5,032,556	96,515	4,936,041
East South Central:					
Alabama	1,694,827	1,378,722	3,073,549	298,122	2,775,427
Kentucky, Mississippi, and Tennessee	609,591	807,071	1,416,662	62,255	1,354,407
Total: 1957	2,304,418	2,185,793	4,490,211	360,377	4,129,834
1956	2,065,555	2,278,119	4,343,674	264,477	4,079,197
West South Central:					
Arkansas, Louisiana, and Oklahoma	44,396	145,413	189,809	3,271	186,538
Texas	755,660	1,115,147	1,870,807	28,891	1,841,916
Total: 1957	800,056	1,260,560	2,060,616	32,162	2,028,454
1956	719,673	1,239,599	1,959,272	52,665	1,906,607
Rocky Mountain:					
Arizona, Nevada, and New Mexico	14,946	65,095	80,041	2,876	77,165
Colorado and Utah	1,254,089	554,576	1,808,665	12,058	1,796,607
Idaho, Montana, and Wyoming	5,807	19,631	25,438	31	25,407
Total: 1957	1,274,842	639,302	1,914,144	14,965	1,899,179
1956	1,073,728	649,463	1,723,191	17,696	1,705,495

See footnotes at end of table.

TABLE 2.—Iron and steel scrap, net available supply[1] for consumption in 1957, by districts and States, in short tons—Continued

District and State	Home production	Receipts from dealers and all others	Total available supply	Shipments[2]	Net available supply for consumption
Pacific Coast:					
California	1,098,546	1,639,014	2,737,560	86,983	2,650,577
Oregon	42,089	187,454	229,543	5,010	224,533
Washington	93,332	336,918	430,250	2,888	427,362
Total: 1957	1,233,967	2,163,386	3,397,353	94,881	3,302,472
1956	1,304,250	2,239,184	3,543,434	127,608	3,415,826
Total United States: 1957	43,996,309	33,861,684	77,857,993	2,775,839	75,082,154
1956	43,675,614	39,424,571	83,100,185	2,579,289	80,520,896

[1] Net available supply for consumption is a net figure computed by adding home production to receipts from dealers and all others and deducting consumers scrap shipped, transferred, or otherwise disposed of during the year.
[2] Includes scrap shipped, transferred, or otherwise disposed of during the year.

CONSUMPTION AND USES

The total domestic consumption of ferrous scrap during 1957 decreased 8 percent from the previous year and comprised 49 percent of the total charge of ferrous materials, scrap and pig iron. This decreased consumption of ferrous scrap was accompanied by increased use of pig iron, totaling 76.4 million short tons, the second largest quantity consumed. The average monthly consumption rate of ferrous scrap was 6.1 million short tons compared with 6.7 million short tons in 1956.

The output of steel ingots and castings (112 million short tons) decreased 2 percent from 1956 and required melting 125.5 million short tons of ferrous materials, scrap and pig iron, in steelmaking furnaces (open-hearth, Bessemer, oxygen-steel process, and electric). These furnaces consumed 56.7 million short tons of scrap and 68.8 million short tons of pig iron, a 9-percent decrease and a 4-percent increase, respectively, compared with 1956. The use of pig iron in these furnaces during January established a record and totaled 6.5 million short tons.

The proportions of scrap and pig iron used in steel furnaces in 1957 were 45 and 55 percent, respectively, compared wtih 48 and 52 percent in 1956. The charge of scrap and pig iron used in iron foundries, mainly cupola furnaces, comprised 67 percent scrap and 33 percent pig iron, compared with 66 and 34 percent in 1956.

As in 1956, a noticeably greater quantity of scrap than pig iron was consumed in the New England, West North Central, West South Central, and Pacific Coast districts. These districts together used 11 percent of the total scrap and 4 percent of the pig iron consumed in 1957, unchanged from 1956. The average ratio of scrap to pig iron in these 4 districts was 2.5 : 1, compared with 2.7 : 1 in 1956. The United States average was 0.96 : 1, compared with 1.07 : 1 in 1956.

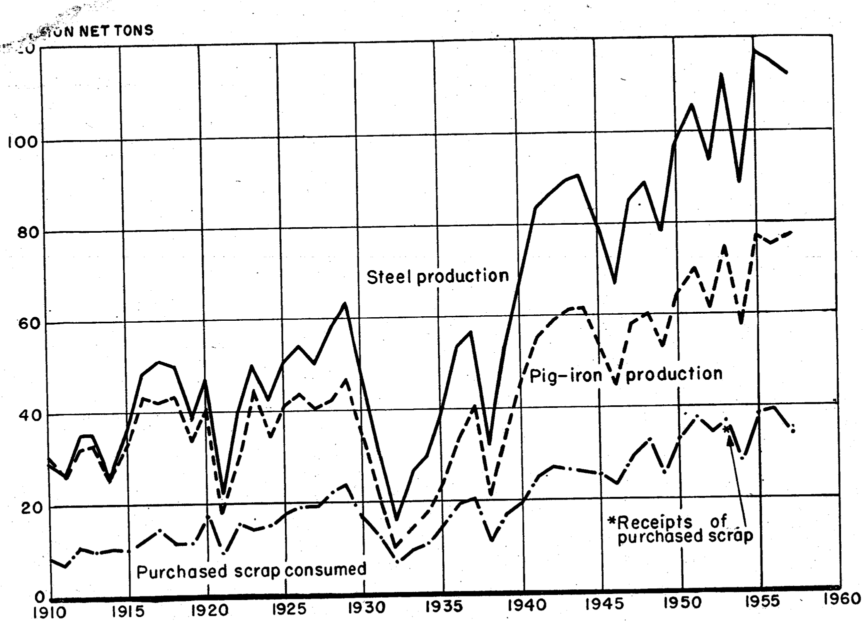

FIGURE 1.—Consumption of purchased scrap in the United States, 1910–52, and output of pig iron and steel, 1910–57. Figures on consumption of purchased scrap for 1910–32 are from State of Minnesota vs. Oliver Iron Mining Co., et al., Exhibits, vol. 5, 1935, p. 328; those for 1933–34 are estimated by authors; and those for 1935–52 are based on Bureau of Mines records. Data for 1953–57 represent receipts of purchased scrap by consumers, based on Bureau of Mines records. Data on steel output were supplied by the American Iron and Steel Institute.

TABLE 3.—Ferrous scrap and pig iron consumed in the United States and percent of total derived from scrap and pig iron, 1956–57, by districts

District	1956			1957		
	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, 280, 530	76. 6	23. 4	963, 141	76. 0	24. 0
Middle Atlantic	47, 904, 683	49. 1	50. 9	46, 414, 857	47. 0	53. 0
East North Central	72, 076, 494	52. 2	47. 8	67, 437, 247	49. 5	50. 5
West North Central	2, 841, 214	76. 9	23. 1	2, 577, 915	75. 7	24. 3
South Atlantic	11, 179, 773	44. 5	55. 5	11, 336, 257	39. 7	60. 3
East South Central	8, 730, 769	46. 9	53. 1	9, 176, 086	43. 5	56. 5
West South Central	2, 578, 353	73. 4	26. 6	2, 940, 851	68. 7	31. 3
Rocky Mountain	3, 868, 423	43. 1	56. 9	4, 326, 634	43. 4	56. 6
Pacific Coast	4, 850, 410	70. 1	29. 9	4, 728, 961	69. 2	30. 8
Total	155, 310, 649	51. 7	48. 3	149, 901, 949	49. 1	50. 9

TABLE 4.—Consumption of ferrous scrap and pig iron in the United States, 1956–57, by type of furnace, in short tons

Type of furnace or equipment	Total scrap	Pig iron	Total scrap and pig iron
1956			
Open-hearth	50,805,559	62,165,807	112,971,366
Bessemer [1]	413,347	4,038,845	4,452,192
Electric	11,057,113	232,921	11,290,034
Cupola	11,025,003	5,349,402	16,374,405
Air	1,269,099	292,717	1,561,816
Crucible	91	36	127
Blast	4,403,833		4,403,833
Direct castings		2,915,751	2,915,751
Ferroalloy	371,130		371,130
Miscellaneous	969,995		969,995
Total	80,315,170	74,995,479	155,310,649
1957			
Open-hearth	46,438,637	64,997,545	111,436,182
Bessemer [1]	387,478	3,494,883	3,882,361
Electric	9,938,540	275,102	10,213,642
Cupola	10,324,726	4,660,016	14,984,742
Air	1,152,323	244,552	1,396,875
Crucible	78	22	100
Blast	4,170,833		4,170,833
Direct castings		2,681,006	2,681,006
Ferroalloy	337,570		337,570
Miscellaneous	798,638		798,638
Total	73,548,823	76,353,126	149,901,949

[1] Includes scrap and pig iron used in oxygen-steel process.

TABLE 5.—Proportion of scrap and pig iron used in furnaces in the United States, 1956–57, in percent

Type of furnace	1956		1957	
	Scrap	Pig iron	Scrap	Pig iron
Open-hearth	45.0	55.0	41.7	58.3
Bessemer [1]	9.3	90.7	10.0	90.0
Electric	97.9	2.1	97.3	2.7
Cupola	67.3	32.7	68.9	31.1
Air	81.3	18.7	82.5	17.5
Crucible	71.7	28.3	78.0	22.0
Blast	100.0		100.0	

[1] Includes oxygen-steel process.

CONSUMPTION BY DISTRICTS AND STATES

The use of domestic scrap for all purposes decreased in 7 of the 9 geographical areas; the largest decrease—25 percent—occurred in the New England district. The use of pig iron increased in all but 3 districts; the largest increase—35 percent—was in the West South Central district. As in previous years, the largest consuming districts, for scrap and pig iron, were East North Central, Middle Atlantic, and South Atlantic. The States consuming the largest quantities of scrap and the percentages consumed were: Pennsylvania 24, (23 in 1956); Ohio, 16 (18 in 1956); Indiana, 11 (10 in 1956); and Illinois, 9 (10 in 1956).

TABLE 6.—Consumption of ferrous scrap and pig iron in the United States in 1957, by type of consumer and type of furnace, in short tons

Type of furnace or equipment	Type of consumer: Manufacturers of steel ingots and castings[1]			Manufacturers of steel castings[2]			Iron foundries and miscellaneous users			Total		
	Scrap	Pig iron	Total scrap and pig iron	Scrap	Pig iron	Total scrap and pig iron	Scrap	Pig iron	Total scrap and pig iron	Scrap	Pig iron	Scrap and pig iron
Open-hearth	45,624,292	64,827,917	110,452,209	814,345	169,628	983,973				46,438,637	64,997,545	111,436,182
Bessemer[3]	369,357	3,491,797	3,861,154	11,373	761	12,134	6,748	2,325	9,073	387,478	3,494,883	3,882,361
Electric	8,030,989	222,550	8,253,539	1,725,639	32,371	1,758,010	181,912	20,181	202,093	9,938,540	275,102	10,213,642
Total steelmaking furnaces	54,024,638	68,542,264	122,566,902	2,551,357	202,760	2,754,117	188,660	22,506	211,166	56,764,655	68,767,530	125,532,185
Cupola	804,511	578,489	1,383,000	528,195	24,501	552,696	8,992,020	4,057,026	13,049,046	10,324,726	4,660,016	14,984,742
Air	33,059	14,708	47,767	262,184	53,600	315,784	857,080	176,244	1,033,324	1,152,323	244,552	1,396,875
Crucible	20		20				58	22	80	78	22	100
Blast[4]	4,170,833		4,170,833							4,170,833		4,170,833
Direct castings		1,673,849	1,673,849					1,007,157	1,007,157		2,681,006	2,681,006
Ferroalloy							337,570		337,570	337,570		337,570
Miscellaneous	218,700		218,700				579,938		579,938	798,638		798,638
Total: 1957	59,251,761	70,809,310	130,061,071	3,341,736	280,861	3,622,597	10,955,326	5,262,955	16,218,281	73,548,823	76,353,126	149,901,949
1956	64,707,933	68,445,053	133,152,986	3,752,554	302,805	4,055,359	11,854,683	6,247,621	18,102,304	80,315,170	74,995,479	155,310,649

[1] Includes only those castings made by companies producing steel ingots.
[2] Excludes companies that produce both steel ingots and steel castings.
[3] Includes scrap and pig iron used in oxygen-steel process.
[4] Includes consumption in all blast furnaces producing pig iron.

TABLE 7.—Consumption of ferrous scrap and pig iron in the United States, 1953–57, 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:				
1953	942, 226	+0. 2	305, 786	+3. 3
1954	757, 486	−19. 6	243, 579	−20. 3
1955	939, 422	+24. 0	281, 820	+15. 7
1956	981, 225	+4. 4	299, 305	+6. 2
1957	732, 387	−25. 4	230, 754	−22. 9
Middle Atlantic:				
1953 [1]	23, 270, 654	+12. 7	24, 499, 189	+20. 1
1954 [1]	16, 257, 629	−30. 1	17, 793, 842	−27. 4
1955	23, 143, 420	+42. 4	24, 726, 296	+39. 0
1956	23, 498, 290	+1. 5	24, 406, 393	−1. 3
1957	21, 794, 682	−7. 2	24, 620, 175	+. 9
East North Central:				
1953 [1]	35, 465, 748	+13. 5	33, 695, 462	+24. 1
1954 [1]	29, 269, 021	−17. 5	26, 498, 859	−21. 4
1955	38, 827, 041	+32. 7	35, 394, 815	+33. 6
1956	37, 622, 379	−3. 1	34, 454, 115	−2. 7
1957	33, 408, 645	−11. 2	34, 028, 602	−1. 2
West North Central:				
1953 [1]	2, 187, 526	−5. 7	697, 850	+. 3
1954 [1]	1, 819, 496	−16. 8	601, 147	−13. 9
1955	2, 230, 430	+22. 6	748, 457	+24. 5
1956	2, 183, 518	−2. 1	657, 696	−12. 1
1957	1, 951, 747	−10. 6	626, 168	−4. 8
South Atlantic:				
1953 [1]	5, 078, 804	+10. 7	5, 951, 217	+14. 2
1954 [1]	4, 221, 583	−16. 9	5, 639, 798	−5. 2
1955	5, 145, 031	+21. 9	6, 350, 084	+12. 6
1956	4, 971, 985	−3. 4	6, 207, 788	−2. 2
1957	4, 502, 109	−9. 5	6, 834, 148	+10. 1
East South Central:				
1953 [1]	3, 959, 665	+13. 5	5, 219, 535	+19. 3
1954 [1]	3, 323, 212	−16. 1	4, 318, 997	−17. 3
1955	4, 232, 268	+27. 4	5, 457, 229	+26. 4
1956	4, 098, 150	−3. 2	4, 632, 619	−15. 1
1957	3, 989, 923	−2. 6	5, 186, 163	+11. 9
West South Central:				
1953	1, 377, 747	+15. 4	580, 625	+34. 7
1954	1, 508, 612	+9. 5	670, 494	+15. 5
1955	1, 863, 407	+23. 5	759, 527	+13. 3
1956	1, 893, 789	+1. 6	684, 564	−9. 9
1957	2, 019, 792	+6. 7	921, 059	+34. 5
Rocky Mountain:				
1953	1, 595, 976	+9. 8	2, 507, 558	+41. 1
1954	1, 483, 596	−7. 0	1, 889, 679	−24. 6
1955	1, 657, 623	+11. 7	2, 259, 956	+19. 6
1956	1, 668, 006	+. 6	2, 200, 417	−2. 6
1957	1, 877, 868	+12. 6	2, 448, 766	+11. 3
Pacific Coast:				
1953 [1]	3, 167, 946	+3. 5	1, 249, 255	−4. 5
1954 [1]	2, 643, 106	−16. 6	1, 005, 654	−19. 5
1955	3, 336, 457	+26. 2	1, 238, 151	+21. 1
1956	3, 397, 828	+1. 8	1, 452, 582	+17. 3
1957	3, 271, 670	−3. 7	1, 457, 291	+(2)
Undistributed:				
1953 [1]	84, 210		1, 267	
1954 [1]	70, 708			
1955–57				
United States, 1948–52 (average)	66, 790, 919		62, 276, 313	
1953 [1]	77, 130, 502	+11. 7	74, 707, 744	+21. 4
1954 [1]	61, 354, 449	−20. 5	58, 662, 049	−21. 5
1955	81, 375, 099	+32. 6	77, 216, 335	+31. 6
1956	80, 315, 170	−1. 3	74, 995, 479	−2. 9
1957	73, 548, 823	−8. 4	76, 353, 126	+1. 8

[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 8.—Consumption of ferrous scrap and pig iron in the United States in 1957, by districts and States, in short tons

District and State	Total scrap (short tons)	Percent of total	Pig iron (short tons)	Percent of total	Total scrap and pig iron (short tons)	Percent of total
New England:						
Connecticut	202,513	0.3	41,506	0.1	244,019	0.1
Maine	7,523	(1)	3,171	(1)	10,694	(1)
Massachusetts	408,656	.6	135,025	.2	543,681	.4
New Hampshire	17,297	(1)	3,710	(1)	21,007	(1)
Rhode Island	74,276	.1	38,381	(1)	112,657	.1
Vermont	22,122	(1)	8,961	(1)	31,083	(1)
Total	732,387	1.0	230,754	.3	963,141	.6
Middle Atlantic:						
New Jersey	632,882	.8	168,947	.2	801,829	.5
New York	3,906,761	5.3	4,000,712	5.3	7,907,473	5.3
Pennsylvania	17,255,039	23.5	20,450,516	26.8	37,705,555	25.2
Total	21,794,682	29.6	24,620,175	32.3	46,414,857	31.0
East North Central:						
Illinois	6,565,983	8.9	5,771,407	7.5	12,337,390	8.2
Indiana	8,215,756	11.2	9,589,218	12.6	17,804,974	11.9
Michigan	6,107,461	8.3	4,333,789	5.7	10,441,250	7.0
Ohio	11,721,889	15.9	14,101,850	18.5	25,823,739	17.2
Wisconsin	797,556	1.1	232,338	.3	1,029,894	.7
Total	33,408,645	45.4	34,028,602	44.6	67,437,247	45.0
West North Central:						
Iowa	360,460	.5	70,060	.1	430,520	.3
Kansas and Nebraska	99,752	.2	3,959	(1)	103,711	.1
Minnesota, North Dakota, and South Dakota	515,269	.7	500,217	.6	1,015,486	.6
Missouri	976,266	1.3	51,932	.1	1,028,198	.7
Total	1,951,747	2.7	626,168	.8	2,577,915	1.7
South Atlantic:						
Delaware, District of Columbia, and Maryland	2,685,870	3.6	4,642,440	6.1	7,328,310	4.9
Florida and Georgia	283,855	.4	19,448	(1)	303,303	.2
North Carolina	54,035	.1	25,061	(1)	79,096	.1
South Carolina	27,644	(1)	13,297	(1)	40,941	(1)
Virginia and West Virginia	1,450,705	2.0	2,133,902	2.8	3,584,607	2.4
Total	4,502,109	6.1	6,834,148	8.9	11,336,257	7.6
East South Central:						
Alabama	2,644,697	3.6	4,168,930	5.5	6,813,627	4.5
Kentucky, Mississippi, and Tennessee	1,345,226	1.8	1,017,233	1.3	2,362,459	1.6
Total	3,989,923	5.4	5,186,163	6.8	9,176,086	6.1
West South Central:						
Arkansas, Louisiana, and Oklahoma	201,920	.3	7,972	(1)	209,892	.2
Texas	1,817,872	2.5	913,087	1.2	2,730,959	1.8
Total	2,019,792	2.8	921,059	1.2	2,940,851	2.0
Rocky Mountain:						
Arizona, Nevada, and New Mexico	75,470	.1	195	(1)	75,665	.1
Colorado and Utah	1,779,112	2.4	2,448,029	3.2	4,227,141	2.8
Idaho, Montana, and Wyoming	23,286	(1)	542	(1)	23,828	(1)
Total	1,877,868	2.5	2,448,766	3.2	4,326,634	2.9
Pacific Coast:						
California	2,656,218	3.6	1,436,691	1.9	4,092,909	2.7
Oregon	213,524	.3	1,902	(1)	215,426	.1
Washington	401,928	.6	18,698	(1)	420,626	.3
Total	3,271,670	4.5	1,457,291	1.9	4,728,961	3.1
Total United States: 1957	73,548,823	100.0	76,353,126	100.0	149,901,949	100.0
1956	80,315,170	100.0	74,995,479	100.0	155,310,649	100.0

[1] Less than 0.05 percent.

TABLE 9.—Consumption of iron and steel scrap and pig iron, by districts and States, by type of manufacturers for year 1957, in short tons

District and State	Steel ingots and castings [1]		Steel castings [2]		Iron foundries and miscellaneous users		Total	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
New England:								
Connecticut	82, 107		7, 354	167	113, 052	41, 339	202, 513	41, 506
Maine					7, 523	3, 171	7, 523	3, 171
Massachusetts	138, 499	57, 191	30, 687	4, 959	239, 470	72, 875	408, 656	135, 025
New Hampshire			3, 415	206	13, 882	3, 504	17, 297	3, 710
Rhode Island	43, 234	20, 652			31, 042	17, 729	74, 276	38, 381
Vermont					22, 122	8, 961	22, 122	8, 961
Total	263, 840	77, 843	41, 456	5, 332	427, 091	147, 579	732, 387	230, 754
Middle Atlantic:								
New Jersey	169, 799	37, 001	59, 015	1, 311	404, 068	130, 635	632, 882	168, 947
New York	3, 193, 049	3, 757, 156	149, 083	31, 008	564, 629	212, 548	3, 906, 761	4, 000, 712
Pennsylvania	15, 882, 246	19, 664, 322	591, 396	77, 654	781, 397	708, 540	17, 255, 039	20, 450, 516
Total	19, 245, 094	23, 458, 479	799, 494	109, 973	1, 750, 094	1, 051, 723	21, 794, 682	24, 620, 175
East North Central:								
Illinois	5, 071, 659	5, 205, 646	376, 702	28, 795	1, 117, 622	536, 966	6, 565, 983	5, 771, 407
Indiana	7, 335, 106	9, 274, 356	239, 959	18, 005	640, 691	296, 857	8, 215, 756	9, 589, 218
Michigan	4, 055, 131	3, 610, 409	177, 521	3, 968	1, 874, 809	719, 412	6, 107, 461	4, 333, 789
Ohio	9, 895, 628	13, 317, 929	505, 481	67, 366	1, 320, 780	716, 555	11, 721, 889	14, 101, 850
Wisconsin			247, 470	14, 778	550, 086	217, 560	797, 556	232, 338
Total	26, 357, 524	31, 408, 340	1, 547, 133	132, 912	5, 503, 988	2, 487, 350	33, 408, 645	34, 028, 602
West North Central:								
Iowa			38, 115	480	322, 345	69, 580	360, 460	70, 060
Kansas and Nebraska			40, 246	527	59, 506	3, 432	99, 752	3, 959
Minnesota, North Dakota, and South Dakota	319, 703	445, 472	32, 347	450	163, 219	54, 295	515, 269	500, 217
Missouri	701, 456	8, 350	109, 695	11, 594	165, 115	31, 988	976, 266	51, 932
Total	1, 021, 159	453, 822	220, 403	13, 051	710, 185	159, 295	1, 951, 747	626, 168
South Atlantic:								
Delaware, District of Columbia, and Maryland	2, 575, 961	4, 599, 899	35, 711	318	74, 198	42, 223	2, 685, 870	4, 642, 440
Florida and Georgia	239, 374	4, 399	11, 636	166	32, 845	14, 883	283, 855	19, 448
North Carolina					54, 035	25, 061	54, 035	25, 061
South Carolina					27, 644	13, 297	27, 644	13, 297
Virginia and West Virginia	1, 126, 292	2, 017, 505	84, 678	10, 256	239, 735	106, 141	1, 450, 705	2, 133, 902
Total	3, 941, 627	6, 621, 803	132, 025	10, 740	428, 457	201, 605	4, 502, 109	6, 834, 148
East South Central:								
Alabama	1, 790, 945	3, 392, 885	75, 190	880	778, 562	775, 165	2, 644, 697	4, 168, 930
Kentucky, Mississippi, and Tennessee	886, 921	755, 739	56, 666	1, 864	401, 639	259, 630	1, 345, 226	1, 017, 233
Total	2, 677, 866	4, 148, 624	131, 856	2, 744	1, 180, 201	1, 034, 795	3, 989, 923	5, 186, 163
West South Central:								
Arkansas, Louisiana, and Oklahoma	104, 548	1, 744	53, 716	1, 134	43, 656	5, 094	201, 920	7, 972
Texas	1, 416, 690	882, 851	113, 915	787	287, 267	29, 449	1, 817, 872	913, 087
Total	1, 521, 238	884, 595	167, 631	1, 921	330, 923	34, 543	2, 019, 792	921, 059
Rocky Mountain:								
Arizona, Nevada, and New Mexico			38, 398	127	37, 072	68	75, 470	195
Colorado and Utah	1, 606, 355	2, 398, 022	34, 028	726	138, 729	49, 281	1, 779, 112	2, 448, 029
Idaho, Montana, and Wyoming					23, 286	542	23, 286	542
Total	1, 606, 355	2, 398, 022	72, 426	853	199, 087	49, 891	1, 877, 868	2, 448, 766

See footnotes at end of table.

TABLE 9.—Consumption of iron and steel scrap and pig iron, by districts and States, by type of manufacturers for year 1957, in short tons—Continued

District and State	Steel ingots and castings [1]		Steel castings [2]		Iron foundries and miscellaneous users		Total	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
Pacific Coast:								
California	2, 144, 726	1, 342, 071	154, 177	2, 147	357, 315	92, 473	2, 656, 218	1, 436, 691
Oregon	142, 101		40, 533	169	30, 890	1, 733	213, 524	1, 902
Washington	330, 231	15, 711	34, 602	1, 019	37, 095	1, 968	401, 928	18, 698
Total	2, 617, 058	1, 357, 782	229, 312	3, 335	425, 300	96, 174	3, 271, 670	1, 457, 291
Total United States: 1957	59, 251, 761	70, 809, 310	3, 341, 736	280, 861	10, 955, 326	5, 262, 955	73, 548, 823	76, 353, 126
1956	64, 707, 933	68, 445, 053	3, 752, 554	302, 805	11, 854, 683	6, 247, 621	80, 315, 170	74, 995, 479

[1] Includes only those castings made by companies producing steel ingots.
[2] Excludes companies that produce both steel ingots and steel castings.

CONSUMPTION BY TYPES OF FURNACE

Open-Hearth Furnaces.—Despite scattered work stoppages and less demand, production of ingots and castings (101.7 million tons) in open-hearth furnaces was only 1 percent less than the previous year, and resulted in the use of 111.4 million short tons of ferrous materials, scrap and pig iron, being consumed in these furnaces. The use of scrap in open hearths decreased 9 percent from 1956; however, the use of pig iron increased 5 percent over the previous year and established a record yearly consumption in 1957. The open-hearth melt consisted of 42 percent scrap and 58 percent pig iron compared with 45 percent scrap and 55 percent pig iron during 1956. The 42 percent charge of scrap in open-hearth melt is the lowest on record.

Pennsylvania continued to lead in using scrap in open-hearth furnaces, followed by Indiana, Ohio, and Illinois—the first time since 1936 that Ohio has not been second in the use of scrap in open-hearth furnaces.

Bessemer Converters.—The 3.9 million short tons of ferrous raw materials used in Bessemer converters and the oxygen-steel process in 1957 represents a 13-percent decrease from 1956. The largest decrease in metallic charge in these furnaces was in the use of pig iron, 13 percent less than during the previous year. The ratio of scrap to total charge was 1:10 compared with 1:11 during 1956. These furnaces, including the oxygen-steel process, consumed 5 percent of the total pig iron and 0.5 percent of the total scrap, unchanged from the previous year.

Ingots produced only in Bessemer converters decreased 23 percent from 1956.

Electric Steel Furnaces.—Electric furnaces consumed 14 percent of the total scrap (unchanged from 1956) and 0.4 percent of the pig iron, compared with 0.3 percent in 1956. The melt of ferrous scrap and pig iron used in these furnaces in 1957 totaled 10.2 million short tons, a 10-percent decrease from 1956. Scrap used in these furnaces decreased 10 percent from 1956; however, pig iron increased 18 percent. The ratio of scrap to pig iron used in the electric furnaces was 36:1 compared with 47:1 in 1956. Total scrap used in electric furnaces decreased but it increased in 4 of the 9 districts; the largest

TABLE 10.—Consumption of ferrous scrap and pig iron in open-hearth furnaces in the United States in 1957, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Massachusetts and Rhode Island [1]	185,361	79,547	264,908
Total: 1957	185,361	79,547	264,908
1956	314,391	107,421	421,812
Middle Atlantic:			
New Jersey and New York	3,059,605	3,813,611	6,873,216
Pennsylvania	13,224,718	18,160,715	31,385,433
Total: 1957	16,284,323	21,974,326	38,258,649
1956	17,364,379	21,418,958	38,783,337
East North Central:			
Illinois	3,551,282	4,642,046	8,193,328
Indiana	7,203,239	9,281,030	16,484,269
Michigan and Wisconsin	2,041,556	2,906,298	4,947,854
Ohio	7,199,168	11,003,182	18,202,350
Total: 1957	19,995,245	27,832,556	47,827,801
1956	22,410,558	27,593,887	50,004,445
West North Central:			
Minnesota and Missouri	715,486	459,689	1,175,175
Total: 1957	715,486	459,689	1,175,175
1956	916,785	490,318	1,407,103
South Atlantic:			
Delaware and Maryland	2,293,885	4,320,095	6,613,980
Georgia and West Virginia	988,518	2,025,865	3,014,383
Total: 1957	3,282,403	6,345,960	9,628,363
1956	3,706,610	5,594,619	9,301,229
East South Central:			
Alabama, Kentucky, and Tennessee	1,764,153	3,975,337	5,739,490
Total: 1957	1,764,153	3,975,337	5,739,490
1956	1,853,476	3,185,509	5,038,985
West South Central:			
Oklahoma and Texas	871,074	787,644	1,658,718
Total: 1957	871,074	787,644	1,658,718
1956	1,032,072	518,632	1,550,704
Rocky Mountain:			
Colorado and Utah	1,525,438	2,261,701	3,787,139
Total: 1957	1,525,438	2,261,701	3,787,139
1956	1,319,201	1,999,654	3,318,855
Pacific Coast:			
California and Washington	1,815,154	1,280,785	3,095,939
Total: 1957	1,815,154	1,280,785	3,095,939
1956	1,888,087	1,256,809	3,144,896
Total United States: 1957	46,438,637	64,997,545	111,436,182
1956	50,805,559	62,165,807	112,971,366

[1] Connecticut included in 1956.

increase occurred in the West South Central district. The Middle Atlantic and East North Central areas continued to melt the largest quantity of scrap in the electric furnaces, consuming 66 percent of the total.

TABLE 11.—Consumption of ferrous scrap and pig iron in Bessemer [1] converters in the United States in 1957, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England and Middle Atlantic:			
Connecticut and New Jersey	1,410	58	1,468
Pennsylvania	87,254	638,014	725,268
Total: 1957	88,664	638,072	726,736
1956	81,745	716,100	797,845
East North Central:			
Illinois	1,050	73,149	74,199
Michigan [2]	196,765	509,188	705,953
Ohio	93,477	1,998,620	2,092,097
Total: 1957	291,292	2,580,957	2,872,249
1956	322,022	2,953,121	3,275,143
South Atlantic and West South Central:			
Delaware, Maryland, and Louisiana	7,060	275,841	282,901
Total: 1957	7,060	275,841	282,901
1956	9,013	369,611	378,624
Rocky Mountain and Pacific Coast:			
Colorado and Washington	462	13	475
Total: 1957	462	13	475
1956	567	13	580
Total United States: 1957	387,478	3,494,883	3,882,361
1956	413,347	4,038,845	4,452,192

[1] Includes scrap and pig iron used in oxygen-steel process.
[2] Minnesota included in 1956.

Cupolas.—Consumption of ferrous materials, scrap and pig iron, in cupolas, 8 percent less than in 1956, decreased for the second consecutive year; scrap decreased 6 percent and pig iron 13 percent. Despite the decreased use in cupola furnaces, they consumed the second largest quantities of ferrous materials during the year. The charge to cupolas consisted of 69 percent scrap and 31 percent pig iron, compared with 67 and 33 percent, respectively, in 1956.

Michigan, continuing as the leading State, consumed 22 percent of the total scrap used in cupola furnaces. As a result, the East North Central district was the largest consuming area for these furnaces, using 53 percent of the total.

Air Furnaces.—The total charge of scrap and pig iron in air furnaces in 1957 was 11 percent less than in 1956. Total scrap consumed in these furnaces decreased 9 percent from the previous year; pig iron declined 16 percent. Owing to the large consumption of scrap in air furnaces in Ohio, the East North Central district used 73 percent of the total scrap consumed, to continue as the largest consuming area for these furnaces.

TABLE 12.—Consumption of ferrous scrap and pig iron in electric steel furnaces in the United States in 1957, 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	98,726	689	99,415
Massachusetts	28,560	714	29,274
Total: 1957	127,286	1,403	128,689
1956	155,886	1,613	157,499
Middle Atlantic:			
New Jersey	30,574	2,633	33,207
New York	180,492	3,666	184,158
Pennsylvania	1,536,209	23,962	1,560,171
Total: 1957	1,747,275	30,261	1,777,536
1956	2,151,596	33,066	2,184,662
East North Central:			
Illinois	1,483,395	136,480	1,619,875
Indiana	114,406	2,466	116,872
Michigan	1,365,252	20,698	1,385,950
Ohio	1,697,560	25,441	1,723,001
Wisconsin	167,336	3,808	171,144
Total: 1957	4,827,949	188,893	5,016,842
1956	5,792,824	180,333	5,973,157
West North Central:			
Iowa, Kansas, and Nebraska	78,166	800	78,966
Minnesota	23,200	450	23,650
Missouri	368,538	5,529	374,067
Total: 1957	469,904	6,779	476,683
1956	362,357	3,058	365,415
South Atlantic:			
Delaware, District of Columbia, and Maryland	114,094	1,832	115,926
Florida and Georgia	242,111	1,715	243,826
Virginia and West Virginia [1]	118,761	246	119,007
Total: 1957	474,966	3,793	478,759
1956	479,250	2,809	482,059
East South Central:			
Alabama	276,904	28,634	305,538
Kentucky, Mississippi,[2] and Tennessee	340,162	1,160	341,322
Total: 1957	617,066	29,794	646,860
1956	713,321	3,690	717,011
West South Central:			
Arkansas, Louisiana, and Oklahoma	136,480	1,135	137,615
Texas	490,359	9,088	499,447
Total: 1957	626,839	10,223	637,062
1956	378,245	4,711	382,956
Rocky Mountain:			
Arizona, Colorado, Nevada, and Utah	70,072	922	70,994
Total: 1957	70,072	922	70,994
1956	61,060	523	61,583
Pacific Coast:			
California	696,090	2,615	698,705
Oregon	175,065	169	175,234
Washington	106,028	250	106,278
Total: 1957	977,183	3,034	980,217
1956	962,574	3,118	965,692
Total United States: 1957	9,938,540	275,102	10,213,642
1956	11,057,113	232,921	11,290,034

[1] North Carolina included in 1956.
[2] Mississippi not included in 1956.

TABLE 13.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1957, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut	68,629	34,939	103,568
Maine	7,523	3,171	10,694
Massachusetts	210,430	71,819	282,249
New Hampshire	11,604	2,258	13,862
Rhode Island	31,042	17,730	48,772
Vermont	22,122	8,961	31,083
Total: 1957	351,350	138,878	490,228
1956	436,848	176,947	613,795
Middle Atlantic:			
New Jersey	305,676	128,616	434,292
New York	456,089	205,825	661,914
Pennsylvania	659,080	301,121	960,201
Total: 1957	1,420,845	635,562	2,056,407
1956	1,522,158	743,829	2,265,987
East North Central:			
Illinois	887,195	265,905	1,153,100
Indiana	560,940	275,937	836,877
Michigan	2,229,605	897,569	3,127,174
Ohio	1,307,393	532,214	1,839,607
Wisconsin	489,741	193,371	683,112
Total: 1957	5,474,874	2,164,996	7,639,870
1956	5,846,564	2,320,964	8,167,528
West North Central:			
Iowa	186,673	66,720	253,393
Kansas	38,795	3,326	42,121
Nebraska	20,906	314	21,220
Minnesota, North Dakota, and South Dakota	165,671	50,851	216,522
Missouri	152,225	29,814	182,039
Total: 1957	564,270	151,025	715,295
1956	602,375	154,794	757,169
South Atlantic:			
Delaware and Maryland	77,744	41,518	119,262
Florida	6,645	2,928	9,573
Georgia	24,637	11,955	36,592
North Carolina	53,982	25,061	79,043
South Carolina	23,642	13,297	36,939
Virginia	229,179	47,711	276,890
West Virginia	23,429	57,328	80,757
Total: 1957	439,258	199,798	639,056
1956	493,649	229,256	722,905
East South Central:			
Alabama	743,147	780,845	1,523,992
Kentucky and Mississippi	121,165	148,101	269,266
Tennessee	272,377	184,952	457,329
Total: 1957	1,136,689	1,113,898	2,250,587
1956	1,097,355	1,382,878	2,480,233
West South Central:			
Arkansas and Louisiana	8,427	------------	8,427
Oklahoma	41,327	6,837	48,164
Texas	309,983	80,442	390,425
Total: 1957	359,737	87,279	447,016
1956	364,969	132,923	497,892
Rocky Mountain:			
Colorado	78,503	28,553	107,056
Utah	68,324	44,263	112,587
Idaho, Montana, and Wyoming	17,116	542	17,658
Total: 1957	163,943	73,358	237,301
1956	175,846	90,725	266,571

TABLE 13.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1957, by districts and States, in short tons—Continued

District and State	Total scrap	Pig iron	Total scrap and pig iron
Pacific Coast:			
California	341,876	90,764	432,640
Oregon	35,104	1,733	36,837
Washington	36,780	2,725	39,505
Total: 1957	413,760	95,222	508,982
1956	485,239	117,086	602,325
Total United States: 1957	10,324,726	4,660,016	14,984,742
1956	11,025,003	5,349,402	16,374,405

TABLE 14.—Consumption of ferrous scrap and pig iron in air furnaces in the United States in 1957, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
NewEngland:			
Connecticut	33,803	6,026	39,829
Massachusetts and New Hampshire	16,069	4,841	20,910
Total: 1957	49,872	10,867	60,739
1956	55,581	13,271	68,852
Middle Atlantic:			
New Jersey	1,244	705	1,949
New York	42,282	12,501	54,783
Pennsylvania	134,285	44,743	179,028
Total: 1957	177,811	57,949	235,760
1956	218,189	69,904	288,093
East North Central:			
Illinois	158,966	28,499	187,465
Indiana	152,544	29,295	181,839
Michigan	120,019	10,198	130,217
Ohio	335,057	61,634	396,691
Wisconsin	72,787	24,997	97,784
Total: 1957	839,373	154,623	993,996
1956	898,083	183,523	1,081,606
West North Central:			
Iowa, Minnesota, and Missouri	12,774	8,548	21,322
Total: 1957	12,774	8,548	21,322
1956	13,796	9,496	23,292
South Atlantic:			
Delaware, North Carolina, and West Virginia	16,983	8,699	25,682
Total: 1957	16,983	8,699	25,682
1956	22,251	11,414	33,665
East South Central and West South Central:			
Alabama and Texas	43,294	2,569	45,863
Total: 1957	43,294	2,569	45,863
1956	50,423	3,877	54,300
Pacific Coast:			
California	12,216	1,297	13,513
Total: 1957	12,216	1,297	13,513
1956	10,776	1,232	12,008
Total United States: 1957	1,152,323	244,552	1,396,875
1956	1,269,099	292,717	1,561,816

Crucible and Puddling Furnaces.—The consumption of scrap and pig iron in crucible furnaces was negligible—slightly less than in 1956. No iron and steel scrap was reported as melted in puddling furnaces.

Blast Furnaces.—The proportion of scrap used in blast furnaces to pig iron produced was 5.3 percent, compared with 5.8 percent in 1956; total scrap consumption was 5 percent lower than in 1957. Blast-furnace slag-scrap consumption, 560,124 short tons, was reported for the first time in 1957. Domestic and foreign materials other than scrap constitute by far the largest proportion of blast-furnace charge and comprised 135,067,988 short tons of iron ore, agglomerates, and manganiferous ore: 3,945,872 tons of mill cinder and scale; 5,787,924 tons of open-hearth and Bessemer slag; and 4,128,529 tons of miscellaneous materials exclusive of fluxes and coke.

TABLE 15.—Consumption of ferrous scrap in blast furnaces in the United States in 1957, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
New England and Middle Atlantic:		South Atlantic, East and West South Central:	
Massachusetts and New York	242,615	Alabama	293,199
Pennsylvania	1,519,257	Kentucky, Maryland, Tennessee, Texas, and West Virginia	397,651
Total: 1957	1,761,872	Total: 1957	690,850
1956	1,807,552	1956	564,273
East North Central and West North Central:		Rocky Mountain and Pacific Coast:	
Illinois	303,599	California, Colorado, and Utah	78,076
Indiana	177,454	Total: 1957	78,076
Michigan and Minnesota	221,067	1956	67,328
Ohio	937,915		
Total: 1957	1,640,035	Total United States: 1957	4,170,833
1956	1,964,680	1956	4,403,833

USE OF SCRAP IN FERROALLOY PRODUCTION

The ferroalloy plants operating electric furnaces or aluminothermic units used 9 percent less scrap than in 1956.

Scrap used in blast furnaces in manufacturing ferroalloys is included in this chapter under blast furnaces.

TABLE 16.—Consumption of ferrous scrap by ferroalloy producers in the United States in 1957, by districts, in short tons

District	Total scrap	District	Total scrap
Middle Atlantic:		South Atlantic:	
Total: 1957	34,681	Total: 1957	12,515
1956	34,251	1956	13,547
East North Central:		East South Central:	
Total: 1957	70,656	Total: 1957	77,651
1956	73,366	1956	72,659
West North Central:		Pacific Coast:	
Total: 1957	132,986	Total: 1957	9,081
1956	168,421	1956	8,886
		Total United States: 1957	337,570
		1956	371,130

MISCELLANEOUS USES OF SCRAP

Scrap consumed in 1957 for miscellaneous purposes, such as rerolling, nonferrous metallurgy, and as a chemical agent was 1.1 percent of the total scrap consumption, compared with 1.2 percent during the preceding year. The quantity so used decreased 18 percent from that used for similar purposes in 1956.

TABLE 17.—Consumption of ferrous scrap in miscellaneous uses in the United States in 1957, by districts and States, in short tons

District and State	Total scrap
New England:	
Connecticut and Massachusetts	15,513
Total: 1957	15,513
1956	16,239
Middle Atlantic:	
New Jersey	127,971
New York	60,348
Pennsylvania	93,875
Total: 1957	282,194
1956	320,682
East North Central:	
Illinois	180,497
Indiana	7,173
Michigan and Wisconsin	13,846
Ohio	80,604
Total: 1957	282,120
1956	334,671
West North Central:	
Minnesota	359
Missouri	43,011
Total 1957	43,370
1956	99,320
South Atlantic:	
Georgia	1,562
Virginia and West Virginia	30,429
Total: 1957	31,991
1956	46,788
East South Central and West South Central:	
Alabama and Texas	59,296
Total: 1957	59,296
1956	66,024
Rocky Mountain:	
Arizona, Idaho, and Montana	37,408
Colorado and Utah	7,301
Total: 1957	44,709
1956	45,288
Pacific Coast:	
California	38,393
Washington	1,052
Total: 1957	39,445
1956	40,983
Total United States: 1957	798,638
1956	969,995

STOCKS

Complete iron- and steel-scrap figures covering 1957 year-end stocks are not available; producers (railroads and manufacturers) were not canvassed; dealers, brokers, automobile wreckers, and shipbreakers were canvassed and reported on a voluntary basis.

Consumers' Stocks.—Total iron- and steel-scrap stocks held by consumers during the first half of 1957 were slightly below the quantity on hand at the end of 1956. However, beginning in July these stocks increased each month to reach a record quantity of 9.1 million short tons on October 31. By the end of the year iron- and steel-scrap stocks had decreased slightly from the end of October but were 21 percent higher than on January 1, 1957. Increases occurred in all but 2 districts; the largest increase—763,000 tons—was in the East North Central district. Stocks of pig iron held by consumers and suppliers on December 31, 1957, were 62 percent greater than those on hand December 31, 1956.

Suppliers' Stocks.—Stocks of iron and steel scrap in the hands of a combined total of 1,011 dealers, automobile wreckers, and shipbreakers, as reported voluntarily to the Bureau of Mines, totaled 991,652 short tons on December 31, 1957.

TABLE 18.—Consumers' stocks of ferrous scrap and pig iron on hand in the United States on December 31, 1956, and December 31, 1957, by districts and States, in short tons

District and State	December 31, 1956		December 31, 1957	
	Total scrap	Pig iron	Total scrap	Pig iron
New England:				
Connecticut	15,412	10,550	16,605	6,825
Maine	1,234	813	868	430
Massachusetts	60,337	57,431	42,747	102,290
New Hampshire	2,955	295	1,331	321
Rhode Island	11,921	7,213	8,361	4,695
Vermont	2,570	2,520	3,423	1,601
Total	94,429	78,822	73,335	116,162
Middle Atlantic:				
New Jersey	68,672	32,425	80,823	28,409
New York	511,863	232,784	677,141	375,114
Pennsylvania	1,640,957	425,047	1,901,301	812,319
Total	2,221,492	690,256	2,659,265	1,215,842
East North Central:				
Illinois	813,235	172,846	1,040,359	272,955
Indiana	769,542	137,510	1,009,868	146,204
Michigan	362,853	283,262	424,813	335,300
Ohio	1,013,583	390,948	1,252,334	683,521
Wisconsin	72,295	39,295	67,210	29,323
Total	3,031,508	1,023,861	3,794,584	1,467,303
West North Central:				
Iowa	30,760	23,985	31,638	19,617
Kansas and Nebraska	11,860	577	14,020	358
Minnesota, North Dakota, and South Dakota	145,974	24,863	127,725	104,554
Missouri	234,868	24,105	187,220	14,848
Total	423,462	73,530	360,603	139,377
South Atlantic:				
Delaware, District of Columbia, and Maryland	180,793	37,283	350,555	182,699
Florida and Georgia	7,481	3,169	13,075	2,081
North Carolina	6,447	1,539	6,393	3,877
South Carolina	1,911	2,419	2,027	2,575
Virginia and West Virginia	155,634	16,860	187,685	18,277
Total	352,266	61,270	559,735	209,509
East South Central:				
Alabama	139,741	112,829	275,050	297,102
Kentucky, Mississippi, and Tennessee	152,505	101,615	164,081	149,973
Total	292,246	214,444	439,131	447,075
West South Central:				
Arkansas, Louisiana, and Oklahoma	38,380	1,484	17,592	1,395
Texas	295,411	43,435	327,424	48,857
Total	333,791	44,919	345,016	50,252
Rocky Mountain:				
Arizona, Nevada, and New Mexico	13,225	120	13,659	118
Colorado and Utah	171,334	79,177	189,154	93,500
Idaho, Montana, and Wyoming	4,561	325	7,853	378
Total	189,120	79,622	210,666	93,996
Pacific Coast:				
Alaska and Washington	65,552	10,098	92,215	1,098
Oregon	31,678	370	45,085	221
California	380,511	77,604	369,751	75,864
Total	477,741	88,072	507,051	77,183
Total United States	7,416,055	2,354,796	8,949,386	3,816,699

TABLE 19.—Iron and steel scrap: Consumers' stocks, production, receipts, consumption, and shipments by grades, in 1957, in short tons

Grades of scrap	Total stocks on hand Jan. 1, 1957	Scrap produced	Receipts from dealers and all others	Total consumption	Shipments	Total stocks on hand Dec. 31, 1957
No. 1 Heavy-Melting steel	1,852,780	18,609,821	6,031,096	23,405,182	154,612	2,911,684
No. 2 Heavy-Melting steel	1,010,610	1,988,637	4,372,826	6,484,154		910,138
Bundles	1,197,020	1,346,740	8,430,948	9,520,645	15,270	1,438,793
Low-phosphorus scrap	577,495	1,369,025	3,297,985	4,565,424	145,055	534,026
Cast-iron scrap other than borings	1,000,747	6,561,068	4,471,136	10,561,974	356,253	1,114,724
All others	1,777,403	14,121,018	7,257,693	19,011,444	2,104,649	2,040,021
Total, all grades	7,416,055	43,996,309	33,861,684	73,548,823	2,775,839	8,949,386

PRICES [2]

The price of No. 1 Heavy-Melting scrap at Pittsburgh was at a yearly high of $60.70 per gross ton in January—$8.20 higher than in January 1956. The price for this grade of scrap dropped to $42 in April but increased to $56.25 per ton in July, after which it declined to $32.50 (estimate) in December—46 percent lower than at the beginning of the year and the lowest price since December 1954.

No. 1 Heavy-Melting scrap at Chicago averaged $44.43 (estimate) per gross ton for the year. The highest price—$57.90 per ton—for this grade of scrap was during January and the lowest—$30.50 (estimate)—in December, a drop of $27.40 from January.

The average composite price of No. 1 Heavy-Melting iron and steel scrap in January was $59.37 per gross ton, the high for the year, $7.04 higher than in January 1956. The composite price for this grade of scrap fluctuated for the first 6 months, but during July it began a downward trend to reach a low, $32.33 (estimate), for the year in December.

The average annual and monthly composite price for No. 2 Bundles was quoted for the first time in the Iron Age Annual Review and, following the trend of other grades of scrap, was quoted at the highest average in January ($47.43 per gross ton) and the lowest in December ($24.20 per gross ton). The average for the year was $37.63 (estimate).

FOREIGN TRADE [3]

The House of Representatives, Select Committee on Small Business, held hearings during May to consider the limitations on exports of iron and steel scrap and their impact on small business.[4]

The export-licensing regulations governing iron and steel scrap during 1956 remained in effect until February 19, 1957, when processing of export licenses to Japan, the United Kingdom, and the European Coal and Steel Community were temporarily suspended. This suspension was decided upon to protect domestic supplies while review-

[2] Iron Age, vol. 181, No. 1, Jan. 2, 1958, p. 338.
[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.
[4] Hearings Before the Select Committee on Small Business, House of Representatives, 85th Congress, 1st Sess., Pursuant to a Resolution Creating a Select Committee to Conduct a Study and Investigation of the Problems of Small Business, May 20, 22, 23, and 24, 1957, 269 pp.

TABLE 20.—Consumption and stocks, December 31, 1957, of iron and steel scrap, by grades, by districts and States, in 1957, in short tons

District and State	No. 1 Heavy-Melting steel		No. 2 Heavy-Melting steel		Bundles		Low-phosphorous scrap		Cast-iron scrap other than borings		All others		Total all grades	
	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks
New England:														
Connecticut	14, 308	833	23, 773	230	17, 697	808	13, 624	707	45, 686	5, 907	87, 425	8, 120	202, 513	16, 605
Maine	1, 147								6, 217	837	159	31	7, 523	868
Massachusetts	72, 279	6, 666	2, 836	56	26, 020	6, 737	56, 018	3, 577	182, 539	12, 549	68, 964	13, 162	408, 656	42, 747
New Hampshire	2, 744	191	356	53			101		11, 723	853	2, 373	234	17, 297	1, 331
Rhode Island	639	51	20, 770	4, 495	3, 410		11, 042	220	17, 553	2, 432	20, 862	1, 163	74, 276	8, 361
Vermont	4, 519	158	510	6					17, 093	3, 259			22, 122	3, 423
Total	95, 636	7, 899	48, 245	4, 840	47, 127	7, 545	80, 785	4, 504	280, 811	25, 837	179, 783	22, 710	732, 387	73, 335
Middle Atlantic:														
New Jersey	15, 169	4, 153	21, 354	1, 705	75, 952	20, 313	51, 183	11, 761	275, 028	27, 011	194, 196	15, 880	632, 882	80, 823
New York	1, 602, 825	247, 519	105, 299	14, 430	549, 265	227, 826	133, 126	16, 819	428, 427	55, 504	1, 087, 819	115, 043	3, 906, 761	677, 141
Pennsylvania	6, 448, 512	664, 531	1, 163, 858	90, 898	2, 261, 606	263, 270	966, 044	163, 162	1, 662, 857	142, 437	4, 752, 162	577, 003	17, 255, 039	1, 901, 301
Total	8, 066, 506	916, 203	1, 290, 511	107, 033	2, 886, 823	511, 409	1, 150, 353	191, 742	2, 366, 312	224, 952	6, 034, 177	707, 926	21, 794, 682	2, 659, 265
East North Central:														
Illinois	1, 789, 837	235, 868	872, 518	106, 634	1, 025, 274	243, 824	542, 885	68, 238	802, 626	96, 340	1, 532, 843	289, 455	6, 565, 983	1, 040, 359
Indiana	4, 025, 129	623, 964	335, 511	71, 519	1, 210, 475	74, 704	211, 643	28, 166	751, 906	50, 400	1, 681, 092	161, 115	8, 215, 756	1, 009, 868
Michigan	730, 663	78, 263	24, 997	504	1, 141, 057	107, 103	873, 064	68, 771	1, 312, 808	75, 073	2, 024, 872	95, 099	6, 107, 461	424, 813
Ohio	3, 446, 865	407, 725	763, 142	76, 172	1, 409, 550	212, 608	910, 666	99, 373	1, 409, 405	108, 518	3, 782, 261	347, 938	11, 721, 889	1, 252, 334
Wisconsin	53, 504	7, 173	8, 707	495	14, 078	385	213, 449	21, 567	294, 555	16, 213	213, 263	21, 377	797, 556	67, 210
Total	10, 045, 998	1, 352, 993	2, 004, 875	255, 324	4, 800, 434	638, 624	2, 751, 707	286, 115	4, 571, 300	346, 544	9, 234, 331	914, 984	33, 408, 645	3, 794, 584
West North Central:														
Iowa	14, 997	1, 433	8, 471	1, 668	1, 764	19	38, 115	1, 039	141, 874	8, 930	155, 239	18, 549	360, 460	31, 638
Kansas and Nebraska	3, 959	41					32, 321	2, 274	54, 273	11, 436	9, 199	269	99, 752	14, 020
Minnesota, North Dakota, and South Dakota	142, 041	30, 110	59, 560	47, 889	36, 025	58	18, 313	990	157, 724	20, 816	101, 606	27, 862	515, 269	127, 725
Missouri	37, 060	13, 505	577, 125	105, 355	11, 726	3, 011	25, 832	1, 529	240, 403	53, 263	84, 120	10, 557	976, 266	187, 220
Total	198, 057	45, 089	645, 156	154, 912	49, 515	3, 088	114, 581	5, 832	594, 274	94, 445	350, 164	57, 237	1, 951, 747	360, 603

TABLE 20.—Consumption and stocks, December 31, 1957, of iron and steel scrap, by grades, by districts and States in 1957, in short tons—Continued

District and State	No. 1 Heavy-Melting steel		No. 2 Heavy-Melting steel		Bundles		Low-phosphorous scrap		Cast-iron scrap other than borings		All others		Total all grades	
	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks
South Atlantic:														
Delaware, District of Columbia, and Maryland	1,215,484	196,534	96,998	10,477	311,096	4,680	38,005	3,188	228,412	107,155	795,875	28,521	2,685,870	350,555
Florida and Georgia	71,537	4,933	125,133	2,219			1,966	34	26,591	1,155	58,628	4,734	283,855	13,075
North Carolina		403					1,202	269	50,186	5,685	2,647	36	54,035	6,393
South Carolina									19,064	818	8,580	1,209	27,644	2,027
Virginia and West Virginia	18,909	2,505	167,964	18,411	292,630	42,083	60,246	11,531	248,789	30,584	662,167	82,571	1,450,705	187,685
Total	1,305,930	204,375	390,095	31,107	603,726	46,763	101,419	15,022	573,042	145,397	1,527,897	117,071	4,502,109	559,735
East South Central:														
Alabama	867,252	94,441	115,086	22,564	266,423	24,438	61,144	8,558	753,973	88,126	580,819	36,923	2,644,697	275,050
Kentucky, Mississippi, and Tennessee	560,784	62,399	127,560	17,047	178,526	48,261	55,563	1,609	292,786	17,926	130,007	16,839	1,345,226	164,081
Total	1,428,036	156,840	242,646	39,611	444,949	72,699	116,707	10,167	1,046,759	106,052	710,826	53,762	3,989,923	439,131
West South Central:														
Arkansas, Louisiana, and Oklahoma	336		99,125	7,655	505		47,748	3,899	42,073	4,109	12,133	1,929	201,920	17,592
Texas	65,294	7,222	1,124,729	184,363	83,558	58,433	74,972	4,873	355,712	50,669	113,607	21,864	1,817,872	327,424
Total	65,630	7,222	1,223,854	192,018	84,063	58,433	122,720	8,772	397,785	54,778	125,740	23,793	2,019,792	345,016
Rocky Mountain:														
Arizona, Nevada, and New Mexico			31,866	4,170					4,162	919	39,442	8,570	75,470	13,659
Colorado and Utah	1,009,448	68,947	99,525	19,778	105,718	23,978	4,462	513	249,333	34,810	310,626	41,128	1,779,112	189,154
Idaho, Montana, and Wyoming									14,489	3,378	8,797	4,475	23,286	7,853
Total	1,009,448	68,947	131,391	23,948	105,718	23,978	4,462	513	267,984	39,107	358 865	54,173	1,877,868	210,666
Pacific Coast:														
California	988,476	108,642	367,201	66,751	448,986	66,350	102,695	9,323	373,716	64,382	375,144	54,303	2,656,218	369,751
Oregon	63,488	11,738	47,349	11,188	24,629	3,516	2,063	441	30,412	2,913	45,583	15,289	213,524	45,085
Washington	137,977	31,736	92,831	23,406	24,675	6,388	17,932	1,595	59,579	10,317	68,934	18,773	401,928	92,215
Total	1,189,941	152,116	507,381	101,345	498,290	76,254	122,690	11,359	463,707	77,612	489,661	88,365	3,271,670	507,051
Total United States	23,405,182	2,911,684	6,484,154	910,138	9,520,645	1,438,793	4,565,424	534,026	10,561,974	1,114,724	19,011,444	2,040,021	73,548,823	8,949,386

TABLE 21.—Stocks of iron and steel scrap and pig iron on hand at plants of major consuming industries, in short tons

	Manufacturers of steel ingots and castings	Manufacturers of steel castings	Iron foundries and miscellaneous users	Total
	SCRAP STOCKS			
Dec. 31, 1957	7,619,819	414,136	915,431	8,949,386
Dec. 31, 1956	6,036,585	425,034	954,436	7,416,055
	PIG-IRON STOCKS			
Dec. 31, 1957	3,185,130	56,578	574,991	3,816,699
Dec. 31, 1956	1,556,121	81,690	716,985	2,354,796

TABLE 22.—Average monthly price and composite price per gross ton for No. 1 Heavy-Melting scrap in 1957

1957	Chicago	Pittsburgh	Philadelphia	Composite price [1]
January	$57.90	$60.70	$59.50	$59.37
February	49.00	53.50	57.00	53.17
March	44.00	48.75	52.75	48.50
April	39.50	42.00	46.88	42.80
May	42.00	46.25	50.25	46.17
June	51.10	55.50	56.10	54.23
July	51.75	56.25	54.00	54.00
August	52.63	55.00	51.25	52.96
September	46.50	49.00	46.38	47.29
October	36.50	37.90	37.70	37.37
November	31.75	33.00	33.75	32.83
December [2]	30.50	32.50	34.00	32.33
Average [2]	44.43	47.53	48.30	46.75

[1] Composite price, Chicago, Philadelphia, and Pittsburgh.
[2] Estimate.

ing the 1957 supply-demand situation as presented in the United States Department of Commerce report to the Congress. The heavy volume of export applications during early February was also a contributing factor to the suspension. The Bureau of Foreign Commerce, United States Department of Commerce, rescinded this suspension on February 27 and resumed licensing scrap for export to the aforementioned countries for all grades other than Heavy-Melting scrap.

On March 26, the United States Department of Commerce resumed processing applications for export of all grades of iron and steel scrap to Japan, the United Kingdom, and the European Coal and Steel Community. This removed all temporary restrictions on licensing that had been imposed during February.

An interim policy, covering licensing exports of Heavy-Melting grades of steel scrap to the United Kingdom, Japan, and the European Coal and Steel Community, was announced on May 6. Under this policy the quantity of No. 1 and No. 2 Heavy-Melting scrap exported to these countries could not exceed the tonnage of these grades shipped in 1956. Licensing of other grades to the aforementioned destinations, as well as licensing of all grades to all other Free World destinations, remained under open-end quotas.

TABLE 23.—Ferrous scrap imported for consumption in the United States, by countries, 1948–52 (average) and 1953–57, in short tons

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Bahamas	731	198	28	190	885	997
Canada-Newfoundland-Labrador	64,528	131,371	223,030	207,617	235,295	228,402
Canal Zone	4,322	2,180	511	----------	----------	----------
Cuba	26,255	3,012	2,893	3,685	14,940	3,500
Dominican Republic	94	282	----------	198	2	420
French West Indies	1,258	1,381	1,215	57	294	802
Guatemala	403	----------	----------	1,363	336	----------
Honduras	501	401	----------	----------	586	----------
Mexico	487	133	444	211	132	2,060
Netherlands Antilles	3,285	7,104	3,360	----------	2	14
Panama	525	1,410	----------	----------	29	----------
Other North America	5,219	1,993	39	24	33	135
Total	107,608	149,465	231,520	213,345	252,534	236,330
South America:						
Peru	568	----------	----------	10,554	----------	----------
Venezuela	1,945	2,240	2,912	674	----------	----------
Other South America	1,811	----------	----------	----------	----------	16
Total	4,324	2,240	2,912	11,228	----------	16
Europe:						
Belgium-Luxembourg	10,975	----------	----------	----------	----------	----------
Denmark	2,312	----------	----------	13	----------	----------
France	38,303	373	46	----------	----------	30
Germany	202,081	[1] 253	[1] 1	[1] 78	[1] 150	[1] 908
Netherlands	59,953	77	13	----------	66	132
Norway	610	3	----------	----------	----------	9
Sweden	834	----------	152	----------	----------	111
Switzerland	1,347	----------	----------	----------	1,547	----------
United Kingdom	3,857	5,686	591	2,062	132	142
Other Europe	1,299	247	25	100	----------	----------
Total	321,571	6,639	828	2,253	1,895	1,332
Asia:						
India	7,995	----------	----------	----------	27	----------
Japan	84,344	1,751	400	575	537	26
Korea	3,031	----------	----------	----------	----------	----------
Philippines	28,389	51	----------	----------	----------	----------
Other Asia	4,769	----------	----------	----------	----------	----------
Total	128,528	1,802	400	575	564	26
Africa:						
Algeria	8,018	790	688	195	222	220
Morocco	[2] 3,376	[2] 3,778	[2] 906	----------	[2] 109	223
Union of South Africa	5,437	2,167	1,399	802	143	146
Other Africa	362	316	224	122	102	317
Total	17,193	7,051	3,217	1,119	576	906
Oceania:						
Australia	13,708	6,145	56	----------	----------	----------
New Zealand	2,076	318	102	9	----------	----------
Western Pacific Islands	1,364	----------	----------	----------	----------	----------
Other Oceania	1,185	----------	----------	10	----------	----------
Total	18,333	6,463	158	19	----------	----------
Grand total: Short tons	597,557	173,660	239,035	228,539	255,569	238,610
Value	$16,249,726	$5,870,215	[3] $5,947,731	[3] $6,989,360	[3] $11,313,115	$10,149,653

[1] West Germany.
[2] French Morocco.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known not to be comparable with years before 1954.

Voluntary agreements, which resulted from the discussions with the United Kingdom, Japan, and the European Coal and Steel Community (ECSC), prompted the rescinding on June 18, 1957, of the interim licensing policy that had been in effect since May 6, 1957, and reestablished the open-end export quota for iron and steel scrap to all Free World destinations. Under these agreements these countries during 1957 voluntarily limited their total imports of Heavy-Melting grades of scrap from the United States to approximately 13 percent above that imported in each category in 1956.

On April 25, 1957, Public Law 85–27, H. R. 4686, was signed by President Eisenhower, continuing, until June 30, 1958, suspension of duties on certain metal scrap, including iron and steel scrap.

TABLE 24.—Ferrous scrap exported from the United States, 1948–52 (average) and 1953–57, by countries of destination, in short tons [1]

[Bureau of the Census]

Destination	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada-Newfoundland-Labrador	139,343	76,762	48,544	429,751	708,539	475,655
Mexico	110,381	156,394	224,409	258,492	304,702	291,847
Other North America	106			87	245	55
Total	249,830	233,156	272,953	688,330	1,013,486	767,557
South America:						
Argentina	1,901		75,425	103,932	14,137	44,036
Brazil	1,030		928	141	352	11,129
Chile	11			54	25	
Other South America	143	9	191	22	260	380
Total	3,085	9	76,544	104,149	14,774	55,545
Europe:						
Belgium-Luxembourg	74	15	20,330	185,331	256,739	254,768
France	76		31,427	256,631	352,612	231,429
Germany	31		[2] 350,212	[2] 677,235	[2] 249,043	[2] 690,299
Italy	378	171	252,026	1,152,533	1,306,622	1,671,525
Netherlands	321	27	20,906	42,487	35,667	18,244
Spain	11		54,492	25,589	52,488	102,062
United Kingdom	1,935	9,055	181,342	1,056,864	596,108	369,224
Other Europe	1,247	126	87,544	137,684	40,112	90,213
Total	4,073	9,394	998,279	3,534,354	2,889,391	3,427,764
Asia:						
Hong Kong	1,050	121	939	541	525	1,387
India	876	3,205	1,929	1,366	3,192	4,036
Japan	1,815	62,471	316,691	791,086	[3] 2,372,533	2,341,809
Malaya	879	361	73	345	959	414
Philippines	57	287	439	722	1,221	1,050
Taiwan	20			8,000	42,694	54,231
Turkey	373	624	459		197	
Other Asia	354	84	10,741	904	966	1,513
Total	5,424	67,153	331,271	802,964	[3] 2,422,287	2,404,440
Africa:						
Union of South Africa	211	91		50		
Other Africa	76	11	130	104	323	657
Total	287	102	130	154	323	657
Grand total:						
Short tons	262,699	309,814	1,679,177	5,129,951	[3] 6,340,261	6,655,963
Value	$8,328,050	$10,827,452	$50,746,951	$176,660,967	[3] $293,667,911	$321,773,583

[1] In addition to data shown, rerolling materials exported as follows: 1949, Canada, 37 tons; Mexico, 1,095 tons; Honduras, 30 tons; Bolivia, 44 tons; total 1,206 tons ($50,086): 1951, Mexico, 9,813 tons ($358,146): 1952, Canada, 69 tons; Mexico, 1,217 tons; total, 1,286 tons ($77,287): 1953, Belgium-Luxembourg, 163 tons; Japan, 5,873 tons; Mexico, 692 tons; total, 6,728 tons ($391,464): 1954, Canada, 110 tons; Mexico, 3,062 tons; India, 2,824 tons; Japan, 10,688 tons; total, 16,684 tons ($865,413): 1955, Canada, 454 tons; Mexico, 19,504 tons; El Salvador, 76 tons; United Kingdom, 24 tons; Belgium-Luxembourg, 793 tons; Japan, 19,304 tons; India, 1,107 tons; Hong Kong, 561 tons; total 41,823 tons ($1,898,357): 1956, Canada, 5,815 tons; Mexico, 61,208 tons; El Salvador, 147 tons; India, 1,343 tons; Hong Kong, 777 tons; Japan, 36,912 tons; total 106,202 tons ($6,951,722): 1957, Canada, 2,730 tons; Mexico, 37,377 tons; El Salvador, 298 tons; Hong Kong, 349 tons; Japan, 49, 73 tons; Nansei and Nanpo Islands, 224 tons; total 90,351 tons ($6,928,634).

[2] West Germany.

[3] Revised figure.

Imports.—Iron and steel scrap, including tinplate, decreased 7 percent in quantity and 10 percent in value from the previous year. Of the scrap imported, the largest quantity was received from Canada-Newfoundland-Labrador (96 percent of the total). Of the total imports, 15 percent was tinplate scrap, mostly from Canada, compared with 13 percent during the preceding year.

Exports.—Continued record demand by the European Coal and Steel Community and other countries resulted in a record for exports of ferrous scrap from the United States. Exports increased 4.7 percent over those in the previous high year of 1956 and were 105 percent greater than the 5-year pre-World War II annual average (1935–39) of 3,298,000 short tons. Total ferrous scrap, excluding rerolling materials, exported during 1957 increased 5 percent in quantity and 10 percent in value over 1956.

TABLE 25.—Ferrous scrap imported into and exported from the United States, 1948–52 (average) and 1953–57, by classes [1]

[Bureau of the Census]

Year	Imports			Exports				
	Iron and steel scrap	Tinplate scrap	Total	Iron and steel scrap	Tinplate scrap	Tinplate circles, strips, cobbles, etc.	Terneplate clippings and scrap	Total
				SHORT TONS				
1948–52 (average)	548,560	48,997	597,557	253,309	1,107	8,106	177	262,699
1953	131,568	42,092	173,660	291,177	5,818	12,819	--------	309,814
1954	206,316	32,719	239,035	1,664,869	1,057	13,251	--------	1,679,177
1955	196,372	32,167	228,539	5,113,216	161	16,574	--------	5,129,951
1956	222,936	32,633	255,569	[2] 6,311,987	3,782	24,481	11	[2] 6,340,261
1957	203,407	35,203	238,610	6,630,025	4,063	21,875	--------	6,655,963
				VALUE				
1948–52 (average)	$15,021,789	$1,227,937	$16,249,726	$7,276,701	$31,713	$997,836	$21,800	$8,328,050
1953	4,754,939	1,115,276	5,870,215	9,574,911	99,041	1,153,500	--------	10,827,452
1954	[3] 5,115,808	831,923	[3] 5,947,731	49,625,759	22,651	1,098,541	--------	50,746,951
1955	[3] 6,150,376	838,984	[3] 6,989,360	175,275,625	14,423	1,370,919	--------	176,660,967
1956	[3] 10,380,668	[3] 932,447	[3] 11,313,115	[2] 290,938,797	211,080	2,516,954	1,080	[2] 293,667,911
1957	9,077,654	1,071,999	10,149,653	319,024,774	288,456	2,460,353	--------	321,773,583

[1] In addition to data shown, rerolling materials exported as follows: 1949, 1,206 tons ($50,086); 1951, 9,813 tons ($358,146); 1952, 1,286 tons ($77,287); 1953, 6,728 tons ($391,464); 1954, 16,684 tons ($865,413); 1955, 41,823 tons ($1,898,357); 1956, 106,202 tons ($6,951,722); 1957, 90,351 tons ($6,928,634). Not separately classified before 1949.

[2] Revised figure.

[3] Owing to changes in tabulating procedures by the Bureau of the Census data known not to be comparable with years before 1954.

WORLD REVIEW

NORTH AMERICA

Guatemala.—The regulation prohibiting the sale and export of Government-owned iron scrap, which had been in effect since 1952, was removed May 14, 1957, by the Minister of Economy. This was done because of inadequate storage facilities and because of favorable prices in the international market. Exports, by purchasers of this scrap, were limited to 90 percent of the total owned by the Government; the remaining 10 percent was reserved for use by the domestic industry.[5]

SOUTH AMERICA

Peru.—According to terms of Supreme Resolution 150, dated May 31, 1957, the Peruvian Government prohibited exportation of iron and steel scrap.[6]

Authorizations pending for export licenses were revoked, and those that had been issued expired on their respective deadline dates.

The reason given for placing this resolution in effect was that the domestic supply of iron and steel scrap would be needed by the new Chimbote steel plant.

EUROPE

France.—The iron and steel industry of France and the Saar consumed 8,111,000 short tons of iron and steel scrap during 1957, compared with 7,929,000 short tons in 1956. The steel producers in this area supplemented their supply of scrap during 1957 by purchasing 3,703,000 tons from French Dealers, shipyards, other ECSC countries and through imports.[7]

Inventories held by steel producers on December 31, 1957, decreased 12 percent from the first of the year, but they remained satisfactory.

Germany, West.—Through an order of the High Authority of the ECSC, a long-awaited revision of the regulations governing ferrous-scrap distribution in the European Coal and Steel Community was put into effect during December 1956. The revision, additional to the equalization fund, comprised a system of penalties based on scrap consumption of steel producers. The equalization fund, which remained in effect, was paid into on the basis of a Community-wide fee per ton of scrap purchased and used to equalize the cost of expensive scrap imported for Community members.[8]

The penalty system, which began August 1, provided that additional payments be made by a producer to the equalization fund if he exceeded the quota of scrap consumption established for that company. Quotas were determined by the following formula: Each producer selected as his base period any successive 6-month consumption between January 1, 1953, and January 31, 1957. The normal equalization charge on scrap was to be paid on the quantity equal to that used during this base period. On any quantity consumed that exceeded the quantity used during the producer's base period, he must pay into the equalization fund at the present rate plus a penalty increment.

Reduction or elimination of the additional penalty on excess consumption may be obtained by a producer through reducing his specific consumption either below his base period or below the average specific consumption in the Community; 1-percent reduction in either entitled him to a 5-percent reduction in the penalty increment chargeable on his absolute excess of scrap consumption. Thus, when a 20-percent reduction was achieved in specific consumption, no

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[5] U. S. Embassy, Guatemala, State Department Dispatch 681: June 4, 1957.
[6] Foreign Commerce Weekly, vol. 58, No. 2, July 8, 1957, p. 14.
[7] U. S. Embassy, Paris, France, State Department Dispatch 1747: Apr. 2, 1958.
[8] U. S. Consul, Dusseldorf, Germany, State Department Dispatch 105: Feb. 15, 1957.

penalty was chargeable, regardless of how much his absolute scrap consumption exceeded that of the base period.

ASIA

Japan.—About 70 shiploads of steel scrap were scheduled to be shipped to Japan for delivery from April through June, according to the Japanese Steel Scrap Coordinating Committee, which handles—on behalf of Japanese steel mills—the imports of scrap steel from the United States.[9]

These shipments were part of a long-term contract with American shippers for 1,800,000 tons; 70 shiploads had been shipped during January through March, and the remainder were to be delivered from July through September.

Some problems developed in carrying out the purchase contracts for the above-mentioned 1.8 million tons. Domestic scrap prices in Japan declined sharply; as a result, scrap imported from the United States was more expensive; this was the reverse of the situation that prevailed in the early part of the year.[10] As of July 1, ingot-steel production plans had expanded more than enough to compensate for increased prospective supplies of domestic pig iron and scrap imported from sources other than the United States. If these production plans were to be carried out, the scrap contracted for from the United States would be needed.

The tight-money policy of the Japanese Government was strictly enforced and customers of the steel industry, unable to get bank loans, were paying for purchases with promissory notes or reducing their purchases and living off their stockpiles. As a result, production schedules were lowered. Faced with these circumstances, steelmakers were extremely reluctant to purchase and pay for imported scrap at higher than prevailing domestic prices.

TECHNOLOGY

An economical, semiportable flame-cutoff machine that eliminates some manual flame cutting and increases the speed of cutting iron and steel scrap was in use during 1957. The machine is nonautomatic but can be operated from a central position through a control assembly.[11]

The operator works the torch from the control assembly, adjusting the height and speed, and positioning it to begin cutting at the required point. He starts the torch, adjusts the preheat gases and oxygen, and retracts the machine, when cutting is complete.

The cutoff unit comprises an 18-inch, structural-steel guide rail, a carriage, and a torch truck that travels on a boom. The boom rotates horizontally about the center of the carriage, allowing the torch and torch truck to be anywhere in the circle covered by the boom.

Armco Steel tried a new scrap-charging method for their open-hearth furnaces at the Butler (Pa.) plant; this process lowered operating cost by reducing furnace charging and heating time each by 1 hour. The scrap used in this operation is hauled to the furnaces in a modified

[9] American Metal Market, vol. 64, No. 47, Mar. 9, 1957, p. 11.
[10] U. S. Embassy, Tokyo, Japan, State Department Dispatch 209: Aug. 21, 1957.
[11] Iron Age, vol. 179, No. 16, Apr. 18, 1957, pp. 136. 138, 139.

gondola car, where a magnetic crane lifts the scrap and dumps it into a hopper outside the door of the furnace. It is then fed through a hopper into a charging box and shoved into the furnace by a conventional charging machine. This article describes the charging assembly and discusses further the advantages of this method through increased production, reduced heating time, and greater capacity.[12]

More intensive efforts were made by mills to recover scrap from slags and waste materials originating in steelmaking plants, where sizable amounts of scrap are lost.[13]

A convenient method for recovering metallics contained in slags and waste materials has been to use combinations of magnetic separators and heavy-duty cleaning equipment. Commonly used equipment are 2 magnetic separators, 1 having a capacity to handle 150 to 200 yards of material per hour and 1 that is larger for handling 400 to 450 yards of material per hour. Each of the many changes in these machines has tended to prevent jams and improve production. Because the materials handled are abrasive, all wearing surfaces of the machines are made of manganese steel.

A method for handling hot slag and waste materials is to dump them into pits approximately 50 feet wide and 200 to 300 feet long or large enough to hold a 24-hour output of material. Enough pits should be available to allow time for the slag to cool.

A pit is filled with slag, which after spraying with water, is broken up by means of a 10- to 20-ton drop ball. The lifting magnets then remove the large pieces of steel scrap, placing them in trucks for hauling to cleaning facilities. The remainder of the material is dug with a dragline and fed directly into a magnetic separator.

This article describes other ways to process slag and the results in metallics recovered.

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[12] McManus, G. J., Fast Scrap—Charging Boasts Openhearth Output: Iron Age, vol. 181, No. 12, Mar. 20, 1958, pp. 110-111.

[13] Fritz, Lawrence J. (assistant to general supérintendent, Heckett Engineering, Inc., Butler, Pa.), Iron and Steel Eng., vol. 34, No. 4, April 1957, pp. 95-97.

Iron Oxide Pigments

By Taber de Polo[1] and Betty Ann Brett[2]

SALES of iron oxide pigments in 1957 declined slightly, primarily because of the slowdown in housing construction during the latter part of the year.

TABLE 1.—Salient statistics of iron oxide pigment materials in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Mine production: Short tons	(1)	(1)	45,700	56,200	53,900	49,300
Crude pigments sold or used:						
Short tons	(1)	(1)	40,900	52,900	49,800	47,400
Value	(1)	(1)	$371,500	$419,400	$468,300	$462,300
Finished pigments sold or used:						
Short tons	[2] 115,300	108,400	98,000	115,300	[3] 113,900	104,700
Value	[2] $12,909,700	$14,246,700	$13,977,500	$17,471,700	[3] $17,103,500	$16,356,000
Imports:						
Short tons	8,200	11,000	10,700	14,000	13,100	13,100
Value	$586,200	$802,200	$846,400	$1,195,600	$1,201,700	$1,314,400
Exports:						
Short tons	5,500	4,200	3,600	4,700	5,100	3,700
Value	$782,400	$688,300	$682,300	$893,900	$909,200	$1,038,200

[1] Figure not available.
[2] Includes mineral blacks, 1948–51.
[3] Revised figure.

DOMESTIC PRODUCTION

Crude Materials.—The quantity of crude iron oxide pigment materials mined in 1957 decreased 9 percent from 1956, the quantity sold or used decreased 5 percent, and the value of sold or used materials decreased 1 percent. Red iron oxide pigments comprised 67 percent of the quantity and 71 percent of the value of crude material sold or used, compared with 66 and 67 percent in 1956.

Of the 47,400 short tons of material sold or used by crude-pigment producers, 29,000 tons (61 percent) was supplied as a byproduct by iron-ore producers. The average value of byproduct pigments was $9.28 per short ton, and the value of material produced at iron oxide pigment mines was $10.53 per ton.

Finished Pigments.—Combined sales (almost 105,000 short tons) of natural and manufactured iron oxide pigments reported by processors in 1957 were 8 percent lower in quantity and 4 percent lower in value than in 1956. The average price increased $5.95 per ton.

Natural pigments (excluding those in mixtures of natural, manufactured, and undesignated pigments) supplied 30 percent of the

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

TABLE 2.—Crude iron oxide pigment materials mined and sold or used in the United States, 1957, by States

State	Number of producers	Quantity mined (short tons)	Quantity sold or used (short tons)	Value
Pennsylvania	2	1,040	998	$9,116
Colorado, Michigan, Minnesota, Oregon	6	35,760	33,118	287,892
Georgia, New York, Virginia	3	12,548	13,238	165,253
Total	11	49,348	47,354	462,261

TABLE 3.—Crude iron oxide pigment materials mined and sold or used in the United States, 1956–57, by sources

Source	1956			1957		
	Quantity mined (short tons)	Quantity sold or used		Quantity mined (short tons)	Quantity sold or used	
		Short tons	Value		Short tons	Value
Iron oxide pigment mines	21,464	17,312	$168,021	20,360	18,366	$193,349
Iron-ore mines	32,469	32,469	300,245	28,988	28,988	268,912
Total	53,933	49,781	468,266	49,348	47,354	462,261

TABLE 4.—Crude iron oxide pigment materials produced, and sold or used by processors in the United States, 1956–57, by kinds

Pigments	1956			1957		
	Quantity mined (short tons)	Quantity sold or used		Quantity mined (short tons)	Quantity sold or used	
		Short tons	Value		Short tons	Value
Brown iron oxide:						
Sienna	4,270	3,514	$74,260	5,636	3,009	$58,140
Umber	495	455	6,857	551	551	6,277
Red iron oxide	36,322	32,909	312,370	31,781	31,781	326,858
Yellow iron oxide:						
Ocher	8,370	8,370	47,237	6,057	6,057	33,849
Metallic brown [1] natural yellow iron oxide, sulfur mud, and miscellaneous pigments	4,476	4,533	27,542	5,323	5,956	37,137
Total	53,933	49,781	468,266	49,348	47,354	462,261

[1] 1956 only.

tonnage and 15 percent of the value of the total finished pigments in 1957. Mixtures of natural and manufactured pigments (all reds) furnished 7 percent of the tonnage and 7 percent of the value. The average value of finished natural pigments rose from $72.21 per ton to $78.58; the average value of manufactured pigments dropped from $200.18 to $196.62 per ton.

Of the 62,000 tons of manufactured pigments sold in 1957 (a 4-percent decrease from 1956), the reds comprised 75 percent of the market—a slight increase in percentage over 1956. Yellow pigments comprised 20 percent of the market in 1957 compared with 21 percent in 1956. The reds furnished 68 percent of the value in both 1956 and 1957 and the yellows, 23 and 24 percent, respectively. The average value for the reds was approximately $178 and the average value for the yellows $242 per ton.

TABLE 5.—Sales of finished iron oxide pigments in the United States, 1957, by States

State	Number of producers	Quantity sold (short tons)	Value
Georgia	1	1,725	$56,257
Illinois, Ohio, Pennsylvania	8	69,439	9,940,323
Maryland, Virginia	3	12,229	1,173,926
New Jersey, New York	3	2,919	329,182
Other [1]	3	18,426	4,856,297
Total	18	104,738	16,355,985

[1] Includes California, Oregon, and a quantity unspecified by State.

TABLE 6.—Finished iron oxide pigments sold by processors in the United States, 1956–57, by kinds

Pigment	1956		1957	
	Short tons	Value	Short tons	Value
Natural:				
Black: Magnetite	2,790	$82,220	229	$19,055
Brown:				
Iron oxide (metallic)	7,390	684,272	7,497	739,042
Umbers: Burnt	2,901	427,018	2,321	353,460
Raw	597	80,467	580	79,831
Vandyke brown	179	39,190	144	30,808
Red:				
Iron oxide	18,083	948,921	14,140	695,987
Sienna, burnt	1,039	212,888	1,046	218,047
Pyrite cinder	359	32,655	380	34,170
Yellow:				
Iron oxide	174	20,880		
Ocher	5,736	198,024	4,601	172,826
Sienna, raw	908	173,292	719	144,442
Total natural	40,156	2,899,827	31,657	2,487,668
Manufactured:				
Black: Magnetic	1,919	538,617	1,764	513,962
Brown: Iron oxide	1,951	585,745	1,515	421,853
Red:				
Pure red iron oxides:				
Calcined copperas	15,914	4,365,538	14,446	4,207,724
Other chemical processes	6,637	1,839,459	6,647	1,912,542
Other manufactured red iron oxides	21,329	2,166,310	22,169	1,773,791
Venetian red	3,273	375,814	3,122	378,235
Yellow: Iron oxide	13,261	2,997,181	12,355	2,985,836
Total manufactured	64,284	12,868,664	62,018	12,193,943
Mixtures of natural and manufactured red iron oxides	5,689	836,950	7,575	1,149,774
Other and unspecified	[1] 3,732	[1] 498,092	3,488	524,600
Grand total	[1] 113,861	[1] 17,103,533	104,738	16,355,985

[1] Revised figure.

Of the finished iron oxide pigments (natural and manufactured) sold in 1957, the reds dominated the market, with 59 percent of the quantity and 56 percent of the value; yellows supplied 17 percent of the quantity and 20 percent of the value; and browns furnished 12 percent of the quantity and 10 percent of the value. Natural black (magnetite) sales dropped to only 8 percent of the 1956 figure. As in 1956, the highest total valued pigment in 1957, with 14 percent of the total tonnage and 26 percent of the value of the iron oxide pigment market, was manufactured red from calcined copperas, valued at $291 per ton compared with $274 in 1956.

A total of 18 companies in 10 States reported sales of finished iron oxide pigments in 1957, the same as for 1956.

PRICES

Prices of finished iron oxide pigments remained virtually unchanged during 1957.

TABLE 7.—Prices quoted on finished iron oxide pigments in 1957, per pound

[Paint, Oil and Chemical Review]

	Dec. 27, 1957
Blacks:	
Mineral blacks	$0.16
Black oxide of iron, pure	.14¾
Black oxide of iron, synthetic	.12¾
Browns:	
Brown, metallic	.04
Brown, iron oxide, pure	.14½
Umber, Turkey, burnt, powdered	.08½
Umber, American	.07¾
Vandyke brown	.10¾
Reds:	
Crocus martis	.04
Indian red, American common	.12¼
Indian red, American pure	.14¼
Iron oxide, casks:	
Domestic, natural	.06¾
Persian Gulf	.07¾
Spanish	.06
Sienna, American, burnt and powdered, in bags	.09½
Sienna, Italian, burnt and powdered, in barrels	.16¾
Venetian red	.05¼
Yellows:	
Iron oxide, yellow, pure	.11½
Ocher, domestic	.02
Ocher, French	.06
Sienna, American, raw, powdered, in barrels	.09½
Sienna, Italian, raw, powdered, in barrels	.16½

FOREIGN TRADE[3]

Total imports of natural and manufactured iron oxide pigments remained almost the same as in 1956.

Natural pigments supplied 46 percent of the tonnage compared with 54 percent in 1956, but the manufactured pigments accounted for 80

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

percent of the value in 1957 and 73 percent in 1956. The average value of natural pigments imported was $44 per ton and of manufactured pigments $149 per ton in 1957 compared with $46 and $147 in 1956.

Iron oxide pigments designated by the United States Department of Commerce as "natural iron oxide and iron hydroxide pigments, n. s. p. f.," supplied 51 percent of all natural varieties and came from Spain (94 percent), United Kingdom (5 percent), and West Germany. The Union of South Africa furnished all imports of both crude and refined ocher.

TABLE 8.—Selected iron oxide pigments imported for consumption in the United States, 1954–57

[Bureau of the Census]

Pigments	1954		1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Natural:								
Ocher, crude and refined	154	$8,666	218	$15,362	206	$11,827	203	$11,979
Siennas, crude and refined	338	34,848	840	[1] 80,041	722	[1] 71,190	676	56,340
Umber, crude and refined	2,598	74,276	2,654	79,446	2,762	89,489	1,944	64,835
Vandyke brown	89	5,194	151	9,206	200	12,465	139	9,917
Other [2]	2,546	120,600	3,702	161,488	3,168	137,507	3,079	125,227
Total natural	5,725	243,584	7,565	[1] 345,543	7,058	[1] 322,478	6,041	268,298
Manufactured (synthetic)	4,997	602,847	6,394	[1] 850,095	5,997	[1] 879,200	7,033	1,046,139
Grand total	10,722	846,431	13,959	[1] 1,195,638	13,055	[1] 1,201,678	13,074	1,314,437

[1] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with previous years.
[2] Classified by the Bureau of the Census as: "Natural iron oxide and iron hydroxide pigments, n. s. p. f."

Crude and refined siennas came from Italy (57 and 82 percent); and Malta, Gozo, and Cyprus.

Malta, Gozo, and Cyprus supplied all of the crude and 76 percent of the refined umbers; the remainder came from the United Kingdom. Vandyke brown was imported only from West Germany.

Imports of manufactured (synthetic) iron oxide pigments came from West Germany (65 percent), United Kingdom (19 percent), Canada (15 percent), and Netherlands.

The tonnage of iron oxide pigments exported from the United States in 1957 decreased 28 percent compared with 1956, but the value increased 14 percent, rising from $179 to $283 per ton.

Countries in North America received 71 percent of all pigments exported from the United States and Canada alone received 60 percent.

TABLE 9.—Iron oxide pigments exported from the United States, 1954–57, by countries of destination

[Bureau of the Census]

Country	1954		1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	2,208	$265,266	3,149	$404,717	3,552	$427,462	2,212	$380,575
Cuba	197	48,578	205	53,252	281	81,809	195	58,404
Dominican Republic	22	5,122	35	9,480	43	11,514	18	5,350
Guatemala	33	8,162	20	6,931	16	5,801	29	8,267
Haiti	9	3,260	38	4,930	----	----	4	1,390
Mexico	128	61,525	64	27,300	111	35,797	120	53,625
Netherlands Antilles	10	2,720	14	5,195	----	----	(1)	573
Panama	37	5,193	1	390	12	5,605	2	970
Other North America	22	8,320	39	13,075	21	8,430	30	9,307
Total	2,666	408,146	3,565	525,270	4,036	576,418	2,610	518,461
South America:								
Argentina	----	----	20	7,682	(1)	438	(1)	1,871
Bolivia	4	1,060	36	16,763	41	14,830	14	5,190
Brazil	78	21,116	30	8,045	34	8,863	18	7,891
Chile	8	3,290	22	12,764	5	1,858	25	10,200
Colombia	176	76,478	198	62,120	136	50,570	187	60,360
Ecuador	5	1,717	3	795	7	2,235	18	6,032
Peru	15	5,196	95	21,470	41	8,238	31	10,126
Uruguay	1	528	4	9,365	(1)	180	19	13,023
Venezuela	210	38,943	105	38,044	115	66,686	75	56,350
Total	497	148,328	513	177,048	379	153,898	387	171,043
Europe:								
Belgium-Luxembourg	40	11,824	22	18,300	18	7,360	11	13,436
France	5	9,212	61	12,974	37	26,890	53	29,048
Iceland	7	7,347	----	----	7	2,274	3	800
Italy	14	11,007	7	9,785	22	7,640	4	3,824
Netherlands	104	5,918	175	18,675	134	5,580	69	5,560
Norway	----	----	30	1,932	----	----	----	----
Portugal	11	3,068	11	3,075	----	----	15	4,512
Spain	1	564	----	----	70	14,145	----	----
Sweden	7	1,902	3	796	----	----	11	3,290
Switzerland	45	9,948	12	5,636	42	13,434	51	17,506
United Kingdom	----	----	2	1,130	12	4,010	3	2,536
Other Europe	3	695	8	5,058	1	2,632	4	8,746
Total	237	61,485	331	77,361	343	83,965	224	89,258
Asia:								
Indonesia	----	----	10	3,061	40	6,384	29	39,311
Japan	13	7,074	25	7,408	13	12,605	9	6,855
Malaya	----	----	----	----	----	----	18	23,825
Philippines	69	33,656	119	34,955	173	43,784	188	92,041
Taiwan	11	3,451	----	----	1	2,676	31	6,310
Turkey	----	----	33	8,041	3	525	28	9,376
Other Asia	7	2,971	31	6,330	5	2,040	20	7,568
Total	100	47,152	218	59,795	235	68,014	323	185,286
Africa:								
Union of South Africa	51	16,100	101	36,472	67	20,338	98	36,788
Other Africa	1	576	8	4,125	(1)	305	(1)	2,107
Total	52	16,676	109	40,597	67	20,643	98	38,895
Oceania	2	542	8	13,785	11	6,287	33	35,275
Grand total	3,554	682,329	4,744	893,856	5,071	909,225	3,675	1,038,218

1 Less than 1 ton.

WORLD REVIEW

Argentina.—Imports of ochers and terras into Argentina totaled 265 short tons in 1956, 14 tons in 1955, and 7 tons in 1954.[4]

Cyprus.—In 1957 umber production was 4,835 short tons valued at £51,021 (US$143,000), and yellow ocher production was 443 short tons valued at £6,690 (US$18,700).[5]

India.—The production of ocher in 1957 was reported to be 13,902 short tons valued at 270,000 rupees (US$56,700), an increase of 13 percent in tonnage and 7 percent in value from 1956.[6]

Italy.—The output of umber and sienna totaled 4,124 short tons in 1957.[7]

Iran.—Production of natural red iron oxide pigment (Persian Gulf oxide) was 6,792 short tons from March 21, 1955, to March 20, 1956 (Iranian year 1334), and the estimated quantity from March 21, 1956, to March 20, 1957 (Iranian year 1335), was 14,330 short tons.[8]

Morocco.—A total of 1,725 short tons of natural iron oxide pigment, valued at 31 million francs (US$85,000) was produced during 1957.[9]

Peru.—Output of ocher totaled 32 short tons in 1955 and 7 tons each in 1954 and 1953.[10]

Union of South Africa.—Production and local sales of ochers, umber, and other iron oxides decreased in 1956, compared with 1955.[11]

TABLE 10.—Production and local sales of iron oxide pigments in Union of South Africa, 1955–56

	Production		Local sales			
	1955	1956	1955		1956	
	Short tons	Short tons	Short tons	Value	Short tons	Value
Ochers	8,223	7,111	431	$3,906	177	$1,921
Umbers	2,811	2,115	2,346	53,149	1,703	39,373
Other iron pigments	1,435	1,142	1,253	11,379	1,285	14,392
Total	12,469	10,368	4,030	68,434	3,165	55,686

TECHNOLOGY

A siderite deposit in Southern Australia, partly oxidized to hematite and containing over 50 percent Fe_2O_3, was investigated. The deposit was said to be suitable for use as a paint pigment. The reserve was estimated to be 700,000 tons.[12]

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[4] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 27.
[5] U. S. Consulate, Nicosia, Cyprus, State Department Dispatch 66: Feb. 28, 1958, p. 1.
[6] U. S. Embassy, New Delhi, India, State Department Dispatch 983: Mar. 3, 1958, enclosure 1, p. 1.
[7] U. S. Embassy, Rome, Italy, State Department Dispatch 859: Jan. 15, 1958, p. 1.
[8] U. S. Embassy, Tehran, Iran, State Department Dispatch 1099: May 25, 1957, p. 1.
[9] U. S. Embassy, Rabot, Morocco, State Department Dispatch 271: Mar. 17, 1958, enclosure 1, p. 2.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 26.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, p. 27.
[12] Johns, R. K., Copper King Ocher Deposit: Southern Australia, Dept. Mines, Mining Review, No. 100, 1954 (pub. in 1956), pp. 42–48; Chem. Abs., vol. 51, No. 5, Mar. 10, 1957, p. 3383e.

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A comprehensive review covering the composition, properties, and uses of pigments, including iron oxides,[13] and a concise review of the pigment industry in Japan [14] were published.

Investigations showed the influence on color and quality of red pigments precipitated as basic ferric sulfates rather than as ferric hydroxide.[15] A patent was issued for preparing a modified hydrous ferric oxide pigment by precipitation in the presence of a sulfur-containing compound.[16]

[13] Wormold, G., Review: Paint and Varnish Production, vol. 47, No. 4, April 1957, pp. 37–44; No. 5, May 1957, pp. 53–56; No. 6, June 1957, pp. 43–48.

[14] Mori, Masutoshi, Pigments in Japan—1956: Paint, Oil and Chemical Rev., vol. 120, No. 22, Oct. 31, 1957, pp. 10–11.

[15] Kranz, M., [Red Pigments Composed of Ferric Oxide of Sulfates of Alkali Earth Metals in Systems: Fe_2O_3–$BaSO_4$, Fe_2O_3–$SrSO_4$, Fe_2O_3–$CaSO_4$]: Przemysl Chem., vol. 13, 1957, pp. 171–177; Chem Abs., vol. 51, No. 19, Oct. 10, 1957, p. 15143i.

[16] Jackson, Julius (assigned to E. I. duPont de Nemours & Co.), Modified Iron Oxide Pigments: U. S. Patent 2,818,348, Dec. 31, 1957.

Jewel Bearings

By Henry P. Chandler[1] and Betty Ann Brett[2]

PRODUCTION of finished jewel bearings in the United States during 1957 increased slightly over 1956, but domestic consumption declined. Imports increased both in quantity and value.

DOMESTIC PRODUCTION

The output of finished jewel bearings increased slightly over 1956. Firms in Santa Barbara (Calif.), North Falmouth, Waltham, and West Lynn (Mass.), Newark, Perth Amboy, and Trenton (N. J.), Rochester (N. Y.), Rolla (N. Dak.), and Morrisville (Pa.) reported production of jewel bearings.

TABLE 1.—Salient statistics of the jewel-bearings industry in the United States, 1948–52 (average) and 1953–57 [1]

[Million jewel bearings]

	1948–52 (average)	1953	1954	1955	1956	1957
Production:						
Blanks	1.0	6.0	0.8	2.9	4.8	(2)
Finished jewels [3]	5.8	15.7	10.5	[4] 11.8	[4] 13.8	13.9
Consumption:						
Blanks	8.3	7.9	2.8	4.9	5.0	3.6
Finished jewels [3]	73.6	70.9	66.2	74.8	74.6	66.1
Shipments:						
Blanks	.1	8.2	(5)	2.2	4.3	(2)
Finished jewels [3]	20.6	36.8	29.4	40.1	42.9	47.5
Stocks on hand Dec. 31:						
Blanks	5.5	1.4	.7	1.5	1.8	.9
Finished jewels [3]	96.0	97.5	95.4	103.6	96.4	97.0

[1] The annual jewel-bearings industry survey is conducted by the Federal Bureau of Mines in cooperation with the Business and Defense Services Administration, U. S. Department of Commerce. The 1957 survey included data from 97 respondents in 16 States and Puerto Rico.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes finished jewels made from glass; includes phonograph needles in 1954–57.
[4] Revised figure.
[5] Less than 0.1 million.

CONSUMPTION AND USES

Domestic consumption of finished jewels in 1957 declined 11 percent and consumption of blanks 28 percent from 1956.

Synthetic sapphire and ruby bearings constituted 87 percent of the total consumption and glass bearings nearly 13 percent; bearings of various other materials made up the remainder.

The more widely used types of jewel bearings were illustrated in the Jewel Bearings chapter of Minerals Yearbook, 1955.

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

In 1957, 13 firms in New York consumed 25 percent of the national jewel-bearings total; 10 firms in Illinois consumed 32 percent.

The following firms used 86 percent of the jewel bearings consumed in the United States in 1957:

Simpson Electric Co., Division of American Gage & Machine Co., Chicago, Ill.
Elgin National Watch Co., Elgin, Ill.
Westclox Div., General Time Corp., La Salle, Ill.
Sangamo Electric Co., Springfield, Ill.
Duncan Electric Mfg. Co., Lafayette, Ind.
General Electric Co., West Lynn, Mass., and Sommersworth, N. H.
Westinghouse Electric Corp., Newark, N. J.
Weston Electrical Instrument Corp., Newark, N. J.
Bulova Watch Co., Flushing, N. Y.
Hamilton Watch Co., Lancaster, Pa.
The George W. Borg Corp., Delavan, Wis.

TABLE 2.—Consumption and sales of finished jewels in the United States, 1957, by uses

(Million jewel bearings)

Use	Consumption	Sales	Use	Consumption	Sales
Synthetic sapphire and ruby:			Glass:		
Watch holes:			Vees	8.2	7.3
Olive	13.2	0.9	Instrument rings (including hole jewels)	.1	--------
Straight	12.7	2.2			
Pallet stones	4.1	(1)	Total number of glass bearings	8.3	7.3
Roller (jewel) pins	2.2	.1	Other jewel bearings	.1	(1)
End stones or caps:					
Watch	14.8	9.3	Total finished jewel bearings	66.1	47.5
Instrument	.3	2.4			
Vees	3.8	7.5			
Instrument rings	.8	9.6			
Cups or double cups	5.0	4.0			
Orifice jewel	.4	.3			
Dies (wire drawing)	----------	(1)			
Other [2]	.4	3.9			
Total number of finished synthetic sapphire and ruby jewel bearings	57.7	40.2			

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Includes phonograph needles.

TABLE 3.—Consumption of finished jewel bearings in the United States and the Commonwealth of Puerto Rico, 1957, by States

State	Number of consumers	Jewel bearings (million)	State	Number of consumers	Jewel bearings (million)
California	4	0.4	Ohio	4	1.1
Connecticut	6	.6	Pennsylvania	3	6.1
Illinois	10	21.4	Puerto Rico	1	.3
Indiana	1	1.2	Rhode Island	1	.7
Massachusetts	9	2.0	Wisconsin	3	7.9
New Hampshire	4	3.0	Other States [1]	5	.1
New Jersey	7	4.9			
New York	13	16.4	Total	71	66.1

[1] Figure includes Maryland, Michigan, Minnesota, and Missouri.

FOREIGN TRADE [3]

Imports of jewel bearings into the United States in 1957 increased 28 percent in quantity and 13 percent in value compared with 1956. Of these imports, 89 percent came from Switzerland and 7 percent from Italy. Canada supplied most of the remainder. Jewel bearings in loose form (not assembled in units) were dutiable at 10 percent ad valorem.

TABLE 4.—Jewel bearings imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Jewel bearings (million)	Value (thousand dollars)	Year	Jewel bearings (million)	Value (thousand dollars)
1948–52 (average)	111.5	4,533	1955	66.1	[1] 2,875
1953	86.9	3,708	1956	54.8	[1] 2,456
1954	49.3	[1] 2,219	1957	70.1	2,780

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known not to be comparable to years before 1954.

TABLE 5.—Imports [1] of jewel bearings in 1957, by uses

Use	Jewel bearings (percent)	Use	Jewel bearings (percent)
Watch holes:		Vees	7
Olive	14	Instrument rings	14
Straight	21	Cups or double cups	5
Pallet stones	5	Other [2]	6
Roller (jewel) pins	2	Total	100
End stones or caps:			
Watch	25		
Instrument	1		

[1] As reported to the Bureau of Mines.
[2] Includes glass vees, dies, agate balls, orifice jewels, rollers, insulators, bearing pads, phonograph points, jewel tips, specialties, and guides.

TECHNOLOGY

Beginning with the cutting of "blanks" from sapphire boule and rod, the manufacture of V-jewel bearings was outlined, with special emphasis on the automatic equipment used in the various processes and the care taken to prevent defects in the finished bearings.[4]

Methods for calculating frictional losses in jewel-bearing movements and the necessity for care in their manufacture were discussed.[5] Also, a general article on jewel bearings gave much information on the materials used and the design of bearings for various applications.[6]

New growing techniques in synthetic sapphire production make possible larger size pieces. The physical properties of jewel bearings, precautions required in their fabricating, and possible applications were discussed.[7]

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.
[4] Humphrey, R., and Leeds, R. E., Mechanized Production of Instrument Jewels: Engineering, vol. 183, No. 4746, Feb. 22, 1957, pp. 236–238.
[5] Warring, R. H., Calculating Frictional Losses in Jewel Bearing Movements: Design News, vol. 12, No. 7, Apr. 1, 1957, pp. 148–151.
[6] Warring, R. H., Industrial Jewel Bearings: Machinery Lloyd (London), vol. 29, No. 20A, Oct. 5, 1957, pp. 39–42.
[7] Materials in Design Engineering, Synthetic Sapphire: Vol. 46, No. 3, March 1957, p. 161.

Kyanite and Related Minerals

By Brooke L. Gunsallus[1] and Gertrude E. Tucker[2]

DOMESTIC production of crude kyanite decreased less than 1 percent from 1956 in 1957. No domestic output of other minerals of this group was reported. Crude kyanite imports decreased owing to competition from African sillimanite, the availability of synthetic mullite comparable in quality and price with that made from high-quality imported kyanite, and the reduction in accumulated stocks of Indian kyanite.

Kyanite, sillimanite, andalusite, dumortierite, topaz, and synthetic mullite are discussed in this chapter because of similarities in properties and end use. These minerals are aluminum silicates that may be used to produce mullite-containing refractories.

DOMESTIC PRODUCTION

Kyanite was the only natural mullite-forming mineral produced in the United States in 1957. All kyanite produced was recovered as flotation concentrate. Demand for kyanite concentrate was limited, largely because mullite produced from it is of such small grain size and low strength that it is not suitable for the highest grade refractories.

For many years only two companies have produced kyanite in the United States: Commercialores, Inc., New York, N. Y., from deposits near Clover, S. C.; and Kyanite Mining Corp., Cullen, Va., from its Farmville, Prince Edward County, Va., property and from its Willis Mountain property near Dillwyn, Buckingham County, Va., at which a new plant was completed during the year.

The following companies produced synthetic mullite in 1957:

Babcock & Wilcox Co., Refractories Division, New York, N. Y. (plant at Augusta, Ga.).
Carborundum Co., Niagara Falls, N. Y. (plant at Keasbey, N. J.).
Harbison-Walker Refractories Co., Pittsburgh, Pa. (plant at Vandalia, Mo.).
Laclede-Christy Co., Division of H. K. Porter Co., Inc., St. Louis, Mo. (plant at Shelton, Conn.).
Richard C. Remmey Son Co. (a subsidiary of A. P. Green Fire Brick Co.), Philadelphia, Pa. (plant at same address).
Chas. Taylor Sons Co. (a subsidiary of National Lead Co.), Cincinnati, Ohio (plant at Taylor, Ky.).

Production of synthetic mullite in the United States in 1957 was estimated at 20,000 short tons, with an estimated value of over $2 million.

CONSUMPTION AND USES

Mullite was produced in 1957, as in 1956, either by calcining natural ores or by synthesis. The output was used almost entirely in manufacturing superduty refractories. Mullite refractories repre-

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

sented only a small percentage of the total tonnage of refractories used in the United States; but they occupied an important position because of their relatively high softening points, low coefficients of expansion, and resistance to loads at high temperatures, thermal shock, and corrosive action of certain fluxing agents. Although mullite refractories were relatively expensive, industry found it profitable to use them for some superduty-refractory applications.

Mullite refractories have been used as brick and shapes or in cements, mortars, plastics, and ramming mixtures. In some instances the relatively fine grained domestic mullite has been blended with coarse-grained mullite obtained from imported kyanite or synthetic mullite in the production of refractory brick and shapes. Domestic kyanite has been satisfactory for use in refractory cement and for other uses that do not require a coarse-grained material; such uses composed the major part of United States consumption of domestic kyanite in 1957.

For a number of years about 90 percent of all mullite refractories have been employed to line furnaces operated by the metallurgical and glass industries. In 1957 about 50 percent of the mullite refractories were used by the metallurgical industry and 40 percent by the glass industry. The remaining 10 percent was consumed in miscellaneous applications, chiefly in the ceramic industry.

In the metallurgical industry the principal use of mullite refractories in 1957 was in electric furnaces (largely the induction type) for melting brass, bronze, copper-nickel alloys, certain steels, and ferrous alloys. Other metallurgical applications were in zinc-smelting and gold-refining furnaces.

In the glass industry mullite refractories were used mainly in constructing continuous tanks, especially in the superstructure, and in plungers, rings, and tubes for feeding molten glass to the forming machines.

In the ceramic industry small quantities of mullite refractories were used for manufacturing kiln furniture (for placing ceramic ware in kilns), in saggers (open-topped refractory boxes for protecting ware during firing), and in kiln construction. Small quantities of kyanite without calcination were used as a source of alumina in glass and as an ingredient of electrical and chemical porcelain and pyrometer tubes.

PRICES

As reported in E&MJ Metal and Mineral Markets for December 1957, 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 (60-percent grade) in bags were $76 to $81 per short ton, c. i. f. Atlantic ports.

FOREIGN TRADE [3]

India continued as the principal supplier of kyanite in 1957 (1,630 short tons). Imports from Union of South Africa in 1957 (4,140 short tons) were sillimanite, not kyanite; the 1956 imports from

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

Union of South Africa (1,709 short tons) should have been classified as sillimanite. Competition from African sillimanite and domestic synthetic mullite and the reduction of accumulated stocks of Indian kyanite were the principal causes for the abnormal drop in imports of Indian kyanite.

TABLE 1.—Kyanite and allied minerals imported for consumption into and exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Imports			Exports		
Year and origin	Short tons	Value	Year and destination	Short tons	Value
1948–52 (average)	15,051	$474,944	1948–52 (average)	912	$38,509
1953	6,620	287,689	1953	1,032	41,401
1954	4,826	[1] 196,609	1954	1,147	57,952
1955	7,581	338,993	1955	1,716	87,315
1956			1956		
Asia: India	5,242	255,376	North America:		
Africa: Union of South Africa	1,709	50,805	Canada	826	34,530
			Mexico	332	18,537
Grand total, 1956	6,951	306,181			
			Total	1,158	53,067
1957					
			Europe:		
Europe: Netherlands	5	550	Italy	143	8,126
Asia: India	1,630	93,704	United Kingdom	30	2,000
Africa: Union of South Africa	4,140	144,487			
Oceania: Australia	224	24,634	Total	173	10,126
Grand total, 1957	5,999	263,375	Grand total, 1956	1,331	63,193
			1957		
			North America:		
			Canada	1,147	53,164
			Mexico	893	40,252
			Total	2,040	93,416
			South America: Peru	22	3,700
			Europe:		
			France	91	6,224
			Germany, West	60	3,393
			Italy	181	10,620
			Netherlands	44	2,304
			United Kingdom	60	3,640
			Total	436	26,181
			Asia: Indonesia	90	6,666
			Grand total, 1957	2,588	129,963

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.

WORLD REVIEW

India.—Principal kyanite deposits occur in Singhbhum (Bihar) and Seraikella (Orissa). The Bihar reserves were estimated at 750,000 tons to a depth of 10 feet.

TABLE 2.—Production and exports of kyanite from India, 1952–56, in short tons [1]

Year	Production	Exports	Year	Production	Exports
1952	30,108	28,495	1955	13,206	28,937
1953	17,219	16,660	1956	16,654	29,752
1954	47,410	25,669			

[1] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, Spec. Suppl. 52, p. 8.

Sillimanite deposits occur in Assam. The minimum reserves were estimated at 250,000 tons. Sillimanite brick sold for US$50.36 per hundred.

TABLE 3.—Production of sillimanite in India, 1952–56, in short tons [1]

Year	Short tons	Year	Short tons
1952	5,685	1955	2,714
1953	6,150	1956	5,600
1954	3,434		

[1] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, Spec. Suppl. 52, p. 8.

Kenya.—During the first part of 1957 reorganization of Kenya Kyanite, Ltd., was begun by the new owner, G. F. K. Refractories, Ltd., a subsidiary of New Consolidated Goldfields, Ltd. Kenya Kyanite, Ltd., which had been in technical difficulties for several years, went into receivership in July 1955.[4]

Union of South Africa.—The Pella corundum-sillimanite, an important reserve of refractory material with high alumina content, had been utilized since 1954 for manufacturing furnace linings in West Germany.[5]

The Pella West deposits lie between the Bushmanland Plateau in the south and the highly dissected valley of the Orange River, which passes about 8 miles to the north, on a flat, low-lying, partly sand-covered terrace in the southwestern corner of the Pella Mission Farm. The farm is in the Namaqualand district about 90 miles from Springbok and about 108 miles from the railroad at Kakamas, in the Northwestern Cape Province of the Union of South Africa.

The available reserves of the Pella deposits totaled approximately 400,000 short tons at the end of June 1955, equivalent to 33 years' production, at the rate of 1,000 tons a month.

The average chemical composition is: SiO_2, 19.68; Al_2O_3, 74.65; Fe_2O_3, 1.63; TiO_2, 2.49; and ignition loss, 1.28 percent.

TECHNOLOGY

The new Willis Mountain plant of Kyanite Mining Corp. near Dillwyn, Buckingham County, Va., was completed and began operating full scale. Potential plant capacity may double the output of kyanite concentrate by the company. Mining was by open pit, and the ore was concentrated by froth flotation. Byproducts were sand and pyrites.

Chas. Taylor Sons Co. rebuilt its batching and grinding system and its screening system, with installation of controlled batching, at the Taylor, Ky., plant. These new facilities made it possible to produce mullite brick and shapes and special mullite refractories, including high-temperature cements and ramming mixtures, using fused mullite, sintered bauxite (domestic and imported), and calcined Indian kyanite in any desired proportions. The company was preparing to produce sintered mullite from Bayer alumina and other aluminous and siliceous raw materials.[6]

[4] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 29.
[5] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, pp. 23–24.
[6] Chas. Taylor Sons Co., Letter to the Bureau of Mines, Apr. 7, 1958.

Lead

By O. M. Bishop [1] and Edith E. den Hartog [2]

CONTINUED supply in excess of consumer needs, actual or impending cutback in United States Government acquisitions of lead, and increasing industry stocks and falling prices marked both the United States and the foreign lead industries in 1957.

Lead supply in the United States was 1.35 million tons, 2 percent more than in 1956, and 211,000 tons in excess of consumption. Domestic mine production and secondary metal recovery both declined about 4 percent, but total imports of primary lead increased 14 percent from 459,000 to 522,000 tons. Combined producers' and consumers' stocks of lead increased 54,000 short tons, and 100,075 tons of foreign lead acquired through barter contracts was delivered to the Government supplemental stockpile.

Other lead acquisitions to the Government stockpile were not made public, but on August 1 the Office of Defense Mobilization (ODM) announced that at the then current rate of procurement the long-term objective for lead (and zinc) would be met within a few months. In late April the Commodity Credit Corporation (CCC) announced that no further lead and zinc barter contracts would be made until the program had been evaluated. Later, when barter-contract negotiations were again authorized, the authorization was under restrictive terms that sharply delimited offerings. In August the British Government announced it would dispose of 20,000 tons of lead (and 27,000 tons of zinc) from its stockpile. Under the impact of these announcements, growing stocks, and declining American consumption, the price of lead dropped from 16.0 cents a pound—

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a price that had prevailed since January 13, 1956—to 15.5 cents on May 9, 1957, 15.0 cents on May 16, 14.0 cents on June 11, 13.5 cents on October 14, and 13.0 cents on December 2. Zinc prices between May 6 and July 1 were dropped from 13.0 to 10.0 cents a pound. Almost at once domestic mining companies began to curtail operations or shut down mines, and output of recoverable lead in the last quarter of 1957 was down 13 percent from that of the first quarter. Production of 534,000 tons refined lead from domestic and foreign ores was the second greatest quantity refined since 1942.

LEGISLATION AND GOVERNMENT PROGRAMS

Government programs affecting lead chiefly related to stockpiling and mineral exploration or to mobilization plans. Under the Provisions of the Defense Production Act of 1950, as amended, exploration continued to be carried out by the Defense Minerals Exploration Administration (DMEA), and the procurement for the national stockpile was continued by the General Services Administration (GSA) while the Office of Minerals Mobilization (OMM) continued evaluation of metal and mineral supply versus requirements and the development of mobilization programs. Lead was also acquired by the Federal Government through the barter program authorized under the Agricultural Trade Development and Assistance Act of 1954.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

The DMEA program to encourage exploration and increase domestic reserves of strategic and critical minerals and metals was continued throughout 1957. DMEA provided 50 percent of the approved cost of exploration contracts for lead and zinc.

During 1957, 15 new contracts were executed for exploration, altogether costing $2,150,000. Amendments to existing lead-zinc

TABLE 1.—Salient statistics of the lead industry in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Production of refined primary lead:						
From domestic ores and base bullion	377,734	328,012	322,271	321,132	349,188	347,675
From foreign ores and base bullion	78,844	139,879	164,441	158,025	193,120	185,858
Total	456,578	467,891	486,712	479,157	542,308	533,533
Recovery of secondary lead	476,787	486,737	480,925	502,051	506,755	489,229
Imports (general):						
Lead in pigs, bars, and old	347,792	390,510	281,941	284,729	283,392	333,526
Lead in base bullion	3,143	869	41		31	84
Lead in ores and matte	83,971	160,899	161,261	177,479	196,452	197,831
Exports of refined pig lead	1,432	803	596	403	4,628	4,339
Consumption of primary and secondary lead	1,129,028	1,201,604	1,094,871	1,212,644	1,209,717	1,138,115
Prices (cents per pound):						
New York:						
Average for period	16.13	13.48	14.05	15.14	16.01	14.66
Quotation at end of period	16.72	13.50	15.00	15.54	16.00	13.00
London average for period	16.89	11.48	12.08	13.19	14.52	12.05
Mine production of recoverable lead [1]	401,907	342,644	325,419	338,025	352,826	338,216
World smelter production of lead	1,780,000	2,060,000	[2] 2,200,000	2,220,000	2,370,000	2,490,000

[1] Includes Alaska.
[2] Revised figure.

exploration contracts made during the year authorized an additional $1,095,000, or a total of $3,245,000 for the year. Since inception of the program in 1951, 257 contracts involving lead and zinc were executed, which authorized Government participation of $12.6 million and combined Government and private expenditures of $25.3 million. Ore discoveries were certified at 78 of the 257 properties explored; discoveries ranged from several hundred tons of zinc and lead ore to one of more than 35 million tons of zinc ore in eastern Tennessee. A list of DMEA contracts for lead and zinc exploration in 1957, as in previous years, is given in the Zinc chapter of this volume.

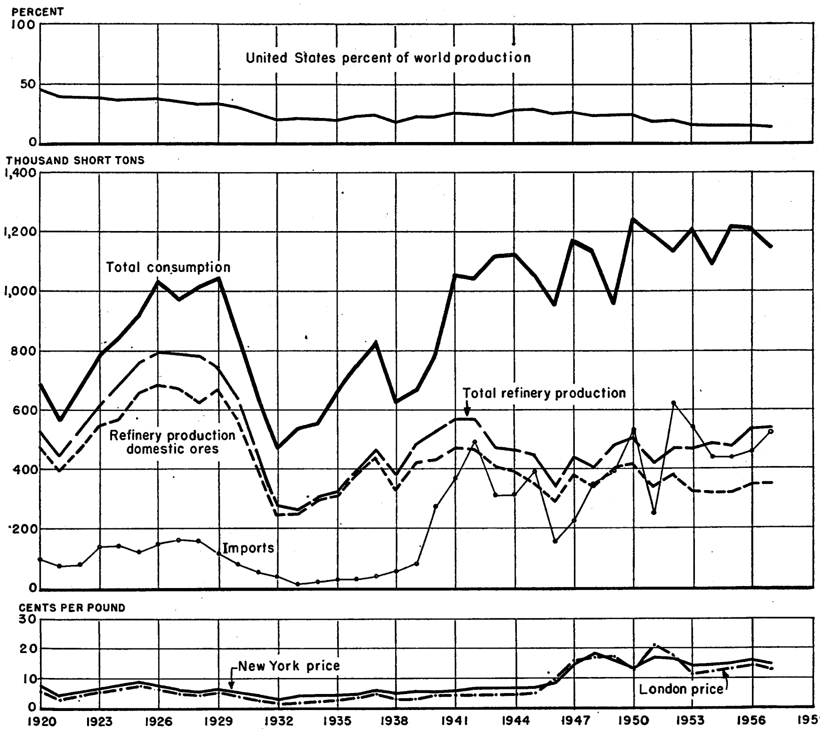

FIGURE 1.—Trends in the lead industry in the United States, 1920–57. Consumption includes primary refined, antimonial, and secondary lead and lead in pigments made directly from ore. Imports are factored to include 95 percent of the lead content of ores, mattes, and concentrates and 100 percent of pigs, bars, base bullion, and scrap.

GOVERNMENT BARTER PROGRAM

Under authority of Public Law 480 (1954) and the ODM Authorization of May 1956, the Department of Agriculture, through its agent, the Commodity Credit Corporation, continued to trade perishable surplus agricultural products for zinc and other commodities of foreign origin. In 1957 the CCC contracted for 55,438 tons of lead (76,325 tons in 1956) to be added to the Government supplemental stockpile.

On April 30 the Department of Agriculture ceased making new barter agreements, pending an evaluation of its program. On May 28 the program was resumed under restrictions to assure that agricultural commodities traded were in addition to marketings that would otherwise have taken place. Relatively few barter contracts were made after April 30 under the modified program.

GENERAL SERVICES ADMINISTRATION

The General Services Administration (GSA) continued to be responsible for stockpile procurement and administration, procurement under foreign-aid programs as agent of the International Cooperation Administration (ICA), and for administration of Defense Production Act programs, including domestic purchase programs. Purchases of lead produced from domestic ores were made against the long-term stockpile objective for lead throughout 1957. The quantities purchased were not made public.

Foreign lead received at GSA warehouses under barter agreements during the year totaled 100,075 tons (29,899 tons in 1956). This lead was credited to the "supplemental" stockpile and cannot be released except by an act of Congress.

DOMESTIC PRODUCTION

Lead output is compiled on both a mine and smelter-refinery basis. Mine output is the sum of the lead recovered from all domestic lead ores, concentrates, mill tailings, and smelter residues or slags. The recovery at smelters, refineries, and other processing plants in the United States in 1957 averaged 97.8 percent of the lead content of the lead-bearing primary material processed.

Pig-lead output, as reported by smelters and refineries, represents actual lead recovered. Smelter and refinery output from domestic ores usually differs from the mine-production figure, because there is a lag between mine shipments and smelter treatment of ore and concentrate and because 3,000 to 5,000 tons of lead concentrate is used directly in manufacturing pigment.

MINE PRODUCTION

Mines in the United States produced 338,200 tons of recoverable lead in 1957—4 percent less than in 1956. The average monthly production rate through April, when lead sold at 16.0 cents a pound, was 4 percent above the monthly rate of 1956. Monthly production declined thereafter in response to drops in price; by December output was 26,000 tons or only 82 percent of that in April. Missouri for the 51st year ranked first as a lead-producing State. For the same years Idaho ranked second and Utah third (except from 1925–27, when Utah was second and Idaho third). Together these 3 States produced 72 percent of the domestic mine production of lead in 1957 and 67 percent in 1956.

Western States.—Mines of the Western States produced 56 percent of the total domestic mine output, the same proportion as in 1956. Sharp declines in Montana, California, New Mexico, Utah, and Nevada were not wholly offset by increases in Idaho, Washington,

TABLE 2.—Ores yielding lead and zinc in the United States in 1957, in short tons [1]

State	Lead ore			Zinc ore			Lead-zinc ore			Copper-lead, copper-zinc, and copper-lead-zinc ores			Total		
	Gross weight	Lead	Zinc	Gross weight	Lead	Zinc	Gross weight	Lead	Zinc	Gross weight	Lead	Zinc	Ore, gross weight	Lead	Zinc
Western States and Alaska:															
Alaska	55	9											55	9	
Arizona	9,762	1,722	132	7,072		1,464	371,412	10,497	23,542	91,059	195	8,754	479,305	12,414	33,892
California	1,609	396	2				68,153	3,042	2,961				69,762	3,438	2,963
Colorado	25,935	1,259	47	785	9	62	422,610	10,914	33,637	499,562	8,525	13,254	948,892	20,707	47,000
Idaho	55,897	2,825	148				1,157,206	61,978	48,441	22	4		1,213,125	64,807	48,589
Montana	7,003	926	114	632,397	9,706	43,574	32,964	1,841	1,641				672,364	12,473	45,329
Nevada	23,055	3,666	303	1,003	12	104	60,438	1,281	4,754	33	2		84,529	4,961	5,161
New Mexico	902	102	12	327,591	1,655	22,705	82,582	3,076	9,962				411,075	4,833	32,679
Utah	34,680	2,897	259	20	1	5	543,577	39,844	38,845	44		8	578,321	42,742	39,117
Washington	110	72					1,189,578	12,658	23,453				1,189,688	12,730	23,453
Total	159,008	13,874	1,017	968,868	11,383	67,914	3,928,520	145,131	187,236	590,720	8,726	22,016	5,647,116	179,114	278,183
West Central States:															
Kansas	2,607	49	2	531,008	1,522	10,012	399,954	2,686	5,845				933,569	4,257	15,859
Missouri	[2] 7,265,023	107,276	2,006	2,900		85	523,005	12,236	860	[3] 354,764	6,751		8,145,692	126,263	2,951
Oklahoma	92,607	1,480	422	238,587	722	5,246	568,779	4,981	9,283				899,973	7,183	14,951
Total	7,360,237	108,805	2,430	772,495	2,244	15,343	1,491,738	19,903	15,988	354,764	6,751		9,979,234	137,703	33,761
States East of the Mississippi River:															
Illinois	1,538	674	1	491,239	1,021	15,905	478	96	9				493,255	1,791	15,915
New York						11,689		1,667	52,970					1,667	64,659
New Jersey				343,852		12,530	1,261,424						1,605,276		12,530
Virginia [4]						3,809		3,143	19,271					3,143	23,080
Tennessee				1,714,582		54,662				1,394,020		3,401	3,108,602		58,063
Wisconsin				719,324	1,808	21,382	8,518	92	193				727,842	1,900	21,575
Total	1,538	674	1	3,268,997	2,829	119,977	1,270,420	4,998	72,443	1,394,020		3,401	5,934,975	8,501	195,822
Grand total	7,520,783	123,353	3,448	5,010,360	16,456	203,234	6,690,678	170,032	275,667	2,339,504	15,477	25,417	21,561,325	325,318	507,766

[1] Does not include lead or zinc recovered from other ores, tailing, slags, dumps, etc., except where exclusion was impossible.
[2] Includes 1,271,684 tons of tailing containing 7,247 tons of recoverable lead and 788 tons of recoverable zinc.
[3] Includes some copper concentrate, yielding 38 tons of recoverable lead.
[4] Data partly combined to avoid disclosure of individual company operations.

Colorado, and Arizona; the group as a whole produced 7,400 tons less than in 1956.

Lead output in Idaho increased to 71,600 tons, the highest level since 1953. Increased output was reported by most of the principal operators. The Bunker Hill mine of the Bunker Hill Co. and the Page mine owned by American Smelting & Refining Co., recorded the largest gains. However, the decline in lead prices during the latter half of the year caused production cutbacks and closures. Idaho mines shut down in 1957 included the Hull lease on the Frisco mine, the Nabob Silver Lead mine, and the Triumph Mining Co. operation. In mid-December the Bunker Hill Co. announced curtailment of its production in the Coeur d'Alene region.

Output of recoverable lead in Utah declined 10 percent, to 44,500 tons, because of the closing of the Eagle-Blue Bell, Chief No. 1, the Plutus mines in June, and the Mayflower-Park Galena (New Park) mines in September. The United States and Lark mine unit continued to be the largest producer in the State. Other important producers in 1957 were United Park City, Mayflower-Park Galena, Calumet, Ophir, and Eagle-Blue Bell mines.

TABLE 3.—Mine production of recoverable lead in the United States, 1948–52 (average) and 1953–57, by States, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Western States and Alaska:						
Alaska	110	9		1	1	9
Arizona	24,753	9,428	8,385	9,817	11,999	12,441
California	12,085	8,664	2,671	8,265	9,296	3,458
Colorado	27,881	21,754	17,823	15,805	19,856	21,003
Idaho	83,660	74,610	69,302	64,163	64,321	71,637
Montana	19,721	19,949	14,820	17,028	18,642	13,300
Nevada	8,750	4,371	3,041	3,291	6,384	5,979
New Mexico	5,864	2,943	887	3,296	6,042	5,294
Oregon	8	5	5	3	5	5
South Dakota	5	10				
Texas	106					
Utah	50,887	41,522	44,972	50,452	49,555	44,471
Washington	8,729	11,064	9,938	10,340	11,657	12,734
Wyoming						
Total	242,559	194,329	171,844	182,461	197,758	190,331
West Central States:						
Arkansas	14					
Kansas	8,502	3,347	4,033	5,498	7,635	4,257
Missouri	123,476	125,895	125,250	125,412	123,783	126,345
Oklahoma	17,842	9,304	14,204	14,126	12,350	7,183
Total	149,834	138,546	143,487	145,036	143,768	137,785
States east of the Mississippi River:						
Illinois	3,534	3,391	3,232	4,544	3,832	2,970
Kentucky	127	52	80		228	411
New York	1,331	1,435	1,187	1,037	1,608	1,667
Tennessee	80	9			5	
Virginia [1]	3,314	2,788	4,324	2,999	3,045	3,152
Wisconsin	1,128	2,094	[2] 1,265	1,948	2,582	1,900
Total	9,514	9,769	10,088	10,528	11,300	10,100
Grand total	401,907	342,644	325,419	338,025	352,826	338,216

[1] Includes 4 tons from North Carolina in 1954, 2 tons in 1955, 10 tons in 1956, and 9 tons in 1957.
[2] Includes 4 tons from Iowa.

Colorado output of lead increased 6 percent to 21,000 tons in 1957. The Idarado Mining Co. mine group continued to be the largest producer in the State. Other important producers included the Eagle mine of the New Jersey Zinc Co. (Eagle County) and the Keystone mine of the American Smelting & Refining Co. (Gunnison County). Mines closed after price declines included the Keystone mine, the Rico group of Rico Argentine Mining Co., and the Leadville properties of Ressurrection Mining Co.

Montana mine production of lead totaled 13,300 tons, 29 percent less than in 1956 and was the smallest since 1946. The Anaconda Co. closed several of its lead-zinc mines in the Butte district (Silver Bow County) in the second half of 1957 and postponed its scheduled mine-expansion program. Production from other Montana mines, principally the Jack Waite and Hand (Maulden) mines, was continued at essentially the same rate as in 1956.

Lead output in Washington increased 9 percent to 12,700 tons, the largest production on record. The principal lead producer was the Pend Oreille Mines & Metals Co. lead-zinc mine in Pend Oreille County. Other mines that produced considerable lead but were predominantly zinc producers were the Grandview (American Zinc, Lead & Smelting Co.) in Pend Oreille County and the Van Stone (American Smelting & Refining Co.). The Van Stone mine was closed in early July 1957.

Although several Arizona mines closed during 1957, the State output of lead increased 4 percent to 12,400 tons. The largest producer, the Iron King mine, operated continuously. Of the other substantial producers, the San Xavier mine suspended operations in June, the Head Center (Athletic) in July, and the Trench unit in October.

California production dropped from 9,300 tons in 1956 to 3,500 tons in 1957. The Anaconda Co. Darwin and Shoshone mine groups, the State's only large lead producers, suspended operations after the mid-year zinc and lead price declines.

In Nevada Combined Metals Reduction Co. closed its mines at Pioche in August, contributing to a 6-percent decline in Nevada production during 1957. New Mexico mines recorded a 12-percent decrease in lead output. The State's principal lead (and zinc) producer, the Ground Hog mine of American Smelting & Refining Co., closed in July, pending higher metal prices.

West Central States.—Kansas, Missouri, and Oklahoma mines yielded 137,800 tons of recoverable lead in 1957—41 percent of the United States domestic total. All production of the West Central States came from the southeast Missouri lead belt and the Tri-State district of Kansas, Oklahoma, and southwestern Missouri.

Mines in southeast Missouri produced 37 percent of the total domestic mine output of lead in 1957—essentially the same as in 1956. The St. Joseph Lead Co., the largest lead-producing company in the Nation on a mine basis, maintained steady output at its Bonne Terre, Desloge, Federal, and Leadwood mine-mill units in St. Francois County and the Indian Creek mine and mill in Washington County. In Madison County the Mine La Motte Corp. and the National Lead Co. each operated a mine group and mill. The ore from the National Lead Co. also yielded byproduct copper, cobalt, and nickel.

Output of recoverable lead in the Tri-State zinc-lead district dropped from 20,400 tons in 1956 to 11,500 tons in 1957 the lowest since railway service was initiated in the 1870's. Nearly all mines in the district were closed, following the sharp declines in lead and zinc prices. The Nellie B mine of the American Zinc, Lead & Smelting Co. was closed in May, and the Eagle-Picher Co. operated its mines and central custom mill only intermittently. The National Lead Co., second largest producer in the district, operated its Ballard-mine group and mill throughout the year.

States East of the Mississippi River.—Lead was recovered from ores in Illinois, Wisconsin, Kentucky, New York, and Virginia in 1957; but production was 11 percent less than in 1956, owing to cutbacks and closures in the Illinois-Wisconsin district. American Zinc, Lead & Smelting Co. closed its Vinegar Hill Division mines and mill in Wisconsin; Eagle-Picher Co. closed the Linden mine and mill and curtailed activity elsewhere in the district. Tri-State Zinc, Inc., 1 of the 3 leading producers, maintained a fairly high production. Lead-bearing zinc ores of New York and Virginia yielded 4,800 tons of lead in 1957. St. Joseph Lead Co. operated its Balmat mine steadily

TABLE 4.—Mine production of recoverable lead in the United States, 1948–52 (average) and 1953–57, by districts or regions that produced 1,000 tons or more during any year, 1953–57, in short tons

District or region	State	1948–52 (average)	1953	1954	1955	1956	1957
Southeastern Missouri region.	Missouri	121,173	125,273	125,173	125,357	123,395	126,323
Coeur d'Alene region	Idaho	77,867	69,885	64,812	59,820	60,221	67,125
West Mountain (Bingham)	Utah	30,838	29,311	29,671	31,712	32,891	29,490
Metaline	Washington	5,173	8,694	(1)	(1)	9,440	11,971
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	28,641	13,273	18,314	19,679	20,373	11,462
Summit Valley (Butte)	Montana	14,634	16,767	11,516	14,331	14,989	9,617
Park City region	Utah	9,601	4,735	5,432	9,954	9,147	9,421
Upper San Miguel	Colorado	6,507	7,440	5,574	5,098	(1)	7,721
Red Cliff	do	2,617	2,500	2,588	3,171	(1)	4,477
California (Leadville)	do	5,567	3,072	1,935	1,404	1,660	3,694
Upper Mississippi Valley	Iowa, northern Illinois, Wisconsin.	2,222	3,688	3,229	3,809	4,306	3,691
Central	New Mexico	3,231	1,460	5	2,604	4,682	3,519
Austinville	Virginia	3,314	2,788	4,320	2,997	3,035	3,143
Creede	Colorado	1,143	1,696	2,178	1,192	1,266	2,231
Rush Valley & Smelter (Tooele County).	Utah	2,760	2,753	2,454	1,607	2,529	1,977
Tintic	do	5,800	3,590	5,926	5,017	3,061	1,775
St. Lawrence County	New York	1,330	1,435	1,187	1,037	1,608	1,667
Kentucky-Southern Illinois	Kentucky-southern Illinois.	2,524	1,849	1,348	2,683	2,336	1,590
Ophir	Utah	908	1,157	1,159	(1)	(1)	1,418
Bayhorse	Idaho	1,491	1,484	1,372	1,367	1,607	1,351
Warm Springs	do	2,566	2,583	2,415	2,388	1,804	1,293
Magdalena	New Mexico	1,393	-------	47	95	688	1,214
Tyndall	Arizona	86	234	202	595	894	1,162
Las Vegas	Nevada	-------	-------	-------	956	2,698	858
Pima (Sierritas, Papago, Twin Buttes).	Arizona	3,169	-------	1	1,105	1,810	750
Northport (Aladdin)	Washington	837	2,165	1,275	2,212	2,085	722
Animas	Colorado	3,063	1,212	-------	-------	-------	508
Hansonberg	New Mexico	460	1,031	800	517	413	455
Breckenridge	Colorado	309	1,056	1,000	474	553	272
Big Bug [2]	Arizona	3,707	4,339	4,336	4,612	5,776	(1)
Eureka	Nevada	18	-------	(1)	828	(1)	(1)
Coso (Darwin)	California	6,805	8,269	(1)	(1)	(1)	(1)
Harshaw	Arizona	1,813	2,104	2,135	(1)	(1)	(1)
Eagle	Montana	819	1,179	-------	706	1,207	(1)
Pioche	Nevada	5,677	3,306	(1)	(1)	(1)	(1)
Elk Mountain	Colorado	104	-------	(1)	(1)	(1)	(1)
Resting Springs	California	(1)	-------	-------	22	(1)	(1)
Pioneer (Rico)	Colorado	1,883	1,871	2,177	(1)	(1)	(1)
Sneffels	do	965	1,307	1,113	634	525	-------

[1] Figure not shown to avoid disclosure of individual company operations.
[2] The following districts or regions are not listed in order of 1957 output.

TABLE 5.—Twenty-five leading lead-producing mines in the United States in 1957, in order of output

Rank	Mine	District or region	State	Operator	Type of ore
1	Federal	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
2	Bunker Hill	Coeur d'Alene	Idaho	The Bunker Hill Co	Lead-zinc.
3	United States & Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Do.
4	Leadwood	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
5	Indian Creek	do	do	do	Do.
6	Desloge	do	do	do	Do.
7	Butte Mines	Summit Valley	Montana	The Anaconda Co	Lead-zinc.
8	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co	Do.
9	Bonne Terre	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
10	Treasury Tunnel-Black Bear-Smuggler Union.	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc.
11	Star	Coeur d'Alene	Idaho	The Bunker Hill Co	Lead-zinc.
12	Iron King	Big Bug	Arizona	Shattuck-Denn Mining Co	Do.
13	Page	Coeur d'Alene	Idaho	American Smelting & Refining Co	Do.
14	Mine La Motte	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
15	Madison	do	do	National Lead Co	Lead-copper.
16	United Park City	Uintah	Utah	United Park City Mines Co	Lead-zinc.
17	Eagle	Red Cliff (Battle Mountain)	Colorado	The New Jersey Zinc Co	Copper, lead-zinc.
18	Lucky Friday	Coeur d'Alene	Idaho	Lucky Friday Silver-Lead Mines, Inc.	Lead-zinc,
19	Austinville	Austinville	Virginia	The New Jersey Zinc Co	Zinc-lead.
20	Grandview	Metaline	Washington	American Zinc, Lead & Smelting Co	Lead-zinc.
21	Mayflower	Blue Ledge	Utah	New Park Mining Co	Do.
22	Darwin Group	Darwin (Coso)	California	The Anaconda Co	Do.
23	Sunshine	Coeur d'Alene	Idaho	Sunshine Mining Co	Silver.
24	Flux Group	Harshaw	Arizona	American Smelting & Refining Co	Lead-zinc.
25	Dayrock	Coeur d'Alene	Idaho	Day Mines, Inc	Lead.

throughout 1957, and the New Jersey Zinc Co. operated its Austinville mine in Virginia continuously, except for a 3-week shutdown caused by a labor dispute in midyear. Mines in the western Kentucky fluorspar district produced 400 tons of recoverable lead from lead-bearing fluorspar-zinc ores in 1957.

The 25 leading lead-producing mines in the United States in 1957 yielded 79 percent of the total domestic output—the 10 leading mines, 59 percent, and the 4 largest mines, 43 percent.

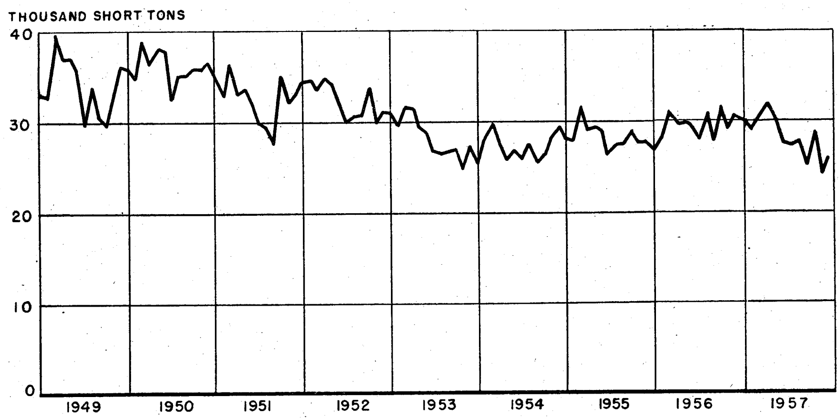

FIGURE 2.—Mine production of recoverable lead in the United States, 1949–57, by months.

TABLE 6.—Mine production of recoverable lead in the United States,[1] 1956–57, by months, in short tons

Month	1956	1957	Month	1956	1957
January	26,813	30,218	August	30,727	27,806
February	28,221	29,061	September	27,781	25,006
March	30,855	30,962	October	31,503	28,663
April	29,549	31,700	November	29,277	24,042
May	29,892	30,104	December	30,486	25,982
June	29,480	27,366			
July	28,242	27,306	Total	352,826	338,216

[1] Includes Alaska.

SMELTER AND REFINERY PRODUCTION

Refined lead produced in the United States was derived from three sources—domestic mine production, imports of foreign ore and base bullion, and scrap material (treated largely at secondary smelters). It was recovered at primary refineries that treat ore, base bullion, and small quantities of scrap and at secondary plants that process scrap exclusively. Refined lead and antimonial (hard) lead were produced by both primary and secondary plants. Because of the large quantity of hard lead (such as battery scrap) melted at secondary smelters, the output from this type of operation was principally antimonial lead.

The 5 smelters, 6 combination smelters and refineries, and 2 refineries treating ore, base bullion, and other primary materials in 1957 are listed below:

Smelters:
- Arkansas Valley, American Smelting & Refining Co., Leadville, Colo.
- East Helena, American Smelting & Refining Co., E. Helena, Mont.
- El Paso, American Smelting & Refining Co., El Paso, Tex.
- Midvale, United States Smelting, Refining & Mining Co., Midvale, Utah.
- Tooele, International Smelting & Refining Co., Tooele, Utah.

Smelter-Refineries:
- Selby, American Smelting & Refining Co., Selby, Calif.
- Bunker Hill, Bunker Hill Co., Bradley, Idaho.
- Federal, American Smelting & Refining Co., Alton, Ill.
- Herculaneum, St. Joseph Lead Co., Herculaneum, Mo.
- Galena, Eagle-Picher Co., Galena, Kans.
- Perth Amboy, American Smelting & Refining Co., Barber, N. J.

Refineries:
- East Chicago, U. S. S. Lead Refinery, Inc., East Chicago, Ind.
- Omaha, American Smelting & Refining Co., Omaha, Nebr.

In addition to primary plants operating in 1957, 259 secondary plants smelted lead scrap, and 58 foundries and manufacturers melted and cast or otherwise directly used lead scrap or other scrap containing lead. These firms variously produced soft and hard lead and various alloys in pig or other commercial shapes or manufactured form. An incomplete list of major secondary smelting firms, with plant locations, follows:

American Smelting & Refining Co. (including Federated Metals Division). Plants: Los Angeles, San Francisco, and Selby, Calif.; Whiting Ind.; Omaha, Nebr.; Newark and Perth Amboy, N. J.; Houston, Tex.
Bers & Co., Inc., Philadelphia, Pa.
The Bunker Hill Co., Seattle, Wash.
Continental Smelting & Refining Co., McCook, Ill.
Detroit Lead Corp., Detroit Mich.
Eastern Smelting & Refining Co., Los Angeles, Calif.
Electric Storage Battery Co., Philadelphia, Pa.
Goldsmith Bros. Smelting & Refining Co., Chicago, Ill.
Gopher Smelting & Refining Co., St. Paul, Minn.
Imperial Type Metals Co. Plants: Chicago, Ill., and Philadelphia, Pa.
Inland Metals Refining Co., Chicago, Ill.
Nassau Smelting & Refining Co., Inc., Tottenville, N. Y.
National Lead Co. (including Magnus Metal Division, Morris P. Kirk & Son, Inc., and Master Metals, Inc.). Plants: Los Angeles, Calif.; Denver, Colo.; Atlanta, Ga.; Chicago and Granite City, Ill.; Indianapolis, Ind.; Topeka, Kans.; Baltimore, Md.; Boston and Fitchburg, Mass.; St. Louis Park, Minn.; St. Louis, Mo.; Omaha, Nebr.; Perth Amboy, N. J.; Albany and Depew, N. Y.; Cincinnati and Cleveland, Ohio; Portland, Oreg.; Philadelphia and Pittsburgh, Pa.; Dallas and Houston, Tex.; Milwaukee, Wis.
National Metal & Smelting Co., Fort Worth, Tex.
North American Smelting Co., Wilmington, Del.
Pennsylvania Smelting & Refining Co., Philadelphia, Pa.
Price Battery Corp., Hamburg, Pa.
Revere Smelting & Refining Co., Newark, N. J.
Schuylkill Products Co., Baton Rouge, La.
Thos. F. Seitzinger's Sons, Inc., Atlanta, Ga.
Southern Lead Co., Dallas, Tex.
U. S. S. Lead Refinery, Inc., East Chicago, Ind.
Hyman Viener & Sons, Richmond, Va.
Western Lead Products Co., Los Angeles, Calif.
Willard Smelting Co., Inc., Charlotte, N. C.

Refined Lead—Primary and Secondary

The 13 primary lead smelters and refineries operating in the United States in 1957 consumed about 565,000 tons of lead in primary raw materials and 46,000 tons in secondary materials to produce 536,800 tons of refined lead and 64,700 tons of lead in 67,800 tons of antimonial lead. Standard specifications for pig lead (ASTM Standard Specification B 29–55) were published in the Lead chapter of Volume 1, 1956, Minerals Yearbook.

Of the 536,800 tons of refined lead, 3,300 tons was from scrap and the remainder from ores and bullion, of which 65 percent was domestic

TABLE 7.—Refined lead produced at primary refineries in the United States, 1948–52 (average) and 1953–57, by source material, in short tons

Source	1948–52 (average)	1953	1954	1955	1956	1957
Refined lead:						
From domestic ores and base bullion	377,734	328,012	322,271	321,132	349,188	347,675
From foreign ores	75,912	139,711	164,353	157,863	193,084	185,798
From foreign base bullion	2,932	168	88	162	36	60
Total from primary sources	456,578	467,891	486,712	479,157	542,308	533,533
From scrap	8,120	4,211	5,066	4,079	4,069	3,263
Total refined lead	464,698	472,102	491,778	483,236	546,377	536,796
Average sales price per pound	$0.161	$0.131	$0.137	$0.149	$0.157	$0.143
Total calculated value of primary refined lead [1]	$147,018,000	$122,587,000	$133,359,000	$142,789,000	$170,285,000	$152,590,000

[1] Excludes value of refined lead produced from scrap at primary refineries.

TABLE 8.—Refined primary lead produced in the United States, 1948–52 (average) and 1953–57, by source material and country of origin, in short tons

Source	1948–52 (average)	1953	1954	1955	1956	1957
Domestic ore and base bullion	377,735	328,012	322,271	321,132	349,188	347,675
Foreign ore:						
Australia	7,024	19,886	17,311	26,701	23,811	38,579
Canada	5,983	26,673	47,150	39,919	26,558	20,694
Europe	109	199	865	109		
Mexico	4,972	5,876	16,790	10,123	11,183	23,462
South America	35,599	50,828	58,341	44,855	76,073	75,196
Other foreign	22,224	36,249	23,896	36,156	55,459	27,867
Total	75,911	139,711	164,353	157,863	193,084	185,798
Foreign base bullion:						
Australia	1,418					
Mexico	1,241	42				
South America	153	126	88	162	36	60
Other foreign	120					
Total	2,932	168	88	162	36	60
Total foreign	78,843	139,879	164,441	158,025	193,120	185,858
Grand total	456,578	467,891	486,712	479,157	542,308	533,533

and 35 percent foreign. South America was the chief source of foreign ore, followed by Australia, Mexico, and Canada.

Refined lead recovered from scrap at secondary plants totaled an additional 123,300 tons.

Antimonial Lead—Primary and Secondary

Antimonial lead produced at primary and secondary lead smelters and refineries in 1957 totaled 278,400 tons containing 260,000 tons of lead—about 2 percent less than the 269,600 tons in that produced in 1956. The output of 67,800 tons from primary refineries was the highest since 1948; about two-thirds was from scrap, principally battery lead plates. Production of antimonial lead at secondary smelters totaled 210,600 tons containing 195,300 tons of lead.

TABLE 9.—Antimonial lead produced at primary lead refineries in the United States, 1948–52 (average) and 1953–57

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Short tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1948–52 (average)	64, 727	4, 491	7. 2	14, 269	7, 955	38, 012	60, 236
1953	62, 373	4, 537	7. 3	10, 366	10, 721	36, 749	57, 836
1954	59, 873	3, 521	5. 9	5, 136	7, 661	43, 555	56, 352
1955	64, 044	3, 555	5. 6	5, 259	9, 327	45, 903	60, 489
1956	66, 826	3, 348	5. 0	6, 739	6, 918	49, 821	63, 478
1957	67, 786	3, 064	4. 5	10, 271	9, 599	44, 852	64, 722

Other Secondary Lead

In addition to 126,600 tons of refined lead and 256,600 tons of antimonial lead containing 240,200 tons of lead, smelters and remelters of lead scrap also produced 114,900 tons of babbitt, solder, type metal, cable lead, miscellaneous alloys, and foil containing 96,600 tons of lead.

Considerable lead (35,900 tons) was recovered in processing copper-base scrap at secondary copper smelters and plants of nonferrous ingotmakers.

In summation, secondary lead recovered in the United States in 1957 totaled 489,000 short tons, a decrease of 3 percent from the 507,000 tons reclaimed in 1956. The lead recovered exceeded domestic mine production (338,000 tons) for the 12th consecutive year but was considerably less than the 598,000 tons of lead in refined and antimonial lead produced at primary smelters from domestic and imported primary materials. The more than 300 secondary lead smelters and remelters recovered 405,200 tons or 83 percent of all secondary lead recovered; primary lead smelters recovered 48,100 tons (10 percent), and secondary copper plants 35,900 tons (7 percent).

TABLE 10.—Stocks and consumption of new and old lead scrap in the United States in 1957, gross weight in short tons

Class of consumers and type of scrap	Stocks beginning of year [1]	Receipts	Consumption			Stocks end of year
			New scrap	Old scrap	Total	
Smelters and refiners:						
Soft lead	3,448	48,812		49,397	49,397	2,863
Hard lead	2,344	19,821		20,259	20,259	1,906
Cable lead	3,781	26,492		27,000	27,000	3,273
Battery-lead plates	26,142	376,504		385,149	385,149	17,497
Mixed common babbitt	1,183	10,550		10,083	10,083	1,650
Solder and tinny lead	396	10,222		10,303	10,303	315
Type metals	898	22,888		22,225	22,225	1,561
Drosses and residues	21,825	74,949	74,402		74,402	22,372
Total	60,017	590,238	74,402	524,416	598,818	51,437
Foundries and other manufacturers:						
Soft lead	232	987	6	1,118	1,124	95
Hard lead	2	281	2	174	176	107
Cable lead	96	466		519	519	43
Battery-lead plates	12					12
Mixed common babbitt	281	9,262		9,431	9,431	112
Solder and tinny lead	98	975	971	47	1,018	55
Type metals						
Drosses and residues	367		3		3	364
Total	1,088	11,971	982	11,289	12,271	788
Grand total:						
Soft lead	3,680	49,799	6	50,515	50,521	2,958
Hard lead	2,346	20,102	2	20,433	20,435	2,013
Cable lead	3,877	26,958		27,519	27,519	3,316
Battery-lead plates	26,154	376,504		385,149	385,149	17,509
Mixed common babbitt	1,464	19,812		19,514	19,514	1,762
Solder and tinny lead	494	11,197	971	10,350	11,321	370
Type metals	898	22,888		22,225	22,225	1,561
Drosses and residues	22,192	74,949	74,405		74,405	22,736
Total	61,105	602,209	75,384	535,705	611,089	52,225

[1] Revised.

TABLE 11.—Secondary metal recovered [1] from lead and tin scrap in the United States in 1957, by type of products, gross weight in short tons

Products	Lead	Tin	Antimony	Other	Total
Refined pig lead	109,489				109,489
Remelt lead	16,889				16,889
Lead foil	193				193
Total	126,571				126,571
Refined pig tin		3,610			3,610
Remelt tin		350			350
Total		3,960			3,960
Lead and tin alloys:					
Antimonial lead	240,151	549	15,722	216	256,638
Common babbitt	18,212	1,200	2,005	349	21,766
Genuine babbitt	96	311	35	15	457
Solder	23,610	5,793	372	721	30,496
Type metals	26,962	1,964	4,110	58	33,094
Cable lead	25,560	11	256	4	25,831
Miscellaneous alloys	1,715	788	35	136	2,674
Total	336,306	10,616	22,535	1,499	370,956
Composition foil	461	150	30		641
Tin content of chemical products		627			627
Grand total	463,338	15,353	22,565	1,499	502,755

[1] Most of the figures herein represent actual reported recovery of metal from scrap rather than secondary metal content of shipments as in years before 1956.

TABLE 12.—Secondary lead recovered in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
As refined metal:						
At primary plants	8,120	4,211	5,066	4,079	4,069	3,263
At other plants	136,452	122,363	114,941	124,241	129,323	123,308
Total	144,572	126,574	120,007	128,320	133,392	126,571
In antimonial lead:						
At primary plants	38,012	36,749	43,555	45,903	49,821	44,852
At other plants	180,958	199,806	195,284	201,800	202,761	195,299
Total	218,970	236,555	238,839	247,703	252,582	240,151
In other alloys	113,245	123,608	122,079	126,028	120,781	122,507
Grand total:						
Short tons	476,787	486,737	480,925	502,051	506,755	489,229
Value	$154,102,445	$127,525,094	$131,773,450	$149,611,198	$159,121,070	$139,919,494

TABLE 13.—Lead recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1956–57, in short tons

Kind of scrap	1956	1957	Form of recovery	1956	1957
New:			As soft lead:		
Lead-base	54,435	51,536	At primary plants	4,069	3,263
Copper-base	6,205	5,487	At other plants	129,323	123,308
Tin-base	599	323			
			Total	133,392	126,571
Total	61,239	57,346			
Old:			In antimonial lead [1]	252,582	240,151
Battery-lead plates	260,757	255,208	In other lead alloys	92,448	95,132
All other lead-base	161,439	146,265	In copper-base alloys	28,205	27,279
Copper-base	23,313	30,404	In tin-base alloys	128	96
Tin-base	7	6			
			Total	373,363	362,658
Total	445,516	431,883			
			Grand total	506,755	489,229
Grand total	506,755	489,229			

[1] Included 49,821 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1956 and 44,852 tons in 1957.

Lead Pigments

The principal lead pigments marketed were litharge, white lead, red lead, basic lead sulfate, and leaded zinc oxide. These products were manufactured chiefly from metal, but about 4,500 tons of lead in ore and concentrate was converted directly into pigments. Lead-pigments production is reviewed in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

Domestic consumers used 1.14 million tons of lead in 1957, 6 percent less than in 1956. Of the total consumed, 715,300 tons (63 percent) was soft lead, both secondary and primary; 303,200 tons (26 percent) was in antimonial lead; 50,900 tons (4 percent) in lead-base alloys; 18,400 tons (2 percent) in copper-base scrap; 42,100 tons (4 percent), which went directly from scrap to a finished product; and 8,200 tons (1 percent) recovered from ore in producing leaded zinc oxide and other pigments.

Approximately 71 percent of all lead was consumed in metal products (including storage batteries), 10 percent in pigments, 16 percent in chemicals, and 3 percent in miscellaneous and unclassified uses, including lead used for molding rubber, making lead powder, supplying AEC requirements, and that added to steel. Storage batteries alone took 32 percent of all lead consumed in 1957, tetraethyl fluid 16 percent, and cable covering 10 percent—a total of 58 percent and about 51,000 tons less than was required for these 3 products in 1956. October was the month of highest consumption (105,300 tons) and December the lowest (79,300 tons).

The Association of American Battery Manufacturers, Inc.,[3] reported shipments of 25.9 million units of replacement batteries in 1957, compared with 25 million (revised) in 1956 and 25.4 million in 1955.

New Jersey was again the largest lead-consuming State with 15 percent of total consumption (excluding that going directly from scrap

TABLE 14.—Consumption of lead in the United States in 1956–57, by products, in short tons

	1956	1957		1956	1957
Metal products:			Pigments:		
Ammunition	44,438	42,509	White lead	16,951	15,701
Bearing metals	28,321	26,997	Red lead and litharge	79,199	78,323
Brass and bronze	27,063	24,491	Pigment colors	13,866	12,449
Cable covering	134,339	108,225	Other [1]	10,354	8,888
Calking lead	64,970	65,634			
Casting metals	12,932	12,672	Total	120,370	115,361
Collapsible tubes	10,945	10,316			
Foil	4,593	4,839	Chemicals:		
Pipes, traps, and bends	28,028	24,739	Tetraethyl lead	191,990	177,001
Sheet lead	30,249	27,474	Miscellaneous chemicals	3,146	3,556
Solder	75,290	70,684			
Terne metal	1,709	1,642	Total	195,136	180,557
Type metal	26,709	28,726			
			Miscellaneous uses:		
Total	489,586	448,948	Annealing	5,899	5,317
			Galvanizing	1,658	1,354
Storage batteries:			Lead plating	916	670
Antimonial lead	191,568	185,617	Weights and ballast	7,250	7,526
Lead oxides	179,203	175,398			
			Total	15,723	14,867
Total	370,771	361,015	Other, unclassified uses	18,131	17,367
			Grand total	[2]1,209,717	[2]1,138,115

[1] Includes lead content of leaded zinc oxide and other nonspecified pigments.
[2] Includes lead which went directly from scrap to fabricated products.

TABLE 15.—Consumption of lead in the United States, 1956–57, by months, in short tons [1]

Month	1956	1957	Month	1956	1957
January	110,562	102,952	August	107,711	103,442
February	100,201	95,788	September	96,576	95,790
March	97,755	98,822	October	112,179	105,337
April	97,836	96,189	November	102,408	86,385
May	104,418	96,443	December	91,175	79,298
June	100,571	92,100			
July	88,325	85,569	Total	1,209,717	1,138,115

[1] Includes lead content of leaded zinc oxide and other nonspecified pigments and lead which went directly from scrap to fabricated products.

[3] American Metal Market, vol. 65, No. 25, Feb. 5, 1958, p. 6.

and ore to end products). Illinois followed with 12 percent, California 9 percent, Indiana 7, Pennsylvania 6, Missouri and New York 5 each, and Louisiana and Texas together 13 percent—a total of 72 percent consumed in the 9 States.

TABLE 16.—Consumption of lead in the United States in 1957, by classes of product and types of material, in short tons

	Soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
Metal products	228,503	110,457	50,473	18,400	407,833
Storage batteries	175,398	185,617			361,015
Pigments	106,805	142	190		107,137
Chemicals	180,524	33			180,557
Miscellaneous	9,802	5,056	9		14,867
Unclassified	14,256	1,926	244		16,426
Total	715,288	303,231	50,916	18,400	[1] 1,087,835

[1] Excludes 42,056 tons of lead that went directly from scrap to fabricated products and 8,224 tons of lead contained in leaded-zinc oxide and other nonspecified pigments.

TABLE 17.—Lead consumption, by States, in 1957, in short tons [1]

State	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
California	60,207	27,989	6,307	1,156	95,659
Colorado	1,579	1,524	157	279	3,539
Connecticut	14,980	10,004	9	1,035	26,028
District of Columbia	121	91			212
Florida	1,932	3,335			5,267
Illinois	87,360	40,106	5,993	2,424	135,883
Indiana	45,360	29,610	4,144	776	79,890
Kansas	5,042	8,048	72	421	13,583
Kentucky	150	2,411	3		2,564
Maryland	16,423	13,595	1,188	40	31,246
Massachusetts	5,770	4,545	1,364	364	12,043
Michigan	10,902	11,031	1,762	513	24,208
Missouri	49,091	4,616	417	1,507	55,631
Nebraska	10,067	3,141		54	13,262
New Jersey	114,958	40,726	9,690	594	165,968
New York	31,418	10,563	8,133	897	51,011
Ohio	21,083	16,787	3,213	1,772	42,855
Pennsylvania	38,688	23,308	1,084	2,225	65,305
Rhode Island	4,993	348	33		5,374
Tennessee	335	5,199	345	372	6,251
Virginia	1,620	1,419	1,140	1,665	5,844
Washington	8,477	3,440			11,917
West Virginia	14,444	2,914	3		17,361
Wisconsin	946	3,563	215	364	5,088
Alabama and Georgia [2]	22,807	9,204	828	621	33,460
Iowa and Minnesota	651	5,916	537	356	7,460
Montana and Idaho	8,276				8,276
New Hampshire, Maine, and Delaware	2,314	233	1,594	308	4,449
Arkansas and Oklahoma	2,059	1,862	24		3,945
Hawaii and Oregon	885	2,063	26	262	3,236
North and South Carolina	460	2,606			3,066
Louisiana and Texas	131,493	12,308	1,518	395	145,714
Utah, Nevada, and Arizona	96	634			730
Undistributed	301	92	1,117		1,510
Total	715,288	303,231	50,916	18,400	1,087,835

[1] Excludes 42,056 tons of lead, which went directly from scrap to fabricated products, and 8,224 tons of lead contained in leaded-zinc oxides and other nonspecified pigments.
[2] The following States are grouped to avoid disclosure of individual figures.

STOCKS

National Stockpile.[4]—Under authority of the Strategic and Critical Materials Stockpiling Act of 1946 and supplemental legislation and in accord with directives from ODM monthly purchases of domestic lead and zinc continued to be made throughout 1957. All domestic lead was acquired to meet the long-term objective, since the minimum stockpile objective for lead and the procurement priority level had been equaled or exceeded. In addition to domestic lead, there also were deliveries of lead to the stockpile in repayment of ICA advances under several contracts. On August 1 Director Gray of ODM stated that at the current rate of procurement the long-term stockpile objective for lead and zinc would soon be met.

During 1957 GSA[5] received 100,075 tons of foreign lead (29,899 in 1956), which was acquired under barter contracts authorized under the Agricultural Trade Development and Assistance Act of 1954 and amendments. Lead acquired under this program was placed in the supplemental stockpile and was in addition to quantities acquired under the minimum and long-term-stockpile lead objectives.

Producers' Stocks.—Stocks at the end of 1957 at primary producing plants had reached the highest level since the survey was begun in 1943. Lead in bullion declined almost 2,300 tons but increased 3 percent in antimonial lead and 11 percent in ore, and stocks of refined lead more than doubled during the year. The overall increase over 1956 was 48 percent, and the total (143,900 tons) was 4 percent higher than at any time in the past 10 years. These data represent physical inventories at the plants, irrespective of ownership, and do not include material in process or in transit. However, data from the American Bureau of Metal Statistics show an additional 2,800 tons of bullion in transit to refineries, 23,200 tons of bullion in process at refineries, and approximately 30,000 tons of ore in process at smelting plants—a grand total of primary material at these plants of 205,000 tons.

TABLE 18.—Stocks of lead at primary smelters and refineries in the United States at end of year, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Refined pig lead	33,738	65,035	78,928	21,871	30,237	74,194
Lead in antimonial lead	8,190	14,414	13,253	9,084	10,740	11,079
Lead in base bullion	10,699	13,545	14,934	15,585	11,141	8,855
Lead in ore and matte	45,299	43,734	29,924	42,903	44,925	49,788
Total	97,926	136,728	137,039	89,443	97,043	143,916

Consumers' Stocks.—Consumers' stocks of lead (including those secondary smelter plants that also are consumers of lead) increased 4 percent during the year. Lead in antimonial lead, in alloys, and in copper-base scrap all decreased, but stocks of soft lead increased by about 7,000 tons.

[4] Stockpile Report to the Congress, January–June 1957 and July–December 1957, by Office of Defense Mobilization.

[5] United States Tariff Commission, Lead and Zinc—Report to the President on Escape-Clause Investigation No. 65 Under the Provisions of Sec. 7 of the Trade Agreements Extension Act of 1951, as amended, April 1958, table 9.

TABLE 19.—Consumer stocks of lead in the United States at end of year, 1953–57, by type of material, in short tons, lead content

Year	Refined soft lead	Antimonial lead	Unmelted white scrap	Lead in alloys	Lead in copper-base scrap	Drosses, residues, etc.	Total
1953	75,801	14,867	3,607	7,921	2,083	9,484	113,763
1954	82,039	17,573	3,199	9,367	2,005	10,458	124,641
1955	73,480	23,081	2,914	8,146	1,618	8,219	117,458
1956 [1]	73,673	40,226		8,007	2,089		123,995
1957	80,708	39,375		7,651	1,576		129,310

[1] Beginning 1956, consumer stocks of scrap were added to secondary smelter stocks of scrap, and secondary smelter metal stocks were included with consumer metal stocks.

PRICES

The quoted New York price for common lead, which held at 16.0 cents per pound through most of 1956, was maintained in the early months of 1957. However, reduced consumption, increasing inventories, and announced cutbacks in Government stockpiling started a downward movement in May, which resulted in a 3-cent decline by the end of the year. The first reduction was ½ cent a pound on May 9, followed by an additional ½ cent on May 16, 1.0 cent on June 11, ½ cent on October 14, and another ½ cent on December 2 to a price of 13.0 cents, held through the remainder of the year.

The London Metal Exchange quotations ranged from a high of £118¼ per long ton on January 3 (equivalent to 14.8 cents per pound U. S. currency, computed on the average monthly rate of exchange) to a low of £69 on December 12 (8.6 cents per pound). The bid price on December 31 was £73 per long ton (9.1 cents per pound), and the average for 1957 was £96.7 (12.1 cents per pound).

TABLE 20.—Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1955–57, in cents per pound [1]

Month	1955			1956			1957		
	St. Louis	New York	London [2]	St. Louis	New York	London [2]	St. Louis	New York	London [2]
January	14.80	15.00	12.94	15.96	16.16	14.86	15.80	16.00	14.51
February	14.80	15.00	12.88	15.80	16.00	14.96	15.80	16.00	14.13
March	14.80	15.00	12.96	15.80	16.00	15.17	15.80	16.00	14.10
April	14.80	15.00	13.04	15.80	16.00	14.50	15.80	16.00	13.93
May	14.80	15.00	12.88	15.80	16.00	13.98	15.18	15.38	12.39
June	14.80	15.00	12.80	15.80	16.00	14.16	14.12	14.32	11.42
July	14.80	15.00	13.17	15.80	16.00	14.17	13.80	14.00	11.28
August	14.80	15.00	13.25	15.80	16.00	14.42	13.80	14.00	11.39
September	14.92	15.12	13.38	15.80	16.00	14.56	13.80	14.00	11.17
October	15.30	15.50	13.32	15.80	16.00	14.35	13.49	13.69	10.74
November	15.30	15.50	13.53	15.80	16.00	14.70	13.30	13.50	10.41
December	15.34	15.54	14.18	15.80	16.00	14.38	12.80	13.00	9.17
Average	14.94	15.14	13.19	15.81	16.01	14.52	14.46	14.66	12.05

[1] St. Louis: Metal Statistics, 1958, p. 513. New York: Metal Statistics, 1958, p. 507. London: E&MJ Metal and Mineral Markets.
[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.

FOREIGN TRADE [6]

Imports.—General imports of primary lead totaled 522,200 tons in 1957—an increase of 14 percent over imports in 1956 and the largest quantity of primary lead imported since 1953. Lead in pigs and bars was 62 percent of the total and lead in ore and concentrate 38 percent. Of the pigs and bars, Mexico supplied 32 percent, Australia 29 percent, Yugoslavia 12 percent, Peru 11 percent, Canada 9 percent, and all other countries 7 percent. Of the lead in ore and concentrate, 28 percent came from Peru, 22 percent from Union of South Africa, 19 percent from Australia, 13 percent from Canada, 9 percent from Bolivia, and the remaining 9 percent from all other countries.

Exports.—Lead exported in 1957 consisted of 4,300 tons of pigs and bars, 900 tons in ore, matte, and bullion, and 900 tons in scrap, a total of 6,100 tons.

TABLE 21.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1948–52 (average) and 1953–57, in short tons, in terms of lead content [1]

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
Ore, flue dust, and matte:						
North America:						
Canada-Newfoundland and Labrador	9,473	39,242	40,593	33,090	30,692	25,193
Guatemala	2,213	5,391	2,686	5,208	6,904	8,623
Honduras	383	1,090	1,636	2,757	2,969	2,955
Mexico	3,792	3,443	2,167	2,201	3,866	3,835
Other North America	360		(2)	3	8	113
Total	16,221	49,166	47,082	43,259	44,439	40,719
South America:						
Argentina	9				6	974
Bolivia	18,205	18,984	14,946	13,812	17,177	18,319
Chile	3,162	3,341	173	409	118	35
Colombia	25	255	356	546	1,440	(2)
Peru	16,938	32,842	38,734	44,223	55,174	55,450
Other South America	289	90	110	82	178	105
Total	38,628	55,512	54,319	59,072	74,093	74,883
Europe	109		696		24	264
Asia:						
Korea [3]	165				422	246
Philippines	896	2,980	2,160	2,635	2,222	783
Other Asia	172	92				
Total	1,233	3,072	2,160	2,635	2,644	1,029
Africa:						
Morocco	[4] 1,837	[4] 2,633				
Union of South Africa	17,043	29,777	35,507	41,575	44,208	43,916
Other Africa	32	63	19			25
Total	18,912	32,473	35,526	41,575	44,208	43,941
Oceania:						
Australia	8,835	20,676	21,478	30,938	31,044	36,995
Other Oceania	33					
Total	8,868	20,676	21,478	30,938	31,044	36,995
Total ore, flue dust, and matte	83,971	160,899	161,261	177,479	196,452	197,831

See footnotes at end of table.

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

TABLE 21.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1948–52 (average) and 1953–57, in short tons, in terms of lead content [1]—Continued

Country	1948–52 (average)	1953	1954	1955	1956	1957
Base bullion:						
North America:						
Canada					31	
Guatemala	100	736				
Mexico	1,296					
Total	1,396	736			31	
South America	192	133	41			84
Europe	(2)					
Asia	200					(2)
Africa	6					
Oceania: Australia	1,349					
Total base bullion	3,143	869	41		31	84
Pigs and bars:						
North America:						
Canada-Newfoundland and Labrador	75,914	49,000	59,887	34,453	16,220	28,607
Mexico	136,297	140,751	68,695	93,369	77,541	102,504
Other North America	18	209	20			(2)
Total	212,229	189,960	128,602	127,822	93,761	131,111
South America:						
Bolivia	127	220				1,100
Peru	32,774	52,216	20,047	24,509	33,540	34,999
Other South America	(2)	9				501
Total	32,901	52,445	20,047	24,509	33,540	36,600
Europe:						
Belgium-Luxembourg	2,281	2,017	339	231	1,206	1,852
Germany [5]	4,753	4,006	799	496	168	1,550
Italy	4,954					
Netherlands	1,055	1,981	156			111
Spain	1,520		5,580	10,649	6,700	3,119
United Kingdom	1,066	1,148	2,386	47	115	2,666
Yugoslavia	32,098	51,826	38,465	35,659	38,901	40,262
Other Europe	202	1,496	3,902	2,351	2,162	2,473
Total	47,929	62,474	51,627	49,433	49,252	52,033
Asia:						
Burma	752					
Japan	1,564		10			
Other Asia	299	138		55		
Total	2,615	138	10	55		
Africa:						
Morocco	[4] 1,790	[4] 9,258	[4] 17,555	[4] 7,800	[4] 5,428	9,018
Other Africa	101	448				
Total	1,891	9,706	17,555	7,800	5,428	9,018
Oceania: Australia	33,214	70,348	58,445	54,530	80,673	95,517
Total pigs and bars	330,779	385,071	276,286	264,149	262,654	324,279
Reclaimed, scrap, etc.:						
North America:						
Canada-Newfoundland and Labrador	4,527	371	3,023	7,598	5,898	2,596
Mexico	1,277	98	1,298	6,120	9,701	2,583
Other North America	1,202	847	832	1,378	1,549	652
Total	7,006	1,316	5,153	15,096	17,148	5,831
South America:						
Peru	91	59	173	166	299	
Venezuela	196			1,653	230	
Other South America	44					53
Total	331	59	173	1,819	529	53

See footnotes at end of table.

TABLE 21.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1948–52 (average) and 1953–57, in short tons, in terms of lead content [1]—Continued

Country	1948–52 (average)	1953	1954	1955	1956	1957
Reclaimed, scrap, etc.—Continued						
Europe:						
Belgium-Luxembourg	266	202		576	117	
Denmark	21	14		282	1,000	84
Germany [5]	191		56	3	348	168
Italy	530					
Netherlands	707	502		112	157	
Spain				431		
Yugoslavia	199	103	110			
Other Europe	417	442	103	136	179	32
Total	2,331	1,263	269	1,540	1,801	284
Asia:						
Japan	3,670	21	13		4	
Other Asia	1,259		47	26	1	
Total	4,929	21	60	26	5	
Africa	165	17				
Oceania:						
Australia	2,164	2,666		2,099	1,255	3,079
Other Oceania	87	97				
Total	2,251	2,763		2,099	1,255	3,079
Total reclaimed, scrap, etc	17,013	5,439	5,655	20,580	20,738	9,247
Grand total	434,906	552,278	443,243	462,208	479,875	531,441

[1] Data are "general imports," that is, include lead imported for immediate consumption plus material entering the country under bond.
[2] Less than 1 ton.
[3] Republic of Korea, effective Jan. 1, 1952.
[4] Morocco.
[5] West Germany, effective Jan. 1, 1952.

TABLE 22.—Lead imported for consumption in the United States, 1948–52 (average) and 1953–57, by classes [1]

[Bureau of the Census]

Year	Lead in ores, flue dust or fume, and mattes, n. s. p. f.		Lead in base bullion		Pigs and bars		Sheets, pipe, and shot		Not otherwise specified (value)	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1948–52 (average)	77,968	$20,985,486	3,231	$989,052	328,256	$98,822,519	166	$82,307	$108,024	$125,304,085
1953	67,030	15,214,084	742	294,068	379,119	95,285,223	178	58,291	242,925	111,919,588
1954	196,054	[2]47,967,269	41	10,149	274,286	[2]68,419,607	397	[2]128.812	[2]149,208	[2] 118,125,081
1955	156,433	[2]38,142,741			263,977	73,032,055	2,048	534,931	[2]163,610	[2] 115,804,005
1956	191,302	50,621,209	31	11,311	262,204	[2]77,718,626	7,654	2,017,086	[2]184,107	[2] 135,820,762
1957	228,783	60,459,319	25	7,557	327,236	86,937,198	5,917	1,377,249	[2]360,199	[2] 150,787,291

[1] In addition to quantities shown (value included in total value), "reclaimed, scrap, etc.," imported as follows—1948–52 (average): 16,975 tons, $4,316,697; 1953: 3,660 tons, $824,997; 1954: 7,217 tons, [2] $1,450,036; 1955: 18,944 tons, [2] $3,930,668; 1956: 20,464 tons, [2] $5,268,423; 1957: 7,610 tons, [2] $1,645,769.
[2] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable with years before 1954.

TABLE 23.—Miscellaneous products containing lead, imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Babbitt metal, solder, white metal, and other combinations containing lead			Type metal and antimonial lead		
	Gross weight (short tons)	Lead content (short tons)	Value	Gross weight (short tons)	Lead content (short tons)	Value
1948–52 (average)	1,592	1,008	$1,262,039	10,630	9,406	$3,793,254
1953	2,375	1,343	1,869,312	6,366	5,016	1,921,453
1954	2,309	1,572	[1] 1,945,992	4,138	3,367	1,250,938
1955	2,286	1,283	[1] 1,910,998	14,579	13,213	4,378,769
1956	4,106	2,526	[1] 3,381,310	9,544	8,500	2,762,814
1957	3,502	2,100	[1] 3,048,595	5,275	4,858	1,526,818

[1] Owing to changes in tabulating procedures by the Bureau of the Census data are not comparable with years before 1954.

Tariff.—The duties on pig lead and lead content of ore and concentrate remained at 1$\frac{1}{16}$ cents and $\frac{3}{4}$ cent per pound, respectively, throughout 1957.

In May Secretary Seaton, United States Department of the Interior, presented to Congress a program for legislation to give long-range support to the domestic mining industry. Recommendations included a graduated excise tax on entries of foreign lead and zinc. The sliding-scale adjustment was designed to discourage excessive imports but to permit unhampered entry of the quantity of lead and zinc needed to supplement the domestic supply. After much debate, Congress adjourned without decisive action on the measure.

In September the Emergency Lead and Zinc Committee, representing domestic mining groups, petitioned the Tariff Commission for regulation of imports, claiming that concessions made by the United States under the Trade Agreements Act had caused serious injury to the domestic industry. Formal hearings were held by the Tariff Commission in November, and a study of the facts was in progress at the end of the year.

TABLE 24.—Total lead exported from the United States in ore, matte, base bullion, pigs, bars, anodes and scrap, by destination, 1948–52 (average) and 1953–57, in short tons [1]

[Bureau of the Census]

Destination	1948–52 (average)	1953	1954	1955	1956	1957
Ore, matte, base bullion (lead content):						
North America:						
Canada	630	1,038	18	12	6	54
Mexico				1,322	1,049	851
Total	630	1,038	18	1,334	1,055	905
Europe: Belgium-Luxembourg	(2)					
Asia			84			1
Total ore, matte, base bullion	630	1,038	102	1,334	1,055	906
Pigs, bars, anodes:						
North America:						
Canada	101	32	18	13	38	266
Cuba	54	28	23	36	44	62
Mexico	6	8	34	16	2	18
Other North America	88	135	89	25	53	136
Total	249	203	164	90	137	482
South America	691	161	202	167	306	194
Europe:						
Belgium-Luxembourg	23				2,128	560
Other Europe	49	2	2	13		
Total	72	2	2	13	2,128	560
Asia:						
India	28			5	644	
Japan } Nansei and Nanpo }	5	12			1,176	2,305
Nansei and Nanpo				5	5	16
Philippines	91	405	192	96	180	451
Other Asia	289	13	34	27	46	330
Total	413	430	226	133	2,051	3,102
Africa	7	6	2		6	1
Oceania	(2)	1				
Total pigs, bars, anodes	1,432	803	596	403	4,628	4,339
Scrap:						
North America:						
Canada	(3)	27		1	11	
Mexico	(3)		370			
Total	(3)	27	370	1	11	
South America	(3)		(2)			
Europe:						
Belgium-Luxembourg	(3)		103	754	20	
Germany	(3)	[4] 39	[4] 29	[4] 495	[4] 563	[4] 264
Netherlands	(3)			148	788	304
United Kingdom	(3)	2,000	1,060	880	554	125
Other Europe	(3)		318	219	14	55
Total	(3)	2,039	1,510	2,496	1,939	748
Asia:						
Japan	(3)	640	2,014	486	186	137
Lebanon	(3)					
Total	(3)	640	2,014	486	186	137
Total scrap	(3)	2,706	3,894	2,983	2,136	885
Grand total		4,547	4,592	4,720	7,819	6,130

In addition, foreign lead was reexported as follows: Ore, matte, base bullion, 1948–52 (average): less than 1 ton; 1953–54: none; 1955, 3 tons; 1956: 6 tons; 1957: 4 tons. Pigs, bars, anodes, 1948–52 (average): 28 tons; 1953: 799 tons; 1954–55: none; 1956: 50 tons; 1957: 300 tons. Scrap: 1948–52 (average): less than 1 ton; 1953: none; 1954: 121 tons; 1955–57: none.

[2] Less than 1 ton.

[3] 1948 not separately classified—1949—Belgium-Luxembourg, 362 tons; Canada, 95 tons; Lebanon, 11 tons; United Kingdom, 279 tons; total scrap, 747 tons. 1950—Canada, 41 tons; United Kingdom, 1,271 tons; Germany, 264 tons; total scrap, 1,576 tons. 1951—Canada, 203 tons; Belgium-Luxembourg, 31 tons; Germany 145 tons; United Kingdom, 20 tons; Japan, 195 tons; total scrap, 594 tons. 1952—Canada, 20 tons; United Kingdom, 55 tons; total scrap, 75 tons.

[4] West Germany.

WORLD REVIEW

World mine production of lead in 1957 increased for the 11th successive year to 2.54 million tons compared with 2.44 million in 1956. Of the larger producers, Australia, South-West Africa, U. S. S. R., Morocco, Mexico, and Peru increased output, whereas Canada and the United States each dropped 4 percent. Each of these 8 countries produced more than 100,000 tons, and together they supplied 71 percent of total world production.

Smelter production also increased from 2.37 million to 2.49 million tons in 1957. In Canada, United States, and Belgium output was less by 4, 2, and 3 percent, respectively; but increases in Australia, Mexico, U. S. S. R., and West Germany ranged from 1 percent to a substantial 18 percent. Smelter production from the 7 countries was 71 percent of total output.

Total world consumption of lead is not available, but calculations based on available information, estimates, and stock changes indicate that consumer requirements were of the order of 175,000 to 275,000 tons less than supply. In the United States smelter production and imports of lead exceeded consumption and exports by 225,000 tons.

TABLE 25.—World mine production of lead, by countries, 1948–52 (average) and 1953–57 in short tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	163,959	193,706	218,495	202,762	188,854	181,690
Cuba	22			88	120	90
Greenland					5,000	8,000
Guatemala	3,385	7,789	2,607	5,084	8,967	12,535
Honduras	411	851	1,286	1,961	2,315	[2] 2,955
Mexico	247,723	244,216	238,788	232,383	220,029	236,860
Salvador [3]	400					
United States [4]	401,907	342,644	325,419	338,025	352,826	338,216
Total	817,807	789,206	786,595	780,303	778,111	780,346
South America:						
Argentina	21,821	17,600	32,000	26,500	31,700	34,200
Bolivia (exports) [4]	31,673	26,222	20,092	21,070	22,687	28,789
Brazil	3,241	3,300	3,200	4,400	5,500	[3] 5,000
Chile	5,811	[3] 3,500	[3] 3,500	3,300	3,190	4,000
Ecuador	225	126	121	929		
Peru	78,073	126,303	121,327	130,900	142,281	144,704
Total	140,844	[3] 177,100	[3] 180,200	[3] 187,100	205,358	[3] 216,700
Europe:						
Austria	4,844	5,677	5,432	5,286	5,281	5,969
Bulgaria [3]	10,400	11,000	([5])	([5])	([5])	([5])
Czechoslovakia [3]	1,100	1,650	3,300	5,500	6,600	6,600
Finland	171	239	291	853	1,554	2,623
France	11,785	13,681	12,300	9,900	9,300	11,684
Germany:						
East [3]	2,690	3,300	5,500	6,600	6,600	6,600
West	46,646	69,085	74,171	74,334	72,181	78,392
Greece [6]	3,986	6,300	5,900	9,500	11,400	[3] 10,000
Ireland	[7] 949	1,005	1,511	2,931	2,912	2,240
Italy	40,741	44,600	47,400	56,100	53,200	59,300
Norway	358	579	778	783	882	937
Poland [8]	20,000	23,500	24,000	24,100	24,100	[3] 24,100
Portugal	1,375	1,900	1,931	1,614	1,365	[3] 1,100
Rumania [3] [8]	8,500	11,000	11,600	12,200	13,200	13,200
Spain	39,430	59,750	61,002	68,994	66,765	70,500
Sweden	24,348	28,146	32,731	35,459	36,097	39,683
U. S. S. R.[3]	[8] 123,200	[8] 202,000	[8] 228,500	[8] 255,000	[8] 290,000	310,000

See footnotes at end of table.

TABLE 25.—World mine production of lead, by countries, 1948–52 (average) and 1953–57 in short tons [1]—Continued

Country	1948–52 (average)	1953	1954	1955	1956	1957
Europe—Continued						
United Kingdom	4,183	8,951	9,736	8,336	8,139	7,821
Yugoslavia	83,502	93,864	92,735	99,297	96,257	99,304
Total [3]	428,200	586,200	640,900	709,900	742,200	794,100
Asia:						
Burma	[3] 1,400	8,800	13,200	17,600	17,100	15,400
China [3]	1,260	6,600	11,000	13,200	16,500	16,500
Hong Kong	106	330	220	220	110	80
India	1,132	2,327	2,391	2,948	3,183	3,666
Iran [9]	[10] 13,154	8,800	[3] 13,300	[3] 19,900	[3] 18,700	[3] 18,700
Japan	12,577	20,562	25,176	28,852	32,545	39,533
Korea:						
North [3]	2,900	(5)	(5)	(5)	(5)	(5)
Republic of	117	164	91	753	1,600	1,016
Philippines	963	2,683	2,014	2,555	2,360	897
Thailand	[7] 715	4,000	5,500	6,000	4,400	3,300
Turkey	1,062	[3] 1,500	2,200	3,000	5,100	1,100
Total [3]	35,400	56,900	76,200	97,200	103,800	102,400
Africa:						
Algeria	2,482	8,804	11,564	11,645	11,281	11,497
Belgian Congo	128	72	184	91	[3] 110	[3] 220
Egypt	39	276	143	143	132	[3] 130
French Equatorial Africa	2,470	4,877	3,833	3,673	3,316	2,034
Morocco:						
Northern Zone	365	739	515	900	670	897
Southern Zone	58,979	88,556	90,813	98,000	95,458	101,288
Nigeria	76	39	10	18	49	51
Rhodesia and Nyasaland, Federation of: Northern Rhodesia [8]	15,058	12,890	16,800	17,975	17,024	16,800
South-West Africa [11]	43,596	[4] 65,287	[4] 77,146	100,707	109,367	[3] 110,000
Tanganyika (exports)	1,019	3,085	2,372	4,828	7,804	6,923
Tunisia	20,804	26,514	28,976	29,306	25,848	26,347
Uganda (exports)	25	18	61	90	128	17
Union of South Africa	528	551	181	564	911	1,885
Total	145,569	211,708	232,598	267,940	272,098	278,089
Oceania: Australia	247,882	274,303	319,046	331,458	335,423	372,367
World total (estimate)	1,820,000	2,100,000	2,240,000	2,370,000	2,440,000	2,540,000

[1] This table incorporates a number of revisions of data published in previous Lead chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] U. S. imports.
[3] Estimate.
[4] Tonnage recoverable from ore.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Includes lead content of zinc-lead concentrates.
[7] Average for 1949–52.
[8] Smelter production.
[9] Year ended March 21 of year following that stated.
[10] Average for 1950–52.
[11] Includes lead content of lead-vanadium concentrates.

TABLE 26.—World smelter production of lead, by countries where smelted, 1948–52 (average) and 1953–57, in short tons [1] [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	164,550	166,356	166,379	149,795	149,262	144,017
Guatemala	183	725	[3] 110		147	
Mexico	239,521	236,966	230,567	224,474	213,947	231,745
United States (refined) [4]	453,646	467,723	486,624	478,995	542,272	533,473
Total	857,900	871,770	883,680	853,264	905,628	909,235
South America:						
Argentina	22,251	14,330	26,800	19,800	26,800	28,600
Brazil	2,407	3,250	3,026	4,028	4,896	5,038
Chile			49	554		
Peru	42,963	65,041	63,648	66,533	65,892	75,901
Total	67,621	82,621	93,523	90,915	97,588	109,539
Europe:						
Austria [5]	11,382	13,113	13,294	12,673	12,293	13,156
Belgium [5]	79,313	84,162	79,258	91,242	112,715	109,423
Bulgaria		3,000	3,300	3,750	6,600	20,900
Czechoslovakia [3]	5,461	8,800	8,800	8,800	9,900	9,900
France	56,749	60,390	68,877	76,465	69,776	81,600
Germany:						
East [3] [5]	95,000 (East and West)	24,200	33,000	33,000	33,000	33,000
West		118,801	121,504	118,593	128,417	151,945
Greece	2,652	2,600	3,042	2,776	3,814	3,987
Italy	35,567	41,881	41,150	46,086	43,118	43,703
Netherlands [3]	3,100	1,100	4,000			
Poland	20,000	23,500	24,000	24,100	24,100	[3] 24,100
Portugal	643	973	1,109	2,167	938	[3] 770
Rumania [3]	8,500	11,000	11,600	12,200	13,200	13,200
Spain	41,922	56,492	64,617	68,132	64,829	67,447
Sweden	11,985	17,806	22,147	23,397	25,553	27,600
U. S. S. R. [3]	123,200	202,000	228,500	255,000	290,000	320,000
United Kingdom	3,628	7,446	7,708	6,798	7,212	[3] 7,100
Yugoslavia	64,036	78,039	73,556	83,348	83,509	86,536
Total [3]	563,100	755,300	809,500	868,500	929,000	1,014,400
Asia:						
Burma	3,406	9,641	12,722	15,568	21,889	21,816
China [3] [5]	4,000	10,000	16,500	19,300	22,000	22,000
India	841	1,897	2,005	2,838	2,797	3,556
Iran [6]	[7] 551	500	1,000	1,366	842	[3] 770
Japan	11,132	19,537	28,916	31,918	41,151	[3] 49,000
Korea:						
North [3]	3,000	2,200	(8)	(8)	(8)	(8)
Republic of	[3] 220	55	[3] 30			
Total [3]	23,200	43,800	66,700	79,800	97,500	106,000
Africa:						
Morocco: Southern Zone	16,402	30,240	29,418	29,421	30,991	34,441
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	15,058	12,890	16,800	17,975	17,024	16,800
Tunisia	24,120	30,071	29,972	30,123	27,357	29,669
Total	55,580	73,201	76,190	77,519	75,372	80,910
Oceania:						
Australia:						
Refined lead	177,068	193,164	224,459	209,591	218,500	215,446
Pb content of lead bullion	37,943	38,137	42,723	41,879	46,657	52,958
Total	215,011	231,301	267,182	251,470	265,157	268,404
World total (estimate)	1,780,000	2,060,000	2,200,000	2,220,000	2,370,000	2,490,000

[1] Data derived in part from Monthly Bulletin of the United Nations, Statistical Summary of the Mineral Industry (Colonial Geol. Surveys, London), and the Yearbook of the American Bureau of Metal Statistics.

[2] This table incorporates a number of revisions of data published in previous Lead chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.

[3] Estimate.

[4] Figures cover lead refined from domestic and foreign ores; refined lead produced from foreign base bullion not included.

[5] Includes scrap; but excludes refined lead produced from foreign base bullion.

[6] Year ended March 21 of year following that stated.

[7] 1 year only, as 1952 was first year of commercial production.

[8] Data not available; estimate by senior author of chapter included in total

NORTH AMERICA

Canada.—Output of recoverable lead from Canadian mines in 1957 was 182,000 tons, a 4-percent decrease from the 1956 quantity. Approximately 144,000 tons of lead was produced at Canada's only primary lead smelter, a unit of the smelting and refining works of the Consolidated Mining & Smelting Co. of Canada, Ltd., at Trail, British Columbia. Canadian exports in 1957 included 84,500 tons of refined lead and 44,600 tons of lead in concentrate. Approximately ⅓ of the refined lead and ½ of the lead in concentrate were shipped to the United States. Lead consumed by the Canadian industry in 1957 was estimated at 60,000 tons.

The Consolidated Mining & Smelting Co. of Canada, Ltd., as in previous years, was the largest Canadian producer of lead. During 1957 its Sullivan, H. B., Bluebell, and Tulsequah mines in British Columbia milled 3,274,000 tons of lead-zinc-silver ore (3,661,000 in 1956). Lead and zinc concentrates produced at the 4 concentrating mills were smelted with purchased ores at the company smelters at Trail to produce 144,000 tons of refined lead (149,300),[7] 189,300 tons of zinc (193,000), 95,400 ounces of gold (97,400), 10,877,500 ounces of silver (11,584,000), 900 tons of cadmium (900), 73 tons of bismuth (78), 800 tons of antimony (1,100), and 400 tons of tin (300). The decrease in ore treated and metal recovered resulted from closing the open-pit unit of the Sullivan mine in May and the Tulsequah mines at the end of August. Other British Columbia lead mines included Reeves-McDonald Mines, Ltd., at Remac; Sheep Creek Mines, Ltd., at Nelson; and Yale Lead & Zinc Mines, Ltd., Ainsworth. Giant Mascot Mines, Ltd., another lead-zinc-silver producer at Spillimacheen, British Columbia, was shut down in June.

In Newfoundland the Buchans Mining Co., Ltd. (subsidiary of American Smelting & Refining Co.), continued to operate its mine near Red Indian Lake and to produce lead, zinc, and copper concentrates. In 1957 the mill concentrated 371,000 tons of crude ore. Sinking the McLean shaft, begun in 1956 to develop a new deep ore body, was being continued.

In Yukon Territory the United Keno Hill Mines, Ltd., operated the Hector and Calumet mines in the Mayo district, at capacity throughout the year, but Galkeno Mines, Ltd., suspended production in favor of a development program.

In Quebec New Calumet Mines, Ltd., on Calumet Island, Golden Manitou Mines, Ltd., Abitibi East County, and Anacon Lead Mines, Ltd., Portneuf County, produced lead concentrate.

In Ontario, Jardun Mines, Ltd., produced both lead and zinc concentrates, but the Consolidated Sudbury Basin Mines, which was developing a mine plant to treat 1,500 tons of ore daily, postponed operations.

The newly developed mine of Heath Steele Mines, Ltd., near Newcastle, New Brunswick, began producing early in 1957 from a copper-lead-zinc ore body that averages over 2 percent lead.

Brunswick Mining & Smelting Corp., Ltd., which holds very large deposits of lead-zinc-copper-silver ore near Bathurst, continued mine

[7] Figures in parentheses give corresponding quantities for 1956.

development and intensive test work on ore dressing and concentrate reduction.

Greenland.—The Nordic Mining Co. shipped 8,750 tons of lead concentrate and 13,650 tons of zinc concentrate to Western Germany and Belgium from its mine at Mestersvig during its first year of operation. The company announced that enough ore was developed to permit 4 years production at the 1957 rate.

Guatemala.—Compañia Minera de Guatemala, S. A., produced lead and zinc concentrates from its Caquipec mine near Coban throughout 1957. Compañia Minera de Huehuetenango, S. A., produced lead concentrate for shipment to the Torreon lead smelter, Mexico, throughout 1957. Production from this mine (up to 26,250 tons of lead) is subsidized under terms of a contract made in 1952 with the United States Defense Minerals Procurement Administration (DMPA). Kellie Safi y Cía., Ltd. (Minera Occidental, Ltd.), received a 40-year concession to extract lead-zinc, antimony, and silver from its Anabella mine in Huehuetenango.

Mexico.—Production of lead from Mexican mines in 1957 increased 8 percent to 237,000 tons. American Metal Climax, Inc., through its Mexican subsidiary, Cía. Minera de Penoles, S. A., produced 325,000 tons of crude ore mainly from the Avalos mine unit. A 3½-mile haulage tunnel was begun to develop a large low-grade section from the Avalos mine. Concentrating plants of Penoles yielded 31,275 tons of lead concentrate and 43,320 tons of zinc concentrate during the year. Cía. Metalurgica Penoles, S. A., with a lead smelter at Torreon and a refinery at Monterrey, produced 40 percent of the total lead refined in Mexico.[8]

Except for closing the Aurora-Xichu mine unit, owing to depletion of ore, American Smelting & Refining Co. operated its Mexican mines on a normal basis throughout 1957.[9] Mines leased or owned and managed by American Smelting & Refining Co. were Cía. Metalurgica Mexicana mines, Montezuma Lead Co. mines at Santa Barbara, Plomosas unit at Picachos in Chihuahua, Rosario Property, Nuestra Senora group at Cosala, Sinaloa, and Santa Eulalia and Parral group in Chihuahua. The company operated its lead smelters at San Luis Potosi and Chihuahua throughout 1957. Its lead refinery at Monterrey was closed for 47 days by a labor strike during July and August.

San Francisco Mines of Mexico, Ltd., at San Francisco del Oro, Chihuahua, milled 878,000 short tons of lead-zinc-copper-silver ore during the year ending September 30. Concentrates produced contained 38,300 tons of lead, 59,600 tons of zinc, 4,500 tons of copper, and important quantities of gold and silver.

Fresnillo Co. continued to operate its lead-zinc mines at Fresnillo in Zacatecas and its Naica and Gibraltar mines in Chihuahua. For the year ended June 30, 1957, the company mined and milled 1,036,000 tons of ore to produce 36,900 tons of lead and 39,000 tons of zinc in concentrates as well as values in copper, gold, and silver.

Among other significant lead producers in Mexico during 1957 were El Potosi Mining Co. (subsidiary of Howe Sound Co.), which operated

[8] American Metal Climax, Inc., Annual Report, 1957, 52 pp.
[9] American Smelting & Refining Co., Annual Report, 1957, 32 pp.

its El Potosi and El Carmen mines in Chihuahua to produce both lead and zinc concentrates, and Minas de Iquala, S. A. (subsidiary of Eagle-Picher Co.), at Parral, Chihuahua.

SOUTH AMERICA

Argentina.—Total lead output from Argentine mines in 1957 was 34,000 short tons, a substantial gain over the 32,000 tons produced in 1956. Estimated consumption was 26,500 tons, giving Argentina some surplus over internal needs. The Aguilar mine of Compañía Minera Aguilar, S. A. (subsidiary of St. Joseph Lead Co.), produced 26,300 tons each of lead and zinc in concentrate, which was 77 percent of Argentine mine output of lead in 1957. A National Lead Co. affiliate, Cia Minera Castano Viejo, S. A., produced 5,500 tons of concentrate, containing about 4,300 tons of lead, from its Castano Viejo mine. National Lead operated its smelter at Puerto Villelas and shipped pig lead to metal-fabricating plants in Buenos Aires.

Bolivia.—Production from the nationalized mines—Animas, Pulacayo, San Jose, Tatasi, Pampa Grande, and Matilde—totaled about 9,200 short tons of lead in concentrate, compared with 11,700 tons in the previous year. The lead content of concentrates from principal privately owned mines was 18,700 short tons compared with 13,500 tons in 1956.

Brazil.—Lead was produced by a number of small mines in the States of Sao Paulo and Parana. Estimated consumption of lead in 1957 was 26,700 tons. Production from Brazilian mines was estimated at about 5,000 tons.

Peru.—Mine output of lead in 1957 was 145,000 tons—about 2,500 tons less than in 1956. Cerro de Pasco Corp. continued to be the largest producer. Its copper-lead-zinc mines at Casapalca, Cerro de Pasco, Morococha, San Cristobal, and Yauricocha produced 2,115,840 tons of crude ore. Cerro's lead production from these mines and from purchased ores was 75,890 tons.[10] The company smelter at La Oroya operated without interruption throughout the year. A large quantity of lead-bearing material, accumulated during the smelter strike toward the end of 1956, was treated at Oroya in 1957 and contributed to the refined lead production of the company.

Other significant lead producers in Peru during 1957 were American Smelting & Refining Co. Chilete mine at Chilete, Hochschild & Cia. Esquilache mine, and the Huaron, Volcan, Atacocha Rio Pallanga, and Milpo mines.

According to mid-year reports,[11] Venturosa, Huaron, Yauli, Atacocha, and Milpo had curtailed production, and the Carahuacra unit of Volcan Mines was shut down.

Cía. Minerales Santander, Inc., was engaged in stripping the ore body and constructing a hydroelectric powerplant and a 500-ton-per-day mill on Chancay River, Peru.[12] The plant was to be completed in 1958 but may be left in standby condition, pending an improved market.

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[10] Cerro de Pasco Corp., Annual Report, 1957, pp. 9–10.
[11] American Metal Market, vol. 64, No. 144, July 27, 1957, p. 7; Metal Bulletin (London), No. 4215, July 30, 1957, p. 17.
[12] St. Joseph Lead Co., Annual Report, 1957, 23 pp.

On July 10, 1957, Peru suspended the base export tax of 4 percent on the net export price, the suspension was to remain in effect as long as export prices remained below 12.0 cents a pound on zinc and 15.0 cents on lead. Since payment of the export tax was credited against the corporation profits tax, the suspension gives relief from the tax when the profit is less than the export tax.

EUROPE

Austria.—Lead-zinc mines in the Province of Carinthia, operated by Bleiberg-Bergwerks Union, produced 202,000 short tons of crude and dump ore, which yielded 8,200 tons of lead concentrate (6,000 tons recoverable lead) and 12,600 tons of zinc concentrate (6,300 tons recoverable zinc). The company lead smelter near Arnoldstein produced slightly more than 13,000 short tons of pig lead.

Bulgaria.—According to Comtel-Reuter reports in Vienna, exploration in Bulgaria revealed 37 zinc-lead lodes having a total of 15 million tons of reserve ore in Harmanti, Swilengard, and Ivailovograd areas. Ore production of 330,000 tons annually with a yield of 50,000 tons of concentrates was expected from this source.

France.—Lead and zinc production from the Malines mines of Sociétè Miniere et Metalurgique de Penarroya was doubled, and development of deposits at St. Sebastien d'Agrefeuille was begun. Though several other lead-zinc mines within France contributed to the domestic need, French smelters receive most of their feed from North African concentrate. Morocco shipped 103,000 short tons of lead in concentrate to French smelters in 1957, French Equatorial Africa shipped 6,600 tons, and Algeria shipped 5,500 tons. In addition, Morocco and Tunisia exported 46,000 tons of pig lead to France in 1957.

France taxed most imports (including lead and zinc) 20 percent and granted a 20-percent bonus to French exporters of approved commodities in an effort to create a more favorable trade balance.

Germany, West.—Lead smelters in West Germany produced 195,500 short tons, 86,000 tons of which was from native ores. Estimated consumption was about 200,000 tons in 1957. Bindsfeldhammer lead smelter of Stolberger Zinc, A. G., has been expanded by about 40 percent to a yearly capacity of 50,000 tons. Imported concentrates supplemented domestic ores to furnish feed to the plant.

Ireland.—The output of many small mines totaled 2,240 tons in 1957, a decrease of 23 percent from the preceding year. St. Kevin's lead-zinc mine at Glessdalough, County Wicklow, closed in August. Cyprus Mines Corp. and Cerro de Pasco Corp. were considering the purchase of mining and exploration rights from Silvermines Lead & Zinc Co., Ltd., the largest lead and zinc producer in Ireland.[13]

Sweden.—Boliden Co. continued lead output from its mines at Sal and Larsvall. Concentrates were smelted at Ronnskar. In September Boliden announced it would develop its lead mine at Vassbo, Idre,[14] in the Province of Dalecarlia. Anticipated yield was 12,000 tons of 74 percent lead concentrate a year by 1960. Sweden's apparent lead consumption was 31,000 tons.

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[13] Mining World, vol. 174, No. 4510, January 1958, p. 37.
[14] Metal Bulletin (London), No. 4230, Sept. 24, 1957, p 26.

U. S. S. R.—Official data on lead production in the U. S. S. R. in 1957 were not available, but mine production was estimated at 310,000 short tons and smelter production at 320,000 tons. Pravda announced the workers of the Ust-Kamenogorsk Lead-Zinc Combine exceeded their 1957 quota by 10 percent and that lead and zinc production in Kyzl-Ordinskaya oblast will be 50 percent greater in 1960 than in 1955. The first slag-treating plant in Russia began producing late in 1957 and recovered 3,500 tons of lead from processing slag dumps of Leninogorsk Polymetallic Combine.

United Kingdom.—Concentrate from ores mined in the United Kingdom in 1957 contained 7,800 tons of lead. Output of English refined lead (including lead refined from scrap material and from domestic ores) was 180,000 tons.[15] Imported lead and lead alloys totaled 158,000 tons, 63 percent of which was from Australia. Consumption of lead from all sources was 349,000 tons. In January the British Board of Trade announced that it would release 30,000 tons of lead from its stocks; delivery was spread over a 9-month period beginning in March. In October the Board announced that the remaining 20,000 tons in the stockpile would be sold in a similar manner.

Yugoslavia.—Mines in Yugoslavia produced 1.75 million tons of lead-zinc ore, which yielded 99,000 tons of lead. Newly discovered deposits in Sasa-Toranica Basin were reported adequate to warrant a flotation mill. The major lead-producing regions in Yugoslavia are in adjoining parts of Serbia and Macedonia and in Slovenia. The Trepca mines in Serbia continued to be the largest producer. A new lead-zinc mine opened in 1957 in addition to that at Zletovo near Prokestip. Other discoveries of lead-bearing ore were made along the Yugoslav-Bulgar border in Krieva, Palanka-Delievo areas. Lead concentrates produced in Yugoslavia were smelted at Zvecan near the Trepca mines in Serbia and at Mezica in Slovenia. In 1957 the United States received 40 percent of Yugoslavian lead production.

ASIA

Burma.—The Burma Corp., Ltd., continued to operate the Bawdwin lead-zinc-silver mine in the Shan States of northern Burma. Ore mined during the year ended June 30, 1957, totaled 131,200 tons.[16] The company mill, smelter, and refinery are at Namtu, 13 miles from the mine. The ore reserve was reported to be 2,324,000 long tons containing 20.6 percent lead, 12.7 percent zinc, 0.93 percent copper, and 15.8 ounces silver per ton. The reserve declined by an amount equal to the year's production.

India.—The only lead-producing mines worked in India in 1957 were the Zawar mines of Rajasthan. Output in 1957 was estimated to be 100,000 tons of lead-zinc ore. A smelter at Tundoo in Bihar treated the lead concentrate. Zinc concentrate from the same ore was sent to Japan for smelting.

Japan.—In 1957 refined-lead output from the 8 smelters and refineries of Japan was about 50,000 tons. The principal producer of

[15] American Bureau of Metal Statistics Yearbook, 37th Annual Issue, 1957: June 1958, 136 pp.
[16] Burma Corp., Ltd., Annual Report, June 30, 1957, 4 pp.

both lead and zinc concentrates continued to be the Kamioaka mine of the Mitsui Metal Mining Co., Ltd.

AFRICA

Algeria.—Mine production was essentially the same as that of the previous year; total output was 11,500 tons lead.

French Equatorial Africa.—The M'Fouati mine in Niari-Basin area produced 5,700 tons of concentrate containing 53.3 percent lead. Exports of concentrate totaled 6,000 tons.

Morocco (Southern zone).—Lead concentrate production totaled 140,000 short tons in 1957, a gain of 6 percent over 1956. Approximately 78 percent of the concentrate was exported, mostly to France. The remainder was smelted at the Zellidja-Penarroya lead smelter at Oued-El-Heimer. Most of the lead and zinc output came from the mines at Touissit and Bou Beker, eastern Morocco, on the Algerian border. The large producing companies included the Société des Mines de Zellidja and Companie Royale Asturienne des Mines.

Rhodesian and Nyasaland, Federation of.—The Rhodesia Broken Hill Development Co., Ltd., at New Broken Hill, continued to operate its mine, mill, lead smelter, and refinery and electrolytic zinc plant.[17] The company mill treated 136,600 short tons of lead-zinc ore, analyzing 19.7 percent lead and 29.1 percent zinc. Metal production from the smelters was 16,800 short tons of lead, 33,000 tons of zinc and 63 tons of cadmium, about the same quantities as in 1956.

South-West Africa.—The Tsumeb Corp., Ltd., controlled by Newmont Mining Corp. and American Metal Climax, Inc., operated at capacity in 1957. During the fiscal year ended June 30, 1957, the mill processed 638,000 tons of crude ore averaging approximately 25 percent combined copper, lead, and zinc. Sales of refined metal or concentrate included 87,436 short tons of lead, 27,792 tons of copper, 13,172 tons of zinc, 202 tons of cadmium and 1,702,000 ounces of silver. The assured reserve of Tsumeb high-grade ore was estimated at 9.5 million tons.[18] Exploratory drilling in 1957 disclosed 2 ore bodies of about 1 million tons, averaging 11 percent combined copper and lead.

Tanganyika.—Uruwira Minerals, Ltd., only producer of lead concentrate in Tanganyika, continued to operate its Mpanda lead-copper mine and 1,250-ton-per-day mill. About 13,400 short tons of concentrate containing about 45 percent lead and 10 percent copper was exported to Belgium for smelting.

Tunisia.—Mine output increased 2 percent to 26,300 tons of lead in 1957. Total pig-lead production was 24,100 tons, most of which was produced by Société Miniere et Metallurgique de Penarroya at Megrine.

Union of South Africa.—The Argent mine near Johannesburg in the Transvaal was operated throughout 1957 by Argent Lead & Zinc Co. The lead concentrate was shipped to Germany for smelting.

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17 The Rhodesia Broken Hill Development Co., Ltd., 48th Annual Report, Dec. 31, 1957, 20 pp.
18 American Metal Climax, Inc., Annual Report, 1957, 52 pp.

OCEANIA

Australia.—In 1957 Australia was the leading lead-producing country in the world. Mine output totaled 372,000 tons, an 11-percent gain over the preceding year. The world-production record followed 8 yearly increases in which Australian lead output gained 58 percent. The United States and U. S. S. R., the only close production rivals, trailed Australian output by 34,000 and 62,000 tons, respectively.

The Broken Hill in New South Wales continued by far to be the leading Australian lead-producing district. Mining companies operating in 1957 were New Broken Hill Consolidated, Ltd., Zinc Corp., Ltd., Broken Hill South, Ltd., and North Broken Hill, Ltd. Broken Hill district production was estimated at 2,450,000 tons of crude ore, which yielded 288,000 tons of lead and 282,500 tons of zinc, in addition to several million ounces of silver.

During the fiscal year ended June 30, Mount Isa Mines, Ltd., mined 1,573,400 tons of lead-zinc-copper ore from the Cloncurry district in Queensland. The ore yielded 50,600 tons of lead bullion, 32,340 tons of blister copper, and 39,650 tons of zinc concentrate.[19] The company planned to install a new 4,500-hp. hoist made by the British General Electric Co., designed to increase monthly capacity from 100,000 to 180,000 rock tons a month. Exploration and development increased the ore reserve by more than 50 percent.

The Lake George Mining Corp., Ltd., produced 17,700 tons of lead concentrate and 35,800 tons of zinc concentrate from ores mined in the Captain's Flat district in New South Wales.[20] The company expressed disappointment at failure to extend ore reserves.

Electrolytic Zinc Co. of Australasia, Ltd., continued to operate its mines in the Read-Roseberry district of Tasmania. The larger producing properties were the Roseberry and Hercules mines. Mines on Tasmania's west coast produced 214,000 short tons of ore, which yielded 10,400 tons of lead concentrate, 63,000 tons of zinc concentrate, and 6,700 tons of copper concentrate during the fiscal year ended June 30, 1957.

WORLD RESERVES

The lead reserves compiled here include only lead in ores that have been inventoried and were economic at the time of inventory. The reserves listed include lead in measured and indicated ores but make no allowance for metal in inferred and undiscovered ores. Definitions of the classes of reserves agreed to by the Federal Bureau of Mines and Federal Geological Survey and used in these estimates follow:

Measured ore is ore for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drill holes and for which the grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are so closely spaced and the geologic character is so well defined that the size, shape, and mineral content are well established. The computed tonnage and grade are judged to be accurate within limits which are stated, and no such limit is judged to differ from the computed tonnage or grade by more than 20 percent.

Indicated ore is ore for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for

[19] American Smelting & Refining Co., Annual Report, 1957, 32 pp.
[20] Lake George Mining Corp., Ltd., Annual Report, 1957, 18 pp.

a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to outline the ore completely or to establish its grade throughout.

Inferred ore is ore for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition for which there is geologic evidence; this evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence. Estimates of inferred ore should include a statement of the special limits within which the inferred ore may lie.

TABLE 27.—Estimate of world reserves of lead in measured and indicated ore January 1957, in short tons

	Lead content, tons	Percent of total		Lead content, tons	Percent of total
North America:			Africa:		
Canada [1]	8,033,800	16.5	Algeria, Belgian Congo, Morocco, Northern Rhodesia, South-West Africa, and Tunisia	3,500,000	7.2
Mexico [2]	3,525,000	7.2	Asia:		
United States [3]	2,910,000	6.0	Burma, China, India, Iran, and Japan	2,000,000	4.1
Other North America	150,000	0.3	Australia	12,500,000	25.6
South America:					
Argentina, Bolivia, Peru, and Chile	2,500,000	5.1			
Europe:					
Eastern Europe	4,600,000	9.4			
Western Europe	9,100,000	18.6	Total	48,818,800	100.0

[1] Source: Canada Department of Mines and Technical Surveys, Mines Branch; Memorandum Ser., No. 137.
[2] Estimate by Bureau of Mines in 1957.
[3] Survey by Bureau of Mines in 1957.

TECHNOLOGY

Lead research and new developments reported in the press during the year showed the variety of effort being employed to increase the usefulness of lead. Reports were issued on the use of lead in a new-type dry cell, in ceramic colorants, in lead-corrosion inhibitors, on its effect, on the machinability of steel, in bearing metals, in compounds, in electronics, and in isotopes [21] to obtain information about the geological history of lead ores.

A lead dry-cell cylindrical battery [22] about 1¼ inches in diameter and ⅝ inch thick was developed by the Naval Ordnance Laboratory. The new battery, capable of delivering 0.9 volt, was claimed to have an indefinite shelf life in the uncharged state, and its capacity is said not to be affected by repeated charging over long periods.

Pittsburgh Corning Corp.[23] applied leaded ceramic colors to one face of glass building blocks, giving them a semigloss or satin appearance in blue, green, yellow, or coral colors. The finish is reported to be as scratch- and abrasive-resistant as the glass block, with no significant fading on long exposure to sunlight.

[21] Russell, R. D., and Farquhar, R. M., Isotopic Constitutions and Origins of Lead Ores: Trans. AIME, Min. Eng., vol. 9, No. 5, May 1957, pp. 556–559.
[22] Wall Street Journal, New Lead Uses Reported in Dry Cell Batteries, Glass Building Blocks: Vol. 150, No. 74, Oct. 14, 1957, p. 16.
[23] Work cited in footnote 22.

An article[24] of interest to those concerned with copper-lead-bearing corrosion discussed inhibition of such corrosion in diesel-engine service. A class of inhibitors suitable for use with copper-lead bearings was developed as additives for oils. Zinc organic dithiocarbamate (the organic portion of the compound is a paraffinic) with zinc organic dithiophosphate was formed to reduce the rate of formation of corrosive acids in oil, which attack the lead in the copper-lead bearings.

A new process[25] was developed for manufacturing tetraethyl lead; it converts nearly all the lead in lead acetate to tetraethyl lead, rather than only 25 percent, in the ethyl chloride-sodium-lead-alloy process. It has been found that nearly complete ethylation of lead can be accomplished by carrying out the ethylating process in the presence of cadmium acetate, ethyl iodide, and excess triethyl-aluminum.

Lead in cast steel[26] has been shown to improve the machinability of high-strength cast steel, 0.12 to 0.20 percent lead was reported to have increased the speed of machining cast steel by about 40 percent, with longer tool life and improved surface finish. Best results were achieved only when the lead was uniformly dispersed in the castings.

The Aluminum Co. of America[27] developed an aluminum-bearing alloy containing lead, cadmium, and tin, which is said to withstand loads up to 1,500 pounds per square inch for use in refrigeration equipment, marine motors, and household equipment.

A tinning compound[28] in powder form was developed for tinning all metals before babbitting. The American Solder & Flux Co., developer of the compound, says it forms a strong and permanent chemical bond with cast iron, steel, and all metals used in bearings.

Some binary lead-compound semiconductors[29] have shown unusual capabilities in new uses. Lead telluride (white), lead selenide, and lead sulfide (black) crystals were discovered to be infrared radiation detectors, and lead sulfide now is the essential component in a system developed for the Army's Nike-Cajun rocket to measure the water-vapor content of the earth's gaseous envelope. The lead sulfide function depends on its ability to control electrical energy under the influence of the sun's radiations. Lead sulfide photoconductive cells in combination with infrared light form part of another process for recording an optical-magnetic sound track on motion-picture film. The Army used the technique and CBS-News was switching to the process in 16-mm. news and documentary films.

[24] Thomas, J. R., Harle, O. L., Richardson, W. L., and Bowman, L. O., Copper-Lead Bearing Corrosion Inhibition in Diesel Service: Ind. Eng. Chem., vol. 49, No. 10, October 1957, pp. 1703–1708.
[25] Chemical and Engineering News, Toward Cheaper TEL: Vol. 36, No. 17, Apr. 28, 1958, p. 66.
[26] Phillips, W. J., and Barron, D. B., Lead in Cast Steel: How Much Does Machinability Improve?: Iron Age, vol. 180, No. 7, Aug. 15, 1957, pp. 102–103.
[27] The Northern Miner, New Aluminum-Bearing Alloy: Vol. 43, No. 51, Mar. 13, 1958, p. 11.
[28] American Metal Market, Tinning Compound Prior to Babbitting: Vol. 64, No. 212, Nov. 1, 1957, p. 6.
[29] Lead Industries Association, Lead, Lead Compound Semiconductors: Vol. 22, No. 1, 1958, p. 5.

The Federal Bureau of Mines [30] and the Federal Geological Survey [31] published several reports relating to lead.

In 1957 the United States Patent Office [32] issued a patent for processing lead sulfide on sintering equipment, one for using of goulac and selected fractions of chestnut extract in electrodeposition of lead, one for an alloy of lead with 3 percent titanium and 3 percent copper for bonding metals to ceramics, and one for a zinc-lead alloy for fluxless soldering or welding of aluminum or zinc.

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[30] Salsbury, M. H., Leadville Drainage Tunnel Second Project, Lake County, Colo.: Bureau of Mines Rept. of Investigations 5284, December 1956, 50 pp.

Shell, H. R., Hatch, R. A., and Brown, D. L., Synthetic Asbestos Investigations, III. Synthesis and Properties of Fibrous Potassium-Lead Silicate: Bureau of Mines Rept. of Investigations 5293, January 1957, 20 pp.

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Lane, M. E., Mining Methods and Costs at the Hayden Creek Mine of St. Joseph Lead Co., St. Francois County, Mo.: Bureau of Mines Inf. Circ. 7781, April 1957, 33 pp.

Olds, E. B., and Persons, E. W., Methods and Costs of Deepening the Crescent Shaft, Bunker Hill & Sullivan Mining & Concentrating Co., Shoshone County, Idaho: Bureau of Mines Inf. Circ. 7783, March 1956, 19 pp.

Engel, A. L., and Heinen, H. J., Lead Precipitation-Flotation Tests of a California Copper-Gold Ore: Bureau of Mines Rept. of Investigations 5342, June 1957, 9 pp.

[31] Dings, McClelland, and Robinson, Charles, Geology and Ore Deposits of the Garfield Quadrangle, Colo.: Geol. Survey Prof. Paper 289, 1957, 110 pp.

Bodenlos, A. J., and Straczer, J. A., Base-Metal Deposits of the Cordillera Negra, Dept. de Ancash, Peru: Geol. Survey Bull. 1040, 1957, 165 pp.

Brown, C. E., Whitlow, J. W., and Crosby, P., Geology and Zinc-Lead Deposits in the Catfish Creek Area, Dubuque County, Iowa: Geol. Survey Field Study MF-116, 1957, map.

[32] Wendeborn, Helmut, Schwartz, Werner, Maeizer, Carl-August, and Rausch, Hans (assigned to Metallgesellschaft Aktiengesellschaft, Frankfurt-am-Main, Germany), Process for Producing Lead From Lead Sulfide Containing Materials: U. S. Patent 2,797,158, June 25, 1957. A process for the production of metallic lead from materials containing lead sulfide with a content of at least 50 percent lead. Fly ash or recycled sinter material is mixed with the lead sulfide and sintered under oxidizing-roasting conditions without addition of fuel. Oxygen obtained from lead in the sintered part of the mix compounds with sulfur to form volatile sulfur products and free lead.

Smyers, Frank C., Lantz, Grover B., Mathers, Frank C. (assigned to United States Smelting, Refining & Mining Co., Boston, Mass.), Electrolytic Refining of Lead: U. S. Patent 2,827,410, Mar. 18, 1957. A process for depositing lead in an aqueous electrolyte containing lead-fluosilicate, using 0.1 to 5.0 pounds of goulac and 3.0 to 0.1 pounds of material selected from the group consisting of water-soluble portions of chestnut extract and electrolyte-soluble portions of chestnut extract per ton of lead deposited.

Bender, Harry (assigned to Sylvania Electric Products, Inc., Mass.), Lead Alloy for Bonding Metals to Ceramics: U. S. Patent 2,805,944, Sept. 10, 1957. Metals can be bonded to ceramics with an alloy consisting essentially of lead containing 3 percent Ti and 3 percent Cu.

Freedman, Samuel (assigned to Sightmaster of California Co., Inc., Santee, Calif. (name changed to Chemicalloy-Electronics Corp.)), Process of Producing Lead-Zinc Alloys: U. S. Patent 2,796,345, June 18, 1957. A process is described for producing a more homogeneous alloy of lead and zinc suitable for fluxless soldering or welding of aluminum or zinc.

Lead and Zinc Pigments and Zinc Salts

By Arnold M. Lansche [1] and Esther B. Miller [2]

PRODUCTION of lead and zinc pigments and zinc salts in 1957 was adequate for all demands, and the raw materials—lead and zinc, their ores and scrap—were in surplus supply. Shipments of pigments declined despite increased activity in those industries that were the major consumers, but shipments of the two zinc salts increased.

TABLE 1.—Salient statistics of the lead [1] and zinc pigments industry of the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Shipment of principal pigments:						
White lead (dry and in oil)----short tons--	36,136	26,217	25,571	25,575	25,698	23,574
Red lead----do----	31,401	31,333	27,163	29,272	27,975	26,998
Litharge----do----	149,807	154,518	139,877	148,511	131,525	110,779
Black oxide [2]----do----	71,306	81,831	79,233	113,874	106,956	127,583
Zinc oxide----do----	142,369	148,627	140,285	168,541	154,955	151,267
Leaded zinc oxide--do----	50,074	39,712	33,972	32,661	27,164	24,203
Lithopone----do----	97,737	52,439	44,011	42,845	38,434	(3)
Value of products:						
All lead pigments----	$78,168,000	$64,303,000	$61,756,000	$69,133,000	$67,106,000	$55,430,000
All zinc pigments----	63,714,000	56,475,000	50,438,000	58,031,000	55,245,000	[4] 47,036,000
Total----	141,882,000	120,778,000	112,194,000	127,164,000	122,351,000	[4] 102,466,000
Value per ton received by producers:						
White lead (dry)----	373	378	383	392	413	416
Red lead----	364	312	323	342	364	354
Litharge----	346	285	303	326	346	321
Zinc oxide----	266	264	255	258	271	271
Leaded zinc oxide----	272	259	258	259	282	249
Lithopone----	125	132	135	140	147	(3)
Foreign trade:						
Lead pigments:						
Value of exports----	998,800	799,000	872,000	976,000	[5] 1,106,000	1,404,000
Value of imports [6]----	673,600	16,000	149,000	195,000	1,465,000	1,896,000
Zinc pigments:						
Value of exports----	4,397,200	1,468,000	1,351,000	1,073,000	1,087,000	1,163,000
Value of imports----	470,800	287,000	515,000	773,000	947,000	1,157,000
Export balance----	4,251,600	1,964,000	1,559,000	1,081,000	[5] −219,000	−486,000

1 Excludes basic lead sulfate; figure withheld to avoid disclosing individual company confidential data.
2 Production by battery manufacturers.
3 Figure withheld to avoid disclosing individual company confidential data.
4 Excludes lithopone value; figure withheld to avoid disclosing individual company confidential data.
5 Revised figure.
6 Includes "other lead pigments."

1 Commodity specialist.
2 Statistical assistant.

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DOMESTIC PRODUCTION

The value of reported shipments of lead and zinc pigments in 1957 excluding basic lead sulfate and zinc sulfide was $102 million. Of the total value, lead pigments comprised 54 percent and zinc pigments, 46 percent.

Lead and zinc pigments and zinc salts manufacturers, their plants and products, were listed in Minerals Yearbook, volume 1, 1953, and subsequent changes have been noted annually in the Yearbooks.

LEAD PIGMENTS

Total shipments of lead pigments in 1957 declined about 13 percent to 161,000 tons worth $55.4 million.

The quantity of dry white lead shipped was down 15 percent from that of 1956, but the "in oil" variety increased 5 percent. The total 1957 white lead shipments declined 8 percent below those in 1956 and were 15 percent of the total lead pigments shipped compared with 14 percent in 1956.

Shipments of red lead and litharge declined 34 and 16 percent, respectively.

In addition to these pigments (production and shipments are shown in table 2), 128,000 tons of black or gray suboxide of lead was manufactured by battery makers for their own use in 1957. The suboxide, sometimes called a leady litharge, is used in place of litharge. Suboxide production required 124,000 tons of pig lead in 1957.

White lead, red lead, litharge, and the suboxide were made directly or indirectly from refined lead and constituted 98 percent of all lead used in pigments. The lead content of leaded zinc oxide made up the remaining 2 percent. Basic lead sulfate is not reported herein, except as it enters leaded zinc oxide; lead silicate is included with white lead.

TABLE 2.—Production and shipments of lead pigments [1] in the United States, 1956–57

Pigment	1956				1957			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value [2]			Short tons	Value [2]	
			Total	Average			Total	Average
White lead:								
Dry	17,248	17,448	$7,206,668	$413	15,280	14,898	$6,193,571	$416
In oil [3]	7,203	8,250	4,133,509	501	7,494	8,676	4,072,929	469
Red lead	28,612	27,975	[4] 10,195,102	364	27,094	26,998	9,566,096	354
Litharge	132,659	131,525	45,571,080	346	110,303	110,779	35,597,815	321
Black oxide	106,956				127,583			

[1] Except for basic lead sulfate and orange mineral; figures withheld to avoid disclosing individual company confidential data.
[2] At plant, exclusive of container.
[3] Weight of white lead only, but value of paste.
[4] Corrected figure.

TABLE 3.—Lead pigments [1] shipped by manufacturers in the United States, 1948–52 (average) and 1953–57, in short tons

Year	White lead			Red lead	Litharge	Black oxide [2]
	Dry	In oil	Total			
1948–52 (average)	21,983	14,153	36,136	31,401	149,807	71,306
1953	16,784	9,433	26,217	31,333	154,518	81,831
1954	17,235	8,336	25,571	27,163	139,877	79,233
1955	17,858	7,717	25,575	29,272	148,511	113,874
1956	17,448	8,250	25,698	27,975	131,525	106,956
1957	14,898	8,676	23,574	26,998	110,779	127,583

[1] Excludes basic lead sulfate and orange mineral; figures withheld to avoid disclosing individual company confidential data.
[2] Production by battery manufacturers.

TABLE 4.—Lead content of lead and zinc pigments [1] produced by domestic manufacturers, by sources, 1956–57, in short tons

Pigment	1956				1957			
	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			19,560	19,560			18,219	18,219
Red lead			25,937	25,937			24,561	24,561
Litharge			123,373	123,373			102,582	102,582
Black oxide			102,494	102,494			124,109	124,109
Leaded zinc oxide	4,332	2,063		6,395	3,231	1,253		4,484
Total	4,332	2,063	271,364	277,759	3,231	1,253	269,471	273,955

[1] Excludes lead in basic lead sulfate and orange mineral; figures withheld to avoid disclosing individual company confidential data.

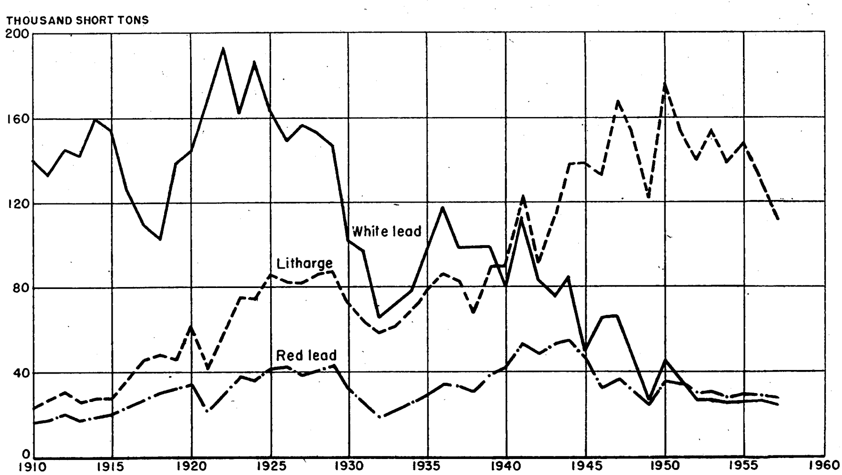

FIGURE 1.—Trends in shipments of lead pigments, 1910–57.

ZINC PIGMENTS AND SALTS

Combined shipments of the reported zinc pigments totaled about 175,000 pounds in 1957. Shipments of zinc oxide and leaded zinc oxide declined 2 and 11 percent, respectively. Shipments of zinc chloride and zinc sulfate increased 10 and 4 percent, respectively.

A mixed trend was displayed in the average values of the zinc pigments and salts as reported by producers in 1957 compared with the general advance in values in 1956 over those of 1955. Compared with 1956 values, zinc oxide remained unchanged at $271 per ton, leaded zinc oxide declined $33 to $249, zinc chloride (50° B.) was up $3 to $127, and zinc sulfate increased $7 to $160.

Zinc ore, refined metal, and secondary materials—scrap metal, residues, drosses, skimmings, and zinc ashes—serve as source materials for manufacturing zinc pigments and salts.

Lead-free zinc oxide was made by several processes; 24 percent was produced from metal by the French process, 67 percent from ores and residues by the American process, and 9 percent by "Other" processes from scrap residues and scrap materials. Zinc sulfate was made from ores and scrap; leaded zinc oxide was made from ores only. Zinc oxide production derived from metal and scrap was 34 percent in 1957 compared with 31 percent in 1956.

Zinc Oxide.—About 151,000 tons of lead-free zinc oxide was shipped—2 percent less than in 1956.

Leaded Zinc Oxide.—Four grades of leaded zinc oxide classified according to lead content were produced in the United States. The 5- to 35-percent grade constituted the bulk of production; smaller quantities were produced as less than 5-percent grade, over 35- to 50-percent grade, and over 50-percent grade. Total shipments of leaded zinc oxide were 24,000 tons, down 11 percent from 1956. Output in 1957 (comparison with 1956 in parentheses) for the 35-percent

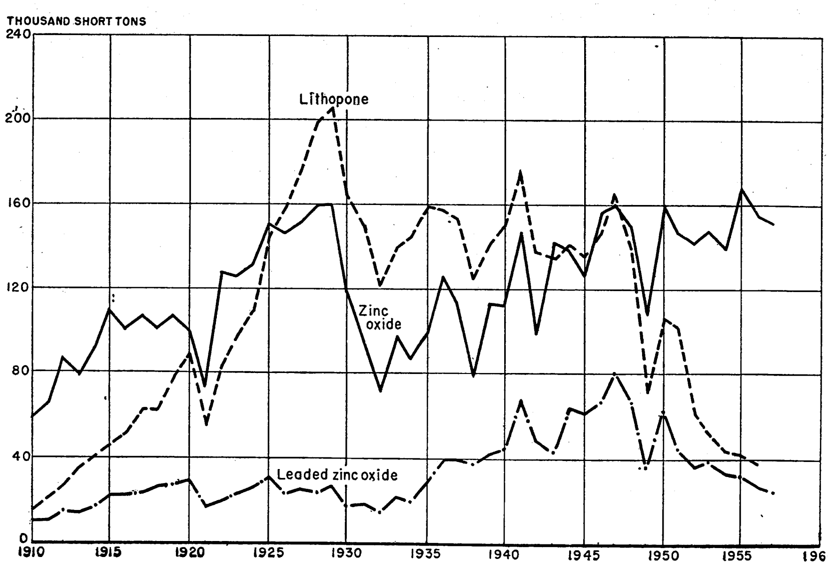

Figure 2.—Trends in shipments of zinc pigments, 1910–57.

lead and under was 24,800 (24,100) tons, and 1,600 (2,100) tons of over 35-percent lead.

Lithopone.—Both ordinary lithopone and the high-strength product were made in 1957.

TABLE 5.—Production and shipments of zinc pigments and salts in the United States, 1956–57

Pigment or salt	1956				1957			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value [1]			Short tons	Value [1]	
			Total	Average			Total	Average
Zinc oxide [2]	158,982	154,955	$41,966,858	$271	152,730	151,267	$41,007,424	$271
Leaded zinc oxide [2]	26,219	27,164	7,647,169	282	26,420	24,203	6,028,233	249
Lithopone	36,639	38,434	5,630,991	147	(3)	(3)	(3)	(3)
Zinc chloride, 50° B.	54,503	53,201	6,590,815	124	61,186	58,569	7,455,739	127
Zinc sulfate	32,861	32,200	4,917,073	153	33,752	33,620	5,368,063	160

[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.
[3] Figure withheld to avoid disclosing individual company confidential data.

TABLE 6.—Zinc pigments and salts [1] shipped by manufacturers in the United States, 1948–52 (average) and 1953–57, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° B.)	Zinc sulfate
1948–52 (average)	142,369	50,074	97,737	60,234	21,720
1953	148,627	39,712	52,439	57,537	22,220
1954	140,285	33,972	44,011	48,252	19,027
1955	168,541	32,661	42,845	54,161	23,864
1956	154,955	27,164	38,434	53,201	32,200
1957	151,267	24,203	(2)	58,569	33,620

[1] Excludes zinc sulfide, figures withheld to avoid disclosing individual company confidential data.
[2] Figure withheld to avoid disclosing individual company confidential data.

TABLE 7.—Zinc content of zinc pigments [1] and salts produced by domestic manufacturers, by sources, 1956–57, in short tons

Pigment or salt	1956					1957				
	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	57,320	29,831	18,894	21,083	127,128	61,399	19,300	19,423	22,129	122,251
Leaded zinc oxide	9,535	5,362			14,897	9,599	6,334			15,933
Lithopone	(3)	(3)		(3)	[4]18,839	(3)	(3)		(3)	(3)
Total pigments			18,894		160,864			19,423		138,184
Zinc chloride				12,133	12,133			(3)	13,873	13,873
Zinc sulfate	(3)	(3)		(3)	(5)	(3)	(3)		(3)	11,948

[1] Excludes zinc sulfide; figures withheld to avoid disclosing individual company confidential data.
[2] These figures are higher than those shown in the report on Secondary Metals—Nonferrous because they include zinc recovered from byproduct sludges, residues, etc., not classified as purchased scrap material.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Includes zinc sulfate production.
[5] Included with lithopone.

CONSUMPTION AND USES

Shipments of all lead and zinc pigments to consumers declined despite greater activity in the industries that use large quantities of pigments. This divergence of pigment shipments from the upward trend in activity of the consuming industries was attributed to reduction in consumer stocks and to increasing use of substitutes. Among the major pigment-consuming industries there were increases in the production of automobiles, trucks, and paint; the consumption of natural and synthetic rubber; and in the value of public and private construction.

The paint industry, the principal consumer received 82, 59, and 99 percent of white lead, red lead, and leaded zinc oxide, respectively; it ranked second in quantity (22 percent) of zinc oxide used and received only 6 percent of litharge (chrome pigments and in varnish) shipments. Of the total quantity of lead and zinc pigments shipped, the paint industry received 99,000 tons in 1957 compared with 101,000 tons in 1956, a decline of 2 percent (for comparability lithopone shipments are not included in the 1956 figure, which totaled 129,000 tons with it).

Titanium pigments continued to furnish the chief competition to lead and zinc pigments in paintmaking. Production and shipments of titanium pigments, based on the titanium dioxide content, decreased about 7 and 10 percent, respectively, from the high in 1956. The use of titanium pigments in paint has about doubled over the past 12 years.

Shipments of replacement automotive batteries increased 4 percent to 25.9 million units.

The rubber industry was in first place for shipments of lead-free zinc oxide, taking 54 percent of the total. The rubber industry also took about 1,900 tons of litharge and a small quantity of leaded zinc oxide. The quantity of natural and synthetic rubber consumed for all purposes increased 2 percent.

The ceramics industry received 3 percent of the white lead, 16 percent of the litharge, and 6 percent of the lead-free zinc oxide shipped. A small quantity of red lead went to the ceramics industry.

LEAD PIGMENTS

White Lead.—Paintmaking required 82 percent of the white lead shipments in 1957 compared with 79 percent of the total in 1956. Shipments to ceramics makers furnished 3 percent of total distribution

TABLE 8.—Distribution of white lead (dry and in oil) shipments,[1] by industries, 1948–52 (average) and 1953–57, in short tons

Industry	1948–52 (average)	1953	1954	1955	1956	1957
Paints	30,808	21,030	20,929	19,825	20,288	19,253
Ceramics	1,341	785	487	484	633	667
Other	3,987	[2] 4,402	[2] 4,155	[2] 5,266	[3] 4,777	[3] 3,654
Total	36,136	26,217	25,571	25,575	25,698	23,574

[1] Excludes basic lead sulfate; figures withheld to avoid disclosing individual company confidential data.
[2] Includes the following tonnages for plasticizers and stabilizers: 1952—986; 1953—1,089; 1954—1,133; 1955—1,355.
[3] Figures for plasticizers and stabilizers withheld to avoid disclosing individual company confidential data.

in 1957. Other uses for the pigment were as plasticizers, stabilizers, base for dry colors, and unspecified purposes. A substantial part of the unspecified category belongs properly under paint.

Basic Lead Sulfate.—Substantial quantities of lead sulfate were used as an intermediate product in manufacturing leaded zinc oxide.

Red Lead.—The paint industry received 59 percent of the red lead shipped in 1957 compared with 51 percent in the previous year. The "Other" classification, consisting of storage batteries, ceramics, rubber, and unspecified uses, composed the remainder.

TABLE 9.—Distribution of red-lead shipments, by industries, 1948–52 (average) and 1953–57, in short tons

Industry	1948–52 (average)	1953	1954	1955	1956	1957
Paints	12,498	14,570	12,568	14,308	14,331	15,993
Storage batteries	15,003	13,975	12,062	11,998	9,953	(1)
Ceramics	816	1,188	1,207	667	1,483	(1)
Other	3,084	1,600	1,326	2,299	2,208	11,005
Total	31,401	31,333	27,163	29,272	27,975	26,998

[1] Included with "Other."

Orange Mineral.—This pigment was reported used in manufacturing ink.

Litharge.—Battery makers continued to claim most of the litharge shipped to industry. The ceramics industry received 16 percent, chrome pigment manufacturers 4 percent; oil refining, varnish, and rubber obtained 3, 3, and 2 percent, respectively. The "Other" classification, composed of storage batteries, insecticides, floor coverings, driers, friction materials, lead chemicals, and unspecified uses, received 72 percent. Total shipments for all purposes declined 16 percent.

Battery makers produced 128,000 tons of leaded litharge, commonly termed black or gray suboxide, for making the paste used in filling the interstices of battery plates.

TABLE 10.—Distribution of litharge shipments, by industries, 1948–52 (average) and 1953–57, in short tons

Industry	1948–52 (average)	1953	1954	1955	1956	1957
Storage batteries	95,017	103,849	94,656	90,200	82,041	(1)
Ceramics	19,954	20,924	17,118	24,173	19,802	18,071
Varnish	4,843	3,915	4,162	5,206	3,571	3,227
Chrome pigments	9,105	8,821	4,335	6,025	3,558	3,955
Oil refining	5,921	4,342	3,775	3,853	3,523	3,266
Insecticides	6,090	2,305	2,501	3,521	(1)	(1)
Rubber	2,406	2,230	1,768	1,947	2,266	1,898
Floor coverings	599	603	596	803	(1)	(1)
Other	5,872	7,529	10,966	12,783	16,764	80,362
Total	149,807	154,518	139,877	148,511	131,525	110,779

[1] Included with "Other."

ZINC PIGMENTS AND SALTS

Zinc Oxide.—The zinc oxide requirements of the rubber industry, the leading user of this pigment, increased about 2 percent over 1956 to 82,000 tons. The rubber industry took 54 percent of the total zinc oxide shipped. The quantity of zinc oxide shipped to the paint industry rose less than 1 percent in 1957.

Shipments to the ceramic, coated-fabric, and floor-covering industries declined 17, 57, and 13 percent, respectively, in 1957. Shipments to the petroleum, agriculture, chemical, and printing industries and to dealers, who resell and export, increased 7 percent above 1956; this category received 16 percent of the zinc oxide shipped. The total zinc oxide distributed was 2 percent less than in 1956.

TABLE 11.—Distribution of zinc oxide shipments, by industries, 1948–52 (average) and 1953–57, in short tons

Industry	1948–52 (average)	1953	1954	1955	1956	1957
Rubber	73, 723	78, 439	71, 058	86, 677	80, 459	81, 745
Paints	31, 408	31, 920	31, 157	33, 932	32, 485	32, 605
Ceramics	10, 015	8, 862	8, 990	10, 617	10, 160	8, 459
Coated fabrics and textiles [1]	6, 901	8, 718	6, 322	11, 263	8, 447	3, 623
Floor coverings	3, 360	2, 234	1, 749	2, 281	1, 436	1, 249
Other	16, 962	18, 454	21, 009	23, 771	21, 968	23, 586
Total	142, 369	148, 627	140, 285	168, 541	154, 955	151, 267

[1] Includes the following tonnages for rayon: 1953—7,388; 1954—5,603; 1955—4,584; 1956—7,721; 1957—2,838

Leaded Zinc Oxide.—Paint manufacturing used 99 percent of the leaded zinc oxide. Rubber and miscellaneous minor uses required the remainder.

TABLE 12.—Distribution of leaded zinc oxide shipments, by industries, 1948–52 (average) and 1953–57, in short tons

Industry	1948–52 (average)	1953	1954	1955	1956	1957
Paints	49, 027	39, 276	33, 690	32, 178	26, 825	23, 904
Rubber	135	41	7			
Other	912	395	275	483	339	299
Total	50, 074	39, 712	33, 972	32, 661	27, 164	24, 203

TABLE 13.—Distribution of lithopone shipments, by industries, 1948–52 (average) and 1953–57, in short tons

Industry	1948–52 (average)	1953	1954	1955	1956	1957
Paint, varnish, and lacquers [1]	72, 129	37, 452	32, 177	30, 522	28, 238	(3)
Coated fabrics and textiles	6, 699	5, 806	3, 995	4, 242	(2)	
Floor coverings	6, 346	2, 575	2, 351	2, 378	1, 600	
Rubber	3, 269	1, 723	1, 701	2, 163	(2)	
Paper	4, 112	2, 096	1, 841	1, 970	(2)	
Printing ink	5, 182	716	195	1, 570	8, 596	
Other		2, 071	1, 751			
Total	97, 737	52, 439	44, 011	42, 845	38, 434	

[1] Includes a small quantity, not separable, used for printing ink, except in 1950, 1951, and 1952.
[2] Included with "Other."
[3] Figure withheld to avoid disclosing individual company confidential data.

Lithopone.—Lithopone was used in the paint, varnish, and lacquer industry and in coated fabrics, rubber, floor covering, paper, and printing inks.

Zinc Chloride.—Statistics on end-use distribution of zinc chloride are not available. The principal uses of the salt were for soldering and tinning fluxes, battery making, galvanizing, vulcanizing fiber, preserving wood, refining oil, and fungicides.

Zinc Sulfate.—Rayon and agriculture were the chief consumers of the zinc sulfate, receiving 60 and 28 percent of the shipments (dry basis), respectively. The remainder was consumed in electrogalvanizing, dyeing and printing, paint manufacturing, and other miscellaneous uses.

TABLE 14.—Distribution of zinc sulfate shipments, by industries, 1948–52 (average) and 1953–57, in short tons

Industry	1948–52 (average)	1953		1954		1955		1956		1957	
	Gross weight	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis
Rayon	9,993	9,008	7,612	6,615	5,740	10,732	9,537	21,083	18,825	19,903	17,785
Agriculture	5,236	6,773	5,894	7,067	6,139	8,187	7,089	7,051	6,291	9,818	8,261
Chemicals	1,871	2,539	2,105	2,300	1,973	(1)	(1)	-------	-------	-------	-------
Glue	476	601	501	648	545	(1)	(1)	(1)	(1)	(1)	(1)
Electrogalvanizing	278	337	225	454	301	258	177	(1)	(1)	(1)	(1)
Flotation reagents	1,087	736	648	357	317	226	202	(1)	(1)	(1)	(1)
Paint and varnish processing	235	106	70	130	114	(1)	(1)	(1)	(1)	(1)	(1)
Textile dyeing and printing	405	155	138	4	4	-------	-------	(1)	(1)	(1)	(1)
Other	2,139	1,965	1,219	1,452	1,024	4,461	3,343	4,066	3,190	3,899	3,465
Total	21,720	22,220	18,412	19,027	16,157	23,864	20,348	32,200	28,306	33,620	29,511

[1] Included with "Other."

PRICES

Total and average values received by producers for lead and zinc pigments and zinc salts are shown in tables 1, 2, and 5. The average value of dry white lead increased $3 per ton in 1957; red lead, litharge, and the in-oil variety of white lead declined $10, $25, and $32 per ton, respectively. The average quoted price for common lead at New York declined from 16 cents per pound to 13 cents. The average weighted sales price of lead was 14.3 cents a pound, compared with 15.7 cents in 1956 and 14.9 cents in 1955.

The average value of zinc oxide did not change from the $271 per ton of 1956. Leaded zinc oxide per ton was $249 compared with $282 in 1956. The average price per ton of zinc chloride, 50° B., and zinc sulfate increased $3 and $7, respectively, in 1957. The average quoted price of Prime Western zinc declined from 13.5 cents per pound to 10 cents. The average weighted sale price for all grades of zinc was 11.6 cents a pound compared with 13.7 cents in 1956.

TABLE 15.—Range of quotations on lead pigments, and zinc pigments and salts at New York (or delivered in the East), 1953–57, in cents per pound

[Oil, Paint and Drug Reporter]

Product	1953	1954	1955	1956	1957
White lead (basic lead carbonate), dry, carlots, bags	16.25–17.25	16.00–17.50	17.50–18.00	18.00–19.00	17.50–19.50
Basic lead sulfate (sublimed lead), less than carlots, bags	15.00–15.75	15.75–16.75	16.75–17.25	17.25–18.50	18.25
Red lead, dry, 95 percent or less, less than carlots, barrels	15.75–18.50	15.50–18.00	18.00–18.50	18.50–20.00	16.25–20.00
Orange mineral, American, less than carlots, barrels	18.10–20.85	17.85–20.60	20.35–21.10	21.10–22.35	18.60–22.35
Litharge, commercial, powdered, less than carlots, barrels	14.75–17.50	14.50–17.00	17.00–17.50	17.50–19.00	15.75–19.00
Zinc oxide:					
American process, lead-free, bags, carlots	13.50–14.25	13.50	13.50–14.00	14.00–14.50	14.50
American process, 5 to 35 percent lead, bags, carlots	14.00–14.40	14.00–14.25	14.25–14.63	14.63–15.50	15.50
French process, red seal, bags, carlots	14.75–15.50	14.75	14.75–15.25	15.25	15.25
French process, green seal, bags, carlots	15.25–16.00	15.25	15.25–15.75	15.75	15.75
French process, white seal, bags, carlots	15.75–16.50	15.75	15.75–16.25	16.25	16.25
Lithopone, ordinary, less than carlots, bags	8.25– 8.50	8.25– 8.50	8.25– 8.50	8.50– 8.75	8.75– 9.13
Zinc sulfide, less than carlots, bags, barrels	25.30–26.30	25.30	25.30	25.30	25.30
Zinc chloride, works:					
Solution, tanks	4.10– 4.85	4.85	4.85	4.85– 5.15	5.15
Fused, drums	9.85–10.85	10.10–10.85	10.10	10.10–10.70	10.70
Zinc sulfate, crystals,[1] less than carlots, barrels	8.10–10.30	7.90– 8.60	8.60–10.60	8.60– 9.75	9.75

[1] Includes granulated.

FOREIGN TRADE [3]

Imports of lead and zinc pigments and salts in 1957 increased in value and quantity 21 and 33 percent, respectively, over 1956. The value of imports was $3.2 million compared with $2.7 million in 1956. The value of major classes of exports was $2.8 million, an increase of less than 1 percent over 1956.

Imports of litharge rose to 8,000 tons, about 51 percent over 1956. In 1957 litharge supplied 95 percent of the lead pigments and salts received. Lead products imported in 1957 increased 46 percent above 1956.

About 5,000 tons of zinc oxide was imported in 1957, a 43-percent increase over 1956. Total imports of all the zinc pigments and salts reported was about 7,000 tons, a 20-percent increase over 1956. Other components of the total were about 60 tons of lithopone, 340 tons of zinc sulfide, 600 tons of zinc chloride, and 700 tons of zinc sulfate. The total value of these imports increased almost 17 percent.

Litharge exports advanced to 2,500 tons, rising 25 percent over 1956. Total exports of the lead pigments and salts were nearly 4,600 tons, an increase of 6 percent.

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

Exports of zinc oxide increased nearly 400 tons (14 percent) to about 3,000 tons. Those of lithopone declined 400 tons (about 29 percent) to almost 1,000 tons. The quantity of zinc pigments exported was the same as in 1956, but the value rose 7 percent.

TABLE 16.—Value of foreign trade of the United States in lead and zinc pigments and salts, 1955–57

[Bureau of the Census]

	Imports for consumption			Exports		
	1955	1956	1957	1955	1956	1957
Lead pigments:						
White lead		$5,980	$25,508	$284,735	$199,528	$273,363
Red lead	$923	30,706	60,040	133,580	147,617	242,166
Litharge	174,895	[1] 1,388,733	1,794,078	558,029	[2] 758,978	888,586
Other lead pigments	18,708	39,241	16,961	(3)	(3)	(3)
Total	194,526	[1] 1,464,660	1,896,587	(3)	(3)	(3)
Zinc pigments:						
Zinc oxide	685,186	770,156	1,043,629	771,621	846,883	985,325
Zinc sulfide	83,732	156,675	104,930	(3)	(3)	(3)
Lithopone	4,355	[1] 19,931	8,124	300,960	239,892	177,891
Total	773,273	[1] 946,762	1,156,683	1,072,581	1,086,775	1,163,216
Lead and zinc salts:						
Lead arsenate				215,206	575,745	231,495
Other lead compounds	72,089	65,610	15,003	21,181	22,874	18,332
Zinc arsenate	1,760	2,570		(3)	(3)	(3)
Zinc chloride	72,369	112,702	104,498	(3)	(3)	(3)
Zinc sulfate	56,301	84,058	74,710	(3)	(3)	(3)
Total	202,519	264,940	194,211	(3)	(3)	(3)
Grand total	1,170,318	[1] 2,676,362	3,247,481	(3)	(3)	(3)

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable to earlier years.
[2] Revised figure.
[3] Data not available.

TABLE 17.—Lead pigments and salts imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons							Total value
	White lead (basic carbonate)	Red lead	Litharge	Lead suboxide	Lead pigments n. s. p. f.	Lead arsenate	Other lead compounds	
1948–52 (average)	855	111	730	44	13	18	43	$697,792
1953	(1)	(1)	60	1	4		18	22,507
1954		2	596	28			86	[2] 169,477
1955		3	751	34	6		352	266,615
1956	20	113	5,371	78			269	[2] 1,530,270
1957	92	258	8,118	33	1		63	1,911,590

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

TABLE 18.—Zinc pigments and salts imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons							Total value
	Zinc oxide		Litho-pone	Zinc sulfide	Zinc chloride	Zinc arsenate	Zinc sulfate	
	Dry	In oil						
1948–52 (average)	1,461	2	404	7	243	(1)	145	$543,461
1953	1,157	29	30	23	179	(1)	46	316,604
1954	2,348		65	106	260		399	[2] 581,832
1955	3,320		30	265	500	(1)	634	903,703
1956	3,667		143	510	632	17	824	[2] 1,146,092
1957	5,245		57	342	601		722	1,335,891

[1] Less than 1 ton.
[2] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparabl with earlier years.

TABLE 19.—Lead pigments and salts exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons					Total value
	White lead	Red lead	Litharge	Lead arsenate	Other lead compounds	
1948–52 (average)	724	713	1,177	482	(1)	[2] $1,227,488
1953	818	417	1,238	152	12	892,904
1954	951	335	1,284	355	31	1,056,754
1955	957	325	1,459	540	33	1,212,731
1956	654	352	[3] 2,000	1,282	28	[3] 1,704,742
1957	812	622	2,502	608	17	1,653,942

[1] Classification established 1949; quantity and value not included in averages.
[2] In addition, lead acetate and sugar of lead exported as follows: 1949—108,533 pounds, $39,565; 1950—64,135 pounds, $19,973; 1951—140,427 pounds, $46,191.
[3] Revised figure.

TABLE 20.—Zinc pigments exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons		Total value	Year	Short tons		Total value
	Zinc oxide	Litho-pone			Zinc oxide	Litho-pone	
1948–52 (average)	6,657	15,058	$4,397,271	1955	2,649	1,892	$1,072,581
1953	2,971	3,927	1,468,100	1956	2,748	1,387	1,086,775
1954	3,111	3,013	1,351,526	1957	3,144	991	1,163,216

TECHNOLOGY

In 1957 the E. & E. Maier Solutier Bleimennigefabrik K. G. of Nuremberg, West Germany, was reported to have designed for sale a red-lead plant with a capacity of 1,200 pounds per hour. The plant used an electrothermal process and produced highly dispersed flaky red lead directly from metallic lead. Electric energy provided the high temperature required for evaporating the lead, which combined with oxygen to form red lead. Precipitation under controlled condensation produced the desired flaky form.

Japanese scientists tested various types of paints in an effort to find which types protect metal against corrosion induced by radiation and can be easily stripped for decontamination.[4] When irradiated, a dry film of oil paint pigmented with zinc oxide became more tacky, was higher on scratch hardness, was brittle on the drawing test, and displayed considerable flaking. The pigment in the paint appeared to give the metal good protection. A dry film of oil paint incorporating white lead subjected to the same intensity of gamma radiation increased in the scratch hardness test and did not change in the drawing or bending test; vinyl chloride paint and chlorinated rubber paint, both pigmented with white lead, decreased in the scratch hardness test; there was some tendency toward increased brittleness in the chlorinated rubber paint, and neither displayed any change in the bending test.

[4] Terai, Ichiro, Damage to Various Films by Gamma Irradiation: Paint, Oil and Chem. Rev. vol. 121, No. 2, Jan. 23, 1958, pp. 6, 7, 9.

Lime

By C. Meade Patterson[1] and James M. Foley[2]

LIME ranks among the largest tonnage chemicals in the United States. It was the leading low-priced alkali in the chemical industry and entered into at least 7,000 uses. Total lime output was lower in 1957 than in 1956, owing to declining business conditions, but the growth of some uses, such as road stabilization, provided an optimistic note to the industry.

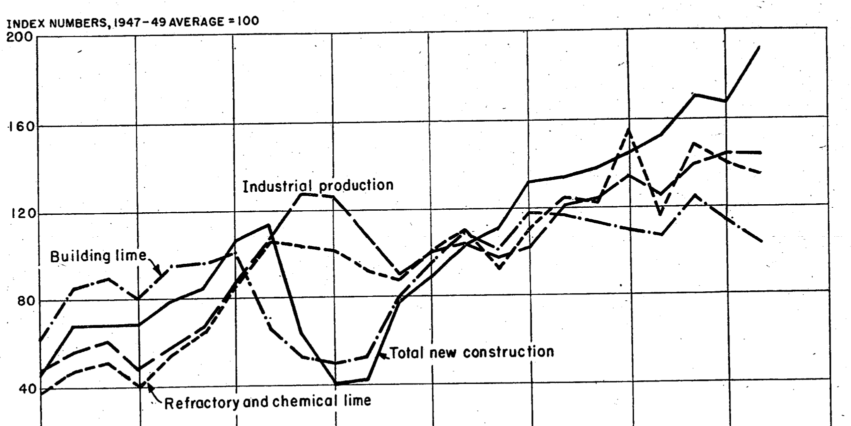

FIGURE 1.—Production of building lime compared with physical volume of total new construction, and output of refractory and chemical lime compared with industrial production, 1935–57. Units are reduced to percentages of the 1947–49 average. Statistics of new construction from U. S. Department of Commerce and on industrial production from Federal Reserve Board.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

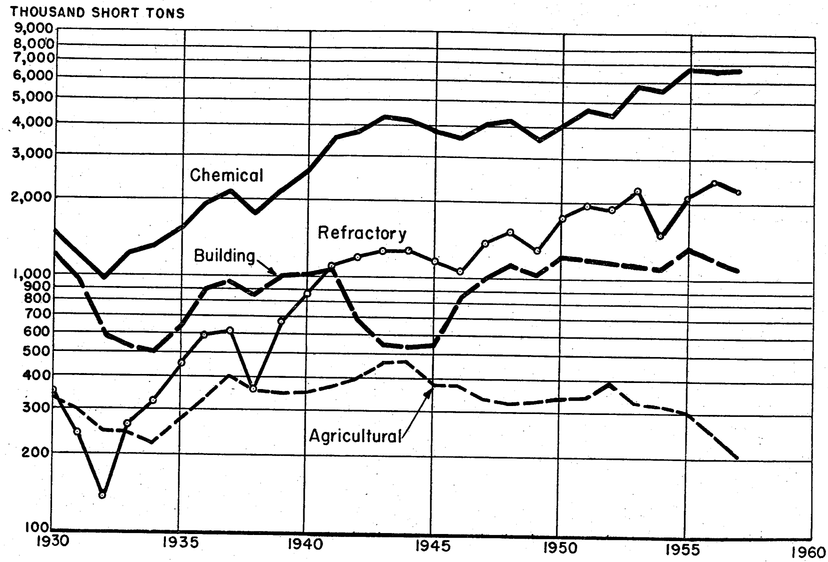

FIGURE 2.—Trends in major uses of lime, 1930–57.

TABLE 1.—Salient statistics of lime sold or used in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Active plants	169	156	154	150	153	146
Sold or used by producers:						
By types:						
Quicklime ... short tons	3, 933, 515	5, 337, 268	5, 128, 370	6, 113, 215	5, 967, 140	5, 942, 360
Hydrated lime ... do	1, 840, 864	2, 042, 100	1, 979, 895	2, 237, 753	2, 186, 247	2, 080, 718
Dead-burned dolomite ... do	1, 703, 478	2, 294, 815	1, 520, 854	2, 128, 960	2, 423, 909	2, 251, 428
Total lime:						
Short tons	7, 477, 857	9, 674, 183	8, 629, 119	10, 479, 928	10, 577, 296	10, 274, 506
Value [1]	$83, 979, 215	$112,158,060	$101,723,102	$127,144,035	$135,727,133	$135,322,835
Per ton	$11. 20	$11. 59	$11. 79	$12. 13	$12. 83	$13. 17
Total open-market lime short tons	7, 038, 909	8, 114, 396	7, 180, 159	8, 929, 803	9, 004, 139	8, 516, 132
Total captive tonnage lime short tons	[2] 438, 948	1, 559, 787	1, 448, 960	1, 550, 125	1, 573, 157	1, 758, 374
By uses:						
Agricultural ... short tons	344, 103	329, 455	323, 557	305, 417	252, 035	208, 600
Building ... do	1, 173, 401	1, 166, 240	1, 130, 032	1, 309, 774	1, 203, 005	1, 101, 310
Chemical and industrial ... do	4, 256, 875	5, 883, 673	5, 654, 676	6, 735, 777	6, 698, 347	6, 713, 168
Refractory (dead-burned dolomite) ... short tons	1, 703, 478	2, 294, 815	1, 520, 854	2, 128, 960	2, 423, 909	2, 251, 428
Imports for consumption ... do	32, 455	37, 202	36, 298	39, 616	41, 691	49, 666
Exports ... do	60, 351	79, 934	73, 246	82, 461	82, 737	65, 195

[1] Selling value, f. o. b. plant, excluding cost of containers.
[2] Incomplete figures; before 1953 the coverage of captive plants was incomplete.

DOMESTIC PRODUCTION

Lime production in 1957 declined 3 percent from the alltime high of 1956 to 10.3 million short tons. The loss was entirely in open-market sales. Captive output rose 12 percent. Seventeen percent of the total lime production was captive in 1957 compared with 15 percent in 1955 and in 1956. All major use categories showed slight to moderate declines compared with 1956.

At the end of 1957 some lime plants were operating at only 65-percent capacity; others, virtually at full capacity, and nationwide, at 80-percent capacity. In areas where the steel industry was the principal consumer, lime production was expected to continue at about 75 percent of capacity into 1958.[3]

Lime production was widespread. It was produced by 33 States and 2 Territories in 1957. Ohio, Missouri, and Pennsylvania, in descending order, remained the 3 leading lime-producing States, furnishing 53 percent of the national output. The States ranking next in lime production during 1957, in descending order, were Texas, Illinois, Alabama, Virginia, and California.

Large tonnages of lime entered interstate commerce. Most lime shipped in 1957 came from the following lime-producing States, in decreasing order: Ohio, Missouri, Pennsylvania, and Virginia.

When Chemical Lime Co. began operating its new $2 million lime plant 5 miles north of Baker in October, Oregon had commercial lime production for the first time since 1952. The company plans to produce 75,000 tons of high-calcium lime a year from 2 rotary kilns. Chemical-grade lime, pulverized quicklime, and regular and superfine hydrated lime will be used in acetylene manufacture, steel production, nickel smelting, paper manufacturing, water treatment, adhesives, insecticides, and building materials.[4]

GasprO, Ltd., rebuilt its lime plant at its Waianae, Hawaii, quarry site 30 miles from Honolulu at the end of 1957. Major improvements included modernizing the rotary kilns and installing new wet dust collectors.[5]

Woodville Lime Products Co., Toledo, Ohio, one of the largest of all independent lime manufacturers marketing building, agricultural, and industrial lime, announced that modern equipment was being added and facilities were undergoing changes intended to improve quality and efficiency.[6]

Edna Bay Pure Stone Co., Dallas, Tex., announced plans for constructing a $5-million limestone and lime-processing plant at Vancouver, Wash., to produce 300 tons per day.[7]

Linwood Stone Products Co., Linwood, Iowa, produced pebble quicklime for water treatment, carbide manufacture, and steel-furnace flux and hydrated lime for water treatment, chemical uses, and masonry. Its 175-foot rotary kiln was gas-fired, except in winter when coal was used. To make hydrated lime, pebble lime was crushed, fed to a 6-ton-per-hour continuous hydrator, and then pulverized.[8]

[3] Oil, Paint and Drug Reporter, vol. 173, No. 4, Jan. 27, 1958, p. 33.
[4] Mining Engineering, Chemical Lime Co. Plant in Baker, Oreg.: Vol. 10, No. 2, February 1958, pp. 216–218; Utley, H. F., Chemical Lime Company. First Large Scale Commerical Lime Producer in Oregon: Pit and Quarry, vol. 50, No. 6, December 1957, pp. 144–145, 150; Chemical Engineering, vol. 64, No. 12, December 1957, p. 170; Rock Products (Industry News), vol. 60, No. 12, December 1957, p. 33.
[5] National Lime Association, Limeographs: Vol. 24, February 1958, p. 65.
[6] Pit and Quarry, vol. 50, No. 8, February 1958, p. 35.
[7] National Lime Association, Limeographs: Vol. 23, April 1957, p. 86.
[8] Trauffer, Walter E., Iowa's Rotary Kiln Lime Plant: Pit and Quarry, vol. 49, No. 11, May 1957, pp. 101–104, 156.

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TABLE 2.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, 1956–57, by States

State or Territory	1956			1957		
	Active plants	Short tons	Value	Active plants	Short tons	Value
Alabama	9	466,399	$5,088,695	9	553,552	$6,271,495
Arizona	4	126,876	1,755,774	5	138,221	2,126,708
Arkansas	2	(1)	(1)	2	(1)	(1)
California	5	302,479	5,077,951	5	325,309	5,407,588
Colorado				1	2,500	45,500
Connecticut	1	39,748	609,202	1	30,341	503,295
Florida	2	39,542	490,086	2	(1)	(1)
Hawaii	1	9,555	305,709	1	8,469	270,686
Illinois	6	(1)	(1)	6	(1)	(1)
Indiana	1	80	[2] 960			
Iowa	1	(1)	(1)	1	(1)	(1)
Louisiana	1	(1)	(1)	1	(1)	(1)
Maine	1	11,997	179,162	1	(1)	(1)
Maryland	5	52,604	580,928	3	(1)	(1)
Massachusetts	3	134,248	2,093,195	3	137,284	2,232,731
Michigan	3	(1)	(1)	3	(1)	(1)
Minnesota	1	(1)	(1)	1	(1)	(1)
Missouri	6	1,481,611	15,813,573	6	1,392,780	16,475,404
Montana	2	(1)	(1)	2	(1)	(1)
Nevada	3	(1)	(1)	3	(1)	(1)
New Jersey	1	(1)	(1)	1	(1)	(1)
New Mexico	1	30,771	372,641	1	23,986	290,231
New York	3	86,737	1,029,996	2	(1)	(1)
Ohio	18	2,995,320	40,804,580	18	2,763,128	38,383,106
Oklahoma	1	(1)	(1)	1	(1)	(1)
Oregon				1	(1)	(1)
Pennsylvania	27	1,443,430	18,282,135	23	1,298,401	18,405,823
Puerto Rico	2	(1)	(1)	2	(1)	(1)
South Dakota	1	(1)	(1)	1	(1)	(1)
Tennessee	3	124,592	1,436,200	3	93,650	1,134,221
Texas	9	592,136	6,937,951	10	796,394	7,488,795
Utah	3	55,110	829,772	3	53,360	821,293
Vermont	2	(1)	(1)	2	(1)	(1)
Virginia	11	512,346	5,925,915	10	510,216	6,029,142
Washington	1	(1)	(1)			
West Virginia	5	(1)	(1)	5	(1)	(1)
Wisconsin	8	(1)	(1)	7	(1)	(1)
Undistributed [1]		2,071,715	28,112,708		2,146,915	29,436,817
Total	153	10,577,296	135,727,133	146	10,274,506	135,322,835

[1] Figures withheld to avoid disclosing individual company confidential data.
[2] Estimated by Bureau of Mines.

TABLE 3.—Lime sold or used by producers in the United States,[1] 1956–57, by types and major uses

	1956				1957				Change from 1956, percent
	Sold	Used	Total	Percent of total	Sold	Used	Total	Percent of total	
By type:									
Quicklime	7,047,079	1,343,970	8,391,049	79	6,650,584	1,543,204	8,193,788	80	−2
Hydrated lime	1,957,060	229,187	2,186,247	21	1,865,548	215,170	2,080,718	20	−5
Total lime	9,004,139	1,573,157	10,577,296	100	8,516,132	1,758,374	10,274,506	100	−3
By use:									
Agricultural:									
Quicklime	96,049	80	96,129	1	69,382		69,382	1	−28
Hydrated lime	155,857	49	155,906	1	139,218		139,218	1	−11
Total	251,906	129	252,035	2	208,600		208,600	2	−17
Building:									
Quicklime	123,918	54,890	178,808	2	98,529	43,545	142,074	1	−21
Hydrated lime	1,009,465	14,732	1,024,197	10	939,160	20,076	959,236	10	−6
Total	1,133,383	69,622	1,203,005	12	1,037,689	63,621	1,101,310	11	−8
Chemical and other industrial:									
Quicklime	4,425,146	1,267,057	5,692,203	54	4,250,964	1,479,940	5,730,904	56	+1
Hydrated lime	791,738	214,406	1,006,144	9	787,170	195,094	982,264	9	−2
Total	5,216,884	1,481,463	6,698,347	63	5,038,134	1,675,034	6,713,168	65	(2)
Refractory (dead-burned dolomite)	2,401,966	21,943	2,423,909	23	2,231,709	19,719	2,251,428	22	−7

[1] Includes Hawaii and Puerto Rico.
[2] Less than 1 percent.

TABLE 4.—Distribution of lime (including refractory) plants, 1955–57, according to size of production [1]

Size group (short tons)	1955			1956			1957		
	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	10	4,855	(2)	12	5,041	(2)	9	5,698	(2)
1,000 to less than 5,000	20	53,585	(2)	19	48,401	(2)	16	46,800	(2)
5,000 to less than 10,000	14	95,335	1	12	86,652	1	11	75,879	1
10,000 to less than 25,000	22	386,119	4	23	405,379	4	26	492,269	5
25,000 to less than 50,000	33	1,285,061	12	30	1,109,215	11	27	998,243	10
50,000 to less than 100,000	22	1,641,229	16	29	2,004,186	19	28	1,885,062	18
100,000 and over	29	7,013,744	67	28	6,918,422	65	29	6,770,555	66
Total	150	10,479,928	100	153	10,577,296	100	146	10,274,506	100

[1] Includes captive tonnage.
[2] Less than 1 percent.

TABLE 5.—Hydrated lime sold or used by producers in the United States, 1956–57, by States, in short tons

State or Territory	1956				1957			
	Active plants	Open-market	Captive	Total	Active plants	Open-market	Captive	Total
Alabama	5	(1)	(1)	73,078	5	(1)	(1)	(1)
California	5	(1)	(1)	35,521	5	36,309	----------	36,309
Hawaii	1	9,510	----------	9,510	1	8,466	----------	8,466
Illinois	4	(2)	----------	(2)	4	(1)	(1)	(1)
Maryland	3	12,798	----------	12,798	2	(1)	(1)	(1)
Massachusetts	3	(1)	(1)	64,077	3	(1)	(1)	65,071
Missouri	5	227,164	----------	227,164	4	220,662	----------	220,662
Ohio	14	(1)	(1)	680,011	14	615,363	4,924	620,287
Pennsylvania	16	294,404	----------	294,404	14	276,693	1,102	277,795
Tennessee	3	29,057	----------	29,057	3	(1)	(1)	(1)
Texas	6	(1)	(1)	242,443	5	97,156	139,812	236,968
Virginia	8	(1)	(1)	53,417	9	57,337	----------	57,337
Other States[2]	32	399,937	64,830	464,767	31	307,028	60,161	367,189
Undistributed	--------	984,190	164,357	----------	--------	246,534	9,171	190,634
Total	105	1,957,060	229,187	2,186,247	100	1,865,548	215,170	2,080,718

[1] Figures withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[2] Includes the following States and number of plants in 1957 (1956 same as 1957 unless shown differently in parentheses): Arizona 2, Arkansas 1, Colorado 1 (1957 only), Connecticut 1, Florida 1, Illinois 4, Iowa 1, Maine 1, Michigan 1, Minnesota 1, Montana 1, Nevada 3, New Jersey 1, New Mexico 1, New York 2, Oklahoma 1, Oregon 1 (1957 only), Puerto Rico 1, Utah 2, Vermont 1, Washington 1 (1956 only), West Virginia 3 (4), and Wisconsin 4 (5).

CONSUMPTION AND USES

Sixty-five percent of total lime produced in 1957 was consumed by chemical and industrial plants; 22 percent was used as a refractory material in metallurgical processes; 11 percent was used by the building trades; and 2 percent was employed in liming land.

Quicklime and hydrated lime (excluding refractory lime or dead-burned dolomite) were used in three major fields—chemical and industrial processes, building trades, and agriculture. Of the total sold or used by producers in 1957, 84 percent was employed in chemical and industrial applications, 14 percent in building and construction, and 2 percent in agriculture. The corresponding 1956 percentages were, 82, 15, and 3, respectively.

Most captive tonnage was consumed in chemical and industrial plants. Eighty percent of open-market lime (excluding refractory lime or dead-burned dolomite) entered chemical and industrial uses; 17 percent was employed in building and construction; and 3 percent in agriculture. Dead-burned dolomite or refractory lime was used for metallurgical furnace linings.

Moderate to substantial gains were made in the quantities of lime used in concentrating ore, treating sewage and trade wastes, and in manufacturing glue, rubber, precipitated calcium carbonate, and refractory silica brick. Lime used in purifying gas and in manufacturing coke byproducts, glass, paper, paint, steel, insecticides, fungicides, disinfectants, sand-lime brick, and slag brick declined. Other chemical and industrial uses of lime remained about the same in 1957 as in 1956. Table 11 compares the use of lime in soil conditioning in 1957 with the following competitive liming materials: Crushed shell, pulverized limestone, calcareous marl, and blast-furnace slag.

TABLE 6.—Lime (quick and hydrated) sold by producers in the United States in 1957, by districts[1] and by types

State or Territory	Agricultural		Building		Chemical and other industrial		Refractory		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
District 1: Connecticut, Maine, Massachusetts, and Vermont	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)
Districts 2 and 3: Maryland, New Jersey, New York, Pennsylvania, and West Virginia	127,423	$1,708,950	126,587	$2,092,468	1,094,494	$14,809,250	337,801	$5,372,698	1,686,305	$23,983,366
District 4: Virginia	25,230	354,287	4,333	51,995	480,653	5,622,860			510,216	6,029,142
District 5: Ohio	34,931	481,809	510,052	9,049,380	917,827	8,410,762	1,300,318	20,441,155	2,763,128	38,383,106
District 7: Illinois, and that part of Missouri east of the 93d meridian			50,026	942,432	1,285,396	15,380,872	530,267	8,510,960	1,865,689	24,834,264
Districts 6, 8, and 9: Iowa, Michigan, Minnesota, South Dakota, and Wisconsin	(2)	(2)	(2)	(2)	360,144	4,755,497			403,701	5,382,436
Districts 10 and 11: Alabama, Florida, and Tennessee	(2)	(2)	86,129	982,265	596,846	6,869,423	(2)	(2)	685,812	7,888,623
District 12: Arkansas, Oklahoma, Louisiana, and that part of Missouri west of the 93d meridian			(2)	(2)	(2)	(2)			602,144	6,570,578
District 13: Texas	300	2,950	51,510	594,081	744,584	6,891,764			796,394	7,488,795
Districts 14 and 15: Arizona, California, Montana, Nevada, New Mexico, Utah, Oregon, and Colorado	(2)	(2)	104,211	1,663,139	566,254	8,021,541	(2)	(2)	752,769	11,224,913
Noncontiguous territories:										
Hawaii			1,535	52,989	6,934	217,697			8,469	270,686
Puerto Rico			(2)	(2)	(2)	(2)			(2)	(2)
Undistributed[2]	20,716	309,730	166,927	2,619,728	660,036	7,565,732	83,042	1,546,421	199,879	3,266,926
Total	208,600	2,857,726	1,101,310	18,048,477	6,713,168	78,545,398	2,251,428	35,871,234	10,274,506	135,322,835

[1] The districting is the same as that used by the National Lime Association. Non-lime-producing States are omitted.
[2] Figures withheld to avoid disclosing individual company confidential data.

TABLE 7.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, 1956–57, by uses, in short tons

Use	1956			1957		
	Open-market	Captive	Total	Open-market	Captive	Total
Agriculture	251, 906	129	252, 035	208, 600	----------	208, 600
Building:						
Finishing lime	660, 422	5, 285	665, 707	503, 108	4, 400	507, 508
Mason's lime	441, 224	5, 980	447, 204	437, 824	6, 529	444, 353
Other (including masonry mortars)	31, 737	58, 357	90, 094	96, 757	52, 692	149, 449
Total	1, 133, 383	69, 622	1, 203, 005	1, 037, 689	63, 621	1, 101, 310
Chemical and other industrial:						
Alkalies (ammonium, potassium and sodium compounds)	3, 151	894, 228	897, 379	13, 490	843, 932	857, 422
Asphalts and other bitumens	----------	----------	----------	(1)	----------	(1)
Bleach, liquid and powder [2]	----------	----------	----------	----------	----------	----------
Brick, sand-lime and slag	16, 789	100	16, 889	14, 525	----------	14, 525
Brick, silica (refractory)	22, 548	----------	22, 548	25, 158	50	25, 208
Calcium carbide and cyanamide	781, 626	----------	781, 626	739, 877	----------	739, 877
Calcium carbonate (precipitated)	32, 763	----------	32, 763	36, 738	----------	36, 738
Coke and gas (gas purification and plant byproducts)	31, 500	----------	31, 500	18, 922	----------	18, 922
Explosives	5, 314	----------	5, 314	4, 563	----------	4, 563
Food and food byproducts	28, 231	----------	28, 231	5, 230	----------	5, 230
Glassworks	287, 924	----------	287, 924	259, 300	----------	259, 300
Glue	2, 808	----------	2, 808	3, 668	----------	3, 668
Grease, lubricating	11, 071	----------	11, 071	13, 222	----------	13, 222
Insecticides, fungicides, and disinfectants	70, 069	----------	70, 069	62, 998	----------	62, 998
Medicines and drugs	(1)	----------	(1)	(1)	----------	(1)
Metallurgy:						
Nonferrous smelter flux	----------	----------	----------	----------	----------	----------
Steel (open-hearth and electric-furnace flux)	1, 349, 521	147, 346	1, 496, 867	1, 319, 166	143, 451	1, 462, 617
Ore concentration [3]	200, 715	342, 178	542, 893	202, 491	366, 890	569, 381
Wire drawing	[4] 12, 820	----------	[4] 12, 820	12, 818	----------	12, 818
Other [5]	130, 504	----------	130, 504	125, 202	----------	125, 202
Oil drilling	18, 248	----------	18, 248	16, 317	----------	16, 317
Paints	(1)	(1)	22, 555	(1)	(1)	15, 249
Paper mills	(1)	(1)	857, 254	(1)	(1)	817, 466
Petrochemicals (glycol)	110, 945	----------	110, 945	(1)	----------	(1)
Petroleum refining	35, 841	----------	35, 841	35, 834	----------	35, 834
Rubber manufacture	2, 487	----------	2, 487	2, 799	----------	2, 799
Salt refining	(1)	----------	(1)	(1)	----------	(1)
Sewage and trade-wastes treatment	106, 164	2, 524	108, 688	123, 048	55	123, 103
Soap and fat	(1)	----------	(1)	(1)	----------	(1)
Sugar refining	(1)	(1)	36, 433	30, 033	7, 067	37, 100
Tanneries	74, 905	----------	74, 905	70, 397	----------	70, 397
Varnish	----------	----------	----------	----------	----------	----------
Water purification	638, 456	23, 904	662, 360	640, 504	23, 850	664, 354
Wood distillation	----------	----------	----------	----------	(1)	(1)
Undistributed [6]	[4] 1, 050, 637	70, 804	[4] 205, 199	1, 097, 001	119, 839	384, 125
Unspecified	191. 847	379	192, 226	164, 833	169, 900	334, 733
Total	5, 216, 884	1, 481, 463	6, 698, 347	5, 038, 134	1, 675, 034	6, 713, 168
Refractory lime (dead-burned dolomite)	2, 401, 966	21, 943	2, 423, 909	2, 231, 709	19, 719	2, 251, 428
Grand total lime	9, 004, 139	1, 573, 157	10, 577, 296	8, 516, 132	1, 758, 374	10, 274, 506

[1] Included with "Undistributed" and "Total" columns to avoid disclosing individual company confidential data.
[2] Bleach used in paper mills excluded from "Bleach" and included with "Paper mills."
[3] Includes flotation, cyanidation, bauxite purification, and magnesium manufacture.
[4] Revised figure.
[5] Includes barium and vanadium processing, cupola, gold recovery, and unspecified metallurgical uses.
[6] Includes alcohol, asphalt, medicine and drugs, magnesium products, paints, paper mills, polishing compounds, retarder, salt soap, and fat, sugar, sulfur, varnish, and miscellaneous industrial uses.

TABLE 8.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States,[1] 1956–57, by major uses

Use	1956			1957		
	Short tons	Value[2]		Short tons	Value[2]	
		Total	Average		Total	Average
Agricultural	252,035	$3,082,509	$12.23	208,600	$2,857,726	$13.70
Building:						
Finishing lime	665,707	11,634,025	17.48	507,508	9,152,826	18.03
Mason's lime	447,204	6,296,199	14.08	444,353	6,976,493	15.70
Other (including masonry mortars)	90,094	1,026,516	11.39	149,449	1,919,158	12.84
Total building	1,203,005	18,956,740	15.76	1,101,310	18,048,477	16.39
Chemical and industrial uses	6,698,347	75,942,536	11.34	6,713,168	78,545,398	11.70
Refractory (dead-burned dolomite)	2,423,909	37,745,348	15.57	2,251,428	35,871,234	15.93
Grand total lime	10,577,296	135,727,133	12.83	10,274,506	135,322,835	13.17

[1] Includes Hawaii and Puerto Rico.
[2] Selling value, f. o. b. plant, excluding cost of container.

TABLE 9.—Quicklime sold or used by producers in the United States, 1956–57, by uses, in short tons

Use	1956			1957		
	Open-market	Captive	Total	Open-market	Captive	Total
Agriculture	96,049	80	96,029	69,382	----------	69,382
Building	123,918	54,890	178,808	98,529	43,545	142,074
Chemical and industrial:						
Bleach, liquid and powder	----------	----------	----------	----------	----------	----------
Brick, sand-lime and slag	6,679	100	6,779	4,775	----------	4,775
Brick, silica	2,454	----------	2,454	2,188	50	2,238
Coke and gas	(1)	----------	(1)	(1)	----------	(1)
Food products	10,904	----------	10,904	1,476	----------	1,476
Insecticides, fungicides, and disinfectants	17,909	----------	17,909	15,466	----------	15,466
Metallurgy	1,631,920	428,477	2,060,397	1,592,851	455,905	2,048,756
Paints	(1)	(1)	7,041	(1)	(1)	4,006
Paper mills	(1)	(1)	805,370	(1)	(1)	774,288
Petroleum	12,673	----------	12,673	12,414	----------	12,414
Sewage and trade-waste treatment	61,945	2,524	64,469	72,400	55	72,455
Sugar refining	(1)	(1)	15,254	5,820	7,067	12,887
Tanneries	28,858	----------	28,858	23,930	----------	23,930
Water purification	403,370	23,242	426,612	389,532	23,610	413,142
Undistributed[2]	2,248,434	812,714	2,101,393	2,018,761	823,353	2,063,820
Unspecified	(1)	(1)	132,090	111,351	169,900	281,251
Total	4,425,146	1,267,057	5,692,203	4,250,964	1,479,940	5,730,904
Refractory lime (dead-burned dolomite)	2,401,966	21,943	2,423,909	2,231,709	19,719	2,251,428
Grand total quicklime	7,047,079	1,343,970	8,391,049	6,650,584	1,543,204	8,193,788

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes alkalies, calcium carbide, cement products, glass, glue, grease (lubricating), medicines and drugs, oil-well drilling, petrochemicals, rubber, and miscellaneous industrial uses.

TABLE 10.—Hydrated lime sold or used by producers in the United States, 1956–57, by uses, in short tons

Use	1956			1957		
	Open-market	Captive	Total	Open-market	Captive	Total
Agricultural	155,857	49	155,906	139,218		139,218
Building	1,009,465	14,732	1,024,197	939,160	20,076	959,236
Chemical and industrial:						
Bleach, liquid and powder						
Brick, sand-lime and slag	10,110		10,110	9,750		9,750
Brick, silica	20,094		20,094	22,970		22,970
Coke and gas	(1)		(1)	(1)		(1)
Food products	17,327		17,327	3,754		3,754
Insecticides, fungicides, and disinfectants	52,160		52,160	47,532		47,532
Metallurgy	[2] 61,640	61,047	[2] 122,687	66,826	54,436	121,262
Paints	(1)	(1)	15,514	(1)	(1)	11,243
Paper mills	(1)	(1)	51,884	(1)	(1)	43,178
Petroleum	23,168		23,168	23,420		23,420
Sewage and trade-waste treatment	44,219		44,219	50,648		50,648
Sugar refining	21,179		21,179	24,213		24,213
Tanneries	46,047		46,047	46,467		46,467
Water purification	235,086	662	235,748	250,972	240	251,212
Undistributed [3]	[2] 260,708	152,697	[2] 285,871	187,136	140,418	273.133
Unspecified	(1)	(1)	60,136	53,482		53,482
Total	791,738	214,406	1,006,144	787,170	195,094	982,264
Grand total hydrated lime	1,957,060	229,187	2,186,247	1,865,548	215,170	2,080,718

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Revised figure.
[3] Includes alkalies, calcium carbide, cement products, coke and gas, glass, glue, grease (lubricating), medicines and drugs, oil-well drilling, petrochemicals, rubber, and miscellaneous industrial uses.

TABLE 11.—Lime and other calcareous materials sold or used for conditioning soil in the United States,[1] 1956–57

Calcareous material	1956			1957		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Lime (agricultural):						
Quick	96,129	$3,082,509	$12.23	69,382	$2,857,726	$13.70
Hydrated	155,906			139,218		
Total lime	252,035	3,082,509	12.23	208,600	2,857,726	13.70
Limestone	19,864,045	32,087,185	1.62	18,941,235	31,397,800	1.66
Shell [2]	591,000	825,000	1.40	591,000	825.000	1.40
Marl	285,653	214,562	.75	264,841	158,527	.60
Blast-furnace slag	77,043	112,742	1.46	68,643	107,148	1.56
Grand total	21,069,776	36,321,998	1.72	20,074,319	35,346,201	1.76

[1] Owing to changes in tabulating procedures, data are not comparable with previous years.
[2] 1956–57 average figures to conceal confidential data.

TABLE 12.—Apparent consumption of lime sold and used in continental United States in 1957, by States, in short tons

State	Sales by producers	Shipments from State [1]	Shipments into State	Apparent consumption		Total
				Quicklime	Hydrated lime	
Alabama	553,552	244,655	11,464	291,147	29,214	320,361
Arizona	138,221	15,838	8,340	120,030	10,693	130,723
Arkansas	(2)	(2)	(2)	76,621	6,879	83,500
California	325,309	4,544	105,044	335,002	90,807	425,809
Colorado	2,500	1,000	41,375	28,818	14,057	42,875
Connecticut	30,341	30,341	31,045	9,226	21,819	31,045
Delaware			57,925	50,597	7,328	57,925
District of Columbia			6,446	200	6,246	6,446
Florida	(2)		(2)	114,417	78,940	193,357
Georgia			113,243	84,750	28,493	113,243
Idaho			10,979	9,224	1,755	10,979
Illinois	(2)	(2)	(2)	426,965	160,133	587,098
Indiana			521,868	481,926	39,942	521,868
Iowa	(2)	(2)	(2)	82,388	18,408	100,796
Kansas			53,032	32,970	20,062	53,032
Kentucky			564,222	541,921	22,301	564,222
Louisiana	(2)		(2)	325,723	66,381	392,104
Maine	(2)		(2)	92,216	13,419	105,635
Maryland	(2)	(2)	(2)	121,508	23,399	144,907
Massachusetts	137,284	80,129	40,676	46,995	50,836	97,831
Michigan	(2)	(2)	(2)	312,741	64,642	377,383
Minnesota	(2)	(2)	(2)	85,833	23,613	109,446
Mississippi			48,904	42,049	6,855	48,904
Missouri	1,392,780	1,179,793	24,410	183,824	53,573	237,397
Montana	(2)	(2)	(2)	61,338	3,961	65,299
Nebraska			11,131	3,632	7,499	11,131
Nevada	(2)	(2)	(2)	113	32,941	33,054
New Hampshire			12,980	5,669	7,311	12,980
New Jersey	(2)	(2)	(2)	42,380	101,649	144,029
New Mexico	23,986		34,271	29,561	28,696	58,257
New York	(2)	(2)	(2)	199,422	130,929	330,351
North Carolina			92,245	58,036	34,209	92,245
North Dakota			7,788	5,577	2,211	7,788
Ohio	2,763,128	1,560,062	286,739	1,344,631	145,174	1,489,805
Oklahoma	(2)	(2)	(2)	59,130	11,781	70,911
Oregon	(2)	(2)	(2)	38,669	10,134	48,803
Pennsylvania	1,298,401	478,667	693,252	1,293,059	219,927	1,512,986
Rhode Island			18,517	9,555	8,962	18,517
South Carolina			12,469	5,827	6,642	12,469
South Dakota	(2)		(2)	9,929	1,437	11,366
Tennessee	93,650	73,455	54,740	49,793	25,142	74,935
Texas	796,394	98,309	50,104	662,412	85,777	748,189
Utah	53,360	4,449	36,437	59,364	25,984	85,348
Vermont	(2)	(2)	(2)	7	1,645	1,652
Virginia	510,216	414,777	37,396	87,998	44,837	132,835
Washington			32,783	23,840	8,943	32,783
West Virginia	(2)	(2)	(2)	205,385	28,438	233,823
Wisconsin	(2)	(2)	(2)	96,369	49,261	145,630
Wyoming			3,011	163	2,848	3,011
Undistributed [2]	2,137,939	1,004,503	2,045,708			
Total	10,257,061	5,190,522	5,068,544	8,248,950	1,886,133	10,135,083

[1] Includes 139,423 tons exported or unclassified as to destination.
[2] Figures withheld to avoid disclosing individual company confidential data; included with "Undistributed."

PRICES

The average price for quicklime and hydrated lime in 1957, f. o. b. plant, excluding cost of container, was $13.17 compared with $12.83 in 1956. The trend in prices over a period of years is shown in figure 3.

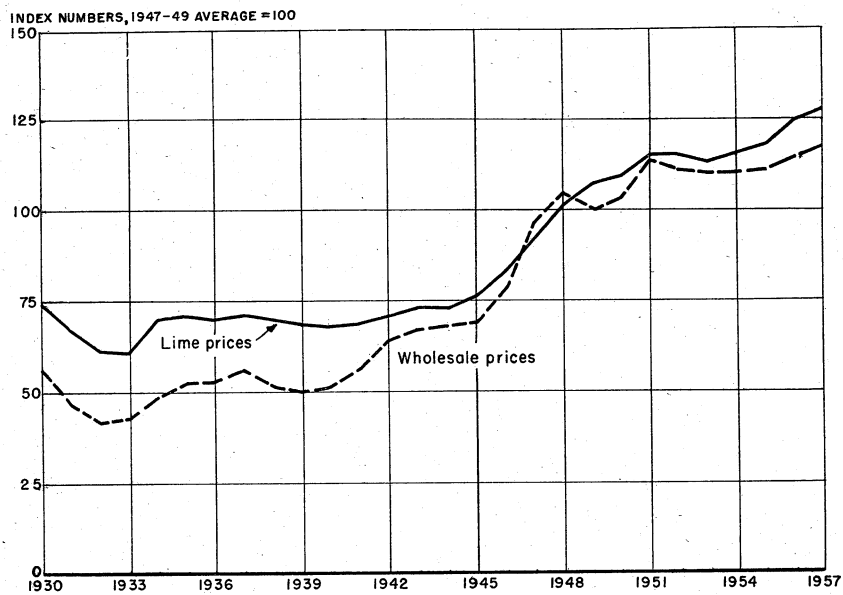

FIGURE 3.—Average price of lime per ton compared with wholesale prices of all commodities, 1930–57. Units are reduced to percentages of the 1947–49 average. Wholesale prices from U. S. Department of Labor.

Oil, Paint and Drug Reporter [9] quoted the following:

Type:	*Price, Jan. 1, 1957*	*Price Dec. 31, 1957*
Quicklime (or chemical lime).	$20.46 per ton, becoming $20.82 Feb. 11, 1957, to Sept. 2, 1957, afterwards.	$22. 13
Hydrated lime	$21.96 per ton, becoming $22.32, Feb. 11, 1957, to Sept. 2, 1957, afterwards.	$23. 63
Spray	$25.96 per ton (bags), becoming $26.32, Feb. 11, 1957, to Sept. 2, 1957, afterwards.	$27. 63

FOREIGN TRADE [10]

Imports.—Lime imports received by the United States in 1957 were relatively small as usual—only 49,666 short tons, including dead-burned dolomite. They reached an alltime high, however—19 percent above the previous record of 1956. All 1957 imports of lime came from Canada, entering border States from New England to Washington.

Exports.—During 1957 lime exports went to more than 25 countries in all continents but fell to 65,195 short tons, 21 percent below the

[9] Oil, Paint and Drug Reporter: Vol. 171, Nos. 1–27; vol. 172, Nos. 1–27, Jan. 7–Dec. 30, 1957.
[10] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

record high of 1956. As usual, lime exports exceeded imports, but only by a much reduced margin of 31 percent. Exports of lime were less in 1957 than in any year since 1952. In descending order, five North American countries—Canada, Honduras, Costa Rica, Panama, and Mexico—received 90 percent of all exported lime.

TABLE 13.—Lime imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Hydrated lime		Other lime		Dead-burned dolomite [1]		Total	
	Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value
1948–52 (average)	1,406	$26,568	28,691	$480,737	2,358	$100,504	32,455	$607,809
1953	2,177	30,944	31,149	506,704	3,876	259,427	37,202	797,075
1954	1,259	17,326	30,613	537,676	4,426	344,665	36,298	899,667
1955	1,359	17,983	30,264	559,216	7,993	557,554	39,616	1,134,753
1956	757	12,312	31,903	549,290	9,031	586,754	41,691	1,148,356
1957	245	4,603	39,002	687,421	10,419	639,741	49,666	1,331,765

[1] "Dead-burned basic refractory material consisting chiefly of magnesia and lime."
[2] Includes weight of immediate container.

TABLE 14.—Lime imported for consumption in the United States, 1955–57, by countries and customs districts [1]

[Bureau of the Census]

Country and customs district	1955		1956		1957	
	Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value
North America:						
Canada:						
Buffalo	1,880	$23,063	153	$2,075	438	$5,166
Duluth and Superior	108	1,874				
Maine and New Hampshire	166	2,062	270	3,704	124	1,885
Montana and Idaho					615	10,842
St. Lawrence	1	3				
Vermont	31	468	1,120	15,330	630	8,813
Washington	28,676	542,925	31,053	539,920	37,440	665,318
Total Canada	30,862	570,395	32,596	561,029	39,247	692,024
Mexico: El Paso	761	6,804	64	573		
Total North America	31,623	577,199	32,660	561,602	39,247	692,024
Grand total	31,623	[3] 577,199	32,660	561,602	39,247	692,024

[1] Exclusive of dead-burned basic refractory material.
[2] Includes weight of immediate container.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.

TABLE 15.—Lime exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	60,351	$988,634	1955	82,461	$1,464,036
1953	79,934	1.422,238	1956	82,737	1,546,127
1954	73,246	1,299,681	1957	65,195	1,328,575

TABLE 16.—Lime exported from the United States, 1955–57, by countries of destination

[Bureau of the Census]

Destination	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	45,542	$730,837	55,031	$945,686	35,677	$653,401
Costa Rica	11,588	218,814	7,410	148,234	7,285	153,891
Cuba	295	6,310	61	2,450		
Dominican Republic	406	11,090	457	10,552	288	9,996
El Salvador	118	2,990			232	20,976
Honduras	10,648	201,068	9,144	194,487	8,998	189,455
Mexico	2,502	54,641	2,074	50,055	2,240	63,487
Netherlands Antilles	150	2,920	240	7,132	150	3,450
Nicaragua	300	5,680	267	4,081	483	11,752
Panama	7,029	140,684	3,446	70,632	4,471	93,914
Other North America	121	2,973	71	2,535	160	6,001
Total	78,699	1,378,007	78,201	1,435,844	59,984	1,206,323
South America:						
Chile			3	541	245	8,600
Colombia	2,926	59,639	4,060	91,860	4,396	78,226
Peru					122	4,408
Venezuela	505	11,140	92	2,445	25	719
Other South America	50	2,265	55	2,980	82	2,738
Total	3,481	73,044	4,210	97,826	4,870	94,691
Europe	13	1,236	25	743	25	829
Asia:						
Indonesia					18	2,043
Japan	16	2,000	8	1,186	34	3,953
Korea, Republic of					128	13,388
Nansei and Nanpo Islands	123	3,810	88	2,412		
Pakistan			125	4,025	25	950
Philippines	94	2,204	50	1,160		
Thailand					50	2,000
Other Asia	5	212	15	2,380	25	1,580
Total	238	8,226	286	11,163	280	23,914
Africa	21	2,083			36	2,818
Oceania	9	1,440	15	551		
Grand total	82,461	1,464,036	82,737	1,546,127	65,195	1,328,575

WORLD REVIEW

NORTH AMERICA

British West Indies.—Lime production in the Bahama Islands totaled about 4,800 short tons valued at US$36,367 in 1956.[11]

Canada.—The industrial growth of Canada has been reflected in a steadily increasing lime production. The 1956 output was 300 percent greater than that of 1926.[12]

All Provinces except Prince Edward Island have limestone deposits suitable for lime manufacture. Dolomitic and high-calcium limes were produced in Manitoba, New Brunswick, and Ontario. High-calcium lime only was produced in Alberta, British Columbia, and Quebec.[13] Quicklime production in 1955 totaled 995,639 short tons valued at Can$12,221,541 (Can$12.28 per ton average) and hydrated lime production, 335,479 short tons at Can$3,589,363 (Can$10.70

[11] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 30.
[12] Dominion Bureau of Statistics (Industry and Merchandising Division, Mineral Statistics Section, Ottawa), General Review of the Mining Industry, 1956: 1958, pp. A-8, A-9.
[13] Western Miner and Oil Review, vol. 30, No. 10, October 1957, p. 49.

per ton average).[14] Quicklime production in 1956 was 947,316 short tons valued at Can$11,852,860 (Can$12.51 per ton average) and for hydrated lime, 348,383 short tons at Can$3,814,738 (Can$10.95 per ton average).[15] Preliminary figures placed 1957 production of all lime at 1,379,871 short tons valued at Can$16,563,493.[16]

TABLE 17.—Lime (quick and hydrated) sold or used by producers in Canada 1955–56, by Provinces

[Dominion Bureau of Statistics]

Province	1955		1956	
	Short tons	Value	Short tons	Value
Alberta	38,335	Can$553,526	41,309	Can$624,060
British Columbia	56,362	1,115,591	45,536	803,209
Manitoba	57,510	886,901	64,286	1,066,704
New Brunswick	18,861	385,979	18,432	408,338
Ontario	698,245	8,420,382	673,357	8,258,857
Quebec	461,805	4,448,525	452,779	4,506,430
Total	1,331,118	$15,810,904	1,295,699	$15,667,598

Although high-calcium limestone low in impurities and of good white color for chemical uses is relatively scarce in Canada, facilities for producing chemical lime continued to expand. North American Cyanamid, Ltd., announced plans for a 300-ton-per-day plant near Beachville, Ontario.[17] A new use for substantial quantities of lime was in the treatment of uranium ores in the Blind River and Bancroft, Ontario, areas. A new $150,000 lime-distributing system was put into operation by United Steel Corp., Ltd., Toronto, for supplying Northspan Uranium Mines, Ltd., in the area surrounding Spanish Junction, Northern Ontario. This was considered to be the forerunner of similar systems in the Northern Ontario uranium field.[18]

The lime industry in Canada was concentrated in Ontario, Quebec, and Manitoba. Thirty-eight plants with 140 kilns, including 18 rotary kilns, operated in Canada in 1956.[19] Limestone used in manufacturing lime reached 2,274,211 short tons in 1955 and an estimated 2,272,500 tons in 1956.[20] Almost all of the lime that Canada imported in 1957 came from the United States.[21] Canada exported 36,184 short tons of lime valued at Can$741,969 in 1957; virtually the entire quantity was shipped to the United States; 5 tons valued at Can$165 went to St. Pierre.[22]

[14] Dominion Bureau of Statistics (Industry and Merchandising Division, Mineral Statistics Section, Ottawa), Preliminary Report on Mineral Production, 1956: 1957, pp. 7, 10–11, 14–15, 42.
[15] Dominion Bureau of Statistics (Industry and Merchandising Division, Mineral Statistics Section, Ottawa), The Lime Industry, 1956: 1957, 8 pp.
[16] Dominion Bureau of Statistics (Ottawa), Preliminary Estimate of Canada's Mineral Production for 1957: Jan. 2, 1958, p. 3; Northern Miner (Toronto), vol. 43, No. 27, Sept. 26, 1957, p. 16.
[17] Chemical Week, vol. 80, No. 16, Apr. 20, 1957, p. 35.
[18] Precambrian, vol. 30, No. 10, October 1957, p. 92
[19] Woodrooffe, H. M., Lime in Canada, 1956 (Prelim.): Canada Dept. of Mines and Tech. Surveys, Ind. Min. Div., Ottawa, Bull. 42, 1957, 6 pp.
[20] Woodrooffe, H. M., Limestone (General) in Canada, 1956 (Prelim.): Canada Dept. of Mines and Tech. Surveys, Ind. Min. Div., Ottawa, Bull. 43, 1957, p. 2.
[21] Dominion Bureau of Statistics (International Trade Division, External Trade Section, Ottawa), Trade of Canada, Imports, 1957: 1958, p. 151.
[22] Dominion Bureau of Statistics (International Trade Division, External Trade Section, Ottawa), Trade of Canada, Exports, 1957: 1958, p. 142.

Winnipeg Fuel & Supply Co., Winnipeg, Manitoba, a lime producer, became actively interested in the lime stabilization of roads in Western Canada.[23]

SOUTH AMERICA

Peru.—Preliminary 1956 figures [24] showed lime production totaled 53,814 short tons. Use in agriculture totaled 8,956 tons; in chemical and industrial applications, 11,133 tons; in construction, 20,117 tons; and in mineral concentration, 13,608 tons. Output of lime, excluding lime used in cement manufacture, totaled 132,577 tons in 1955, 94,843 tons in 1954, and 92,842 tons in 1953.

EUROPE

Belgium.—A traveling-grate-kiln system planned for Chaux de Meuse was expected to produce 170 to 200 tons of lime a day.[25] The traveling grate affords good heat transfer, low dust loss, and nonsegregation of pelletized raw feed.

Norway.—Two large, unusual kilns, suitable for alternate or combination firing with either fuel oil, carbide furnace gas, or coke by the mixed-feed principle, were planned.[26]

Sweden.—In March 1957 the Swedish lime industry consisted of about 80 plants producing 660,000 short tons annually; 25 percent of which was building lime.[27] A vertical kiln at Limhamn near Malmö, Sweden, burned a hard chalk, which did not disintegrate as readily as most Scandinavian limes. Oil-firing was tried, but the operators returned to firing with producer gas.[28]

United Kingdom.—Chalk, Lime, and Allied Industries Research Association was organized in February 1955 to aid British firms producing or marketing lime, chalk, or their products. In June 1957 there were more than 30 members from the lime and sand-lime brick industries. Their new laboratories at Welwyn, England, conducted research on lime uses in building and highway construction and in sand-lime brick manufacture. Fundamental research on lime calcination and hydration was planned.[29]

ASIA

Philippines.—The Portland Cement Co. at Buena Vista, Guimaras Island, produced about 125 short tons of hydrated lime monthly for sale to sugar centrals.[30]

AFRICA

Belgian Congo.—In 1956 lime production totaled 107,070 short tons with an estimated value of $1,554,000.[31]

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23 National Lime Association, Limeographs: Vol. 23, May 1957, p. 102.
24 Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 27.
25 Rock Products, vol. 60, No. 12, December 1957, p. 113.
26 Azbe, Victor J., Lime Around the World: Rock Products, vol. 60, February 1958, p. 172.
27 National Lime Association, Limeographs: Vol. 23, March 1957, p. 82.
28 Knibbs, N. V. S., Scandinavian Experience With Heavy Oil as a Fuel in Shaft Lime Kilns: Pit and Quarry, vol. 49, No. 11, May 1957, pp. 116–118, 120.
29 Chemical Trade Journal & Chemical Engineer (London), vol. 141, No. 3658, July 12, 1957, p. 112; Chem. and Ind. (London), No. 24, June 15, 1957, p. 751.
30 U. S. Embassy, Manila, Philippines, State Department Dispatch 384, Oct. 22, 1957, p. 17.
31 U. S. Consulate, Elisabethville, Belgian Congo, State Department Dispatch 8, Encl. No. 1, Dec. 8, 1957.

Rhodesia and Nyasaland, Federation of.—In 1956 Southern Rhodesia imported 24,000 tons of hydrated lime from South Africa. The two new Rhodesia Cement Co. lime plants at Colleen Bawn near Gwanda and at Shamva were expected to produce enough hydrated lime to meet all the needs of the Federation of Rhodesia and Nyasaland by the end of 1957. The Colleen Bawn lime plant, largest in the Federation, had a vertical kiln that produced 25 tons per day of hydrated, air-separated lime. The Shamva lime plant opened August 23, 1957, to supply hydrated-lime needs in the Salisbury district.[32]

South-West Africa.—Lime production in 1956 increased 212 percent—5,674 short tons compared with 1,821 tons in 1955.[33]

Tanganyika.—Although the value of lime produced in 1956 remained virtually the same as in 1955, increasing slightly from $55,412 to $55,485, total export and domestic lime tonnages declined 12 percent. Exports in 1956 were 862 short tons valued at $9,733 compared with 1,053 short tons valued at $11,640 in 1955. Local sales were 4,845 short tons valued at $45,752 in 1956, whereas they were 5,397 short tons valued at $43,772 in 1955.[34]

Uganda.—Production of hydrated lime totaled 9,247 short tons in 1956, showing a marked increase from 1,609 short tons in 1955, 454 tons in 1954, and 644 tons in 1953.[35]

Union of South Africa.—Union Lime Co., Ltd., produced 867,186 tons of lime and limestone in the year ending June 30, 1957, approximately 10 times its 1946 production of 87,430 tons. Two additional kilns and a duplication of the primary crushing and sorting section were planned for the next fiscal year's operation.[36]

Production of lime and limestone totaled 7,232,657 short tons in 1956 compared with 7,248,932 tons in 1955. Lime and limestone exports increased from 4,403 short tons valued at $43,344 in 1955 to 5,635 tons valued at $63,386 in 1956. Lime exports in 1956 to Rhodesia totaled 2,936 tons or 52 percent; to Portuguese East Africa, 2,438 tons or 43 percent; to Kenya, 240 tons or 4 percent; and to Mauritius and Belgian Congo, 21 tons or less than 1 percent.[37]

OCEANIA

Australia.—There have been very few lime plants in Australia. In October 1957 a survey was undertaken under the auspices of Hydrated Lime, Ltd., Adelaide, South Australia, and the South Australian Geological Survey Bureau to find limestone deposits suitable for calcining. Many samples were collected, a testing laboratory was set up, and a new oil-fired plant was planned.[38]

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[32] South African Mining and Engineering Journal (Johannesburg), vol. 68, No. 3343, Mar. 8, 1957, p. 431; Chem. Age (London), Rhodesian Lime Production: Vol. 78, No. 1991, Sept. 7, 1957, p. 364.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 27.
[34] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 39.
[35] Work cited in footnote 34.
[36] Menell, S. G., Union Lime Company, Ltd.: South African Min. and Eng. Jour. (Johannesburg), vol. 68, No. 3380, pt. 2, Nov. 22, 1957, pp. 684–685.
[37] Work cited in footnote 33, pp. 27–28.
[38] Azbe, Victor J., Lime Around the World: Rock Products, vol. 61, No. 2, February 1958, pp. 110–112, 172.

TECHNOLOGY

Patents.—Lime patents fell into two principal categories: (1) Patents relating to lime manufacture; (2) patents involving lime uses. Technological improvements in lime manufacturing were intended to conserve fuel, regulate and conserve heat, control dust, increase kiln efficiency, extend refractory life, apply FluoSolids techniques, improve product quality, increase production, reduce costs, and save manpower by automatic controls.

A method and apparatus for calcining finely divided limestone or any other solid material was patented.[39] Limestone is kept in a fluidized state during both the pre-heating and heat-processing stages. To conserve heat, a process was patented [40] whereby the heat from a fluidized bed of pulverized limestone being calcined is utilized in pre-heating aerially suspended fresh material. To control accurately the flow of fluidized-lime particles from bins to kilns and bagging machines, a feed regulator was patented.[41]

Aqueous limestone suspensions must be dewatered and dried before calcination, so kiln capacity will be increased and fuel requirements decreased. A patent for an apparatus to predry slurries was granted.[42] A rotary drum was designed to improve heat economy and to minimize dust formation during drying, calcining, and cooling by high-velocity, circulating gases.[43]

Efforts were directed toward better kiln design. A vertical-shaft kiln, in which crushed limestone, or other raw material, was to be deflected to flow around a central burner in its upper section, was patented.[44] The burner and burning chamber were arranged to permit combustion at an equal rate throughout the kiln cross section, thus producing uniformly burned lime and avoiding undue deterioration of refractory lining at inlet points. Another means of controlling calcination in vertical limekilns was patented.[45] Local overheating, which results in the formation of undesirable hard-burned or vitrified lime, was counteracted by a new method of recirculating waste gases.

A new device for air-cooling burned lime was patented.[46] Thin, successive layers of lime spread on a partially inclined and stepped rotating platform expose a large surface area to the atmosphere for heat loss through radiation. A sanitary lime for treating garbage and other wastes may be produced by a recently patented process.[47] Hydrated lime may be manufactured by a new method.[48] High-calcium quicklime is continuously hydrated with water at atmospheric pressure and at a temperature not exceeding 80° C. The hydrated-

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[39] Bradford, J. H. (one-half assigned to Combined Metals Reduction Corp., Utah), Method of Heat Processing Finely Divided Materials and Furnace Therefor: U. S. Patent 2,782,018, Feb. 19, 1957.

[40] Knibbs, N. V. S., and Thyer, E. G. S. (assigned to Fawkham Developments, Ltd., London, England), Heat Treatment of Finely-Divided Solids: U. S. Patent 2,812,592, Nov. 12, 1957.

[41] Krauss, W. (assigned to Fuller Co., Catasauqua, Pa.), Material Feed Regulator: U. S. Patent 2,802,698, Aug. 13, 1957.

[42] Gordon, C. W., Apparatus for Drying Material Slurry and Introducing Into a Kiln Which Calcines or Otherwise Treats It: U. S. Patent 2,812,934, Nov. 12, 1957.

[43] Simon, J., and Kiesbauer, J., Rotary Drum Apparatus for Gaseous Treatment of Divided Material: U. S. Patent 2,809,024, Oct. 8, 1957.

[44] Pooley, H., and Parker, L. D. (assigned to Vickers-Armstrongs, Ltd., London, England), Shaft Kilns: U. S. Patent 2,788,961, Apr. 16, 1957.

[45] Vogel, R. B. (assigned to The National Lime & Stone Co., Findlay, Ohio), Lime Kiln: U. S. Patent 2,784,956, Mar. 12, 1957.

[46] Vreeland, G. W. (assigned to Kaiser Steel Corp., Oakland, Calif.), Cooling Device: U. S. Patent 2,792,924, May 21, 1957.

[47] Cheronis, H. D., Treatment of Garbage and Other Wastes: U. S. Patent 2,793,973, May 28, 1957.

[48] Locke, R. S., Lawson, R. B., and Green, H. O. (assigned to Diamond Springs Lime Co., California), Lime Process: U. S. Patent 2,784,062, Mar. 5, 1957.

lime putty formed contains 10 to 15 percent free moisture. It is continuously, mechanically agitated while being exposed to a circulating gas heated between 370° and 425° C. The dried hydrate is then ground in tube mills at temperatures below 100° C.

Some 1957 patents involved lime uses. Continuous circulation of an oil-well drilling mud composed of lime (or portland cement), an amine-treated bentonite, and a hydrocarbon was expected to form a stable filter cake on the borehole walls.[49] Lime, exceeding the amount that combines with the drilling-mud clay, forms the base of low-water-loss drilling muds; the water-loss inhibitor being either karaya gum [50] or ground Irish moss.[51] A new role for hydrated lime in the building industry was that of an ingredient in a casein adhesive used for cementing layers of gypsum wallboard into laminated wall and partition structures.[52] Lime may be used as an ingredient with graphite, magnesium chloride, magnesia, and water in a patented sand-core coating.[53] A thick slurry of hydrated lime may be used to form a hard, resistant crust on iron-ore briquets to protect them from breakage before entering the furnace.[54] After drying, the lime-coated briquets are fired above the lime-iron oxide eutectic point.

To stabilize soil in a road base, lime and fly ash may be added to the inert aggregate.[55] Finely divided calcium carbonate (whiting) was produced in a patented process [56] by suspending, heating, and moistening quicklime or hydrated lime. After the water had vaporized, the lime-particle cloud was treated with CO_2. Lime was used in a process for manufacturing terephthalamic acid derivatives.[57] A slag was formulated in France for rapidly desulfurizing cast iron. It consisted of 60 to 85 percent fluorite, 15 to 40 percent lime, and from none to 20 percent alkali halide or alkaline earth metal.[58] A patented process for recovering lithium salts from spodumene was developed for use in the Belgian Congo.[59] Crushed spodumene was heated with a lime flux to about 1,300° C. The calcined mass was cooled, finely ground, and leached with dilute acid (such as hydrochloric), at elevated temperature and pressure, to extract a soluble lithium salt.

Calcination.—At Odda, Norway, from 1950 to 1954 a standard gas-fired, 100-ton-per-day vertical kiln, similar to that used in England and elsewhere in Europe and by Ash Grove Lime & Portland Cement Co. near Springfield, Mo., was fired by high-pressure (500 p. s. i.) atomized oil injected into recirculated kiln-exhaust gases. The lime

[49] Ilfrey, W. T., and Prokop, C. L. (assigned to Esso Research and Engineering Co., Elizabeth, N. J.), Method of Drilling Wells: U. S. Patent 2,776,112, Jan. 1, 1957.
[50] Watkins, T. E. (assigned to Socony Mobil Oil Co., New York, N. Y.), Method of Treating Lime Base Drilling Fluids to Reduce Water Loss: U. S. Patent 2,816,071, Dec. 10, 1957.
[51] Watkins, T. E. (assigned to Socony Mobil Oil Co., New York, N. Y.), Method of Reducing Water Loss of Lime Base Drilling Fluids: U. S. Patent 2,816,072, Dec. 10, 1957.
[52] Nelsson, N. (assigned to United States Gypsum Co., Chicago, Ill.), Laminated Wall and Partition Structure: U. S. Patent 2,810,166, Oct. 22, 1957.
[53] Waterhouse, F. L., and Zinsmeister, L. L. (assigned to Eaton Manufacturing Co., Cleveland, Ohio), Sand Core Coating Composition: U. S. Patent 2,809,117, Oct. 8, 1957.
[54] Veale, J. H., and West, H. F. (assigned to Illinois Clay Products Co., Joilet, Ill.), Crust-Bearing Iron Oxide Agglomerate: U. S. Patent 2,806,777, Sept. 17, 1957.
[55] Havelin, J. E., and Kahn, F., Stabilized Soil: U. S. Patent 2,815,294, Dec. 3, 1957.
[56] Avedikian, S. Z., Process for Preparing Completely Carbonated Lime: U. S. Patent 2,802,719, Aug. 13, 1957.
[57] Hotten, B. W. (assigned to California Research Corp., San Francisco, Calif.), Use of Lime in the Production of Monoesters of N-Alkyl Terephthalamic Acids: U. S. Patent 2,808,427, Oct. 1, 1957.
[58] Perrin, R., and Lamberton, J. (assigned to Societe d'Electro Chimie d'Electro-Metallurgie et des Acieries Electriques d'Ugine, Paris, France), Process for Rapidly Desulphurizing Cast Iron: U. S. Patent 2,794,730, June 4, 1957.
[59] Kroll, A. V. (assigned to Compagnie Geologique et Minière des Ingénieurs et Industriels Belges "Geomines" Société par Actions a Responsabilitié Limitee, Manono, Belgian Congo), Method of Producing Lithium Salts From Lithium Minerals: U. S. Patent 2,793,933, May 28, 1957.

formed was too friable and created a dust problem in the recirculated gases.[60] Considering the Scandinavian fuel problem, oil should be used, but it should be either gasified by partial combustion or atomized and injected into exhaust gases, so that the mixture will assume a gaseous behaviour.

Three gas-fired, 100-ton-per-day vertical kilns, 50 by 11 feet square, were converted to oil-fired 480-ton-per-day kilns at Electro Metallurgical Co., Ashtabula, Ohio. Lime for carbide manufacture and metallurgical uses was produced. Hanging of lime to kiln walls, refractory-lining damage, and operating costs were reduced by control of increased heat input, distribution of liquid fuel across the kilns, and highest practical rate of throughput. Three transverse, watercooled, steel-burner ducts were installed at two levels.[61]

West End Chemical Co., Westend, Calif., installed an automatic, natural gas, 8- by 340-foot rotary kiln in 1956. Its use reversed emphasis on lime. CO_2 is usually lost in calcining or recovered as a byproduct only, but West End considered it the primary kiln product and used it for processing sodium chemicals. Bulk chemical-grade quicklime and bagged pulverized hydrated lime were only byproducts. From the feed end of the kiln CO_2 was passed through 3 scrubbers, cooled to 125° F., and piped to soda-ash plant.[62]

Stabilization.—Annual consumption of lime for road stabilization reached 150,000 tons in 1957, according to the National Lime Association. Lime-stablized roads were reported as having withstood hurricane and floodwater damage better than connecting nonstabilized roads in Louisiana and Texas.[63]

In a Milwaukee, Wis., suburb 400 bags of hydrated lime were used to stabilize the 6-inch layer of crushed bank-run clay gravel used in a 400-foot residential street.[64]

In constructing the Dallas-San Antonio-Laredo, Tex., interstate highway 22,000 tons of hydrated lime was used in 1957 for stabilizing a weak, highly plastic subgrade.[65]

Over 3,000 tons of hydrated lime were to be used to stabilize the plastic-clay subbase of a 300-foot-wide runway, 2½ miles long, at Bergstrom Air Force Base, Austin, Tex.[66]

Reuse.—National Carbide Co., Division of Air Reduction Co., announced plans for lime recovery at Louisville and Calvert City, Ky. Lime will be recovered from residues of acetylene operations for use in calcium carbide production. The two $2-million reclamation plants will use heat and centrifuging to dewater sludge, which has accumulated at the rate of several hundred tons per day on a 70-acre tract at the Louisville plant.[67]

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60 Work cited in footnote 28.

61 Pit and Quarry, Industrial Minerals Given New Prominence: Vol. 49, No. 11, May 1957, pp. 89–90. De Wet Erasmus, H., and Leuenberger, H., High-Capacity Vertical Kilns: Pit and Quarry, vol. 49, No. 11, May 1957, pp. 106, 154, 156.

62 Utley, H. F., West End Chemical's New Rotary-Kiln Lime Plant: Pit and Quarry, vol. 49, No. 11, May 1957, pp. 138–140, 142.

63 National Lime Association, Limeographs: Vol. 24, July–August 1957, p. 8.

64 Work cited in footnote 63, p. 9.

65 National Lime Association, Limeographs: Vol. 24, September 1957, p. 21; Roads and Streets, Lime Subgrade Stabilization on Texas Interstate Projects: Vol. 100, No. 7, July 1957, pp. 75–76, 83–84, 87, 99.

66 National Lime Association, Limeographs: Vol. 24, October 1957, p. 30.

67 Chemical and Engineering News, vol. 36, No. 1, Jan. 6, 1958, p. 33; Chemical Week, vol. 81, No. 25, Dec. 21, 1957, p. 23; vol. 82, No. 2, Jan. 11, 1958, p. 24.

Research.—Research sponsored by the National Lime Association at the Masonry Materials Research Laboratory, Massachusetts Institute of Technology, employed a heating microscope to observe lime shrinkage during calcination and to study the relation of shrinkage to hydration and temperature of calcination. Those quicklimes, which had high shrinkages and consequently low porosities, had low-hydration rates. Higher temperatures were found to produce higher shrinkages. A quicklime produced at a high heating rate shrank more than one produced at a low rate. Shrinkage on calcination may or may not depend upon concentrations of air and/or CO_2 in the kiln atmosphere. Sodium salts added to limestone reduced shrinkage on calcining, and shrinkage of a lime was found to vary inversely with the soda content of its parent limestone.[68]

The Chalk, Lime, and Allied Industries Research Association Laboratories, Welwyn, England, investigated the analytical and physical chemistry of lime and lime products, the rheology of mortars, the structural and chemical features of soil relating to lime stabilization in highway and foundation construction, and the nature and properties of calcium silicate hydrates formed in manufacturing brick when sand and lime are steam-treated under pressure.[69]

The British Department of Scientific and Industrial Research began laboratory work to study lime reactions with various soils. Their first report, Laboratory Experiments in the Stabilization of Clays With Hydrated Lime, by K. E. Clare and A. E. Cruchley, appeared October 1956.[70]

New Uses.—Acidic drainage from two nearby coal mines had lowered the pH of Lake Alma, Vinton County, Ohio, to 4.5, destroying fish life. Over a 4-year period, beginning in 1952, 5 tons of hydrated lime were added to the 72½-acre lake, raising its pH to 7.1, and fish life was reported as thriving again.[71]

To prevent contamination of grazing land and resulting bone disease (fluorosis) in dairy herds, a process was introduced at the United States Steel Corp. Columbia-Geneva mill near Provo, Utah, for injecting hydrated lime dust (95 percent below 325-mesh) at the rate of 20 pounds a minute into 800° F. fluorine- and fluoride-bearing furnace gases to form calcium fluoride particles later removed by cycloning and electrostatic precipitation.[72] Ninety percent of the fluorine was removed by this $9-million installation.

[68] Murray, James A., Shrinkage Activity as Functions of Lime Burnig Conditions: Pit and Quarry, pt. 1, vol. 49, No. 11, May 1957, pp. 122–127, 152; pt. 2, vol. 49, No. 12, June 1957, pp. 140–143.
[69] Work cited in footnote 29.
[70] National Lime Association, Limeographs: Vol. 23, March 1957, p. 83.
[71] Work cited in footnote 63, pp. 5–6.
[72] Chemical Engineering, Giant Fume Catcher Stops Fluoride Emission: Vol. 65, No. 4, Feb. 24, 1958, pp. 66, 68; Eng. Min. Jour., USS Unveils $9-Million Fluorine Plant: Vol. 159, No. 1, January 1958, p. 154.

Lithium

By Albert E. Schreck[1]

MARKET development and expansion, rather than increases in production capacity, characterized the lithium industry in 1957. Some of the cloak of secrecy surrounding the industry was lifted with the announcement that the Atomic Energy Commission (AEC) was purchasing lithium hydroxide from three lithium-chemical producers. Prices of lithium carbonate and hydroxide were sharply reduced.

DOMESTIC PRODUCTION

No new firms entered the lithium picture in 1957, and no major expansion of existing facilities was undertaken. American Potash & Chemical Corp. continued producing dilithium-sodium phosphate from Searles Lake brines; Foote Mineral Co. produced spodumene from its open pit at Kings Mountain, N. C., and Maywood Chemical Works produced spodumene from its Etta mine in the Black Hills, S. Dak. Lithium Corp. of America continued to produce lithium chemicals at its Bessemer City, N. C., plant from spodumene concentrate supplied by Quebec Lithium Corp. American Lithium Chemicals, Inc., a subsidiary of American Potash & Chemical Corp. at San Antonio, Tex., processed lepidolite from Southern Rhodesia to lithium chemicals.

In addition to these major producers, the following firms produced lithium minerals in 1957: Consolidated Feldspar Corp., from the Hugo mine, Pennington County, S. Dak. (amblygonite); Bland Mining & Milling Co., from the Beecher No. 3 mine, Custer County, S. Dak. (spodumene); Walter Hough and A. L. Judson from the High Climb mine, Custer County, S. Dak. (amblygonite); the Black-Hills-Keystone Corp., from the Ingersoll mine, Pennington County, S. Dak. (lepidolite and amblygonite); and York Minerals from the Helen Beryl mine, Custer County, S. Dak. (spodumene).

TABLE 1.—Shipments of lithium ores and compounds from mines in the United States, 1948–52 (average) and 1953–57

Year	Ore		Li_2O (short tons)	Year	Ore		Li_2O (short tons)
	Short tons	Value			Short tons	Value	
1948–52 (average)	9,307	$617,000	711	1954	37,830	$3,126,000	2,459
1953	27,240	2,134,000	1,767	1955–57	(1)	(1)	(1)

[1] Data not available.

[1] Commodity specialist.

American Potash & Chemical Corp. began commercial production of lithium metal during the latter half of 1957. Production of lithium perchlorate and lithium nitrate was also started.[2]

Modernization of the Foote Mineral Co. ceramic grinding unit at Cold River, N. H. (acquired in late 1956), was completed, and commercial processing of Ceramic-grade petalite was begun.[3]

Lithium Corp. of America further expanded its lithium-metal-production facilities at the St. Louis Park, Minn., plant.

CONSUMPTION AND USES

The AEC revealed early in 1957 that it had contracts with Foote Mineral Co., Lithium Corp. of America, and American Lithium Chemicals, Inc., to purchase undisclosed quantities of lithium hydroxide. The Commission was reported to be extracting the lithium-6 isotope from the hydroxide. The residue (lithium hydroxide rich in lithium-7) was stockpiled and made available for repurchase by the suppliers. The Commission is obligated to refrain from selling, other than to the supplier, stockpiled lithium hydroxide until 10 years after termination of the contracts. In this manner the producers are protected from competition with a Government stockpile.

The leading commercial consumers of lithium compounds in 1957 were the all-purpose grease and the ceramics industries. For use in lithium-base greases lithium hydroxide is converted to the stearate. The addition of lithium stearate increases water and temperature resistance. In ceramics, lithium carbonate added to porcelain enamels for steel and aluminum coatings imparts high gloss and greater impact and acid resistance and permits thinner, more fluid coats which can be fired at lower temperatures.

In glasses and glazes lithium reduces viscosity and improves electrical properties and resistance to weathering.

Lithium bromide and chloride were used in industrial air-conditioning systems, and the chloride and fluoride are used in welding and brazing compounds. Lithium hydroxide was used as an additive in alkaline storage-battery electrolytes to increase output and lengthen cell life.

Lithium metal was used in alloys, as a deoxidizer, desulfurizer, and degasifier in metal manufacture, and as a catalyst in synthetic "natural" rubber manufacture and in organic synthesis.

Research continued on use of lithium metal and compounds in high-energy chemical fuels, in lithium-aluminum and other lightweight alloys, and in many other potential applications.

PRICES

The prices of the two major lithium compounds—lithium carbonate and lithium hydroxide—were sharply reduced in 1957. The carbonate, technical grade, was quoted at $0.82 per pound in January and reduced to $0.77 per pound in May and to $0.73 in November. Likewise, the hydroxide, which was quoted at $0.80 per pound in January, was reduced to $0.78 in May and to $0.75 in November and

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[2] Chemical Engineering, Lithium Compounds: Vol. 64, No. 10, October 1957, p. 174.
[3] Foote Mineral Co., 41st Annual Report, 1956: Philadelphia, Pa., p. 5.

further reduced in the latter part of December to $0.55 per pound. Producers believed that the reduction would stimulate the market and help increase sales to levels commensurate with production capacity.[4]

E&MJ Metal and Mineral Markets quoted lithium metal, 98 percent pure, at $11 to $14 a pound.

Prices of lithium minerals were not quoted in trade journals.

TABLE 2.—Range of prices of selected lithium compounds, in 1957, in pounds

[Oil, Paint and Drug Reporter]

Name of compound	January 1957	December 1957
Lithium benzoate, drums	$1.65–$1.67	$1.65–$1.67
Lithium bromide, NF, drums, works, freight equalized	2.45	2.60
Lithium carbonate, technical, drums, car lots, ton lots, delivered, freight allowed, works	.82	[1].73
Less than car lots, same basis	.85–1.11½	----------
Drums, ton lots, same basis	----------	[2].79
Drums, smaller lots, same basis	----------	[2].85
Lithium chloride, technical, anhydrous, drums, car lots, ton lots, delivered or works, freight allowed	1.00– 1.05	.87
Less than car lots, same basis	1.05– 1.05½	.88– .92
Lithium hydride, powder, drums, 500-pound lots, works	10.50–12.50	9.50
Lithium hydroxide monohydrate, drums, car lots, ton lots, delivered or works, freight allowed	.80– .80½	[3].55
Less than car lots, same basis	.81– .81½	[4].56
Lithium nitrate, technical, drums, 100-pound lots	1.25	1.15– 1.25
Lithium stearate, drums, car lots, works	.47½	.47½
Ton lots, works	.48½	.48½
Less than ton lots, works	.53½	.53½

[1] Quotation changed to read "Lithium carbonate, technical, drums, car lots, ton lots, freight allowed," Nov. 11, 1957.
[2] New quotation as of Nov. 11, 1957.
[3] The term "delivered or works" dropped from quotation, Nov. 11, 1957.
[4] Quotation changed to read "drums, less than car lots, freight allowed," Nov. 11, 1957.

FOREIGN TRADE

Canada and the Federation of Rhodesia and Nyasaland continued to be the principal sources of imported lithium minerals.

Figures on imports and exports of lithium minerals and compounds are not separately classified by the United States Department of Commerce on the import or export schedules.

WORLD REVIEW

NORTH AMERICA

Canada.—An article describing and giving the location of the lithium occurrences in Canada was published.[5] Methods for recognizing lithium minerals and evaluating deposits were discussed and geologic features of lithium deposits described.

Quebec Lithium Corp., Canada's only lithium producer, announced plans to construct a lithium-chemical plant at Rouses Point, N. Y.[6] The firm had an option on a 450-acre site near the Canadian border, due south of Montreal. Output for the firm in 1957 totaled 50,430 tons of spodumene concentrate averaging 5.1 percent lithia. The

[4] Chemical Week, Lithium Prices' Long Slide: Vol. 81, No. 25, Dec. 21, 1957, pp. 20–21.
[5] Mulligan R., Lithium in Canada: Canadian Min. Jour., vol. 78, No. 4, April 1957, pp. 121–126.
[6] Northern Miner (Toronto), Quebec Lithium Chooses Plant Site for New Refinery: Vol. 43, No. 30, Oct. 17, 1957 p. 1.

concentrate was valued at $2,827,143.[7] The firm operated on a 44-hour week, 265-day-per-year schedule. The average hoisting rate was reported to be 1,027 tons per day, and the mill treated an average of 856 tons per day. The shaft was enlarged from 3 compartments to 5. At the close of 1957, 152 persons were employed at the mine.

American Metal Co. obtained an option to participate in a joint venture with Montgary Explorations, Ltd., to develop the latter's spodumene deposit at Bernic Lake, Manitoba; however, American Metals allowed its option to expire on November 1. Montgary has indicated that it plans to develop the operation through the lithium-chemicals stage. The ore body reportedly contains 8 million tons of ore averaging 1.85 percent lithia.[8]

EUROPE

U. S. S. R.—The Soviet Academy of Sciences reported that a large lithium deposit was discovered in the Kola Peninsula in northern European Russia. The discovery reportedly increased the Russian reserves "a thousandfold." [9]

AFRICA

Rhodesia and Nyasaland, Federation of.—The output of lithium minerals in 1956, all from Southern Rhodesia, increased over 20,000 tons compared with 1955.

Most of the lithium exported from the Federation went to the United States, with smaller quantities to Germany, France, and the United Kingdom.

TABLE 3.—Production of lithium minerals in Southern Rhodesia, 1954–56, in short tons [1]

Type	1954	1955	1956
Amblygonite	434	180	646
Lepidolite	26,909	57,714	84,599
Petalite	26,707	24,210	13,524
Spodumene		50	4,445
Total	54,050	82,154	103,214

[1] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 3, March 1957, p. 24; vol. 45, No. 3, September 1957, pp. 28, 29.

TABLE 4.—Exports of lithium ores from the Federation of Rhodesia and Nyasaland, 1956 [1]

Country of destination	Short tons	Value	Country of destination	Short tons	Value
France	3,488	$49,672	Union of South Africa	47	$1,932
Germany, West	4,832	80,125	United Kingdom	5,432	109,107
Italy	40	980	United States	63,470	1,007,734
Japan	250	5,314			
Netherlands	633	52,237	Total	78,192	1,307,101

[1] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 29.

[7] Northern Miner (Toronto), Quebec Lithium Profits Climb; Views Future With Confidence: Vol. 43, No. 44, Jan. 23, 1958, pp. 1, 8.
[8] Chemical and Engineering News, vol. 35, No. 24, June 17, 1957, p. 107.
[9] Oil, Paint and Drug Reporter, Boron, Lithium Deposits Unearthed in Soviet Union: Vol. 172, No. 24, Dec. 9, 1957, p. 5.

South-West Africa.—Production of lithium minerals declined in 1956, but exports (composed primarily of petalite) increased. The following firms produced lithium minerals in South-West Africa in 1956: E. M. Becker, Karibib (lepidolite); M. H. C. Brockmann, Karibib (amblygonite, lepidolite); Consolidated Tin Mines, Omaruru (amblygonite); J. E. E. Huhle, Karibib (amblygonite); P. J. Human, P. O. Omaruru (amblygonite); E. E. Simon, Karibib (amblygonite, petalite); S. W. A. Lithium Mines, Windhoek (amblygonite, lepidolite, petalite); and P. Weidner, Warmbad (amblygonite).

TABLE 5.—Production of lithium minerals in South-West Africa, 1955–56, in short tons

Type	Li_2O, percent	1955	1956
Amblygonite	6–8	1,414	831
Lepidolite	3–3.6	1,832	1,139
Petalite	3–4	5,278	3,675
Total		8,524	5,645

TABLE 6.—Exports of lithium minerals in South-West Africa,[1] 1955–56

Country of destination	1955		1956	
	Short tons	Value f. o. b.	Short tons	Value f. o. b.
Amblygonite:				
Netherlands	1	$140	438	$50,610
Germany, West	1,157	137,404		
United Kingdom	221	23,430	226	17,209
United States	88	7,784		
Total	1,467	168,758	664	67,819
Lepidolite:				
Germany	496	9,932	301	9,635
Netherlands	694	32,029	208	8,798
United Kingdom	200	4,900	56	1,131
United States	100	3		
Total	1,490	46,864	565	19,564
Petalite:				
Belgium	335	6,720		
Germany	501	6,633	165	3,466
Netherlands	22	448	901	21,316
United Kingdom	101	2,089	2,181	55,580
United States	339	6,832	355	8,392
Total	1,298	22,722	3,602	88,754
Spodumene: Netherlands	(2)	8		
Grand total	4,255	238,352	4,831	176,137

[1] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, pp. 31–32.
[2] 416-pound sample.

Union of South Africa.—Lithium-ore output increased from 426 short tons in 1955 to 713 in 1956.

Of the total 556 tons exported, 389 tons (valued at $24,290) went to the United States and the remaining 167 tons (valued at $11,200) to Germany.[10]

[10] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, p. 29.

TECHNOLOGY

An article describing Surpass Petrochemicals' new lithium-grease plant at Toronto, Canada, was published.[11] It was said to be the second continuous-process plant to be built in the United States and Canada. The annual capacity of the plant was reported to be 25 million pounds. The pros and cons of continuous processing versus batch processing were discussed, and a flowsheet accompanied the article.

Half of the oil required for the grease is agitated in one of two 300-gallon slurry tanks, the tank is evacuated to deaerate the oil, and the lithium stearate and other ingredients are added. After mixing, the slurry passes to a heat-transfer unit, where the temperature is raised from 85° to 400° F. in 3 minutes. Rotating blades insure high heat transfer and provide additional mixing. The mix then passes to an agitated steel blender, where the remaining oil, heated to 190° F., is added. The oil is blended at 300° F. and agitated slowly to avoid high shear. The blended material passes through a cooling unit, where its temperature is reduced to 140° F.; here the gel formation is completed. The cooled grease is then milled, deaerated, and barreled.

Methods for identifying various lithium minerals, including their physical properties, tests for determining the presence of the element lithium, and tests for identifying specific lithium mineral species, were outlined in an article.[12] The difficulties encountered in using flame tests and methods for resolving these problems were given. The author also described fusion tests for lithium minerals, differentiating lithium mineral from related minerals and identifying grains in composite samples by staining amblygonite grains, decrepitation or staining tests for spodumene, and fluorescence tests for petalite.

Several methods for recovering lithium from ores were patented. One method involves calcining spodumene to the beta form and digesting the beta spodumene with excess aqueous hydrochloric acid above 90° C. but below the boiling point of the acid for at least 10 hours.[13] The lithium in the spodumene is converted to lithium chloride, which is recovered by washing.

In another method water-soluble lithium salts are produced from silicoaluminous lithium ores by heating the ore to above about 1,050° C, cooling, and treating the calcined ore with sodium or potassium acetate between 280° and 324° C. The mass is cooled and lithium acetate extracted. The acetate can be converted to the carbonate by treating with an alkali carbonate.[14]

Lithium values can also be recovered from spodumene ores by converting alpha spodumene to beta spodumene, roasting the beta spodumene at 300°–700° F., with dry ammonium sulfate to convert the lithium to the sulfate. The resulting mass is leached with aqueous ammonia to recover lithium sulfate and ammonium sulfate. The

[11] Chemical Engineering, New Grease Process Ousts Batch Kettles: Vol. 64, No. 6, June 1957, pp. 150, 152.

[12] Hosking, K. F. G., Identification of Lithium Minerals: Mining Mag., vol. 96, No. 5, May 1957, pp. 271–276.

[13] Reader, Lawrence, J. (assigned to Foote Mineral Co., Philadelphia, Pa.), Method of Recovering Lithium Values: U. S. Patent 2,803,518, Aug. 20, 1957.

[14] Kroll, A. V. (assigned to Compagnie Géologique et Minière des Ingenieurs et Industriels Belges "Geomines" Société par Actions à Responsabilité Limitée, Manono (Belgian Congo), Brussels, Belgium), Method of Extracting Lithium From Its Silico-Aluminous Ores: U. S. Patent 2,816,007, Dec. 10, 1957.

leach liquor is then treated to recover the lithium values. The ammonium sulfate is recovered from the leach liquor or can be recycled.[15]

In still another process silicoaluminous ores are calcined at about 1,100°–1,300° C. to a vitreous and substantially noncrystalline state. The mass is then cooled and ground. The lithium salt is next extracted by using an aqueous leach, such as hydrochloric acid, sodium chloride, potassium chloride, sodium sulfate, or others, at superatmospheric pressure and temperatures from 100°–400° C.[16]

The use of lithium carbonate in a dry-powder fire-extinguishing composition was patented.[17] The powder consists of a finely divided dry mixture of about 85 percent by weight of sodium bicarbonate and about 15 percent by weight of lithium carbonate.

Alcoa Research Laboratories developed a lithium-aluminum alloy that retains its strength at higher temperatures than existing aluminum aircraft alloys.[18] The alloy reportedly stays strong up to 400° F., which means that the thermal barrier has been moved up 100° F. The density of the alloy is reported to be 3 percent less than that of alloys previously used in aircraft and has improved the modulus of elasticity of aluminum-aircraft alloys by 8 percent.

Research by the Wool Textile Research Laboratory at Geelong, Australia, indicated that lithium compounds, such as the sulfate, chloride, hydroxide, citrate, bromide, and iodide, are deadly to clothes moths and carpet-beetle larvae.[19]

The diversity of uses for lithium compounds was increased further when a patent was issued on the use of lithium carbonate in laundering.[20] Soiled articles are rinsed in a solution of lithium carbonate and cold water and then washed in a regular manner. The carbonate absorbs odors and reportedly leaves no irritating residue.

The American Lithium Institute sponsored research on lithium in various applications. A project to determine the behavior of lithium in glass was underway at Pennsylvania State University; research on lithium alloys was being conducted at Massachusetts Institute of Technology; and lithium's role as a polymerization catalyst was being investigated at Princeton University. In addition to these projects the Institute was preparing a treatise on lithium and its compounds to be published as an American Chemical Society monograph.

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[15] Dwyer, Thiel E. (assigned to Tholand, Inc., New York, N. Y.), Recovery of Lithium From Spodumene Ores: U. S. Patent 2,801,153, July 30, 1957.

[16] Kroll, A. V. (assigned to Compagnie Géologique et Minière des Ingenieurs et Industriels Belges "Geomines" Société par Actions à Responsabilité Limitée, Manono (Belgian Congo), Method of Producing Lithium Salts from Lithium Minerals: U. S. Patent 2,793,933, May 28, 1957.

[17] Sylvester, Walter G., and Anthony, Charles J. (assigned to Specialties Development Corporation, Belleville, N. J.), Fire-Extinguishing Composition and Method of Extinguishing Fires: U. S. Patent 2,776,942, Jan. 8, 1957.

[18] Chemical and Engineering News, New Alloy Resists Heat: Vol. 35, No. 41, Oct. 14, 1957, p. 83.

[19] McPhee, J. R., Toxicity of Lithium Salts to Keratin-digesting Insect Larvae: Nature, vol. 180, No. 4593, Nov. 9, 1957, pp. 1001-1002.

[20] Melander, L. W. (one-half assigned to Ikel C. Benson), Process for Eliminating Urine Odors in Textile Materials by Applying Lithium Carbonate: U. S. Patent 2,815,260, Dec. 3, 1957.

Magnesium

By H. B. Comstock [1]

PRODUCTION of magnesium in the United States in 1957, which rose 19 percent above 1956, was 48 percent of world output. In the United States consumption of magnesium fell 17 percent below 1956, and exports fell 64 percent. Research continued in 1957, both in development of magnesium alloys with improved qualities and in fabrication and use techniques. Use of light metals in the atomic

TABLE 1.—Salient statistics of magnesium, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Domestic production:						
Primary magnesium.....short tons..	36,813	93,075	69,729	61,135	68,346	81,263
Secondary magnesium.....do....	9,199	11,930	8,250	10,246	10,529	10,658
Imports [1].....do....	1,641	2,443	733	1,844	630	982
Exports.....do....	797	2,722	3,096	8,230	3,388	1,208
Consumption.....do....	23,168	46,843	39,218	46,463	53,610	44,442
Price [2].....cents per pound..	22.4	26.6	27.0	29.5	33.9	35.25
World: Primary production.....short tons..	72,700	168,000	136,000	143,000	[3] 157,000	168,000

[1] Metallic and scrap.
[2] Magnesium ingots (99.8 percent) in carlots, f. o. b. Freeport, Tex.
[3] Revised figure.

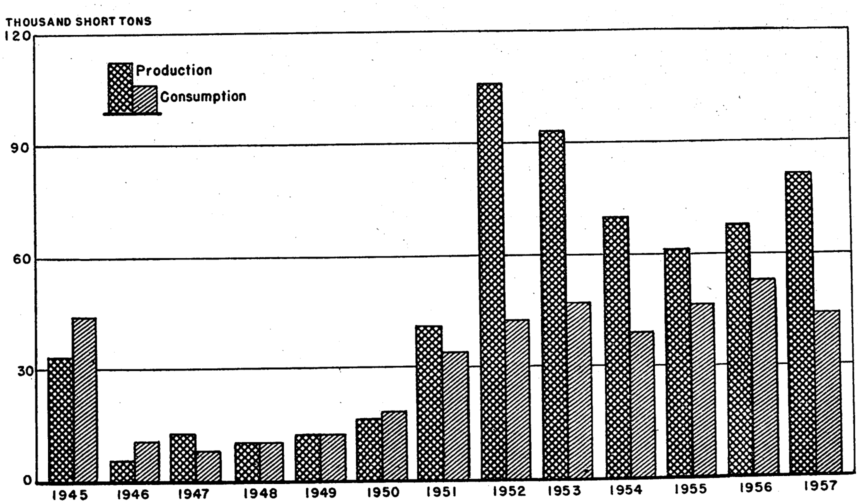

FIGURE 1.—Trends in domestic production and consumption of primary magnesium, 1945–57.

[1] Commodity specialist.

energy and missile programs promoted development of magnesium alloys with superior strength at elevated temperatures. The relatively new technique of pellet extrusion of magnesium with high compressive yield strength was in use in 1957 to produce stronger sections for military aircraft and missiles.

DOMESTIC PRODUCTION

Primary.—In 1957 output of primary magnesium in the United States was 81,263 tons—the highest yearly production since 1953. Dow Chemical Co. operated its electrolytic plant at Freeport, Tex., and the Government-owned electrolytic plant at Velasco, Tex., which it had leased since 1951. On November 4, 1957, Dow purchased the Velasco plant.[2]

Nelco Metals, Inc., continued to produce magnesium and calcium in the Government-owned silicothermic plant at Canaan, Conn.

Titanium Metals Corp. of America reported a decrease below 1956 of the quantity of magnesium it recycled as an integrated operation with its production of titanium at Henderson, Nev.

TABLE 2.—Production of primary magnesium in the United States, 1948–52 (average) and 1953–57, by months, in short tons

Month	1948–52 (average)	1953	1954	1955	1956	1957
January	2,435	9,908	6,447	5,090	6,337	7,391
February	2,426	9,078	5,856	4,647	5,908	6,617
March	2,720	10,352	6,545	4,942	6,347	7,383
April	2,712	9,751	6,204	1,859	6,081	7,222
May	2,809	9,116	6,460	4,277	6,359	7,227
June	2,815	7,286	6,191	4,757	6,098	6,718
July	3,127	6,207	6,049	5,112	1,136	6,777
August	3,274	6,266	5,772	5,881	3,314	7,152
September	3,203	6,076	5,325	5,923	6,128	6,486
October	3,534	6,341	5,149	6,287	6,735	6,468
November	3,735	6,227	4,942	6,130	6,818	5,995
December	4,023	6,467	4,789	6,230	7,085	5,827
Total	36,813	93,075	69,729	61,135	68,346	81,263

Secondary.—Secondary magnesium recovered from scrap in 1957 was 10,658 tons, 129 tons above 1956. This slight increase resulted from the use of a larger quantity of aluminum scrap containing magnesium. As in 1956, the three largest uses of secondary magnesium were in magnesium and aluminum alloys and anodes for cathodic protection. Of the total 9,518 tons of magnesium scrap consumed, 94 tons was used in magnesium castings, 5,249 in magnesium-alloy ingot, 497 in aluminum alloys, 53 in other alloys and chemicals, and 3,625 in anodes for cathodic protection. Although consumption of wrought magnesium scrap rose 66 percent, no secondary magnesium was reported used in wrought products. Use of magnesium turnings and cast scrap fell 16 and 7 percent, respectively, below 1956.

[2] American Metal Market, Dow Chemical Co. Buys Magnesium Plant From Government: Vol. 65, No. 214, Nov. 5, 1957, pp. 1, 9.

TABLE 3.—Magnesium recovered from scrap processed in the United States, 1956–57, in short tons [1]

Recoverable magnesium content of scrap processed			Magnesium recovered from scrap processed		
Kind of scrap	1956	1957	Form of recovery	1956	1957
New scrap:			In magnesium-alloy ingot [1]	4,072	4,200
Magnesium-base	3,099	3,360	In magnesium-alloy castings (gross weight)	206	75
Aluminum-base	2,071	2,237	In magnesium-alloy shapes	5	
Total	5,170	5,597	In aluminum alloys	3,188	3,383
			In zinc and other alloys	85	22
Old scrap:			In chemical and other dissipative uses	11	29
Magnesium-base	4,662	4,350	In cathodic protection	2,962	2,949
Aluminum-base	697	711			
Total	5,359	5,061	Grand total	10,529	10,658
Grand total	10,529	10,658			

[1] Figures include secondary magnesium incorporated in primary magnesium ingot.

TABLE 4.—Stocks and consumption of new and old magnesium scrap in the United States in 1957, gross weight in short tons

Scrap item	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Cast scrap	485	6,477	1,012	5,313	6,325	637
Solid wrought scrap	176	1,587	1,584		1,584	179
Borings, turnings, drosses, etc	278	1,536	1,609		1,609	205
Total	939	9,600	4,205	5,313	9,518	1,021

CONSUMPTION AND USES

The lag in the defense-missile program in 1957 was a substantial factor in the 18-percent drop below 1956 in consumption of primary magnesium.[3]

The volume of the use of the metal in permanent mold castings was the lowest since 1950. Production of magnesium forgings, which had increased steadily during 1954–56, fell below that in 1953.

The drop in production of aluminum alloys and the use of reducing agents other than magnesium for titanium production accounted for most of the 18-percent decrease below 1956 in consumption of primary magnesium for nonstructural purposes.

Although a 10-percent decrease was noted in production of sheet and plate, new uses were reported for magnesium tooling plate and photoengraving plate.[4] Use of magnesium extrusions continued above 5,000 tons. Extrusion capacity was greatly increased in 1957, when the 13,200-ton press went into operation at the Dow Chemical Co. plant at Madison, Ill. This press, capable of extruding aluminum also, could produce sections up to 40 inches wide and 80 feet long. Pellet extrusions produced in this press were used in 1957 in military

[3] Wall Street Journal, Air Force Cancels Further Work on North American Aviation Missile: Vol. 150, No. 9, July 12, 1957, p. 16.
Snyderman, Nat, Magnesium Sales Rise Seen Tied to Missiles: Electronic News, vol. 2, No. 58, Nov. 18, 1957, p. 14.
[4] Materials and Methods, New Uses of Magnesium: Vol. 45, No. 1, January 1957, pp. 112–115.

TABLE 5.—Domestic consumption of primary magnesium (ingot equivalent and magnesium content of magnesium-base alloys), by uses, 1948–52 (average) and 1953–57, in short tons

Product	1948–52 (average)	1953	1954	1955	1956	1957
For structural products:						
Castings:						
Sand	6,560	14,306	9,545	6,872	6,478	6,076
Die	871	2,401	1,743	2,619	1,875	1,649
Permanent mold	478	1,106	785	876	1,034	571
Wrought products:						
Sheet and plate	3,382	5,443	3,033	6,424	5,496	4,916
Extrusions (structural shapes, tubing)	3,213	4,744	2,461	4,106	6,223	5,081
Forgings	231	24	110	307	473	7
Total for structural products	14,735	28,024	17,677	21,204	21,579	18,300
For distributive or sacrificial purposes:						
Powder	418	1,219	582	681	918	386
Aluminum alloys	4,449	10,347	8,061	11,104	13,323	11,236
Other alloys	340	418	103	364	98	587
Scavenger and deoxidizer	771	423	80	654	865	867
Chemical	404	363	63	124	63	325
Cathodic protection (anodes)	1,404	2,539	5,479	3,941	3,036	2,997
Reducing agent for titanium, zirconium, hafnium, and beryllium	(1)	(1)	6,386	8,056	13,303	9,695
Other [2]	647	3,510	787	335	425	49
Total for distributive or sacrificial purposes	8,433	18,819	21,541	25,259	32,031	26,142
Grand total	23,168	46,843	39,218	46,463	53,610	44,442

[1] This use, which was very small before 1954, was included in the figure for other distributive purposes.
[2] Includes primary metal consumed for experimental purposes, debismuthizing lead, producing nodular iron and secondary magnesium alloys.

aircraft and missiles.[5] (Pellet extrusion is described under Technology.)

Increased uses for magnesium in 1957 were reported by the automotive and trucking industries.[6] Among new uses for the metal were items of materials handling equipment, automobile carriers for convoy trucks, hospital stretchers and carts, and military electronics items.[7]

STOCKS

Producers' and consumers' stocks at the close of 1957 were 58,864 tons of primary magnesium and 11,041 tons of primary magnesium-alloy ingot. This was equivalent to approximately 19 months' supply of the metal at the rate of consumption during 1957. Government agencies continued to hold quantities of primary magnesium, as provided by the Strategic and Critical Materials Stockpiling Act.

[5] American Metal Market, Largest Magnesium Extrusion Press Operating at Dow Plant: Vol. 64, No. 87, May 7, 1957, p. 11.
[6] American Metal Market, Corvette Pilot Model Features Greater Usage of Light Metals: Vol. 64, No. 56, Mar. 22, 1957, p. 9.
Glaza, G. K., Magnesium Swings More Weight in Trucking: Iron Age, vol. 179, No. 3, Jan. 17, 1957, pp. 78-79.
[7] Modern Metals, Pallet Dollies: Vol. 13, No. 3, April 1957, p. 96. Sensible Stretcher System: Vol. 12, No. 12, January 1957, pp. 68, 70.
Fortune, Lightweight Auto Carriers: Vol. 56, No. 5, November 1957, p. 208.
Maynard, A. F., Magnesium in Military Electronics: Modern Metals, vol. 13, No. 4, May 1957, pp. 66, 68, 70.

PRICES

The base price of primary magnesium ingot in standard 42-pound pig form remained throughout 1957 at 35.25 cents per pound, f. o. b. Velasco, Tex.[8]

FOREIGN TRADE [9]

Imports.—Imports of magnesium in 1957 rose 369 tons above 1956. About 16 percent of the total 1,025 tons was scrap metal. On June 30, 1957, duty on magnesium metal was reduced from 17.2 cents to 14.3 cents per pound; and on magnesium powder, sheets, tubing, manufactures, etc., duty was lowered from 19 cents per pound, plus 9.5 percent ad valorem, to 18 cents per pound plus 9 percent ad valorem. Suspension of duty on magnesium scrap was extended to June 30, 1958. The metal came from eight countries in 1957. Of the total 1,025 tons imported, 4 came from Algeria, 304 from Canada, 1 from the Dominican Republic, 55 from West Germany, 5 each from Morocco and Pakistan, 160 from Taiwan, and 491 from the United Kingdom.

Exports.—Magnesium exports in 1957 fell 2,346 tons below 1956 and were the lowest since 1952. The countries that received the metal are shown in table 7.

TABLE 6.—Magnesium imported for consumption and exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Imports						Exports					
	Metallic and scrap		Alloys (magnesium content)		Sheets, tubing, ribbons, wire, and other forms, (magnesium content)		Metal and alloys in crude form and scrap		Semifabricated forms, n. e. c.		Powder	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	1,641	$403,831	4	$7,304	32	$63,460	587	$295,898	210	$210,380	(1)	(1)
1953	2,443	877,130	3	15,537	5	19,983	2,722	1,718,232	[2] 227	[2] 771,032	21	$41,591
1954	733	337,773	6	29,767	3	14,159	3,096	1,766,650	[2] 161	[2] 605,251	34	44,605
1955	1,844	1,034,241	9	52,254	4	[3] 24,526	8,230	4,556,229	[2] 236	[2] 514,986	14	33,911
1956	630	303,586	24	202,675	2	[4] 8,715	3,388	2,239,577	[2] 487	[2] 901,924	56	98,635
1957	982	479,855	35	283,099	8	16,952	1,208	1,114,234	[2] 355	[2] 767,656	22	39,469

[1] Not separately classified before 1952. 1952—43 tons ($59,843).
[2] Owing to changes in items included in each classification, data are not strictly comparable with earlier years.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.
[4] Revised figure.

[8] American Metal Market, Magnesium: Vol. 65, No. 1, Jan. 1, 1958, p. 8.
[9] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

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TABLE 7.—Magnesium exported from the United States in 1957, by classes and countries, in short tons

[Bureau of the Census]

Country	Primary metal, alloys, and scrap	Semifabricated forms, n. e. c.	Powder
North America:			
Canada	94	165	14
Mexico	100	2	
Netherlands Antilles	7	24	
Nicaragua	5		
Trinidad and Tobago	76		
Other North America	7		(1)
Total	289	191	14
South America:			
Argentina		1	
Brazil	6	2	
Colombia	6	16	
Venezuela	89	19	
Total	101	38	
Europe:			
Belgium-Luxembourg	27	4	5
Denmark	44	2	
France	102	19	
Germany, West	52	6	
Italy	90	2	(1)
Netherlands	10	5	
Norway	71		3
Sweden	95	15	
Switzerland	(1)	17	
United Kingdom	23	2	
Other Europe		(1)	
Total	514	72	8
Asia:			
India	5	9	
Israel	21	5	
Japan	249	28	
Kuwait	7		
Saudi Arabia	12	3	
Other Asia	9	1	
Total	303	46	
Oceania		3	
Africa	1	5	
Grand total	1,208	355	22

[1] Less than 1 ton.

WORLD REVIEW

World production of magnesium in 1957 was 7 percent above 1956. The greatest increase was in the United States, showing actual production of 48 percent of the estimated total.

Canada.—Output of magnesium in Canada in 1957 fell 16 percent below 1956, which was the peak year in the history of its production there. Dominion Magnesium, Ltd., produced thorium at its magnesium plant site at Haley, Ontario, for use in making the new magnesium-thorium alloys.[10]

[10] Northern Miner (Toronto), Dominion Mangesium Produces Thorium for Alloying Uses: Vol. 43, No. 43, Jan. 16, 1958, pp. 1, 5.

TABLE 8.—World production of magnesium metal, by countries, 1948–52 (average) and 1953–57, in short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
Canada	[2] 2,400	[2] 6,600	[2] 6,600	[2] 7,700	9,606	8,037
China, Manchuria	[2] 90	(3)	(3)	(3)	(3)	(3)
France	745	1,098	1,268	1,670	1,676	1,752
Germany, West [4]	----------	----------	154	144	194	261
Italy	270	1,595	1,836	3,161	4,097	[2] 4,300
Japan	----------	----------	23	[5] 148	[5] 86	[2] 100
Norway	[6] 338	3,853	5,813	7,441	8,267	[2] 8,000
Switzerland	176	[2] 275	----------	----------	----------	----------
U. S. S. R.[2]	28,000	55,000	45,000	55,000	60,000	60,000
United Kingdom [4]	3,880	5,936	5,577	6,054	4,064	3,831
United States	36,806	93,075	69,729	61,135	68,346	81,263
World total (estimate)	72,700	168,000	136,000	143,000	157,000	168,000

[1] This table incorporates a number of revisions of data published in previous Magnesium chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[2] Estimate.
[3] Data not available; estimate by author of chapter included in total.
[4] Primary metal and remelt alloys.
[5] In addition, the following amounts of remelted magnesium were produced: 1955, 401 short tons; and 1956, 897 short tons.
[6] Average for 1951–52.

Japan.—Although production of magnesium in Japan in 1957 rose very little above 1956, new markets were sought.[11]

Norway.—Most of the output of magnesium in Norway was exported; however, the producing company announced that in 1957 it produced magnesium anodes for cathodic protection of ships, tanks, and ground pipe.[12]

U. S. S. R.—Announcement was made in the Soviet News that plans were under way to increase production of magnesium during the next 5 years.[13]

United Kingdom.—The electrolytic plant at Clifton Junction, near Manchester, continued in 1957 as the sole producer of primary magnesium in the United Kingdom. Published articles listed new uses and described progress in technology and fabricating facilities and techniques.[14]

The excellent service record of the magnesium-alloy sheaths in the Calder Hall reactor was published.[15]

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[11] American Metal Market, Magnesium—Japan to Export Small Tonnages to Red China on Trial Basis: Vol. 64, No. 175, Sept. 11, 1957, p. 10.
[12] Metal Bulletin (London), Magnesium—Herøya Producing Anodes: No. 4261, Jan. 14, 1958, p. 26.
[13] Metal Bulletin (London), Soviet Metallurgy Goes Ahead: No. 4267, Feb. 4, 1958, pp. 13–14.
[14] Wilkinson, R. G., Magnesium Forming: Metal Ind. (Birmingham, England), vol. 90, No. 4, February 1957, pp. 83–86.
Emley, E. F., The Founding of Magnesium: Foundry Trade Jour. (London), vol. 103, Nos. 2126 and 2127, July 11 and 18, 1957.
Modern Metals, Magnesium Fabrication Facilities of Magnesium Elektron, Ltd.: Vol. 13, No. 9, October 1957, p. 34.
[15] Bishop, Tom, Metallurgical Aspects of Calder Hall: Metal Prog., vol. 71, No. 6, June 1957, pp. 65–71.

TECHNOLOGY

In 1957 research gained momentum in the development and use of magnesium and its alloys. Published articles reflected detailed studies of the properties of the primary metal.[16]

A report of fundamental studies of the properties and behavior of magnesium and its alloys prepared by the Dow Chemical Co. for the United States Air Force was released.[17]

The Mines Branch of the Department of Mines, Ottawa, Canada, reported development of the new high-strength magnesium alloy designated as ZK61A, containing zinc and zirconium.[18]

Continued work in 1957 developed improved magnesium alloys containing thorium, with good creep resistance in applications reaching temperatures up to 700° F. and with superior tensile strength for short periods in applications reaching 900° F.[19] The Dow Chemical Co. published instructions covering proper health precautions for persons working in plants where magnesium-thorium alloys were melted and fabricated and described hazards from radioactive materials, including thorium, which were controlled by Government regulations.[20]

Reports were published describing a new fabrication technique—pellet extrusion of magnesium. In the process the molten magnesium alloy was poured from the pot onto a metal disk spinning at high speed within an atomizer tank and was hurled off in globules or pellets to the inner walls of the tank. Each cooling spherical pellet retained the exact ratio of alloying constituents as the molten mass. As the spherical pellets (about 0.016 inch in diameter) settled to the bottom of the tank, they were transferred to the extrusion press. The extruded sections had extremely fine grain size and high compressive yield strength.[21]

Reports were published describing improvements in techniques and facilities for casting, forging, rolling, and forming of magnesium alloys.[22]

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[16] Sporh, D. A., and Webber, R. T., Resistance Minimum of Magnesium—Electrical and Thermal Resistivities: Physical Rev., vol. 105, No. 5, Mar. 1, 1957, pp. 1427–1433.
Reed-Hill, Robert E., and Robertson, William D., Deformation of Magnesium Single Crystals by Nonbasal Slip: Jour. Metals, pt. 2, vol. 9, No. 4, April 1957, pp. 496–502.
Conrad, Hans, and Robertson, W. D., Effect of Temperature on the Flow Stress and Strain-Hardening Coefficient of Magnesium Single Crystals: Jour. Metals, pt. 2, vol. 9, No. 4, April 1957, pp. 503–512.
Couling, S. L., and Roberts, C. S., Grain Boundary Deformation in Fine-Grained Electrolytic Magnesium: Jour. Metals, vol. 9, No. 10, October 1957, pp. 1252–1256.
Metal Industry, Ductility of Magnesium: Vol. 91, No. 15, Oct. 11, 1957, pp. 319–320.

[17] Foster, G. D., and others, Investigation of Alloys of Magnesium and Their Properties: WADC Rept. 56–88 PB 121801, Office of Tech. Services, U. S. Department of Commerce, January 1957, 84 pp.

[18] Roast, Harold J., Metallurgy at Canada's Mines Branch: Metal Prog., vol. 71, No. 4, April 1957, pp. 74–77.

[19] Leontis, T. E., New Magnesium Alloys for High Temperature: Metal Prog., vol. 72, No. 2, August 1957, pp. 97–103.
Metal Progress, Constitution of Mg-Th and MgTh-Zr: Vol. 72, No. 6, December 1957, pp. 146, 148.

[20] Dow Chemical Co., Magnesium-Thorium Alloys—Industrial Health Experience in Fabrication and Production: Bull. 141-179, 1957, 14 pp.

[21] Iron Age, Pellet Extrusions and Strength: Vol. 179, No. 15, Apr. 11, 1957, pp. 142, 144.
American Metal Market, Magnesium—Pellet Extrusion Process Adds Strength to Aircraft: Vol. 64, No. 45, Mar. 7, 1957, p. 9.
Materials and Methods, Tiny Magnesium Pellets Yield Strong Extrusions: Vol. 45, No. 5, May 1957, pp. 185–187.
Light Metal Age, Extruding Magnesium Pellets in Big Press: Vol. 15, Nos. 9 and 10, October 1957, pp. 33–34.

[22] Carvell, J. E., Quality Control in Pressure Die Castings: Metal Ind. (Birmingham, England), vol. 90, No. 17, April 1957, pp. 325–327, 334.
Materials and Methods, Magnesium Alloys—Forging Practice: Vol. 45, No. 3, March 1957, pp. 151–152.
Coenen, F. L., Magnesium-Alloy Sheet: Modern Metals, vol. 13, No. 8, September 1957, pp. 88, 90.
American Metal Market, Magnesium—Strength in Forgings Increased by Solution Heat Treatment: Vol. 64, No. 228, Nov. 27, 1957, p. 10.

New coatings to protect magnesium from corrosion were described.[23]

Reports were published outlining the weld characteristics of magnesium alloys and giving instructions for relief from stress corrosion cracks at the point of joining.[24] Automatic welding was described, which insured rapid joining of the metal.[25] A successful process of welding aluminum to magnesium was described.[26]

Progress was reported on tests of magnesium alloys for new structural applications.[27] The technology for new and improved uses of the metal for nonstructural purposes was described. This included work at the Bureau of Mines Northwest Electrodevelopment Experiment Station, Albany, Oreg., in which magnesium was used as a reducing agent.[28]

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[23] Steel, Vapor Plating Magnesium With Aluminum: Vol. 140, No. 23, June 10, 1957, p. 162.
Iron Age, New Coating Gives Magnesium Extra Protection: Vol. 181, No. 2, Jan. 9, 1958, pp. 64–66.

[24] Nelson, R. L., How to Join Magnesium Alloys: Modern Metals, vol. 13, No. 3, April 1957, pp. 42, 44, 46–47.

[25] Iron Age, Welds Magnesium Continuously: Vol. 180, No. 2, July 11, 1957, pp. 132, 134.

[26] Steel, Technical Outlook—Welding Progress: Vol. 140, No. 24, June 17, 1957, p. 103.

[27] American Metal Market, Field Tests Show Magnesium Rods Cut Engine Wear: Vol. 64, No. 141, July 24, 1957, pp. 1, 9. Dow to Construct Magnesium Body for Army Vehicle: Vol. 65, No. 7, Jan. 10, 1958, pp. 1, 5.
Rizley, John H., and Mihalco, Robert E., Future Aircraft and Missile Structures: Light Metal Age, vol. 15, Nos. 11 and 12, December 1957, pp. 24–27.

[28] Chemical Week, A Newly Developed Process for Making Reactor-Grade Hafnium and Zirconium: Vol. 80, No. 29, July 20, 1957, p. 73.
Iron Age, Produces Ductile Iron by New Process: Vol. 181, No. 2, Jan. 9, 1958, pp. 86–88.
Industrial and Engineering Chemistry, Pyrometallurgical Separation of Uranium From Thorium: Vol. 50, No. 2, February 1958, pp. 137–140.
Winsch, Irvin O., and Burris, Leslie, Jr., Magnesium Extraction Process for Plutonium Separation From Uranium: Chem. Eng. Prog., vol. 53, No. 5, June 1957, pp. 237–242.
Steel, Planes Use Metallic Fuels: Vol. 141, No. 10, Sept. 2, 1957, pp. 92–93.

Magnesium Compounds

By H. B. Comstock [1] and Jeannette I. Baker [2]

WORLD PRODUCTION of crude magnesite in 1957 increased 4 percent above 1956. Austria continued to lead; the United States ranked second as a producer. No crude magnesite was imported in 1957, and substantial decreases below 1956 were noted in imports of dead-burned and caustic-calcined magnesia. Domestic producers of caustic-calcined and refractory magnesia reported increased deliveries above 1956; 51 percent of these materials came from sea water and well brines. The program for expanding facilities to produce magnesia and basic refractories, begun in 1956, was continued in 1957, and by the close of the year total annual production capacity was 750,000 tons. Research completed during 1957 indicated new and increased uses for magnesium oxide, particularly in ceramics and refractories. Ceramics developed from ductile magnesium oxide in 1957 promised new aircraft and missile structural materials at temperatures reaching 2,000° F.

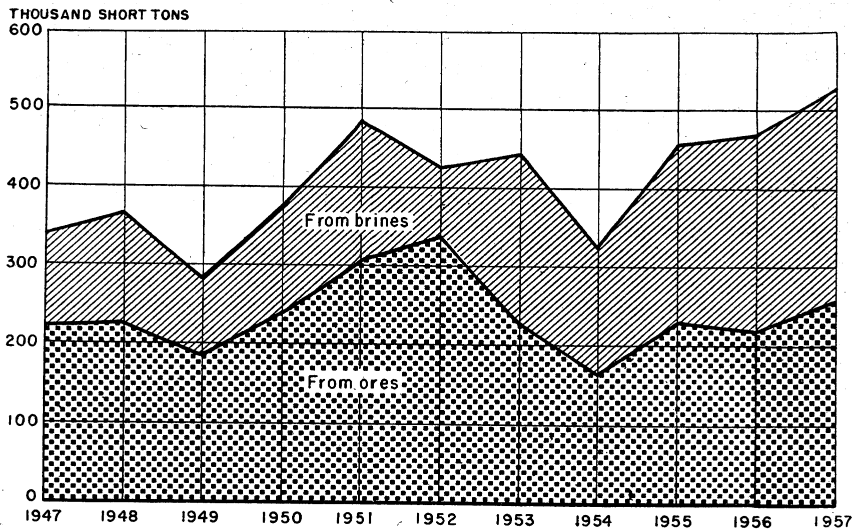

FIGURE 1.—Domestic production of magnesia from ores and brines, 1947–57.

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

TABLE 1.—Salient statistics of magnesite, magnesia, and dead-burned dolomite in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Crude magnesite produced:						
Short tons	453,030	553,147	284,015	486,088	686,569	678,489
Value	$2,992,086	$3,223,759	$1,391,392	$2,712,942	$2,502,218	$3,257,708
Average per ton	$6.60	$5.83	$4.90	$5.58	$3.64	$4.80
Caustic-calcined magnesia sold or used by producers:						
Short tons	39,039	43,020	32,254	35,751	35,508	60,815
Value	$3,841,550	$3,991,309	$2,154,652	$2,240,612	$2,426,424	$3,160,579
Average per ton	$98.40	$92.78	$66.80	$62.67	$68.33	$51.97
Refractory magnesia sold or used by producers:						
Short tons	346,933	399,132	288,270	418,761	430,619	467,723
Value	$14,898,853	$19,060,796	$19,850,712	$20,304,639	$22,663,353	$26,319,103
Average per ton	$42.94	$47.76	$48.05	$48.49	$52.63	$56.27
Dead-burned dolomite sold or used by producers:						
Short tons	1,703,478	2,294,815	1,520,854	2,128,960	2,292,539	2,294,747
Value	$21,595,347	$31,455,384	$21,960,684	$31,424,587	$35,761,630	$36,715,952
Average per ton	$12.68	$13.71	$14.44	$14.76	$15.60	$16.00

DOMESTIC PRODUCTION

Magnesite.—Crude magnesite was mined in Washington by Northwest Magnesite Co. and in Nevada by Basic, Inc., and Standard Slag Co. No magnesite was reported mined in California in 1957. Northwest Magnesite Co. continued to be the leading producer. The total output for 1957 decreased 1 percent in quantity below 1956, but the total value increased 30 percent.

Magnesia.—Of the entire output of magnesia in 1957, 49 percent came from magnesite, brucite, and dolomite and 51 percent from sea water, well brines, and bitterns. Production from sea water and well brines increased 9 percent above 1956; the total recovered from brucite, magnesite, and dolomite increased 18 percent.

The program begun in 1956 for expanding facilities to produce magnesia and basic refractories was continued in 1957. In July, Michigan Chemical Corp. announced final plans to construct a 70,000-ton-capacity plant on the Gulf coast to produce magnesium oxide from sea water.[3]

E. J. Lavino & Co. announced that it would build a plant at Freeport, Tex., for producing high-grade magnesia (periclase) from sea water.[4] The plant was expected to be producing by 1959.

In October Harbison-Walker Refractories Co. delivered the first shipment of chemically bonded basic brick from its new refractories plant at Hammond, Ind.

Kaiser Aluminum & Chemical Corp. completed expansion of its Moss Landing, Calif., magnesia plant by adding a new 150-ton-per-day rotary kiln, which increased production capacity to about 375 tons per day.[5] Kaiser also increased the facilities at its 2-year-old Columbiana, Ohio, plant and doubled its capacity to produce fused and chemically bonded shapes and grain refractories.[6]

[3] Chemical Engineering News, Concentrates—Magnesium Oxide From Sea Water: Vol. 35, No. 27, July 8, 1957, p. 7.
[4] American Metal Market, Lavino Plans $8,000,000 Unit for Magnesite: Vol. 64, No. 197, Oct. 11, 1957, pp. 1, 3.
[5] Chemical Engineering News, Kaiser Expands Magnesia Plant: Vol. 35, No. 34, Aug. 26, 1957, p. 23.
[6] Steel, More Basic Refractories: Vol. 141, No. 7, Aug 12, 1957, p. 136.

Late in 1957, H. K. Porter Co., Inc., began to install a new tunnel kiln at its Bessemer, Ala., refractories plant to permit more rapid delivery of refractory brick to the southern steel industry. The company expected to complete this project in 1958. Porter's new magnesia plant at Pascagoula, Miss., begun in 1956, was nearing completion in 1957 and was expected to begin producing in 1958.[7]

In October 1957 a list of major magnesium oxide producing plants was published, showing total annual production capacity of 750,000 tons; 100,000 tons additional capacity was expected to be ready in 1959.[8]

Dolomite.—The quantity of dead-burned dolomite produced in 1957 remained approximately the same as in 1956 but increased 3 percent in value.

TABLE 2.—Magnesia sold or used by producers in the United States, 1956–57, by kinds and sources

Magnesia	From magnesite, brucite, and dolomite		From well brines, raw sea water, and sea-water bitterns[1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1956						
Caustic-calcined	2,570	$91,925	32,938	$2,334,499	35,508	$2,426,424
Refractory	214,961	9,579,067	215,658	13,084,286	430,619	22,663,353
Total	217,531	9,670,992	248,596	15,418,785	466,127	25,089,777
1957						
Caustic-calcined	28,688	828,035	32,127	2,332,544	60,815	3,160,579
Refractory	228,384	10,624,306	239,339	15,694,797	467,723	26,319,103
Total	257,072	11,452,341	271,466	18,027,341	528,538	29,479,682

[1] Magnesia made from a combination of dolomite and sea water is included with that from sea water.

In 1957 the Federal Geological Survey published a report, summarizing the dolomite and other mineral resources in the United States for producing magnesium and magnesium compounds.[9]

Owing to increased requirements for dolomite by the iron and steel industry in Illinois, two surveys of reserves and quality of the ore in the State were made by the Illinois Geological Survey.[10]

The New Mexico Bureau of Mines published a report, showing the location of dolomite and other magnesium ores in the State and discussing the possibilities for their exploitation.[11]

Brucite.—In 1957 the production of brucite dropped 71 percent in quantity and 43 percent in value below 1956. Basic, Inc., Gabbs, Nev., remained the only producer.

Olivine.—The quantity of olivine mined in 1957 was 6 percent above 1956. The output came from the four mines that were operated in

[7] Chemical Week, Magnesia: Vol. 80, No. 1, Jan. 5. 1957, p, 23.

[8] Chemical Week, Major U. S. Magnesium Oxide Producers: Vol. 81, No. 17, Oct. 26, 1957, p. 95.

[9] Davis, Robert E., Magnesium Resources of the United States—a Geologic Summary and Annotated Bibliography to 1953: Geol. Survey Bull. 1019–E, 1957, 142 pp.

[10] Ostrom, Meredith E., Subsurface Dolomite and Limestone Resources of Grundy and Kendall Counties: Illinois Geol. Survey, 1957, 25 pp.

Lamar, J. E., Chemical Analyses of Illinois Limestones and Dolomites: Illinois Geol. Surv. Rept. of Investigations 200, 1957, 33 pp.

[11] Kottlowski, Frank E., High-Purity Dolomite Deposits of South Central New Mexico: New Mexico Bureau of Mines and Mineral Resources, New Mexico Inst. Min. and Tech., Circ. 47, 1957, 43 pp.

TABLE 3.—Dead-burned dolomite sold in and imported into the United States, 1948–52 (average) and 1953–57

Year	Sales of domestic product		Imports[1]	
	Short tons	Value	Short tons[2]	Value
1948–52 (average)	1,703,478	$21,595,347	2,293	$100,504
1953	2,294,815	31,455,384	3,876	259,427
1954	1,520,854	21,960,684	4,426	[3] 344,665
1955	2,128,960	31,424,587	7,993	[3] 557,554
1956	2,292,539	35,761,630	9,031	[3] 586,754
1957	2,294,747	36,715,952	10,419	[3] 639,741

[1] Dead burned basic refractory material, consisting chiefly of magnesia and lime.
[2] Includes weight of immediate container.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

1955 and 1956. The largest production came from the Harbison-Walker Refractories Co. Addie mine in North Carolina.

Other Magnesium Compounds.—Total production of specified magnesias, U. S. P. and technical grades, both light and heavy, dropped in 1957 about 50 percent below 1956. The production of precipitated magnesium carbonate decreased 10 percent below 1956. The production of magnesium chloride for cell feed increased 13 percent, and of magnesium chloride crystals 59 percent, above 1956. Magnesium hydroxide production increased 79 percent above 1956, and epsom salts output rose 6 percent. Production of magnesium trisilicate decreased 11 percent below 1956.

Mines and plants producing magnesium compounds in the United States in 1957 were the same as those listed in table 5 of the Magnesium Compounds chapter, Minerals Yearbook, 1955.

TABLE 4.—Specified magnesium compounds produced, sold, and used by producers in the United States, 1956–57

Products[1]	Plants	Produced (short tons)	Sold		Used (short tons)
			Short tons	Value	
1956					
Specified magnesias (basis, 100 percent MgO) U. S. P. and technical:					
Extra-light and light	6	4,973	4,821	$1,436,986	----------
Heavy	4	36,865	26,463	2,694,701	10,701
Total	[2] 8	41,838	31,284	4,131,687	10,701
Precipitated magnesium carbonate	8	33,544	4,495	884,000	28,551
Magnesium hydroxide U. S. P. and technical (basis, 100 percent $Mg(OH)_2$)	4	87,537	7,562	494,656	82,716
1957					
Specified magnesias (basis, 100percent MgO) U. S. P. and technical:					
Extra-light and light	5	2,130	2,219	1,196,342	----------
Heavy	3	18,689	17,654	2,133,332	204
Total	[2] 6	20,819	19,873	3,329,674	204
Precipitated magnesium carbonate	7	30,231	7,566	1,768,395	22,111
Magnesium hydroxide U. S. P. and technical (basis, 100 percent $Mg(OH)_2$)	4	156,610	7,526	551,157	148,931

[1] In addition, magnesium chloride, sulfate, phosphate, and trisilicate were produced.
[2] A plant producing more than 1 grade is counted but once in arriving at total.

CONSUMPTION AND USES

Consumption of caustic-calcined magnesia in 1957 increased 71 percent above 1956; consumption of refractory magnesia rose 9 percent. The total quantity of magnesium hydroxide sold or used by producers increased 73 percent above 1956. Consumption of crude magnesite decreased slightly below 1956; brucite dropped 38 percent; and olivine remained about the same. The consumption of specified magnesias, U. S. P. and technical grades, both light and heavy, decreased 52 percent below 1956, and that of precipitated magnesium carbonate declined 10 percent. Total consumption of magnesium sulfate (epsom salts) rose 5 percent above 1956.

Table 5 indicates a rising trend in the use of caustic-calcined magnesia for refractories.

TABLE 5.—Domestic consumption of caustic-calcined magnesia (percent) by uses, 1953–57

Use	1953	1954	1955	1956	1957
Oxychloride and oxysulfate cement	41	33	34	32	30
Rayon	8	3	4	3	1
Fertilizer	2	2	1	2	(1)
85 percent MgO insulation	13	14	11	10	6
Rubber	1	1	3	8	2
Fluxes	1	1	(1)	(1)	(1)
Refractories			4		29
Miscellaneous (including chemicals and paper industry)	34	46	43	45	32
Total	100	100	100	100	100

1 Less than 1 percent.

TABLE 6.—Domestic consumption of U. S. P. and technical-grade magnesias (percent) by uses, 1953–57

Use	1953	1954	1955	1956	1957
Rayon	45	24	16	8	17
Rubber (filler and catalyst)	29	47	27	9	18
Refractories	13	10	15	42	11
Medicinal	3	3	7	1	3
Uranium processing			2	3	4
Fertilizer					(1)
Miscellaneous industrial and chemical (including neoprene compounds)	10	16	33	37	47
Total	100	100	100	100	100

1 Less than 1 percent.

PRICES

Comparison of 1956 and 1957 prices and net-sales values shows that prices remained the same for about half of the magnesium compounds. However, there was an increase of from $6 to $8.75 per ton, in the price of dead-burned and grain magnesite, and an increase of $2.50 per ton in the sales value of periclase. Prices of technical and rubber-grade and light U. S. P.-grade magnesia and of U. S. P.-grade magnesium carbonate rose one-half cent per pound during 1957. The price of magnesium hydroxide decreased 3 cents per pound on February 27, 1957; on December 16 the price of the top grade decreased another 1½ cents, and the lower grade rose 1 cent. Dead-burned dolomite price increases ranged from 65 to 75 cents per ton during 1957.[12]

12 Steel, vol. 139, No. 27, Dec. 31, 1956, p. 90; vol. 141, No. 26, Dec. 23, 1957, p. 106.

TABLE 7.—Prices quoted on selected magnesium compounds, carlots, 1956–57

Commodity	Unit	Container	F. o. b.	Source	January 1956	January 1957	December 1957
Magnesite:							
Caustic-calcined, oxychloride-cement grade, powdered	Short ton	Bags	Newark, Calif	(1)	[2] $79.64	[2] $82.79	[2] $82.79
Dead-burned, grain	do	Bulk	Chewelah, Wash	(3)	40.00	40.00	[4] 46.00
Do	do	Bags	do	(3)	45.75	45.75	[4] 52.00–54.00
Periclase: Kiln-run, 90 percent	do	Bulk	Newark, Calif	(1)	57.50	57.50	[5] 60.00
Epsom salt: Technical grade	100 pounds	Bags	do	(6)	2.15	2.15	2.15
Magnesia, calcined:							
Technical grade	Pound	Cartons	Works	(6)	.2525–.26	.2525–.26	[7] .2575–.265
Synthetic rubber grade	do	do	do	(6)	.2925–.30	.2925–.30	[7] .2975–.305
U. S. P.: Light	do	do	do	(6)	.35–.36	.35–.36	[7] .365–.375
Heavy	do	Barrels	do	(6)	.45–.52	.45–.52	.45–.52
Magnesium carbonate:							
Technical grade	do	Bags	(8)	(6)	.105	.105	.105
U. S. P. grade	do	do	(8)	(6)	.125	.125	[7] .13
Magnesium chloride (hydrous): Powdered or flaked	Short ton	Barrels	Works	(6)	50.00	55.00	55.00
Magnesium hydroxide: Medicinal grade	Pound	Drums		(6)	.256–.30	.265–.30	[9] 24.5–25.5

[1] Westvaco Chemical Division, Food Machinery & Chemical Corp.
[2] Average net sales value.
[3] E&MJ Metal and Mineral Markets.
[4] Effective September 1957.
[5] Effective Jan. 1, 1957.
[6] Oil, Paint and Drug Reporter.
[7] Effective Mar. 1, 1957.
[8] Magnesium carbonate prices are quoted f. o. b. works, freight equalized with metropolitan New York and competitive producing points.
[9] Effective Dec. 16, 1957.

FOREIGN TRADE [13]

Imports.—No crude magnesite was imported in 1957. Decreases of total imports below 1956 were reported for magnesium minerals and compounds.

Imports of dead-burned and grain magnesia (refractory) and periclase decreased 21 percent in quantity and 34 percent in value below 1956. Of the total imports, Yugoslavia supplied 38 percent, Austria 34 percent, and Trieste 27 percent; Canada and Sweden together furnished less than 1 percent.

Imports of lump or ground caustic-calcined magnesia decreased 27 percent in quantity and 24 percent in value below 1956. India supplied 54 percent of the total, Yugoslavia 34 percent, Netherlands 9 percent, Austria 2 percent, and United Kingdom 1 percent.

TABLE 8.—Magnesite imported for consumption in the United States, 1955–57, by countries

[Bureau of the Census]

Country	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
CRUDE MAGNESITE						
North America: Canada	11	$531				
Europe:						
Greece			110	$1,500		
Netherlands			30	1,606		
Total			140	3,106		
Grand total	11	531	140	3,106		
LUMP OR GROUND CAUSTIC-CALCINED MAGNESIA						
North America: Canada	30	$2,375	32	$2,459		
Europe:						
Austria	88	2,815	126	6,791	110	$4,300
France	33	1,440				
Netherlands	16	866	165	9,095	534	30,205
Switzerland			33	1,776		
United Kingdom	50	9,817	70	14,353	45	9,371
Yugoslavia	1,378	51,240	2,370	86,527	1,885	69,997
Total	1,565	66,178	2,764	118,542	2,574	113,873
Asia: India	1,955	75,179	4,945	228,961	3,060	150,955
Grand total	3,550	143,732	7,741	349,962	5,634	264,828
DEAD-BURNED AND GRAIN MAGNESIA AND PERICLASE						
North America: Canada	4,095	$945,995	3,002	$697,320	343	$64,153
Europe:						
Austria	61,460	3,672,000	66,281	4,091,056	25,872	1,701,936
Italy	1,653	87,000	7,115	423,946		
Sweden					11	2,064
Switzerland	19,933	1,265,796	55	3,500		
Trieste					19,998	978,131
Yugoslavia	15,551	757,723	18,431	877,479	28,780	1,286,967
Total	98,597	5,782,519	91,882	5,395,981	74,661	3,969,098
Grand total	102,692	6,728,514	94,884	6,093,301	75,004	4,033,251

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

TABLE 9.—Magnesium compounds imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Oxide or calcined magnesia		Magnesium carbonate, precipitated		Magnesium chloride (anhydrous and n. s. p. f.)		Magnesium sulfate (epsom salt)		Magnesium salts and compounds, n. s. p. f.[1]		Manufactures of carbonate of magnesia	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	1	$100	217	$61,684	5	$583	1,895	$45,610	270	$54,213	20	$6,776
1953	-------	-------	253	72,498	319	9,878	6,782	167,478	182	66.479	15	1,500
1954	1	336	199	60,133	254	8,082	9,605	[2]226,691	33	13,086	-------	-------
1955	113	[2]48,598	282	[2]58,763	220	5,999	11,613	260,275	108	[2]17,369	21	5,135
1956	197	[2]58,507	264	63,771	350	9,421	11,101	[2]256,455	1,508	107,435	3	1,730
1957	412	152,395	307	59,638	431	11,778	10,570	248,948	839	33,867	23	3,769

[1] Includes magnesium silicofluoride or fluosilicate and calcined magnesium.
[2] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable to years before 1954.

Exports.—Magnesite, magnesia, and manufactures (except refractories) exported in 1957, valued at $2,862,981, increased 47 percent above the 1956 value of $1,952,515 (revised figure).

The duty on crude magnesite in 1957, based on the Geneva Agreement of 1947, was 15/64 cent per pound. Duty on dead-burned and grain magnesite and periclase was 23/60 cent per pound, with an ad valorem of 14.26 percent; and on caustic-calcined magnesia, 15/32 cent per pound, with an ad valorem of 19.94 percent. Duty on magnesium oxide was 2½ cents per pound, with an ad valorem of 13.52 percent.

TABLE 10.—World production of magnesite, by countries,[1] 1948–52 (average) and 1953–57 in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America: United States	453,030	553,147	284,015	486,088	686,569	678,489
Total [1] [3]	680,000	880,000	760,000	720,000	990,000	970,000
South America:						
Brazil [3]	7,700	11,000	11,000	11,000	11,000	11,000
Venezuela	1,477	----------	----------	----------	----------	----------
Total [3]	9,177	11,000	11,000	11,000	11,000	11,000
Europe:						
Austria	634,152	895,971	925,007	1,093,173	1,194,502	1,292,567
Czechoslovakia	[3] 193,000	(4)	(4)	(4)	(4)	(4)
Germany, West	[3] 5,000	----------	----------	----------	----------	----------
Greece	42,949	117,879	114,410	66,980	71,650	[3] 71,650
Italy	896	2,269	3,348	4,527	5,448	8,512
Norway	1,682	2,049	915	874	[3] 880	[3] 880
Spain	11,151	16,652	32,399	29,973	26,891	42,355
Yugoslavia	72,007	168,121	153,572	129,114	214,260	233,983
Total [1] [3]	2,400,000	3,100,000	3,100,000	3,200,000	3,400,000	3,500,000
Asia:						
Cyprus (exports)	18	22	----------	----------	----------	----------
India	89,210	103,878	78,968	64,410	102,717	96,161
Korea, Republic of	73	----------	----------	----------	----------	----------
Turkey	2,609	386	1,174	----------	937	998
Total [1] [3]	233,000	340,000	420,000	530,000	570,000	670,000

See footnotes at end of table.

TABLE 10.—World production of magnesite, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]—Continued

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Africa:						
Egypt	255	-----------	-----------	-----------	-----------	-----------
Kenya	42	-----------	-----------	-----------	-----------	117
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	10,526	10,824	7,792	11,610	8,611	2,910
Tanganyika (exports)	617	64	87	367	272	284
Union of South Africa	16,779	25,229	26,874	19,753	33,485	35,414
Total	28,219	36,117	34,753	31,730	42,368	38,725
Oceania:						
Australia	40,923	51,965	48,331	64,595	72,447	[3] 88,200
New Zealand	582	579	807	434	818	[3] 770
Total	41,505	52,544	49,138	65,029	73,265	[3] 88,970
World total (estimate) [1 2]	3,400,000	4,400,000	4,400,000	4,600,000	5,100,000	5,300,000

[1] Quantities in this table represent crude magnesite mined. In addition to countries listed, magnesite is also produced in Canada, China, Mexico, North Korea, Poland, and U. S. S. R., but data on tonnage of output are not available; estimates by senior author of chapter included in total.

[2] This table incorporates a number of revisions of data published in previous Magnesium Compounds chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.

[3] Estimate.

[4] Data not available; estimate by senior author of chapter included in total.

WORLD REVIEW

World production of crude magnesite in 1957 increased 4 percent above 1956. Austria continued to lead.

NORTH AMERICA

The United States reported 13 percent of the world output of crude magnesite in 1957, the same proportion as in 1956.

Canada.—An article related the history of the development and use of Canadian basic refractories for electric furnaces.[14]

SOUTH AMERICA

Brazil.—In 1957 Brazil remained the only country reporting production of magnesite in South America.

EUROPE

Approximately 66 percent of the world output of magnesite in 1957 came from European countries.

Austria.—Austria produced 24 percent of the total world output of magnesite in 1957, an 8-percent increase above its 1956 production.

A magnesite deposit in Fieberbrunn, in the Tyrols, was opened in 1957 by Austria's second largest magnesite producer, the Austro-American Magnesite Co. (Österreichisch-Amerikanische Magnesit A. G. Radenthein). The deposit was reported to contain 100 million tons.[15]

Czechoslovakia.—Plans were reported for mining magnesite from a recently discovered deposit near the Soviet-Czechoslovak border, containing an estimated 100 million tons of high-grade ore.[16]

[14] Thomson, A. H., Canadian Basic Refractory Practice in Electric Furnaces: Pres. at Electric Steel Furnace Conference, Pittsburgh, Pa., AIME Prepr. Dec. 4–6, 1957, 5 pp.

[15] Mining World, vol. 19, No. 13, December 1957, p. 88.

[16] Metal Bulletin (London), Czech Plans: No. 4252, Dec. 10, 1957, p. 26.

TABLE 11.—Exports of caustic-calcined magnesia from Austria, by countries of destination, 1953–57, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
North America: United States	82	98	64	185	139
South America: Argentina	5	160	214	126	204
Europe:					
Belgium-Luxembourg	181	197	148	166	99
Bulgaria	147	44	71	-----	-----
Czechoslovakia	3, 067	3, 275	4, 359	4, 360	4, 868
Denmark	18	82	142	126	82
France	3, 090	3, 297	3, 785	3, 595	3, 347
Germany:					
East	3, 421	424	364	327	379
West	64, 440	70, 202	67, 142	72, 060	72, 923
Hungary	63	437	781	844	1, 027
Italy	2, 441	2, 851	3, 766	3, 059	3, 214
Netherlands	50	98	33	77	15
Norway	44	55	20	-----	-----
Poland	-----	-----	-----	546	2, 918
Rumania	109	-----	-----	-----	-----
Sweden	55	83	127	66	88
Switzerland	1, 341	1, 436	2, 022	2, 280	2, 433
United Kingdom	776	1, 384	1, 391	854	150
Other countries	47	79	23	57	173
Total	79, 377	84, 202	84, 452	88, 728	92, 059

1 Compiled from Customs Returns of Austria.
2 This table incorporates a number of revisions of data published in previous Magnesium Compounds chapters.

TABLE 12.—Exports of refractory magnesia from Austria, by countries of destination, 1953–57, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
North America:					
Canada	3, 300	1, 098	551	88	-----
United States	7, 335	28, 741	63, 477	46, 918	19, 426
South America:					
Argentina	987	1, 439	3, 264	1, 342	1, 601
Brazil	196	14	-----	-----	-----
Chile	19	175	239	136	119
Peru	45	1, 033	1, 305	-----	-----
Europe:					
Belgium-Luxembourg	1, 628	779	1, 041	1, 255	569
Bulgaria	1	2	17	147	116
Czechoslovakia	429	348	463	338	472
Denmark	331	236	618	551	1, 084
Finland	475	512	475	819	474
France	12, 368	9, 065	11, 671	12, 519	9, 927
Germany:					
East	3, 537	52	29	64	-----
West	21, 854	18, 409	44, 874	47, 852	58, 140
Greece	37	83	77	128	191
Hungary	32	7, 748	4, 378	9, 967	7, 417
Italy	10, 993	4, 986	6, 640	9, 857	10, 672
Netherlands	245	138	109	123	186
Norway	192	132	324	336	284
Poland	5, 035	5, 460	-----	54	6, 381
Rumania	5, 917	438	-----	-----	-----
Spain	14	8	21	26	55
Sweden	783	832	801	1, 074	1, 122
Switzerland	559	688	1, 457	1, 555	1, 009
United Kingdom	1, 283	2, 227	22, 508	25, 304	32, 661
Yugoslavia	709	134	138	10	23
Asia:					
India	742	1, 310	571	152	1, 195
Japan	176	-----	1, 126	3, 574	10, 836
Korea, Republic of	-----	-----	-----	-----	655
Turkey	41	19	60	63	266
Oceania: Australia	1	21	636	1, 196	1, 540
Other countries	630	791	738	840	2, 041
Total	79, 894	86, 918	167, 608	166, 288	168, 462

1 Compiled from Customs Returns of Austria.
2 This table incorporates a number of revisions of data published in previous Magnesium Compounds chapters.

TABLE 13.—Exports of magnesite brick from Austria, by countries of destination, 1953–57, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
South America:					
Argentina	801	3,430	8,892	3,433	3,836
Chile	229	60	639	441	595
Colombia	384	563	312	373	554
Mexico	101	52	293	429	379
Europe:					
Belgium-Luxembourg	11,361	7,715	9,636	10,377	9,693
Bulgaria	288		151	874	1,234
Czechoslovakia	510	550	22	550	551
Denmark	4,347	3,641	3,516	4,367	4,980
Finland	4,153	3,180	3,157	2,369	3,075
France	37,947	26,346	36,562	49,680	38,325
Germany:					
East	2,712	1,661	815	1,248	266
West	31,095	38,742	46,843	54,015	63,651
Greece	714	786	1,218	916	1,120
Hungary	4,405	245	137	270	247
Ireland			111	503	811
Italy	18,231	11,896	21,248	27,994	34,304
Netherlands	3,787	2,987	3,610	3,782	6,811
Norway	1,096	921	1,404	1,430	1,835
Poland	15,558	11,662	3,573	1,921	4,990
Rumania	4,974	5,860		3,104	2,144
Saar					2,429
Spain	563	515	302	181	1,289
Sweden	12,785	10,899	13,049	11,299	11,732
Switzerland	1,595	1,197	1,933	2,036	1,130
United Kingdom	1,195	848	2,344	4,608	3,293
Yugoslavia	8,643	5,386	1,484	121	158
Asia:					
India		517	330	700	2,950
Turkey	2,355	602	1,597	3,521	5,074
Africa:					
Belgian Congo	132	410	329	423	142
British South Africa	2,515	1,101			
Egypt	398	669	1,123	883	1,779
Oceania: Australia	20	115	4,110	4,059	6,657
Other countries	1,588	2,231	6,040	4,588	9,420
Total	174,482	144,787	174,780	200,495	225,454

[1] Compiled from Customs Returns of Austria.
[2] This table incorporates a number of revisions of data published in previous Magnesium Compounds chapters.

Greece.—The Austro-American Magnesite Co. concluded an agreement with the Greek Government to operate the Vavdos magnesite mine on the Chalcidice Peninsula in northern Greece.[17] It was reported later than Magnomin A. G. of Zurich, Switzerland, had begun to mine this deposit and to install an electric furnace. Annual production was expected to reach 23,000 tons of magnesite and 12,000 tons of caustic-calcined magnesia.[18]

United Kingdom.—As a result of extensions completed near the close of 1957, the output of refractory magnesia from the Hartlepool works of Steetley Magnesite Co., Ltd., increased 12 percent above 1956.[19] In November Steetley announced plans to open a new dolomite quarry at West Cornforth, County Durham.[20]

[17] Engineering Mining Journal, vol. 158, No. 8, August 1957, p. 216.
[18] Engineering Mining Journal, vol. 158, No. 10, October 1957, p. 200. Refractories Journal (London), No. 10, October 1957, pp. 468–469.
[19] Refractories Journal (London), No. 11, November 1957, p. 517.
[20] Refractories Journal (London), No. 2, February 1958, p. 87.

TABLE 14.—Exports of magnesite, from Greece, by countries of destination, 1953–57, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Austria	(3)	(3)	(3)	10,720	5,508
France	1,323	4,850	5,098	4,387	3,412
Germany:					
East	-----------	-----------	298	-----------	-----------
West	11,401	3,847	982	1,907	(3)
Italy	551	2,320	1,654	2,927	2,028
Netherlands	-----------	-----------	1,543	1,325	829
United Kingdom	1,880	2,315	1,598	888	(3)
Other countries	1,323	827	882	110	6,647
Total	16,478	14,159	12,055	22,264	18,424

[1] Compiled from Customs Returns of Greece.
[2] This table incorporates a number of revisions of data published in previous Magnesium Compounds chapters.
[3] Data not available.

TABLE 15.—Exports of calcined magnesia from Greece, by countries of destination, 1953–57, in short tons [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
France	-----------	1,039	1,064	1,211	(2)
Germany, West	14,370	23,679	15,710	16,721	12,063
Netherlands	1,687	13,027	20,771	19,142	15,782
United Kingdom	661	2,389	3,146	2,589	3,412
Other countries	506	62	111	701	1,802
Total	17,224	40,196	40,802	40,364	33,059

[1] Compiled from Customs Returns of Greece.
[2] Data not available.

TABLE 16.—Exports of refractory magnesia from the Netherlands, by countries of destination, 1953–57, in short tons [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Belgium-Luxembourg	444	503	386	602	595
Denmark	995	825	695	670	588
Egypt	57	-----------	-----------	-----------	-----------
Finland	713	540	784	787	547
France	71	190	131	119	248
Germany, West	9,177	9,197	10,546	8,926	7,980
Norway	424	470	333	331	280
Portugal	65	99	84	112	138
Saar	-----------	202	142	229	126
Sweden	990	975	960	826	774
Union of South Africa	136	127	177	69	106
United Kingdom	3,211	3,746	3,727	3,788	3,285
United States	-----------	-----------	-----------	290	505
Other countries	126	140	233	346	373
Total	16,409	17,014	18,198	17,095	15,545

[1] Compiled from Customs Returns of the Netherlands.

ASIA

India.—Magnesite production in India in 1957 decreased 6 percent below 1956. The history, development, and status of the refractories industry of India to 1957 were related,[21] including the location and size, and description of the country's magnesite deposits, the methods of production, and use of the ore.

AFRICA

Union of South Africa produced 92 percent of the magnesite reported mined in that continent in 1957. Three other countries reported small quantities.

OCEANIA

Australia.—Australia produced 99 percent of the crude magnesite in the area of Oceania in 1957, an increase of 22 percent above its production in 1956. One of the large consumers was Shell Refinery at Geelong, Victoria, which installed more than 3 miles of piping insulated with 85 percent magnesia.[22]

New Zealand.—The small tonnage of magnesite produced in New Zealand was used locally for fertilizer by tobacco growers.

TECHNOLOGY

Reports of research published in 1957 indicated progress in developing improved processes for producing and using magnesium ores and compounds.

The techniques of mining, crushing, and processing of magnesite and brucite in Nevada were discussed, and development of improvements in quality control of the ores was described.[23]

Harbison-Walker Refractories Co. reported in November that it had begun constructing a new research center near Pittsburgh, Pa. All company research activities were coordinated at this central point, and programs in progress included studies of magnesium ores and compounds to develop new and improved processes of producing refractory materials, insulation for industrial furnaces, and magnesium chemicals.[24]

A description was published of the design and operation of the 2 all-basic open-hearth furnaces that were built in 1956.[25] By 1957, 6 all-basic open-hearth furnaces were operating. Their record of operation during 1957 indicated that they permitted higher heat-input rates and higher temperatures, and promised longer refractory life than furnaces with front and back walls made of silica brick.

[21] Bureau of Mines, Mineral Trade Notes, Refractories Industry in India, Special Suppl. 52 (vol. 46, No. 4), April 1958, 20 pp.

[22] Chemical Age (London), Shell's Geelong Refinery Uses Magnesia Insulation: Vol. 79, No. 2010, Jan. 18, 1958, p. 167.

[23] Martin, Conrad, and Willard, H. P., Quality Control in Selective Mining of Magnesite: Min. Eng., vol. 9, No. 4, April 1957, pp. 425–427.

Menzl, Fred W., and Sutton, Raymond E., Production of Calcined Magnesite: Min. Eng., vol. 9, No. 7, July 1957, pp. 753–755.

[24] Blast Furnace and Steel Plant, Research Center Being Erected by Harbison-Walker: Vol. 45, No. 11, November 1957, pp. 1324–1325.

[25] Heuer, R. P., and Fay, M. A., The All-Basic Open Hearth Furnace: Iron Steel Eng., vol. 34, No. 2, February 1957, pp. 95–118.

Development of a new type of high-strength magnesite-chrome basic refractory was announced. The use of basic brick made of this highly corrosion-resistant material was said to increase productivity of steel furnaces as much as 20 percent.[26]

Improved processes to produce fused magnesium oxide were described.[27] Fused magnesium oxide (99.0 percent MgO) was recommended for use as insulation material in such applications as tubular heating elements operating at high-watt densities and temperatures reaching 1,800° F.

Research completed by the close of 1957 promised a wider use of magnesium oxide as a ceramic material.[28] California University was developing a method to produce ductile magnesium oxide.[29] The single crystals of magnesium oxide did not fracture when bent in air at room temperature. In view of the strength and temperature-resistant properties of magnesium oxide, whose melting point is about 5,000° F., it was believed that refractory ceramics could be developed for use as new structural materials in aircraft and missiles where temperatures rise above 2,000° F.[30]

Processes were improved for producing magnesium compounds to use in pharmaceuticals.[31]

The relatively new use of basic refractories in window glass furnaces was described.[32] Tests at the end of 40 months of constant service of the furnaces showed that the checkers, heat-control framework made of burned basic brick, had much longer life than those that had been made of other types of refractories.

Uranium as well as many uranium alloys was melted in magnesia crucibles.[33] The manufacture and use of magnesia crucibles as containers for melting uranium was described.[34]

Development of a new olivine-base molding sand was reported.[35] The absence of silica in olivine was mentioned as a great advantage because it left the foundry workers free from the danger of contracting silicosis. Aluminum castings formed in the olivine-base sand were said to require no outside blasting and minimum blasting for cleaning the inside.

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26 Chemical Engineering, Refractory: Vol. 64, No. 8, August 1957, p. 186.
27 Chemical Engineering News, New Grade of Fused MgO: Vol. 35, No. 42, Oct. 21, 1957, p. 60.
28 American Metal Market, Flexible Ceramics: Vol. 64, No. 220, Nov. 15, 1957, p. 7.
29 Beller, William, Materials Breakthrough: American Aviation, vol. 21, No. 1, June 3, 1957, pp. 27–29.
30 Chemical Engineering News, Structural Ceramics on the Way: Vol. 35, No. 49, Dec. 9, 1957, p. 60. Industrial Engineering Chemistry, Ductile Ceramics: Vol. 50, No. 2, February 1958, pp. 29a–30a.
31 Chemical Age (London), Producing Magnesium Hydroxide From Sea Water: Vol. 78, No. 2006, Dec. 21, 1957, p. 1021.
32 Walker, Henry E., Use of Basic Refractories in Glass Tank Checkers: Am. Ceram. Soc. Bull., vol. 36, No. 9, Sept. 15, 1957, pp. 355–357.
33 Stoddard, S. D., and Harper, W. T., Refractories for Melting and Casting Uranium and Other Metals: Am. Ceram. Soc. Bull., vol. 36, No. 3, March 1957, pp. 105–108.
34 Rengstorff, G. W. P., and Lownie, H. W., Jr., Casting Large Ingots of Uranium: Metal Progress, vol. 72, No. 3, September 1957, pp. 76–78.
35 Schaller, Gilbert, New Foundry Sand: Modern Metals, vol. 13, No. 9, October 1957, pp. 82, 84, 86.

Manganese

By Gilbert L. DeHuff [1] and Teresa Fratta [2]

WITH a continued Government market, domestic production of manganese ore achieved a new record when 366,000 short tons of ore, concentrate, and nodules containing 35 percent or more manganese were shipped in 1957. Domestic consumption at 2.36 million short tons also established a record.

For the second year in succession the trend of consumption was opposed to that of declining steel production and was reflected in a relatively high ratio of manganese ore used to ferromanganese produced.

Manganese-ore imports of 3.1 million short tons in 1957 were almost 1 million tons more than those in 1956 and were second to the record importations of 1953. Brazil supplanted India as the principal supplier, and domestic industrial stocks at year-end were two-thirds of the year's consumption. Alloy stocks at producers' plants were abnormally high.

Financial participation in the exploration for domestic manganese deposits was continued by Defense Minerals Exploration Administration to the extent of 75 percent of approved exploration costs, the funds advanced to be repaid from proceeds of future production.

TABLE 1.—Salient statistics of manganese in the United States, 1948–52 (average) and 1953–57, gross weight in short tons

	1948-52 (average)	1953	1954	1955	1956	1957
Manganese ore (35 percent or more Mn):						
Production (shipments):						
Metallurgical ore	109,991	139,960	191,376	275,544	341,291	364,227
Battery ore	12,293	17,576	14,694	11,711	3,444	2,107
Miscellaneous ore	130	----------	58	----------	----------	----------
Total shipments [1]	122,414	157,536	206,128	287,255	344,735	366,334
General imports	1,814,493	3,500,986	2,165,694	2,078,205	2,238,568	3,105,172
Consumption	1,650,133	2,195,742	1,740,648	2,109,623	2,264,159	2,361,460
Ferromanganese:						
Domestic production	698,925	907,533	718,721	869,977	923,012	963,814
Imports for consumption	91,408	126,518	56,772	65,121	160,203	338,630
Exports	5,798	1,112	1,732	1,789	2,248	7,395
Consumption	748,788	931,401	716,910	934,451	[2] 945,210	935,725
Spiegeleisen:						
Domestic production	73,767	97,729	(3)	(3)	(3)	(3)
Imports for consumption	2,075	785	----------	----------	234	----------
Exports	107	----------	----------	----------	----------	29
Consumption	80,820	73,512	52,082	69,564	62,398	53,615

[1] Shipments are used as the measure of manganese production for compiling United States mineral-production value. They are taken at the point when the material is considered to be in marketable form from the consumer's standpoint. Besides direct shipping ore, they include, without duplication, the following beneficiated products made from domestic ores: Concentrates, nodules, synthetic battery ore, and synthetic miscellaneous ore.
[2] Revised figure.
[3] Bureau of Mines not at liberty to publish.

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

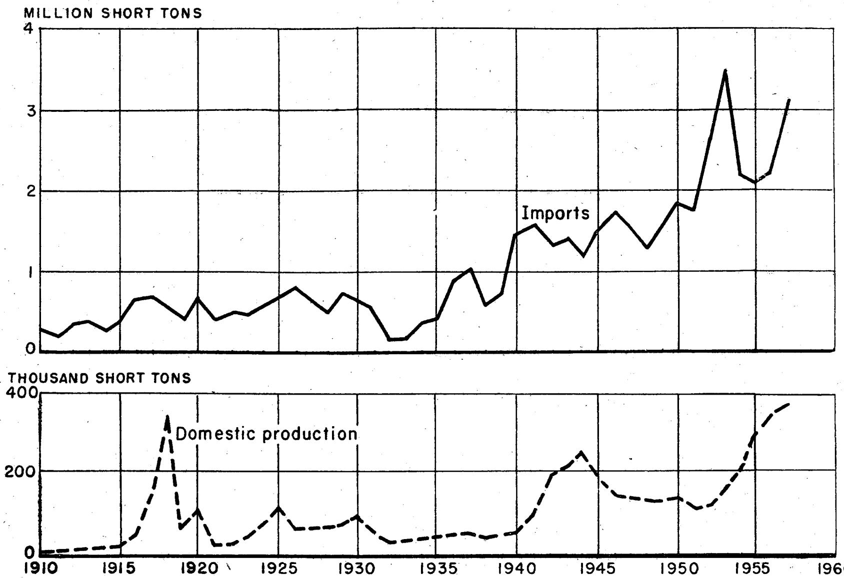

FIGURE 1.—General imports and domestic production (shipments) of manganese ore, 1910–57.

The Government received both high- and low-grade ores and concentrates under its Butte-Philipsburg purchase program. The quantity limitations remained unchanged at 6 million recoverable long-ton units for Butte-Philipsburg and 28 million contained long-ton units for the "carlot" program. The final registration date for participation in the Butte-Philipsburg program was extended to December 31, 1957, and an amendment was made providing for acceptance of certain mixtures of ores and concentrates.

DOMESTIC PRODUCTION

As in 1956, Government purchases of domestic Metallurgical-grade material on the "carlot" program and under special contracts for Nevada nodules provided approximately three-quarters of the 1957 record production of manganese ore containing 35 percent or more manganese. Shipments under the "carlot" program from Western States in 1957 increased more than 50 percent to 115,000 short tons, while those from Arkansas, Tennessee, and Virginia were lower than in the previous year.

Manganese, Inc., with its production from Three Kids oxide ore of metallurgical nodules containing approximately 47 percent manganese, was again responsible for Nevada's leading position among the manganese-ore-producing States. Arizona, with 40 mines shipping to the "carlot" program, was in second place. Metallurgical nodules containing approximately 57 percent manganese, produced by The Anaconda Co. from Butte carbonate ore, provided the bulk of Montana shipments. Trout Mining Division, American Machine and Metals, Inc., Philipsburg, Mont., continued to be the Nation's only producer of natural Battery-grade ore or concentrate. Manganese

Chemicals Corp., Riverton, Minn., continued to use the ammonium carbamate leach process to produce synthetic battery ore and synthetic miscellaneous ores from low-grade Cuyuna range material.

Commercial shipments of low-grade manganese ores containing 10 to 35 percent manganese were made from Georgia, Minnesota, Montana, and New Mexico. Both Michigan and Minnesota shipped manganiferous iron ore containing 5 to 10 percent manganese. Manganiferous zinc residuum continued to be produced from New Jersey zinc ores.

In addition to the shipments recorded in tables 1 through 5, and table 16 as the measure of domestic production, the Government received both high- and low-grade ores and concentrates under its Butte-Philipsburg purchase program. The bulk of the low-grade receipts came from Montana; the remainder from Nevada, Utah, California, and Idaho, in that order. The high-grade receipts were

TABLE 2.—Metallurgical manganese ore shipped in the United States, 1948–52 (average) and 1953–57, by States, in short tons

State	1948–52 (average)	1953	1954	1955	1956	1957
Alabama	28					
Arizona	212	(1)		1,396	42,008	79,505
Arkansas	2,050	6,123	13,728	23,744	29,485	23,261
California	781	720	393	3,136	6,595	9,009
Colorado						175
Montana	105,657	102,878	44,735	94,762	77,573	66,191
Nevada	33	18,368	(1)	101,070	121,017	129,046
New Mexico	781			1,390	22,011	25,459
Oregon		46				
Tennessee	94	2,625	11,823	15,895	17,821	12,938
Texas	11					
Utah	43					142
Virginia	214	8,454	22,678	32,654	20,231	12,655
Washington	87	(1)				
Undistributed [2]		746	98,019	1,497	4,550	5,846
Total	109,991	139,960	191,376	275,544	341,291	364,227

[1] Included with "Undistributed."
[2] Includes shipments from Missouri in 1953; from Georgia and Missouri in 1954; from Georgia and Minnesota in 1955 and 1956; and from Georgia, Minnesota, Missouri, Oklahoma, and West Virginia in 1957.

TABLE 3.—Ferruginous manganese ore shipped in the United States, 1948–52 (average) and 1953–57, by States, in short tons

State	1948–52 (average)	1953	1954	1955	1956	1957
Arizona	45					
Arkansas	3,081					
California	216	534	(1)			
Colorado	15					
Georgia				347	(1)	
Michigan			15,361			
Minnesota	13,184	201,090	7,552	115,285	94,139	200,817
Montana	6,683	5,598	5,266	6,341	4,752	4,547
Nevada	6,362	25,064	12,870			
New Mexico	65,953	(1)	20,546	40,320	38,782	42,535
Oregon		271				
Utah	2,881	5,155	97			
Virginia	748				(1)	
Washington	29					
Undistributed [2]		35,026	135		3,198	
Total	99,197	272,738	61,827	162,293	140,871	247,899

[1] Included with "Undistributed."
[2] Includes shipments from North Carolina and Wyoming in 1953 and from Tennessee in 1954.

TABLE 4.—Manganiferous iron ore shipped in the United States, 1948–52 (average) and 1953–57, by States, in short tons

State	1948–52 (average)	1953	1954	1955	1956	1957
Michigan	41,868	76,251				123,547
Minnesota	983,083	890,401	496,505	749,343	539,780	491,478
New Mexico	13,150					
Utah	215					
Total	1,038,316	966,652	496,505	749,343	539,780	615,025

TABLE 5.—Manganese and manganiferous ores shipped [1] in the United States in 1957, by States, in short tons

	Metallurgical		Battery		Miscellaneous		Total		
	Gross weight	Manganese content	Gross weight	Manganese content	Gross weight	Manganese content	Gross weight	Manganese content	Value
Manganese ore: [2]									
Arizona	79,505	33,117					79,505	33,117	$6,626,097
Arkansas	23,261	10,000					23,261	10,000	1,726,164
California	9,009	3,970					9,009	3,970	802,310
Colorado	175	71					175	71	14,108
Montana	66,191	37,379	2,107	870			68,298	38,249	(3)
Nevada	129,046	60,047					129,046	60,047	(3)
New Mexico	25,459	10,536					25,459	10,536	2,113,962
Tennessee	12,938	5,165					12,938	5,165	1,007,018
Utah	142	58					142	58	11,671
Virginia	12,655	5,464					12,655	5,464	1,057,462
Total	[4] 364,227	[4] 169,229	[4] 2,107	[4] 870	(4)	(4)	[4] 366,334	[4] 170,099	[4] 29,362,859
Ferruginous manganese ore: [5]									
Georgia					2,203	234	2,203	234	(3)
Minnesota	200,817	24,146					200,817	24,146	(3)
Montana	4,547	1,005					4,547	1,005	(3)
New Mexico	42,535	4,254					42,535	4,254	151,912
Total	247,899	29,405			2,203	234	250,102	29,639	(6)
Manganiferous iron ore: [7]									
Michigan	123,547	7,080					123,547	7,080	(3)
Minnesota	491,478	30,846					491,478	30,846	(3)
Total	615,025	37,926					615,025	37,926	(6)

[1] Shipments are used as the measure of manganese production for compiling United States mineral-production value. They are taken at the point that the material is considered to be in marketable form from the consumer's standpoint. Besides direct shipping ore, they include without duplication the following beneficiated products made from domestic ores: Concentrates, nodules, synthetic battery ore, and synthetic miscellaneous ore.
[2] Containing 35 percent or more manganese (natural).
[3] Included in total.
[4] Synthetic battery ore and synthetic miscellaneous ores produced in Minnesota from low-grade Minnesota ore, plus metallurgical ore from Georgia, Missouri, Oklahoma, and West Virginia, are included in metallurgical and grand totals.
[5] Containing 10 to 35 percent manganese (natural).
[6] Combined value for ferruginous manganese ore plus manganiferous iron ore equals $5,413,352.
[7] Containing 5 to 10 percent manganese (natural).

mostly from Montana and Utah, but also from California, Nevada, and Oregon. None of these shipments are included in the tables nor will they appear in them until shipment is made from the depots as usuable ore or concentrate. As of December 31, 1957, total receipts under the Butte-Philipsburg program was reported by GSA as 5,296,218 long-ton units of recoverable manganese; for the "carlot" program, 16,718,218 long-ton units of contained manganese.

CONSUMPTION, USES, AND STOCKS

Consumption of manganese ore increased 4 percent over the preceding year. Domestic sources supplied 2 percent and foreign sources 98 percent of the total manganese ore consumed, compared with 3 and 97 percent, respectively, in 1956 and 2 and 98 percent in 1955 and in 1954. Industrial stocks of ore, at 1.55 million short tons, increased 21 percent over those in 1956.

The consumption of manganese as ferroalloys and direct-charged ore per short ton of open-hearth, bessemer, and electric steel produced was 13.3 pounds compared with 13.2 pounds in 1956. Of the 13.3 pounds, 12.0 pounds was in the form of ferromanganese, 1.1 pound silicomanganese, 0.1 pound spiegeleisen, and 0.1 pound ore and manganese metal. These data apply to the consumption of manganese in producing steel ingots and that part of steel castings made by companies that also produce steel ingots. The companies reporting in this part of the survey approximate those reporting steel production to the American Iron and Steel Institute. If the manganese consumed by companies that produce steel castings only is also included, the manganese consumed in manufacturing steel in 1957 becomes 13.8 pounds per short ton of steel produced, of which 12.4 represents ferromanganese, 1.2 silicomanganese, 0.1 spiegeleisen, and 0.1 ore, metal, and briquets.

TABLE 6.—Consumption of manganese ore [1] and manganese alloys in the United States, 1956–57, and stocks Dec. 31, 1957, gross weight in short tons

Category of use and form in which consumed	Quantity consumed		Stocks Dec. 31, 1957 [2] (including bonded warehouses)
	1956	1957	
Manganese alloys and manganese metal:			
Manganese ore:			
Domestic	63,561	41,315	262
Foreign	2,111,064	2,232,463	1,510,165
Total manganese ore	2,174,625	2,273,778	1,510,427
Ferromanganese, silicomanganese, and manganese metal			148,117
Spiegeleisen			14,323
Steel ingots and steel castings: [3]			
Manganese ore:			
Domestic			6
Foreign	550	234	473
Total manganese ore	550	234	479
Ferromanganese:			
High-carbon	816,591	816,179	146,552
Medium-carbon } Low-carbon	64,773	58,940	9,518
Total ferromanganese	881,364	875,119	156,070
Spiegeleisen	52,166	36,574	11,986
Silicomanganese	98,383	90,558	14,132
Manganese briquets			
Manganese metal	6,706	6,787	817
Steel castings: [4]			
Manganese ore:			
Domestic			
Foreign	171	276	48
Total manganese ore	171	276	48

See footnotes at end of table.

TABLE 6.—Consumption of manganese ore [1] and manganese alloys in the United States, 1956–57, and stocks Dec. 31, 1957, gross weight in short tons—Continued

Category of use and form in which consumed	Quantity consumed 1956	Quantity consumed 1957	Stocks Dec. 31, 1957 [2] (including bonded warehouses)
Steel castings—Continued			
Ferromanganese:			
High-carbon	27,688	24,004	4,194
Medium-carbon; Low-carbon	3,743	3,188	1,026
Total ferromanganese	31,431	27,192	5,220
Spiegeleisen	3,522	3,424	740
Silicomanganese	11,573	11,248	1,538
Manganese briquets	1,050	631	180
Manganese metal	377	639	267
Pig iron:			
Manganese ore:			
Domestic	3,763	4,819	348
Foreign	19,504	6,695	8,212
Total manganese ore	23,267	11,514	8,560
Dry cells:			
Manganese ore:			
Domestic	1,510	1,400	297
Foreign	30,853	28,702	19,939
Total manganese ore	32,363	30,102	20,236
Chemicals and miscellaneous industries:			
Manganese ore:			
Domestic	731	1,014	------------
Foreign	32,452	44,542	6,922
Total manganese ore	33,183	45,556	6,922
Miscellaneous small consumers:			
Ferromanganese:			
High-carbon	25,822	27,366	3,922
Medium-carbon; Low-carbon	[5] 6,593	6,048	1,236
Total ferromanganese	[5] 32,415	33,414	5,158
Spiegeleisen	6,710	13,617	2,648
Silicomanganese	15,865	11,893	3,196
Manganese briquets	14,000	10,531	2,732
Manganese metal	[5] 2,263	3,407	745
Grand total:			
Manganese ore:			
Domestic	69,565	48,548	913
Foreign	2,194,594	2,312,912	1,545,759
Total manganese ore	[6] 2,264,159	[6] 2,361,460	[7] 1,546,672
Ferromanganese:			
High-carbon	870,101	867,549	154,668
Medium-carbon; Low-carbon	[5] 75,109	68,176	11,780
Total ferromanganese	[5] 945,210	935,725	[8] 166,448
Spiegeleisen	62,398	53,615	29,697
Silicomanganese	125,821	113,699	[8] 18,866
Manganese briquets	15,050	11,162	[8] 2,912
Manganese metal	[5] 9,346	10,833	[8] 1,829
Producers stocks ferromanganese, silicomanganese, and manganese metal	------------	------------	148,117

[1] Containing 35 percent or more manganese (natural).
[2] Excluding Government stocks.
[3] Includes only that part of castings made by companies that also produce steel ingots.
[4] Excludes companies that produce both steel castings and steel ingots.
[5] Revised figure.
[6] The greater part of ore consumption was used in manufacturing ferromanganese and silicomanganese. Combining consumption of ore with that of ferromanganese and silicomanganese would result in duplication.
[7] Excludes small tonnages of dealers' stocks.
[8] Excludes producers' stocks.

Electrolytic Manganese and Manganese Metal.—Consumption of electrolytic manganese metal again increased but at a much reduced rate. The electrolytic metal continued to be produced by 2 companies and the electric furnace metal by 1 company.

Ferromanganese.—Production of ferromanganese in the United States was 964,000 short tons in 1957, compared with 923,000 short tons in 1956. The quantity made in blast furnaces was 3¼ times that in electric furnaces—an abrupt reversal to the trend of recent years. Shipments of ferromanganese from producing furnaces decreased 5 percent in quantity but increased slightly in value. Of the 2,103,000 short tons of manganese ore consumed in manufacturing ferromanganese in 1957, 2 percent was of domestic origin.

TABLE 7.—Ferromanganese imported into and made from domestic and imported ores in the United States, 1956–57

	1956		1957	
	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]	40,125	32,166	22,484	18,074
From imported ore[2]	882,887	677,729	941,330	725,560
Total domestic production	923,012	709,895	963,814	743,634
Imported	160,203	123,953	338,630	257,821
Total ferromanganese	1,083,215	833,848	1,302,444	1,001,455
Open-hearth, bessemer, and electric[3] furnace steel produced	115,216,149		112,714,996	

[1] Number of domestic plants making ferromanganese: 1956, 18; 1957, 16.
[2] Estimated.
[3] Includes crucible.

TABLE 8.—Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture,[1] 1948–52 (average) and 1953–57

Year	Ferromanganese produced			Materials consumed (short tons)			Manganese ore used per ton of ferromanganese[1] made (short tons)
	Short tons	Manganese contained		Manganese ore (35 percent or more Mn natural)		Iron and manganiferous iron ores	
		Percent	Short tons	Foreign	Domestic		
1948–52 (average)	698,925	77.24	539,883	1,271,309	98,646	7,673	1.96
1953	907,533	76.74	696,436	1,829,382	75,594	31,562	2.10
1954	718,721	75.04	539,364	1,412,030	31,351	8,404	2.01
1955	869,977	77.03	670,165	[1] 1,924,643	[1] 46,936	1,594	[1] 2.02
1956	923,012	76.91	709,895	2,025,678	63,561	283	2.26
1957	963,814	77.16	743,634	2,066,693	36,692	503	2.18

[1] For 1955 includes ore used in manufacture of silicomanganese and manganese briquets.

TABLE 9.—Manganese ore used in manufacture of ferromanganese [1] in the United States, 1953–57, by source of ore

	1953		1954		1955 [1]		1956		1957	
	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	75, 594	57. 48	31, 351	57. 53	46, 936	58. 01	63, 561	57. 15	36, 692	56. 32
Foreign:										
Africa	637, 934	45. 85	397, 153	45. 51	586, 602	47. 21	668, 826	46. 26	673, 260	44. 99
Brazil	192, 280	40. 20	123, 234	40. 23	138, 276	41. 07	219, 712	39. 76	411, 615	44. 01
Chile	36, 456	43. 95	10, 516	43. 44	24, 707	44. 12	10, 663	45. 31	16, 072	46. 12
Cuba	172, 700	39. 89	144, 870	39. 85	253, 271	40. 25	291, 498	39. 34	185, 746	37. 51
India	716, 568	44. 51	637, 475	46. 10	817, 710	45. 31	679, 306	44. 38	598, 511	44. 47
Indonesia	6, 763	44. 48	6, 988	44. 86	9, 198	45. 34	----------	-------	900	38. 22
Mexico	42, 675	41. 99	54, 969	42. 00	60, 889	44. 00	135, 423	44. 94	143, 731	44. 27
New Caledonia	40	47. 50	4, 943	46. 83	2, 179	45. 57	1, 725	47. 00	----------	-------
Philippines	8, 586	41. 52	591	44. 50	105	39. 05	2, 199	43. 66	2, 645	47. 15
Turkey	8, 382	45. 76	8, 200	45. 73	11, 176	46. 41	1, 591	42. 99	6, 434	39. 00
U. S. S. R	508	45. 87	----------	-------	----------	-------	----------	-------	----------	-------
Other	6, 490	47. 63	23, 091	48. 28	20, 530	45. 46	14, 735	45. 16	27, 779	42. 62
Grand total	1, 904, 976	44. 56	1, 443, 381	44. 91	1, 971, 579	45. 18	2, 089, 239	44. 22	2, 103, 385	44. 10

[1] For 1955, includes silicomanganese and manganese briquets.

TABLE 10.—Ferromanganese shipped from furnaces in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	696, 925	$109, 795, 125	1955	886, 886	$172, 863, 154
1953	900, 110	185, 192, 588	1956	925, 450	209, 412, 426
1954	707, 415	139, 157, 801	1957	882, 066	210, 004, 246

Pittsburgh Coke & Chemical Company equipped 1 of the 2 blast furnaces at its Neville Island (Pittsburgh), Pa., plant for ferromanganese production by providing special gas-cleaning equipment and additional stove capacity, among other improvements. The capacity of the furnace became either 400 tons of ferromanganese per day, or 900 tons of pig iron. Ferromanganese production was begun in December, making the company a new producer.

Silicomanganese.—Ten plants of 5 companies produced silicomanganese in 1957, compared with 11 plants of 5 companies in 1956. The only significant change was one of name—from Globe Metallurgical Corp., Beverly, Ohio, to Interlake Iron Corp., Beverly, Ohio. Consumption of silicomanganese was 12.2 percent that of ferromanganese, compared with 13.3 percent in 1956, 12.0 percent in 1955, and 11.2 percent in 1954.

Spiegeleisen.—New Jersey Zinc Co., Palmerton, Pa., was the only producer of spiegeleisen in 1957.

Manganiferous Pig Iron.—Pig-iron furnaces used 1,667,000 short tons of manganese-bearing ores containing (natural) over 5 percent manganese in 1957. Of this total, 547,000 tons was of domestic origin and 1,120,000 tons foreign. Of the domestic ore used, 496,000 tons contained (natural) 5 to 10 percent manganese, 46,000 tons contained 10 to 35 percent manganese, and 5,000 tons contained over 35 percent manganese. Of the foreign ore used 1,012,000 tons contained (natural) 5 to 10 percent manganese, 101,000 tons contained (natural) 10 to 35 percent manganese, and 7,000 tons contained 35 percent or more manganese.

Battery and Miscellaneous Industries.—Manufacturers of dry-cell batteries during 1957 used 30,000 short tons of manganese ore; 1,400 tons was of domestic origin. All contained over 35 percent manganese (natural).

Chemical plants and miscellaneous industries used 46,000 short tons of manganese ore containing 35 percent or more manganese; 2 percent was from domestic sources. All the manganese dioxide ore used which was essentially of Chemical grade, 28,000 tons, was imported. The consumption of this high-grade dioxide ore by uranium mills, as an oxidant in certain acid-leaching processes, started in the United States in 1954 and by 1957 had become an appreciable proportion of the total used. This high-grade ore continued to be used for manufacturing manganese sulfate, hydroquinone, potassium permanganate, other manganese compounds, and as an oxidizing agent in various chemical processes. This or other grades containing 35 percent or more manganese was used in manufacturing welding rods and welding-rod coatings, frits, dyes, paint and varnish driers, glass, ceramics, bricks, fertilizers, pharmaceuticals, and magnesium alloys and for producing high-quality synthetic manganese dioxide for dry-cell batteries.

TABLE 11.—Foreign ferruginous manganese ore and manganiferous iron ore consumed in the United States, 1954–57, in short tons

Source of ore	Ferruginous manganese ore				Manganiferous iron ore			
	1954	1955	1956	1957	1954	1955	1956	1957
Canada					408,467	408,292	618,998	1,012,063
Egypt	128,102	102,070	[1] 113,062	101,512				
Greece	1,033							
India	56							
Total	129,191	102,070	113,062	101,512	408,467	408,292	618,998	1,012,063

[1] Includes 129 short tons from unidentified sources in Africa.

PRICES

Manganese Ore.—Government prices for domestically mined manganese ore meeting specifications and regulations continued to be calculated on the basis of $2.30 per long dry-ton unit for 48 percent of either contained or recoverable manganese. Commercial prices for Indian manganese ore of 46- to 48-percent manganese content, as quoted by E&MJ Metal and Mineral Markets, opened the year at $1.64 to $1.69 per long-ton unit of manganese, c. i. f. United States ports, import duty extra, including Indian export duty. Prices on this basis gradually decreased, to close the year at $1.36 to $1.39, nominal, but the weighted average for the year at $1.44 to $1.53 was higher than for 1956. Long-term contract prices were not quoted. At the end of the year E&MJ Metal and Mineral Markets quoted crude manganese dioxide, 84 percent MnO_2, c. i. f. United States ports, at $110 to $120 per long ton in bulk; and Chemical grade, 84 percent MnO_2, coarse or fine, per short ton in carlots at $152.50 in drums, $148.00 in burlap bags, and $144.50 in paper bags. Duty on manganese ore remained at ¼ cent per pound of contained manganese, with continuing exceptions that ore from Cuba and the Philippines was exempt from duty and ore from the U. S. S. R. and certain neighboring countries was dutiable at 1 cent per pound of contained manganese.

Manganese Alloys.—The average value, f. o. b. producers' furnaces, for ferromanganese shipped during 1957 was $238.08 per short ton, compared with $226.28 (revised figure) in 1956. The price of ferromanganese at eastern furnaces, carlots, at the beginning of the year was 12.75 cents per pound of alloy and was cut in September to 12.25 cents per pound. According to Iron Age, the price averaged 12.60 cents per pound for the year. The quoted price for spiegeleisen of 19- to 21-percent manganese content, as given by the same source, was unchanged at $102.50 per long ton for the year.

Manganese Metal.—The price of electrolytic manganese metal was quoted by E&MJ Metal and Mineral Markets as increasing 1 cent in April to 34 cents per pound for carlots and 36 cents per pound for ton lots. These prices remained to the end of the year. A premium of 0.75 cent per pound for hydrogen-removed metal was unchanged throughout the year.

FOREIGN TRADE [3]

Imports of manganese ore in 1957 were the second highest of record. The average grade was 46.1 percent manganese, compared with 45.4 percent in 1956 and 46.3 percent in 1955. Brazil, providing 30 percent of the total ore received in 1957, was the leading supplier, surpassing India, which had been the principal source since 1948. Brazil, India, Ghana (formerly Gold Coast), Union of South Africa, and Mexico, in that order, supplied over three-fourths of total United States imports for the year.

Imports for consumption of ferromanganese in 1957 increased 111 percent over those in 1956; value also increased 111 percent. Exports of ferromanganese at 7,395 short tons were more than 3 times those in 1956. Exports of manganese ore and concentrate (10 percent or more manganese) totaled 5,270 short tons valued at $724,447.

Barter of surplus United States agricultural products for various manganese items by the Commodity Credit Corporation, United States Department of Agriculture, continued to be a factor in trade between the United States and other nations.

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

TABLE 12.—Manganese ore (35 percent or more Mn) imported into the United States, 1956–57, by countries

[Bureau of the Census]

Country	General imports [1] (short tons)				Imports for consumption [2]					
					Short tons				Value	
	Gross weight		Mn content		Gross weight		Mn content			
	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957
North America:										
Canada	129	50	58	22		183		81		$5,405
Costa Rica		49		18		49		18		1,767
Cuba	242,036	156,651	104,356	64,086	237,189	159,393	102,126	65,402	$6,290,743	5,727,361
Mexico	171,201	218,229	78,131	98,173	182,632	217,648	83,087	97,950	5,846,807	8,055,126
Total	413,366	374,979	182,545	162,299	419,821	377,273	185,213	163,451	12,137,550	13,789,659
South America:										
Argentina		546		240		546		240		22,135
Brazil	237,219	926,498	99,624	438,769	236,515	600,408	99,296	281,495	7,249,508	25,776,697
British Guiana		332		133		332		133		3,563
Chile	13,353	33,586	6,014	14,859	19,550	28,093	8,959	12,342	712,306	1,295,363
Peru	8,284	15,074	3,634	6,574	10,332	15,074	4,548	6,574	231,189	551,874
Venezuela		6,884		2,917		3,756		1,728		105,000
Total	258,856	982,920	109,272	463,492	266,397	648,209	112,803	302,512	8,193,003	27,754,632
Europe:										
Greece	5,818	6,684	2,722	3,174	6,714	5,565	3,177	2,670	255,139	253,292
Portugal		1,598		789	3,335	1,598	1,600	789	130,875	86,954
Total	5,818	8,282	2,722	3,963	10,049	7,163	4,777	3,459	386,014	340,246
Asia:										
India	648,558	794,583	289,551	359,675	650,528	678,470	293,930	307,626	17,339,742	21,402,789
Indonesia		5,130		2,185		5,130		2,185		141,764
Philippines	7,201	9,835	3,571	4,473	7,201	7,584	3,571	3,445	210,252	309,061
Portuguese Asia, n. e. c.	21,308	18,979	9,280	8,278	2,910	18,979	1,432	8,278	102,600	664,346
Turkey	4,290	13,209	1,927	5,196	4,290	13,209	1,927	5,196	126,231	364,078
Total	681,357	841,736	304,329	379,807	664,929	723,372	300,860	326,730	17,778,825	22,882,038

See footnotes at end of table.

TABLE 12.—Manganese ore (35 percent or more Mn) imported into the United States, 1956–57, by countries—Continued

[Bureau of the Census]

Country	General imports [1] (short tons)				Imports for consumption [2]					
					Short tons				Value	
	Gross weight		Mn content		Gross weight		Mn content			
	1956	1957	1956	1957	1956	1957	1956	1957	1956	1957
Africa:										
Angola	15,295	[3] 47,827	7,258	[3] 23,372	11,487	[3] 32,661	5,365	[3] 15,674	$463,562	[3] $1,539,733
Belgian Congo	206,850	[3] 163,638	[4] 103,439	[3] 81,564	160,867	[3] 139,225	80,610	[3] 69,607	7,156,428	[3] 6,126,762
British East Africa	1,793		860		1,793		860		74,617	
Egypt	34	1,640	14	754	34	1,640	14	754	1,553	87,909
Ghana [5]	288,062	313,270	[4] 140,524	151,195	308,831	249,294	148,552	122,113	13,068,192	11,084,652
Morocco	95,210	50,882	46,666	24,246	87,387	70,015	41,629	34,552	3,130,781	3,687,437
Rhodesia and Nyasaland, Federation of	10,227	25,359	4,875	12,015	10,227	25,359	4,875	12,015	384,324	1,052,264
Sudan		1,958		822						
Union of South Africa	255,738	243,722	111,125	105,317	280,638	224,988	121,682	97,028	6,951,501	6,351,047
Total	873,209	848,296	[4] 414,761	399,285	861,264	743,182	403,587	351,743	31,230,958	29,929,804
Oceania:										
Australia		18,213		8,378		18,213		8,378		1,043,426
British Western Pacific Islands	5,962	30,746	3,232	14,634		22,011		10,839		959,409
Total	5,962	48,959	3,232	23,012		40,224		19,217		2,002,835
Grand total [6]	2,238,568	3,105,172	[4] 1,016,861	1,431,858	2,222,460	2,539,423	1,007,240	1,167,112	69,726,350	96,699,214

[1] Comprises ore received in the United States during year; part went into consumption, and remainder entered bonded warehouses.

[2] Comprises receipts during year for consumption and ore withdrawn from bonded warehouses during year; excludes imports for manufacture in bond and export.

[3] General imports for Belgian Congo include 4,319 short tons (gross weight), 2,224 short tons (Mn content); Belgian Congo imports for consumption include 2,182 short tons (gross weight), 1,155 short tons (Mn content), $114,049 credited by the Bureau of the Census to Angola. In addition, an appreciable part of the ore shown in this table as coming from Angola is believed to have originated in Belgian Congo.

[4] Revised figure.

[5] Effective Mar. 1, 1957; formerly Gold Coast.

[6] In 1957, receipts of ore classified as Battery and Chemical grades totaled 135,777 short tons averaging 54.6 percent manganese. Of this quantity 98,547 short tons came from Ghana, 19,160 short tons from Morocco, 7,582 short tons from Cuba, 8,906 short tons from Belgian Congo (includes 4,319 short tons credited to Angola but believed to have originated in Belgian Congo), and 1,582 short tons from Peru. Imports for consumption of Battery and Chemical grades in 1957 totaled 92,851 short tons valued at $5,969,173 or $64.29 per short ton f. o. b. foreign ports. Of the total Ghana supplied 49,475 short tons ($3,198,763), Morocco 27,443 short tons ($1,862,799), Cuba 7,582 short tons ($344,709), Belgian Congo 6,769 short tons ($439,416) (includes 2,182 short tons valued at $114,049 credited to Angola but believed to have originated in Belgian Congo), and 1,582 short tons ($123,486) from Peru. In addition it is believed some of the ore from Greece reported as Metallurgical grade in 1956 and 1957 was Battery and Chemical grades. Changes in Minerals Yearbook, 1956, pp. 801 are as follows: receipts of Battery and Chemical grades totaled 121,172 short tons. Of this quantity 76,949 short tons came from Ghana.

TABLE 13.—Ferromanganese imported for consumption in the United States, 1955–57, by countries

[Bureau of the Census]

Country	1955			1956			1957		
	Gross weight (short tons)	Mn content (short tons)	Value	Gross weight (short tons)	Mn content (short tons)	Value	Gross weight (short tons)	Mn content (short tons)	Value
North America:									
Canada	1,142	926	$311,889	3,761	2,897	$694,371	124,473	94,872	$22,544,924
Mexico	160	122	21,533	4,996	3,832	702,722	2,154	1,629	366,793
Total	1,302	1,048	333,422	8,757	6,729	1,397,093	126,627	96,501	22.911,717
South America: Chile	4,959	3,910	613,356	2,350	1,861	392,310	1,306	1,022	230,183
Europe:									
Belgium-Luxembourg				2,135	1,628	340,165	4,698	3,571	740,210
France	20,184	16,267	3,525,982	22,412	17,149	3,831,150	101,735	76,219	17,412,582
Germany, West	128	113	57,041	77,095	58,672	12,920,697	32,018	24,403	5,807,324
Norway	23,511	19,357	5,031,651	11,597	9,901	2,596,373	11,405	9,465	2,529,040
Yugoslavia	2,232	1,722	308,014	2,435	1,925	423,085	4,507	3,465	866,307
Total	46,055	37,459	8,922,688	115,674	89,275	20,111,470	154,363	117,123	27,355,463
Asia: Japan	12,805	9,819	2,028,917	33,422	26,088	[1] 6,599,351	55,783	42,734	9,638,636
Africa: Belgian Congo							551	441	95,875
Grand total	65,121	52,236	11,898,383	160,203	123,953	[1] 28,500,224	338,630	257,821	60,231,874

[1] Revised figure.

TABLE 14.—Spiegeleisen [1] imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	2,075	$112,827	1955		
1953	785	63,149	1956	234	$18,085
1954			1957		

[1] Exclusive of spiegeleisen containing not more than 1 percent carbon, manganese metal, and manganese boron.

TABLE 15.—Ferromanganese exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Gross weight (short tons)	Value	Year	Gross weight (short tons)	Value
1948–52 (average)	5,798	$1,034,420	1955	1,789	$642,806
1953	1,112	389,064	1956	2,248	682,257
1954	1,732	614,544	1957	7,395	1,866,456

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WORLD REVIEW

NORTH AMERICA

Canada.—Six separate iron-manganese deposits have been outlined 5 miles west of Woodstock, New Brunswick, on property controlled by Strategic Manganese Corporation, Ltd., subsidiary of Stratmat, Ltd. (Strategic Materials Corp.). Gravimetric surveys and reconnaissance diamond drilling, with detailed drilling confined mostly to 1 deposit, have indicated 194 million short tons, averaging 9 percent manganese and 13 percent iron, to a depth of 500 feet. More than 34,000 feet of drilling was completed, half in 43 holes in the Plymouth deposit. The deposits are similar in type and grade to those of adjoining Aroostook County, Maine. Research on treatment methods continued. A small sink-float plant at the mine was helpful in upgrading electric-furnace feed from certain of the ores.[4]

TABLE 16.—World production of manganese ore, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	Percent Mn	1948–52 (average)	1953	1954	1955	1956	1957
North America:							
Cuba	36–50+	127,108	389,356	296,801	346,680	[3] 257,996	[3] 148,276
Mexico	30+	80,461	269,863	277,996	97,326	[4] 171,000	[4] 220,000
Panama							[3] 2,154
United States (shipments)	35+	122,414	157,536	206,128	287,255	344,735	366,334
Total		329,983	816,755	780,925	731,261	773,731	736,764
South America:							
Argentina	30–40	1,914	5,512	1,323	5,512	9,682	16,535
Brazil	38–50	230,096	255,058	179,157	234,249	342,580	879,717
Chile	40–50	39,585	60,207	58,422	[4] 58,400	51,878	[4] 50,000
Peru	40+	788	1,323	4,960	6,008	8,047	11,850
Venezuela	46–48					10,318	32,939
Total		272,383	322,100	243,862	304,169	422,505	991,041
Europe:							
Bulgaria	30+	[5] 14,330	23,149	36,376	69,005	77,933	[4] 88,000
Greece	35+	8,201	15,577	18,697	27,148	28,660	[4] 28,000
Hungary	30+	84,794	132,038	120,412	105,208	[4] 83,000	[4] 83,000
Italy	30	30,579	44,157	54,902	62,371	50,627	51,811
Portugal	35+	4,468	13,918	10,627	4,388	3,508	5,812
Rumania	35	[4] 92,400	199,518	302,033	429,814	259,054	292,402
Spain	30+	23,250	36,044	39,511	48,375	36,100	40,543
U. S. S. R.[6]		3,760,000	5,115,800	5,356,100	5,228,300	5,443,200	5,467,500
Yugoslavia	30+	10,720	5,181	4,960	4,850	[4] 6,000	[4] 6,000
Total [1]		4,028,742	5,585,382	5,943,618	5,979,459	5,988,082	[4] 6,063,100
Asia:							
Burma	35+	1,897	9,610	4,160	342	1,287	506
India	40+	1,077,278	2,130,511	1,582,639	1,773,566	1,824,483	1,756,163
Indonesia	35–49	2,204	36,729	22,309	38,810	90,568	59,257
Iran [7]	36–46	4,582	[4] 4,400	8,799	5,484	6,614	2,205
Japan	32–40	152,954	214,286	180,155	222,350	314,175	308,429
Korea, Republic of	30–48	2,175	3,371	1,744	3,838	2,158	3,533
Philippines	35–51	27,489	23,708	10,354	13,131	4,866	33,324
Portuguese India	32–50+	54,919	166,227	116,756	149,523	[3] 177,702	131,998
Thailand	52					450	381
Turkey	30–50	42,793	99,038	54,925	55,228	65,962	58,038
Total [1] [4]		1,381,000	2,737,500	2,048,000	2,350,000	2,576,000	2,464,000

See footnotes at end of table.

[4] Sidwell, K. O. J., The Woodstock, N. B., Iron-Manganese Deposits: Canadian Min. and Met. Bull., vol. 50, No. 543, July 1957, pp. 411–416.
Monture, G. C., Woodstock Manganese Ores—Occurrence and Treatment: Canadian Min. Jour., vol. 78, No. 4, April 1957, pp. 117–120.

TABLE 16.—World production of manganese ore, by countries,[1] 1948–52 (average) and 1953–57, in short tons[2]—Continued

Country [1]	Percent Mn	1948–52 (average)	1953	1954	1955	1956	1957
Africa:							
Angola	38–48	28,571	72,603	34,865	34,853	29,647	23,517
Belgian Congo	50	53,115	238,831	424,320	508,972	363,250	404,572
Egypt [8]	57	1,509	3,578	6,991	7,994	21,195	[4] 10,000
Ghana (exports)[9]	48	824,923	835,510	515,475	604,330	712,154	713,757
Morocco:							
Northern zone	50	1,204	1,181	856	1,262	953	732
Southern zone	35–50	339,802	473,304	441,203	453,013	464,523	541,772
Rhodesia and Nyasaland, Federation of:							
Northern Rhodesia	30+	[10] 2,905	7,984	17,562	19,717	44,171	41,294
Southern Rhodesia	--------	355	----------	18	1,330	816	1,785
South-West Africa	--------	[11] 12,515	40,654	34,066	41,880	57,262	89,661
Sudan	36–44	--------	--------	--------	--------	7,716	[4] 9,000
Union of South Africa	40+	739,873	912,333	772,862	649,471	768,395	787,878
Total	--------	2,004,772	2,585,978	2,248,218	2,322,822	2,470,082	2,623,968
Oceania:							
Australia	45–48	10,404	36,897	31,587	53,039	66,510	86,402
Fiji	40+	683	2,448	10,773	19,823	21,636	[3] 27,653
New Caledonia	45+	9,854	6,163	--------	--------	--------	--------
New Zealand	48+	427	324	268	179	175	41
Papua	--------	50	47	--------	17	--------	--------
Total	--------	21,418	45,879	42,628	73,058	88,321	114,096
World total (estimate)[1]	--------	8,038,000	12,094,000	11.307,000	11,761,000	12,319,000	13,000,000

[1] In addition to countries listed, China and North Korea have produced manganese ore; data of output are not available, but estimates for them are included in the totals. Czechoslovakia and Sweden report production of manganese ore, but because the manganese content averages less than 30 percent, the output is not included in this table. Sweden averages annually 15,000 tons of approximately 15-percent manganese content.
[2] This table incorporates a number of revisions of data published in previous Manganese chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Exports.
[4] Estimate.
[5] 1 year only.
[6] Grade unstated. Source: The Industry of the U. S. S. R., Central Statistical Administration, 1957 (Moscow).
[7] Year ending March 20 of year following that stated.
[8] In addition to high-grade ore shown in the table, Egypt produced the following tonnages of less than 30 percent manganese content: 1948–52 (average), 152,160; 1953, 309,571; 1954, 188,703; 1955, 227,042; 1956, 200,075; and 1957, not available.
[9] Dry weight.
[10] Average for 1951–52.
[11] Average for 1950–52.

Central American Countries.—Manganese deposits of Costa Rica, Guatemala, Honduras, and Panama were described.[5] Only those of Costa Rica and Panama have produced ore.

Cuba.—Annual production of Chemical-grade manganese ore from the mines of Holston Trading Corp., subsidiary of Eastman Kodak Co., has run between 5,000 and 6,000 tons. Plus purchases from numerous small independent operators, the total ore handled by the company in Cuba has approximated 17,000 tons per year of both Chemical and Metallurgical grades. Some of the latter is invariably obtained in producing the chemical ore. All of the Chemical grade and most of the Metallurgical normally is shipped to the United States. The principal company mining operations have been near Bueycito, some 90 miles from Santiago. Late in 1957 Holston was developing a new mine near El Cristo, about 15 miles north of Santi-

[5] Roberts, Ralph J., Irving, Earl M., and Simons, Frank S., Mineral Deposits of Central America: Geol. Survey Bull. 1034, 1957, pp. 104–142.

ago.[6] Cuba's only heavy-medium manganese plant was that of Inter-American Industries, Inc., at Cambute, Oriente, about 35 miles east of Santiago.[7]

Mexico.—Preliminary figures indicate that 1957 exports of manganese totaled 88,000 short tons (metal content); all went to the United States.[8]

SOUTH AMERICA

Brazil.—The first shipment of manganese ore from the Amapa deposits of Industria e Commercio de Minerios, S. A. (ICOMI) was made January 9, 1957. The ore was reported to be of excellent quality—a hard ore containing more than 51 percent manganese, low in iron, silica, and phosphorus. The mine was open-pit, with overburden reported to vary up to 30 feet. The ore was washed to remove clay. According to preliminary figures, approximately 80 percent of the Brazilian manganese ore exported in 1957 came from Amapa, less than 1 percent from Baiá, and the remainder principally from the Lafaite mine of United States Steel Corp.'s Cia. Meridional de Mineracão in Minas Gerais. Of the total, approximately 1 percent went to West Germany, 52 percent to the United States Government, and the remainder to United States industry.

British Guiana.—An agreement was signed May 6, 1957, between the Government of British Guiana and the Northwest Guiana Mining Co., Ltd., to provide for mining manganese on the 38,000-acre company lease in northwestern British Guiana on the Barima River. Plans called for investing approximately US $12 million and for production to begin in 1959 at a monthly rate of 10,000 tons, to be increased to 30,000 tons by 1961. A 38-mile railroad was to be constructed from the mine to a shipping point.[9] The ore then will be barged to Trinidad for transshipment to Newport News, Va.[10] The first commercial shipment of manganese ore from British Guiana, of approximately 300 short tons, was in December 1956.[11]

Chile.—The 52,000 short tons of manganese ore produced in 1956 had a manganese content of 24,000 short tons. Two-thirds of this ore was produced by Cia. Manganesos de Atacama, which also made 2,500 short tons of ferromanganese for export. Chile's other ferromanganese producer, Fabrica Nacional de Carburo y Metalurgia, consumed 18,000 short tons of manganese ore in producing 7,200 short tons of ferromanganese and 3,700 short tons of silicomanganese.[12] During the first half of 1957, Chile exported 12,000 short tons of manganese ore averaging 45.7 percent manganese, of which Germany received 550 short tons and the United States the remainder. In the same period 1,400 short tons of ferromanganese was exported, plus 300 short tons of silicomanganese. The United Kingdom took 81 percent of the ferromanganese and the United States, Uruguay, Netherlands, and Peru, the remainder in that order. All of the silicomanganese went to the United States except for 6 tons to Mexico.[13]

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[6] U. S. Consulate, Santiago de Cuba, Cuba, State Department Dispatch 45: Jan. 28, 1958.
[7] Engineering and Mining Journal, High-Grade Manganese Source Grows in Cuba: Vol. 158, No. 9, September 1957, pp. 90–91.
[8] U. S. Embassy, Mexico, D. F., Mexico, State Department Dispatches 276 and 981: Sept. 9, 1957 and Mar. 11, 1958.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 11.
[10] Engineering and Mining Journal, vol. 158, No. 12, December 1957, p. 205.
[11] U. S. Consulate, Georgetown, British Guiana, State Department Dispatch 66: Oct. 15, 1957.
[12] U. S. Embassy, Santiago, Chile, State Department Dispatch 128: Aug. 6, 1957.
[13] U. S. Embassy, Santiago, Chile, State Department Dispatch 498: Nov. 21, 1957.

Peru.—In 1956 Cia. Minas Gran Bretana supplied 80 percent of Peru's manganese ore production of 5,100 short tons (MnO_2 content). A small quantity was consumed in Peru by the zinc refineries of Cerro de Pasco Corp., and 3,300 short tons was exported to the United States. Local consumption is expected to increase when the Chimbote steel mill under construction is completed.[14]

Venezuela.—Operations of Upata Mines, S. A., had stopped by mid-1957.[15] Manganese ore was exported to Europe and the United States during the period of mining which began late in the previous year.

EUROPE

France.—Of the 723,000 short tons of manganese ore imported in 1956, Morocco supplied 280,000, India 184,000, U. S. S. R. 117,000, and South Africa 52,000.[16]

Greece.—Exports of manganese ore in 1956 totaled 14,000 short tons compared with 21,000 in 1955. The quantities, by country of destination, were (1955 figures in parentheses): United States, 6,200 (3,200); Italy, 2,900 (2,000); France, 1,700 (none); West Germany, 1,300 (7,800); other countries, 2,000 (7,800).[17]

Norway.—Production of ferromanganese in 1956 and 1955 was, respectively, 77,000 and 66,000 short tons; ferrosilicomanganese, respectively, 45,000 and 32,000 short tons. Of the 83,000 short tons of ferromanganese exported in 1956, the 3 principal receiving countries were United Kingdom and Belgium-Luxembourg, with 23,000 tons each, and the United States, with 12,000 tons. In 1955 the United States was the leading recipient, with 27,000 short tons out of a total 72,000. Belgium-Luxembourg was second, with 18,000 short tons; and West Germany third, with 11,000 tons. In 1956, 51,000 short tons of ferrosilicomanganese was exported; West Germany took 23,000 short tons, the United Kingdom 15,000, and Belgium-Luxembourg 2,900. In 1955 the total was 34,000 short tons, and the 3 principal receiving countries were: West Germany, 16,000; United Kingdom, 11,000; and Austria, 2,900. Imports of ferroalloys other than ferrosilicon were insignificant in 1956. Imports of manganese ore in 1956 and 1955, respectively, totaled 240,000 and 171,000 short tons. The three principal supplying countries in 1956 were British West Africa, 156,000; U. S. S. R., 27,000; and South Africa, 20,000 short tons; in 1955 British West Africa, 104,000; U. S. S. R., 31,000; and India, 13,000 short tons.[18]

Portugal.—Exports of manganese ore in 1957 totaled 5,500 short tons, of which Sweden received 2,600 tons, Netherlands 2,400, and the United States 500.[19]

Rumania.—Manganese ore in the form of roasted carbonates or unprocessed ore was reported to be available for export.[20]

Sweden.—Imports of manganese ores in 1956 totaled 42,000 short tons compared with 35,000 short tons in 1955. The largest suppliers

[14] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 2, February 1958, p. 19.
[15] U. S. Embassy, Caracas, Venezuela, State Department Dispatch 134: Sept. 3, 1957.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 2, February 1958, p. 19.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, pp. 16–17.
[18] U. S. Embassy, Oslo, Norway, State Department Dispatch 436: Dec. 30, 1957.
[19] U. S. Embassy, Lisbon, Portugal, State Department Dispatch 488: Mar. 11, 1958.
[20] Metal Bulletin (London), No. 4201, June 7, 1957, p. 26.

in 1955 were U. S. S. R., 12,000 short tons; Union of South Africa, 10,000; India, 9,000; and Belgian Congo, 2,700.[21]

U. S. S. R.—A new Franco-Russian trade treaty, signed in February, provided for the exchange of French iron and steel products for Soviet manganese ore among other things.[22] From import statistics of the various countries concerned, Soviet exports of manganese ore to non-Soviet bloc countries in 1956 apparently totaled 406,000 short tons compared to 386,000 in 1955, and 243,000 in 1954. The distribution was as follows:

Country	*1954*	*1955*	*1956*
United Kingdom	141, 000	133, 000	164, 000
West Germany	900	57, 000	51, 000
France	37, 000	102, 000	117, 000
Sweden	36, 000	12, 000	20, 000
Norway	4, 300	31, 000	27, 000
Yugoslavia	--------	8, 500	18, 000
Italy	23, 000	20, 000	4, 900
Japan	-------	22, 000	4, 000
Others	650	900	-------

ASIA

India.—Tata Iron and Steel Co., at Jamshedpur, was the principal producer of ferromanganese in India. The other producers were the Indian Iron and Steel Co. at Asansol and the Mysore Iron and Steel Works at Bhadravati. Production in India has been intermittent, normally varying between 12,000–20,000 tons per year. In 1956, 28,000 tons was produced. The record was 36,784 tons in 1954.[23] Tata's output was from blast furnaces. Electro Metallurgical Works, Ltd.'s, new ferromanganese plant at Dandeli, Mysore State, went into operation before the close of 1957. Several other electric furnace plants were under construction or planned.

Central Provinces Manganese Ore Co., Ltd., continued exploration by diamond drilling. Good-quality concentrate continued to be produced at the company heavy-medium-separation plant at the Dongri Buzurg mine, and shaft sinking at Balaghat continued during the year.[24]

Magnetic surveys by the Geological Survey of India in the Tirodi area of Balaghat district, Madhya Pradesh, were credited with leading to the discovery of many isolated massive manganese ore bodies.[25] The State Trading Corp. planned to ship manganese and iron ore through Cochin port on an experimental basis.[26] Internal rail-transportation difficulties continued to hamper Indian shipments, and a quota system for moving and exporting manganese ores was continued with some modifications. As a result of Government efforts toward conservation and difficulties in marketing the lower grade ores, serious consideration was given to plans for beneficiating more of these ores.

Indonesia.—In the 6-month period, November 1956 through April 1957, Indonesia exported 50,000 short tons of manganese ore, dis-

[21] U. S. Embassy, Stockholm, Sweden, State Department Dispatch 251: Aug. 28, 1957.
[22] American Metal Market, vol. 64, No. 34, Feb. 19, 1957, p. 1.
[23] Narayanaswami, S., Ferromanganese in India: Indian Min. Jour., vol. 5, No. 10, October 1957 (ECAFE Number), pp. 82–87.
[24] Mining Journal (London), vol. 248, No. 6356, June 14, 1957, p. 766.
[25] Kailasam, L. N., The Use of Geophysics in Prospecting for Metallic Ores: Indian Min. Jour., vol. 5, No. 10, October 1957 (ECAFE Number), p. 73.
[26] Foreign Commerce Weekly, vol. 57, No. 21, May 27, 1957, p. 19.

tributed as follows: Japan, 33,000; Belgium-Luxembourg, 12,000; and Netherlands, 5,000 short tons.[27]

Philippines.—Through 1955, a total of 110,000 short tons of manganese oxide ore is believed to have been shipped from the deposits of the Anda Peninsula, Bohol. The average grade shipped since 1949 was 40 percent manganese, but some high-grade masses of pyrolusite-type ore contained 45 to 55 percent manganese. Manganese was first found in this region in 1936.[28] The manganese-mining operations of General Base Metals, Inc., have been based on the Anda Peninsula.

Philippine exports of manganese ore in 1956 totaled 7,100 short tons, slightly more than half of which went to Japan and the rest to the United States.[29] Preliminary figures indicate that in 1957 33,000 tons was exported, with Japan and the United States receiving all in about the same proportions. Eight firms supplied the ore in 1957.[30]

Portuguese India.—Exports of manganese ore from Goa in 1957 totaled 206,000 short tons. The United States received 50,000; West Germany, 40,000; Italy, 32,000; Netherlands, 29,000; France, 27,000; Austria, 22,000; Trieste, 3,900; and Japan, 2,000.[31]

Syria.—Recent discoveries of manganese ore near al-Rouaiseh assayed 50.6 percent manganese, 1.7 percent iron, and 5.2 percent silicon. Reported deposits near al-Touaykli (56.7 percent manganese, 0.7 percent iron, and 4.6 percent silicon) and at al-Azruth (42.6 percent manganese, 0.6 percent iron, and 27.3 percent silicon) are in Latakia region. Quantity data were not available.[32]

Turkey.—Manganese ore mined in Turkey had a manganese content ranging from 32 to 50 percent. Part of the production was used in the Government-owned Karabuk iron and steel plant.[33]

AFRICA

Egypt.—Most manganese ore produced in Egypt in 1956 was from the operations of one company in the Um-Bogma district of Sinai. Two classes of ore were shipped: High-grade, having a manganese dioxide content of 80 to 92 percent; and ferruginous manganese ore, containing 20 percent manganese and 35 percent iron. Production has been of the order of 10,000 tons a year of the former and 200,000 tons a year of the latter. Part of the dioxide ore was used by the local steel industry, and the rest was exported; all of the ferruginous ore was exported. Total exports in 1956 were 294,000 short tons, compared with 237,000 in 1955; the United States continued to be the chief recipient.[34] Both production and plant suffered heavily as a result of the Israeli invasion and occupation of the Sinai Peninsula. After return of the region to Egypt, the sequestered mine of Egypt's only large manganese-mining organization (Sinai Mining Co., Ltd.) was in the hands of an Egyptian Government company, Société Sinai pour le Manganese, S. A. E.[35]

[27] U. S. Embassy, Djakarta, Indonesia, State Department Dispatch 108: Aug. 28, 1957.
[28] Fernandez, N. S., Sorem, R. K., and Palacio, D. N., Manganese Deposits of the Anda Peninsula, Bohol: Philippines Bureau of Mines—Special Projects Series, Pub. 11, Manganese, Manila, 1956, 49 pp.
[29] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 11.
[30] U. S. Embassy, Manila, P. I., State Department Dispatches 181, 488, 754: Aug. 29 and Nov. 27, 1957, and Mar. 10, 1958.
[31] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 16.
[32] U. S. Embassy, Damascus, Syria, State Department Dispatch 179: Oct. 11, 1957.
[33] U. S. Embassy, Ankara, Turkey, State Department Dispatch 475: Jan. 14, 1958.
[34] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, pp. 13–14.
[35] U. S. Embassy, Cairo, Egypt, State Department Dispatch 632: Dec. 21, 1957.

French Equatorial Africa.—To receive certain tax concessions, Compagnie Miniere de l'Ogooue (COMILOG) agreed to develop its large manganese deposits near Moanda and Franceville, Gabon. A production target of 500,000 tons a year within 6 years was established.[36] By the end of 1957, final surveys had been virtually completed for 175 miles of railway plus 45 miles of overhead cable tramway to connect the deposits with the existing railway from Brazzaville to Pointe Noire.

French West Africa.—Interest was shown in large manganese deposits containing 20 to 30 percent manganese, in the Ivory Coast and French Guinea.

Ghana.—Exports of manganese ore in 1957 totaled 718,000 short tons, of which 86,000 tons was Battery grade, 627,000 tons was Metallurgical grade, and 5,000 tons contained less than 30 percent manganese.[37]

Morocco.—Of the 465,000 short tons of manganese ore produced in 1956, 42,000 tons were Chemical grade. Reserves of the 2 principal fields were estimated to be as follows: South Atlas (Imini, Tiouine, and Tasdrent), greater than 6.6 million tons; and Bou Arfa, East Morocco, 1.65 million tons.[38] In the first quarter of 1957 the Department of Mines reported production of 17,000 short tons of chemical ore, and 120,000 tons (45.4 percent manganese) of metallurgical ore. Preliminary Customs figures for the quarter showed that France received almost three-quarters of the exports of both grades; the United States about 15 percent of each. Norway, Italy, and Sweden took the remainder of the metallurgical ore; Netherlands, Germany, Great Britain, and Denmark, the rest of the Chemical grade.[39]

Rhodesia and Nyasaland, Federation of.—Exports of manganese ore in 1956 totaled 23,000 short tons, having the following distribution: United States, 13,000; Japan, 8,000; France, 1,000; United Kingdom, West Germany, Sweden, and Union of South Africa, the remainder.[40] The Bahati mine of Rhodesian Vanadium Corp., subsidiary of Vanadium Corp. of America, was mined as a surface operation, using bulldozers and front-end loaders. The ore occurs as high-grade, steep-dipping veins, extending 150 feet deep, averaging 1,200 feet long and 3 feet wide, with lower grade material in immediate association. A washing plant with trommels and jigs was a part of the installation. Transportation for export from the port of Beira, Mozambique, presented problems in trucking 150 miles to Mufulira and railing from that point.[41] The same corporation obtained an additional 2,500-square-mile concession in the nearby Chipili East manganese fields, scene of a recent manganese prospectors' "rush."[42]

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[36] American Metal Market, vol. 64, No. 44, Mar. 6, 1957, p. 1.
[37] U. S. Embassy, Accra, Ghana. State Department Dispatch 393: Apr. 28, 1958.
[38] U. S. Embassy, Rabat, Morocco, State Department Dispatch 150: Nov. 8, 1957.
[39] U. S. Consulate General, Casablanca, Morocco, State Department Dispatch 33: Sept. 12, 1957.
[40] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, pp. 17–18.
[41] Mining World, Rhodesian Firm Opens Mangabelt District for Large-Scale Mining: Vol. 19, No. 6, May 1957, pp. 50–52.
Fockema, R. A. P., and Austen, A. L. S., [Manganese Deposits of Northern Rhodesia]: XX Congreso Geologico Internacional, Symposium Sobre Yacimientos de Manganeso, vol. 2, 1956, pp. 273–291.
[42] South African Mining and Engineering Journal (Johannesburg), vol. 68, pt. 1, No. 3349, Apr. 19, 1957, pp. 713, 715.

South-West Africa.—Exports of manganese ore in 1957 were 94,000 short tons (45 percent manganese) [43] compared with 55,000 short tons (48 percent manganese) in 1956.[44]

Union of South Africa.—Production of manganese ore in 1956, short tons by grades, follows (local sales in parentheses): 40 percent and less, 462,000 (250,000); 40 to 45 percent, 209,000 (76,000); 45 to 48 percent, 74,000 (none); and over 48 percent, 23,000 (67). In June 1957 a new company, Ferroalloys, Ltd., was formed to produce standard ferromanganese in electric furnaces. The Associated Manganese Mines of South Africa, Ltd., of the Anglo-Transvaal group, held a 40-percent interest and will supply the ore. At least one pilot plant was in operation in South Africa in 1957, producing electrolytic manganese from uranium leaching plant effluent.[45] Many of the South African uranium mills had facilities for recovering for reuse as the dioxide the manganese used as oxidant in the leaching process. The Daggafontein plant was equipped for a 75 percent recovery.[46] The supply of railway trucks continued inadequate to meet both export needs and increased local demand; no improvement was expected for 1958. The major part of the exports of South African Manganese, Ltd., was through Port Elizabeth, and that company entered into a long-term contract to supply manganese ore to African Metals Corp., Ltd., for its production of ferromanganese which was expected to be increased substantially. South African Manganese began stripping overburden and constructing plant and townsite preparatory to opening a new mine on a large deposit of manganese ore at Hotazel farm in the Kuruman district, production being planned for early 1959.[47] This district lies between the older ones of Postmasburg and Black Rock. Mining in these areas continued to be by open pit for the most part, but some underground work was done at Black Rock.

OCEANIA

New Zealand.—The output of New Zealand's only operating manganese mine, known as G. M. Manning's Manganese Mine, Otau, was used for manufacturing fertilizer in 1957. The mine, employing one man, is in the South Aukland district.[48]

[43] U. S. Consulate General, Johannesburg, Union of South Africa, State Department Dispatch 200: Feb. 21, 1958.
[44] U. S. Consulate General, Johannesburg, Union of South Africa, State Department Dispatch 249: Apr. 10, 1957.
[45] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, pp. 11-12.
[46] Industrial and Engineering Chemistry, Uranium From Gold Wastes: Vol. 49, No. 1, January 1957, pp. 9-10.
[47] South African Mining and Engineering Journal (Johannesburg), South African Manganese, Ltd.: Vol. 68, pt. 2, No. 3382, Dec. 6, 1957, pp. 797-798.
[48] U. S. Embassy, Wellington, New Zealand, State Department Dispatch 166: Sept. 16, 1957.

TECHNOLOGY

Three reports of Federal Bureau of Mines investigations of, and metallurgical research on, the Artillery Peak deposits of Arizona were published during the year. Field work by the Bureau in 1949–51 included exploration by trenching and diamond drilling, mine development by adits, and one experimental room-and-pillar mine panel. At a cutoff grade of 5 percent manganese, a reserve of slightly less than 2 million tons of "hard" (enriched) ore was established for the limited area under investigation. This reserve averaged 10.6 percent manganese and represented an ore zone 7.5 to 29.5 feet thick.[49]

Following extensive laboratory investigations of ore from this mine, pilot-mill flotation tests were made in a 25-ton-per-day plant at the Bureau's Electrometallurgical Experiment Station, Boulder City, Nev. Using the oil-emulsion flotation process here, a recovery of 80 percent of the manganese was achieved in obtaining concentrate assaying 35.6 percent manganese, 2.8 percent iron, 19.4 percent silica plus alumina, 0.9 percent lead, and 0.08 percent phosphorus. The oil-emulsion collector was composed of 16 percent tall oil, 32 percent No. 2 fuel oil, and 2 percent petroleum sulfonate. Proper conditioning was the most critical step.[50] A sinter of blended flotation concentrate from the above operations, analyzing 41.5 percent manganese and 19.9 percent silica plus alumina, was leached with a heated 50-percent caustic soda solution in a pilot plant, using equipment of standard commercial design. This leaching of silica gave a product analyzing 43.7 percent manganese and 14.3 percent silica plus alumina.[51]

A report also described Boulder City experiments on producing Battery-grade manganese dioxide by chemical means.[52]

The Bureau's Southwest Experiment Station, Tucson, Ariz., showed by laboratory and larger scale tests that percolation sulfur dioxide leaching of roasted low-grade wad-type ores and of unroasted low-grade granular ores was technically feasible in either vats or open heaps.[53]

Laboratory mineral-dressing tests of samples representing different kinds of low-grade manganese-ore deposits of the Batesville district of Arkansas produced Specification-grade metallurgical concentrate, but with low recoveries for the most part.[54]

Results were reported of core-drilling the Dudley low-grade manganese deposit in the northern district of Aroostook County, Maine, to obtain a representative bulk sample for metallurgical research. At a 5-percent manganese cutoff composite samples analyzed 10.3

[49] Kumke, C. A., Rose, C. K., Everett, F. D., and Hazen, S. W., Jr., Mining Investigations of Manganese Deposits in the Maggie Canyon Area, Artillery Mountains Region, Mohave County, Ariz.: Bureau of Mines Rept. of Investigations 5292, 1957, 87 pp.

[50] Rosenbaum, J. B., Schack, C. H., Lang, R. S., and Clemmer, J. B., Pilot-Plant Flotation of Manganese Ore From the Maggie Canyon Deposit, Artillery Mountains Region, Mohave County, Ariz.: Bureau of Mines Rept. of Investigations 5330, 1957, 45 pp.

[51] Perkins, E. C., Caustic Leaching of Manganese Flotation Concentrate From Artillery Peak, Ariz.: Bureau of Mines Rept. of Investigations 5341, 1957, 16 pp.

[52] Lundquist, R. V., Manganese Dioxide Prepared From Manganous Hydroxide: Bureau of Mines Rept. of Investigations 5347, 1957, 34 pp.

[53] Bender, F. N., and Rampacek, Carl, Percolation Leaching of Manganese Ores With Sulfur Dioxide: Bureau of Mines Rept. of Investigations 5323, 1957, 20 pp.

[54] Fine, M. M., A Mineral-Dressing Study of Manganese Deposits of the Batesville, Ark., District: Bureau of Mines Rept. of Investigations 5301, 1957, 12 pp.

percent manganese, 17.3 percent iron, 31.5 percent silica, 10.7 percent alumina, and 0.6 percent phosphorus. The manganese mineralization is extremely fine textured and intimately mixed.[55]

Studies by the Federal Bureau of Mines indicated that manganese might be extracted from low-grade materials by bacterial action.

A contract involving an amount not to exceed $270,541 was signed January 4, 1957, between General Services Administration and Vitro Corporation of America, whereby the latter was to build and operate a pilot plant at West Orange, N. J., to test and develop the Sheer-Korman "Hi-Arc" process for obtaining manganese from low-grade domestic manganese deposits, particularly the rhodonite deposits of the Silverton area of Colorado. Operation of the pilot plant was limited to 19 months from the date of the contract. In the process a mixture of rhodonite and carbon is shaped into anodes that are vaporized in a high-intensity arc at temperatures of 7,000° to 10,000° C. Manganous oxide and silica condense as a fine powder from which manganese is extracted by leaching.[56]

Ethyl Corporation announced that a new gasoline antiknock additive, containing manganese, was being tested as a supplement to tetraethyl lead.

Production of ferromanganese at U. S. Steel Corporation's Duquesne works was reported to have been increased 25 percent by the use of oxygen in the furnace blast.[57]

In the synthesis and testing of manganese and other ferrites, spinel-type metallic oxides, it was found that furnace atmosphere influenced their magnetic properties. X-ray diffraction measurements showed that manganese ferrite ($MnFe_2O_4$) forms at 850° to 1,250° C., dependent upon furnace atmosphere.[58]

For economic treatment, the wad ore from the Three Kids mine (Nevada) requires a high recovery of manganese in slimes. Good recovery is achieved by intensive conditioning of the pulp by mechanical agitation after addition of all the reagents—sulfur dioxide solution first, followed immediately by an emulsion of tall oil soap skimmings (a lightweight petroleum oil) and a petroleum sulfonate wetting agent. As much as 38 kw.-hr. per dry short ton of ore was used for conditioning a pulp containing 18 to 23 percent solids. One roughing, 1 scavenging, and 4 cleaning stages were used in the flotation circuit.[59]

A paper describing the Dean-Leute ammonium carbamate process, as practiced by Manganese Chemicals Corp. at Riverton, Minn., on Cuyuna range materials containing 9 to 10 percent manganese and 25 to 28 percent iron, emphasized importance of careful control in the initial reduction step. The high-purity manganese carbonate produced is readily converted to manganese oxides. In 1955 oxide metallurgical nodules containing more than 60 percent manganese, low in silica and iron, was the plant's principal end product. In 1956

[55] Eilertsen, N. A., and Earl, K. M., Bulk Sampling by Diamond Drilling, Dudley Manganese Deposit, Northern District, Aroostook County, Maine: Bureau of Mines Rept. of Investigations 5303, 1957, 26 pp.
[56] Chemical Week, High-Intensity Arc: Getting Ready to Go Commercial: Vol. 80, No. 10, Mar. 9, 1957, pp. 28–34.
[57] Iron and Steel Engineer, vol. 34, No. 7, July 1957, p. 11.
[58] Kedesdy, Horst, and Tauber, Arthur, Synthesis of Some Ferrites: Min. Eng., vol. 9, No. 7, July 1957, pp. 784–792.
[59] Gates, Ellis H., Agglomeration Flotation of Manganese Ores: Min. Eng., vol. 9, No. 12, December 1957, pp. 1368–1372.

and 1957 the end product was high-quality synthetic manganese dioxide for dry-battery use, made from the high-purity carbonate by chemical means. The cost of producing synthetic dioxide in this manner was claimed to be lower than by electrolysis.[60]

Strategic Materials Corp. continued to investigate the Udy selective reduction process for producing ferromanganese from low-grade ores. Following work in a 100-kv.-a. electric-furnace pilot plant at Niagara Falls, N. Y., activities were transferred to a pilot plant using 50 tons of feed a day at Niagara Falls, Ontario, Canada, containing three 1,000-kv.-a. electric arc furnaces. It was claimed that the data obtained forecast competitive costs for a commercial-size operation using manganiferous-ferruginous slates and manganiferous hematite from Woodstock, New Brunswick (see World Review—Canada).[61] On October 1, Koppers Company, Inc., and Strategic Materials Corp. announced a working agreement between the two companies whereby the former was to provide certain funds and personnel.[62]

[60] Welsh, J. Y., and Peterson, D. W., Manganese From Low-Grade Ore by the Ammonium Carbamate Process: Jour. Metals, vol. 9, No. 6, June 1957, pp. 762–765.

[61] Chemical Week, How to Pull Manganese From Ore: Vol. 80, No. 6, Feb. 9, 1957, pp. 40–42, 46, 48.
Monture, G. C., Woodstock Manganese Ores—Occurrence and Treatment: Canadian Min. Jour., vol. 78, No. 4, April 1957, pp. 117–120.
Burke, J. J., Ferromanganese From Low-Grade Ores: Jour. Metals, vol. 9, No. 3, March 1957, pp. 340–342

[62] Northern Miner, vol. 43, No. 30, Oct. 17, 1957, p. 3.

Mercury

By J. W. Pennington [1] and Gertrude N. Greenspoon [2]

MERCURY output at domestic mines rose 38 percent to 33,400 flasks in 1957—the highest annual peacetime rate (except for 1940) since 1904, when 35,100 flasks was recovered. Significant gains in Alaska, California, Nevada, and Oregon more than offset the decline in Idaho's output, and Washington produced mercury for the first time since 1942. Of the total primary output, 10 mines supplied 83 percent and 20 mines 95 percent. Production of 5,800 flasks of mercury from secondary sources was the same as in 1956.

Despite an increase in receipts of mercury from Spain, general imports in 1957 declined 13 percent from 1956, as less metal was received from the other principal sources—Italy, Mexico, and Yugoslavia. Exports and reexports of mercury continued to rise and reached the highest annual rates since 1941 and 1943, respectively.

Expansions at chlorine and caustic soda plants using mercury cells, coupled with a 20-percent increase in the quantity of mercury required for replacement purposes at all similar installations in 1957, helped to keep mercury consumption high at 53,000 flasks—only 2 percent less than in the preceding year. In other major uses, consumption of mercury for agricultural purposes fell 36 percent to 6,300 flasks and for electrical apparatus 6 percent to 9,200 flasks; for industrial and control instruments it continued virtually unchanged at 6,000 flasks.

Mercury prices, after remaining constant at $255–$257 a flask from the beginning of 1957 to the latter part of July, gradually declined to $225–$230 a flask in November and stayed at the latter range the remainder of the year. As a result, the average price of $246.98 a flask for 1957 was about $13 a flask below that of 1956.

Government assistance to the mercury industry under provisions of the Defense Production Act of 1950, as amended, continued in 1957. During the year the General Services Administration (GSA) guaranteed-price purchase program for mercury, which was scheduled to expire December 31, 1957, was extended to December 31, 1958; the Defense Minerals Exploration Administration (DMEA) program was revised to lower Government participation from 75 percent to 50 percent of approved costs for exploration of mercury deposits; and the expansion goal for mercury was closed by the Office of Defense Mobilization (ODM).

With increased output in virtually all the major mercury-producing countries, world production of mercury in 1957 reached 235,000 flasks—the highest annual rate since 1942. Foreign (London) mercury prices fluctuated more frequently than domestic quotations and averaged $232.36 a flask for the year.

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[2] Statistical assistant.

TABLE 1.—Salient statistics of mercury, 1948–52 (average) and 1953–57, in 76-pound flasks

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Production	9,739	14,337	18,543	18,955	24,177	33,380
Number of producing mines	29	49	71	98	147	93
Imports:						
For consumption	62,177	83,393	64,957	20,354	47,316	42,005
General	62,565	85,784	65,317	20,948	52,009	45,449
Exports	438	546	890	451	1,080	1,919
Reexports	714	916	1,436	267	2,025	3,275
Stocks at end of year	30,259	27,021	22,486	10,028	22,310	20,642
Producers	2,999	1,121	186	928	1,210	3,642
Consumers and dealers	27,260	25,900	22,300	9,100	21,100	17,000
Consumption	46,946	52,259	42,796	57,185	54,143	52,889
Average price per flask: New York	$129.29	$193.03	$264.39	$290.35	$259.92	$246.98
World: Production	133,500	160,000	180,000	185,000	215,000	235,000

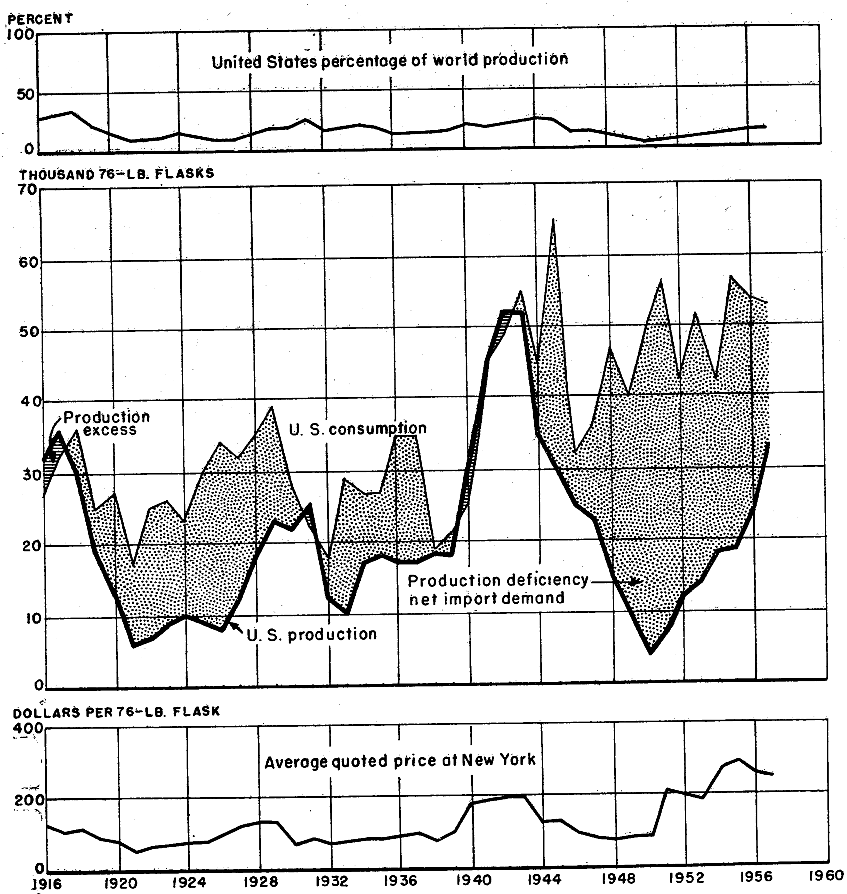

FIGURE 1.—Trends in production, consumption, and price of mercury, 1916–57.

LEGISLATION AND GOVERNMENT PROGRAMS

Under provisions of the Defense Production Act of 1950, as amended, the Defense Minerals Exploration Administration (DMEA) entered into contracts for the exploration of mercury deposits. The assistance advanced amounted to 75 percent of approved costs for mercury-exploration projects. In October 1957, DMEA issued Order 1, Revised, which lowered Government participation to 50 percent on mercury applications on and after October 22. Contracts that were executed during 1957 are shown in table 2. In addition, amendments to prior contracts were executed, which totaled $70,318.

TABLE 2.—DMEA contracts involving mercury executed during 1957, by States

State and contractor	Property	County	Contract	
			Date	Total amount [1]
CALIFORNIA				
New Idria Mining & Chemical Co	New Idria	San Benito	Oct. 1	$96,980
Palo Alto Mining Corp	Guadalupe	Santa Clara	July 31	20,020
NEVADA				
Walter L. & Dorothy Low	Mount Tobin	Pershing	Sept. 11	10,544
OREGON				
International Engineering & Mining Co	Axe Handle	Jefferson	Aug. 21	10,420
Orion Exploration & Development Co	Log Cabin, Ridge & Camp.	Crook	Aug. 9	12,100
TEXAS				
Dow Chemical Co	Maravillas	Brewster	Apr. 24	59,244
Southern Geophysical Co., Inc	Texas-Almaden	do	Sept. 4	63,240

[1] Government participation in exploration projects was 75 percent.

The Government guaranteed-purchase-price program announced by General Services Administration (GSA) in July 1954 and in force in 1955 and 1956 was continued in 1957. The program provided for purchasing 125,000 flasks of domestic mercury and 75,000 flasks of Mexican metal at $225 a flask and was scheduled to end December 31, 1957. The import duty of $19 a flask was included in the price for Mexican mercury.

On March 21 the Office of Defense Mobilization announced that it was authorizing GSA to extend the purchase program through 1958. The extension would permit purchasing up to 50,000 flasks (30,000 domestic, including Alaska, and 20,000 Mexican) at $225 a flask. Revisions 1 to Regulations 11 and 12 were issued November 8, extending the program and revising packaging specifications. After mercury producers stated that they could not meet the delivery deadline because of the new packaging requirements, they were notified by GSA that deliveries against the December 31, 1957, quota could be made until March 31, 1958.

From the inception of the program in 1954 until November 1957 only 5 flasks of mercury had been tendered and purchased, as the market price had been higher than $225 a flask; however, following the price decline in November, both domestic and Mexican mercury were tendered GSA. Under the 1957 quotas GSA purchases totaled 8,596 flasks of domestic and 766 flasks of Mexican mercury; however, only 2,967 flasks of domestic and 15 of Mexican mercury were delivered up to December 31, 1957.

On April 25 Office of Defense Mobilization (ODM) closed expansion goal 64 for mercury, which had been established April 1, 1952, following studies that indicated enough capacity either is planned or now exists to meet mobilization requirements now known.

DOMESTIC PRODUCTION

Mercury production in the United States rose for the 7th consecutive year; output in 1957 increased 38 percent above 1956 to 33,400 flasks—the highest since 1944. Alaska, California, Nevada, and Oregon shared the increased production, whereas Idaho's output declined. Alaska and Nevada reported record high outputs; California's production was the largest since 1947; and Washington produced for the first time since 1942. Although the number of properties that produced mercury dropped from 147 in 1956 to 93 in 1957, the quantity of ore treated rose 22 percent and was the largest since 1944. The average grade of the ore treated exceeded 1956 by 1 pound of mercury per ton—the highest since 1950, when mercury production was the smallest in 100 years. The same quantity of secondary mercury was produced as in 1956.

Production in California was 69 percent higher than in 1956, and the State continued to be the leading mercury producer in the United States. Because of a substantial gain in output, California furnished 46 percent of the total United States production compared with 37 percent in 1956 and 52 percent in 1955. The number of producing operations dropped from 71 to 43 in 1957, but the quantity of ore treated rose 34 percent.

Nevada continued in second place and supplied 19 percent of the domestic total. The 8-percent increase in output from 1956 was due in large part to production at the Red Ore mine in Humboldt County, where the Triumph Mining Co. operated a flotation plant for concentrating cinnabar ore. Another flotation plant was operated by the United Mercury Corp. in Pershing County.

Alaska displaced Idaho as the third ranking mercury-producing State in 1957. Output was 66 percent more than the previous record for 1956 and represented 16 percent of the total United States production. Virtually all the output was from the Red Devil mine in the Kuskokwim River region.

Output in Oregon more than doubled the 1956 total and was the largest since 1943. The gain in production enabled the State to rank fourth in output and raised Oregon's contribution to the total United States production from 8 percent in 1956 to 12 percent in 1957.

Idaho dropped to fifth place among leading mercury-producing States, as the Idaho-Almaden mine in Washington County was the only large producer in 1957. The other principal mine in Idaho—the Cinnabar in Valley County—was closed when the plant was destroyed by fire in August 1956. The company was reported to be experimenting with a new method using flotation, leaching, and electrolytic deposition for recovering mercury from the ore. Output was also recorded for the Vermillion mine in Valley County.

Arizona, Texas, and Washington supplied the remainder of the United States output. Washington's production was the first since 1942.

TABLE 3.—Mercury produced in the United States, 1954–57, by States

Year and State	Producing mines	76-pound flasks	Value [1]	Year and State	Producing mines	76-pound flasks	Value [1]
1954:				1956:			
Alaska	2	1,046	$276,552	Alaska	2	3,280	$852,538
Arizona	3	163	43,096	Arizona and Texas	8	734	190,781
California	35	11,262	2,977,560	California	71	9,017	2,343,699
Idaho	1	609	161,013	Idaho	2	3,394	882,168
Nevada	21	4,974	1,315,076	Nevada	51	5,859	1,522,871
Oregon	9	489	129,287	Oregon	13	1,893	492,029
Total	71	18,543	4,902,584	Total	147	24,177	6,284,086
1955:				1957:			
Alaska and Texas	4	690	200,342	Alaska	2	5,461	1,348,758
Arizona	4	477	138,497	Arizona	5	28	6,915
California	48	9,875	2,867,206	California	43	15,266	3,770,397
Idaho	2	1,107	321,417	Idaho	2	2,260	558,174
Nevada	33	5,750	1,669,512	Nevada	31	6,313	1,559,185
Oregon	7	1,056	306,610	Oregon	8	3,993	986,191
				Texas and Washington	2	59	14,572
Total	98	18,955	5,503,584	Total	93	33,380	8,244,192

[1] Value calculated at average price at New York.

TABLE 4.—Mercury produced in the United States, 1948–52 (average) and 1953–57, by quarters, in 76-pound flasks

Quarter	1948–52 (average)	1953	1954	1955	1956	1957
First	2,474	3,530	4,170	4,050	4,910	6,630
Second	2,094	3,790	4,700	4,860	5,980	8,560
Third	5,046	3,040	5,160	4,720	6,300	8,710
Fourth		3,970	4,470	5,200	6,750	9,440
Total: Preliminary	9,614	14,330	18,500	18,830	23,940	33,340
Final	9,739	14,337	18,543	18,955	24,177	33,380

TABLE 5.—Mercury ore treated and mercury produced in the United States, 1953–57 [1]

Year	Ore treated (short tons)	Mercury produced: 76-pound flasks	Mercury produced: Pounds per ton of ore	Year	Ore treated (short tons)	Mercury produced: 76-pound flasks	Mercury produced: Pounds per ton of ore
1953	138,090	14,262	7.8	1956	244,148	24,109	7.5
1954	174,083	18,524	8.1	1957	298,752	33,374	8.5
1955	222,740	18,819	6.4				

[1] Excludes mercury produced from placer operations and from cleanup activity at furnaces and other plants.

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A total of 93 mines, compared with 147 in 1956, contributed to production in 1957; 10 properties each produced 1,000 flasks or more and supplied 84 percent of the total output. The largest producers were as follows:

State:	County	Mine
Alaska	Aniak district	Red Devil.
California	Lake	Abbott.
	San Benito	New Idria.
	San Mateo	Challenge.
	Santa Clara	Guadalupe.
		New Almaden Mine and dumps.
Idaho	Washington	Idaho-Almaden.
Nevada	Humboldt	Cordero.
Oregon	Douglas	Bonanza.
	Malheur	Bretz.

In addition to the foregoing mines, the following produced 100 flasks or more during 1957:

State:	County	Mine
California	Kings	Fredana Group.
	Lake	Sulphur Bank.
	Marin	Edward Bros.
	Napa	Oat Hill.
	San Benito	San Carlos.
	San Luis Obispo	Buena Vista.
	Santa Barbara	Gibraltar.
	Sonoma	Buckman.
		Mount Jackson (including Great Eastern).
Nevada	Humboldt	Red Ore.
	Pershing	Pershing Group.
Oregon	Jefferson	Horse Heaven.
	Lane	Black Butte.

The 23 mines listed produced 96 percent of the total domestic output. Of the leading producers, properties that produced for the first time in several years were the Red Ore and Pershing Group mines.

Secondary.—Production of secondary mercury in 1957 was about the same as in 1956. Although less metal was recovered from the usual scrap sources, secondary output did not decline, as mercury was reclaimed from a plant that abandoned a process using mercury.

TABLE 6.—Production of secondary mercury in the United States, 1953–57, in 76-pound flasks

Year:	Quantity
1953	2, 800
1954	6, 100
1955	10, 030
1956	5, 850
1957	5, 800

CONSUMPTION AND USES

Although industrial consumption of mercury in 1957 was 2 percent less than in 1956, it was only 8 percent less than the peacetime peak in 1955 and otherwise was the largest since 1951. Expansions in chlorine and caustic soda plants using mercury cells at McIntosh, Ala., Western Division of Dow Chemical Co., Brunswick, Ga., and Calvert City, Ky., were chiefly responsible for the continued high level of consumption.

TABLE 7.—Mercury consumed in the United States, 1948–52 (average) and 1953–57, in 76-pound flasks

Use	1948–52 (average)	1953	1954	1955	1956	1957
Pharmaceuticals	3,396	1,858	1,846	1,578	1,600	1,751
Dental preparations [1]	1,049	1,117	1,409	1,177	1,328	1,371
Fulminate for munitions and blasting caps	342	39	106	90	11	----------
Agriculture (includes insecticides, fungicides, and bactericides for industrial purposes)	5,968	6,936	7,651	7,399	9,930	6,337
Antifouling paint	1,898	655	512	724	511	568
Electrolytic preparation of chlorine and caustic soda	1,384	2,380	2,137	3,108	3,351	4,025
Catalysts	2,442	826	594	729	871	859
Electrical apparatus [1]	8,822	9,630	10,833	9,268	9,764	9,151
Industrial and control instruments [1]	5,725	5,546	5,185	5,628	6,114	6,028
Amalgamation	161	200	203	217	239	244
General laboratory	517	1,241	1,129	976	984	894
Redistilled [1]	7,413	7,784	9,281	9,583	9,483	9,703
Other	7,829	14,047	1,910	16,708	9,957	11,958
Total	46,946	52,259	42,796	57,185	54,143	52,889

[1] A breakdown of the "redistilled" classification showed ranges of 53 to 43 percent for instruments, 16 to 5 percent for dental preparations, 39 to 16 percent for electrical apparatus, and 17 to 8 percent for miscellaneous uses in the period 1948–56, compared with 39 percent for instruments, 8 percent for dental preparations, 44 percent for electrical apparatus, and 9 percent for miscellaneous uses in 1957.

As a result of new installations and expansions at chlorine and caustic soda plants, the quantity of mercury required to replace losses in these operations rose for the third consecutive year; in 1957, 20 percent more metal was used for this purpose than in 1956. The consumption of mercury in pharmaceuticals increased 9 percent over 1956, and dental preparations took 3 percent more.

Among the uses that required less metal in 1957 were agriculture (including insecticides, fungicides, and bactericides for industrial purposes), which dropped 36 percent and electrical apparatus 6 percent. Industrial and control instruments and catalysts each consumed about the same quantities as in 1956.

TABLE 8.—Mercury consumed in the United States, 1948–52 (average) and 1953–57, by quarters, in 76-pound flasks

Quarter	1948–52 (average)	1953	1954	1955	1956	1957
First	11,420	12,700	11,500	19,500	12,400	16,400
Second	11,140	13,200	11,300	17,900	11,700	12,000
Third	10,080	11,000	9,000	8,300	12,300	14,600
Fourth	14,260	15,500	9,500	11,600	17,500	9,400
Total: Preliminary	46,900	52,400	41,300	57,300	53,900	52,400
Final	46,946	52,259	42,796	57,185	54,143	52,889

STOCKS

Consumers' and dealers' stocks of mercury dropped 7 percent in 1957, mainly because of the withdrawal of metal from inventories for expansions at chlorine and caustic soda plants during the year. Metal at industrial plants at the end of 1957 continued to include mercury accumulated for chlorine and caustic soda installations in the near future; except for such metal, inventories were well below those normally held by industry.

TABLE 9.—Stocks of mercury at producers and consumers and dealers, 1953–57, in 76-pound flasks

End of year	Producers	Consumers and dealers	Total
1953	1,121	25,900	27,021
1954	186	22,300	22,486
1955	928	9,100	10,028
1956	1,210	21,100	22,310
1957	3,642	17,000	20,642

Stocks held by producers were more than double those at the end of 1956. They were the largest since 1949 and represented 18 percent of total inventories.

In addition to the stocks of metal shown in table 9 the National Stockpile contained inventories of mercury that may not be disclosed.

PRICES

The annual average mercury quotation in 1957 was $246.98 a flask, 5 percent less than in 1956. The price quotation of $255–$257 from early November 1956 remained constant through the third week of July 1957. It dropped to $252–$255 a flask the last week in July and remained there during the first 2 weeks in August. Thereafter, the price declined gradually and without interruption to $225–$230 by mid-November and ended the year at that range.

TABLE 10.—Average monthly prices per 76-pound flask of mercury at New York and London and excess of New York price over London price, 1955–57

Month	1955			1956			1957		
	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	$322.00	$304.63	$17.37	$273.04	$248.38	$24.66	$255.00	$236.94	$18.06
February	322.00	304.63	17.37	267.58	245.03	22.55	255.00	236.96	18.04
March	321.56	305.24	16.32	258.78	242.90	15.88	255.00	238.28	16.72
April	315.85	304.12	11.73	266.56	240.41	26.15	255.00	239.85	15.15
May	302.92	301.96	.96	265.23	240.61	24.62	255.00	248.12	6.88
June	283.27	301.30	[3] 18.03	258.12	243.27	14.85	255.00	254.26	.74
July	264.92	300.77	[3] 35.85	255.00	238.30	16.70	254.31	248.81	5.50
August	253.89	280.75	[3] 26.86	255.00	233.50	21.50	251.11	240.43	10.68
September	263.40	259.15	4.25	255.00	232.38	22.62	244.75	238.13	6.62
October	275.56	258.61	16.95	254.77	232.51	22.26	231.62	213.06	18.56
November	279.39	253.79	25.60	255.00	233.73	21.27	226.96	197.23	29.73
December	279.42	200.81	78.61	255.00	234.11	20.89	225.00	193.60	31.40
Average	290.35	280.22	10.13	259.92	238.68	21.24	246.98	232.36	14.62

[1] Engineering and Mining Journal, New York.
[2] Mining Journal (London) prices in terms of pounds sterling were converted to American dollars by using average rates of exchange recorded by Federal Reserve Board.
[3] London excess.

FOREIGN TRADE[3]

Imports.—Imports of mercury for consumption in the United States in 1957 were 11 percent less than the quantity received in 1956. Of the imports for consumption, 9,114 flasks from Spain, 4,003 from Italy, and 2,000 from the United Kingdom entered the country duty free for the United States Government; in addition, 12 flasks were also received from Canada duty free.

The chief suppliers were Spain (60 percent), Italy (19 percent), and Mexico (13 percent). As receipts from Italy in 1957 were less than half the 1956 entries, Italy dropped to second place among the principal suppliers of mercury. The quantity from Yugoslavia was the smallest received since that country became a supplier of mercury following acquisition of the Idria mine after World War II. Of the chief mercury-producing countries, only Spain shipped more metal to the United States in 1957 than in 1956. Small quantities of mercury were received from Colombia and Peru, and the remainder came from Canada and the United Kingdom. The latter two countries are normally importers of mercury, and the 1957 shipments no doubt represented reexported mercury.

Imports of various mercury compounds, usually insignificant, dropped 32 percent in 1957. Of the 18,891 pounds (27,985 in 1956) of mercuric chloride, corrosive sublimate, mercurous chloride (calomel), oxide (red precipitate), and other mercury preparations received in 1957, 12,300 pounds came from Canada, 4,269 from the United Kingdom, 1,551 from Yugoslavia, 551 from Spain, and 220 from Italy; 330 pounds of vermilion reds was imported from Italy.

Exports.—Exports of mercury rose 78 percent in 1957 but were small in relation to total imports. Of the total of 1,919 flasks exported in 1957 (1,080 in 1956), 798 (400) went to Japan, 776 (none) to the United Kingdom, 102 (100) to Canada, 56 (29) to Venezeula, 41 (27) to Cuba, 29 (86) to Korea, 25 (47) to Colombia, 24 (16) to Brazil, and the remainder in lots of less than 10 flasks to 14 other countries.

Reexports.—Although reexports of mercury also are usually small, they rose 62 percent in 1957 to the largest since 1943, when substantial quantities were shipped to the U. S. S. R. following the German occupation of the Donets Basin—the principal source of Russian mercury. Of the 3,275 flasks reexported in 1957 (2,025 in 1956), 1,855 (823) went to Japan, 697 (1,164) to Canada, 499 (none) to the United Kingdom, 153 (none) to Taiwan, 23 (none) to Korea, 20 (none) to Rhodesia and Nyasaland, 15 (10) to Cuba, 7 (18) to Venezuela, and 2 each (none) to Nicaragua, Ecuador, and Chile.

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[3] Figures on United States imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, from records of the U. S. Department of Commerce, Bureau of the Census.

TABLE 11.—Mercury imported for consumption in the United States, 1948–52 (average) and 1953–57, in flasks [1]

[Bureau of the Census]

Country	1948–52 (average)		1953		1954		1955		1956		1957	
	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value
North America:												
Canada	159	$28,607	171	$33,217	115	$31,221	114	$36,500	80	$20,876	66	$15,580
Honduras	2	428										
Mexico	4,622	537,050	13,298	2,079,096	8,887	1,729,601	10,250	2,545,925	11,536	2,617,553	5,280	1,023,251
Total	4,783	566,085	13,469	2,112,313	9,002	1,760,822	10,364	2,582,425	11,616	2,638,429	5,346	1,038,831
South America:												
Bolivia	4	349										
Chile									25	5,837		
Colombia											15	3,732
Peru			6	875			95	26,276	372	88,880	244	52,358
Total	4	349	6	875			95	26,276	397	94,717	259	56,090
Europe:												
Czechoslovakia	40	1,984										
Denmark	60	4,020										
Germany	50	7,981										
Italy	30,392	2,936,655	36,120	5,938,004	22,180	3,393,759	629	178,487	16,810	3,933,934	8,056	1,869,085
Netherlands	205	14,594	50	8,959					20	4,976		
Spain	19,233	1,724,834	28,049	4,549,115	29,884	4,875,352	5,458	1,302,234	15,713	3,667,215	25,276	5,677,032
Sweden	348	34,362										
Switzerland	41	4,690										
United Kingdom	169	10,629	(2)	36			1	314	350	77,840	2,500	559,511
Yugoslavia	5,357	649,748	5,649	951,008	3,891	753,724	3,807	1,059,260	2,350	579,446	568	132,175
Total	55,895	5,389,497	69,868	11,447,122	55,955	9,022,835	9,895	2,540,295	35,243	8,263,411	36,400	8,237,803
Asia:												
India			25	3,666								
Japan	1,485	73,687	25	4,600								
Turkey									60	13,388		
Total	1,485	73,687	50	8,266					60	13,388		
Africa: Morocco	10	1,650										
Grand total	62,177	6,031,268	83,393	13,568,576	64,957	[3] 10,783,657	20,354	5,148,996	47,316	11,009,945	42,005	9,332,724

[1] Flask = 76 pounds.
[2] Less than 1 flask.
[3] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with other years.

TABLE 12.—Mercury imported (general imports) into the United States, 1957, by months

[Bureau of the Census]

Month	76-pound flasks	Month	76-pound flasks
January	6,818	August	2,063
February	5,618	September	4,562
March	4,325	October	1,881
April	4,014	November	1,548
May	2,836	December	2,856
June	5,628		
July	3,300	Total	45,449

TABLE 13.—Mercury imported (general imports) into the United States, 1948–52 (average) and 1953–57, in 76-pound flasks

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	163	171	115	114	80	66
Honduras	2					
Mexico	4,903	13,637	9,374	10,310	12,502	5,991
Total	5,068	13,808	9,489	10,424	12,582	6,057
South America:						
Bolivia	4					
Chile					125	
Colombia						15
Peru		6		95	372	244
Total	4	6		95	497	259
Europe:						
Denmark	60					
Germany	50					
Italy	30,270	37,827	21,858	579	17,592	9,208
Netherlands	185	50			20	
Spain	19,364	28,303	29,859	5,524	18,104	25,993
Sweden	363					
Switzerland	41					
United Kingdom	10	(1)		1	564	2,500
Yugoslavia	5,627	5,765	4,057	4,325	2,590	1,432
Total	55,970	71,945	55,774	10,429	38,870	39,133
Asia:						
Japan	1,513	25				
Turkey			54		60	
Total	1,513	25	54		60	
Africa: Morocco	10					
Grand total	62,565	85,784	65,317	20,948	52,009	45,449

[1] Less than 1 flask.

TABLE 14.—Mercury exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Pounds	76-pound flasks	Value	Year	Pounds	76-pound flasks	Value
1948–52 (average)	33,306	438	$55,699	1955	34,301	451	$155,433
1953	41,497	546	105,975	1956	82,044	1,080	284,418
1954	67,628	890	183,417	1957	145,833	1,919	483,892

TABLE 15.—Mercury reexported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Pounds	76-pound flasks	Value	Year	Pounds	76-pound flasks	Value
1948–52 (average)	54,259	714	$65,548	1955	20,274	267	$77,664
1953	69,640	916	157,880	1956	153,896	2,025	475,667
1954	109,147	1,436	257,342	1957	248,864	3,275	763,303

Tariff.—The duty of 25 cents a pound ($19 a flask) on imports of mercury, in effect since 1922, was continued.

WORLD REVIEW

The highest annual world production of mercury since 1942 was attained in 1957 as output rose 20,000 flasks to an estimated 235,000 flasks. Increased mine output was recorded in all major mercury-producing countries except Yugoslavia, where it declined slightly. Except for small fluctuations, production in the minor mercury-producing countries continued unchanged.

TABLE 16.—World production of mercury, by countries,[1] 1948–52 (average) and 1953–57, in 76-pound (34.5-kilogram) flasks [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Honduras	2					
Mexico	6,118	11,643	14,755	29,881	19,530	21,089
United States	9,739	14,337	18,543	18,955	24,177	33,380
South America:						
Bolivia (exports)	4					
Chile	364	100	243	526	575	[3][4] 520
Colombia				36		
Peru			77	148	335	[4] 395
Europe:						
Austria	17	22	27	16	6	6
Czechoslovakia [3][5]	760	725	725	725	725	725
Italy	49,163	51,373	54,477	53,520	61,932	63,237
Spain	38,079	43,541	43,135	36,231	48,269	[3] 50,000
U. S. S. R.[3][5]	11,600	12,300	12,300	12,300	([6])	([6])
Yugoslavia	13,473	14,272	14,446	14,591	13,228	12,328
Asia:						
China	[3] 2,000	[3] 5,000	[3] 10,000	[3] 11,500	([6])	([6])
Japan	2,078	6,406	10,264	4,990	8,334	11,864
Philippines				635	3,015	3,363
Taiwan			44	58		
Turkey	5		261	841	562	[3] 500
Africa:						
Algeria	99					
Tunisia				166	22	
World total (estimate)	133,500	160,000	180,000	185,000	215,000	235,000

[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. Data do not add to totals shown owing to rounding where estimates are included in the detail.
[3] Estimate.
[4] Exports.
[5] According to the 44th annual issue of Metal Statistics (Metallgesellschaft) through 1955.
[6] Data not available; estimate by author of chapter included in total.

TABLE 17.—Exports of mercury from Italy, 1953–57, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Argentina				470	
Australia	76	98	165	215	197
Austria	43	471	368	629	1,010
Belgium-Luxembourg	400	288	299	690	264
Brazil	11	141	310		4,052
Canada		400	473	1,125	99
Colombia	9			2,100	
Czechoslovakia	1,389	177	1,433	1,848	812
Finland	599	512	232	232	
France	3,351	5,629	3,014	6,846	4,363
Germany:					
East			348		
West	3,881	15,234	12,473	9,796	5,924
Hungary	583		270	335	
India		3		2,260	487
Indonesia			339		
Japan			641	6,353	2,680
Netherlands	496	820	595	316	99
Norway	466	145			
Poland	2,817	751	1,738	2.039	818
Rumania			325		
Sweden		304	177	806	78
Switzerland	100	250	67	339	78
Union of South Africa	181			299	148
United Kingdom	8,506	16,210	3,951	13,735	3,252
United States	32,025	20,230		24,242	4,151
Other countries	235	257	705	328	276
Total	55,168	61,920	27,923	75,003	28,788

[1] Compiled from Customs Returns of Italy.

Mexico.—It was reported [4] that a low-grade mercury deposit that may become one of Mexico's principal mercury sources would be put into operation in 1957. The deposit is on the Luz Julieta exploitation concession near Pedernales, municipality of Guerrero, 130 kilometers west of Chihuahua City. Uniform grade of furnace feed, 5 pounds of mercury per ton, would be maintained by blending of the ores. Although the reduction plant was rated at 75 tons per day, only a 50-ton-per-day rotary furnace would be required, because one-third of the total plant input was to be discarded as waste ahead of the furnace.

TABLE 18.—Exports of mercury from Mexico, 1953–57, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Argentina				271	
Canada	100	193	2,060	978	889
Germany	110	294	460	711	1,108
Japan	236	605	1,575	1,626	5,340
Netherlands	50	517	339	11	
United Kingdom		4,790	5,284	1,388	2,973
United States	15,629	11,469	14,251	17,821	10,637
Other countries	234	596	267	271	18
Total	16,359	18,464	24,236	23,077	20,965

[1] Compiled from Customs Returns of Mexico.

[4] Mining World, Old Mexico's Newest Mercury Mine Developed by Cia. Minera Peralta: Vol. 19, No. 9, August 1957, pp. 47–49.

Philippines.—Palawan Quicksilver Mines, Inc., continued to be the only quicksilver producer in the Philippines. Production totaled 3,400 flasks, 12 percent greater than in 1956. It was reported that a third kiln would be added to the furnacing plant on Palawan Island where two 80-ton Gould furnaces are in operation. A D-type retort was installed to process the soot and settling-tank residues.[5]

Exploration and development were continued through diamond drilling, tunnels, and trenches. Reserves [6] were estimated to total 23,000 flasks, enough for 5 years' operation at the increased rate of production. In 1957 Palawan was reclassified as a major producer and allowed to barter only 15 percent of its shipments,[7] whereas, during the latter half of 1956, Palawan was granted barter licenses under the No-Dollar Import Law for 100 percent of its exports because it was considered a minor producer.

TABLE 19.—Exports of mercury from Spain, 1953–57, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Australia	105	1,392	195	220	
Austria			64		181
Belgium-Luxembourg	38		123	195	856
Brazil	367	777	1,437	2,352	1,836
Canada			1,501	601	651
Denmark				450	4
Finland		1,001	297	317	1,340
France	3,415	4,226	7,629	3,991	5,140
Germany	2,606	1,460	4,214	2,434	4,450
India				1,689	550
Japan	1,761	901	927	1,787	1,178
Netherlands	441	1,016	896	1,964	3,749
Norway	290	145	150	145	300
Portugal	96	345	159	96	341
Sweden	320	640	1,236	2,599	1,256
Switzerland	2,451	751	1,159	153	618
United Kingdom	6,701	6,315	4,203	3,859	6,482
United States	24,972	24,217	7,835	16,586	17,258
Venezuela				1,287	
Other countries	105	348	220	10	307
Total	43,668	43,534	32,245	40,735	46,497

[1] Compiled from Customs Returns of Spain.

United Kingdom.—Foreign trade data for the United Kingdom indicated that consumption of mercury in 1957 was the lowest since 1946. Imports of metal dropped 7 percent in 1957; but reexports rose sharply, and the new supply of mercury available for consumption was 2,900 flasks.

	1953	1954	1955	1956	1957
Imports	21,300	29,500	12,900	19,600	18,200
Reexports	2,500	6,600	3,300	4,000	15,300
Apparent consumption	18,800	22,900	9,600	15,600	2,900

[5] Mining World, vol. 19, No. 8, July 1957, p. 10.
[6] Engineering and Mining Journal, vol. 158, No. 7, July 1957, p. 196.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, pp. 12–13.

Reexports of mercury in 1956 and 1957, in 76-pound flasks, were as follows:

Destination:	1956	1957
United States	810	9,308
Canada	-----	1,129
Germany, West	-----	821
Sweden	334	592
Finland	255	553
Australia	422	389
India	573	341
Union of South Africa	-----	298
Hong Kong	200	275
Denmark	364	265
Belgium	140	259
Netherlands	-----	218
Korea	164	186
Rhodesia and Nyasaland, Federation of	72	103
Other	687	573
Total	4,021	15,310

Yugoslavia.—Although new mercury deposits have been discovered in recent years near Fonica and Kresevo in Bosnia, near Beograd in Serbia, and in the vicinity of Sutomore, Montenegro, virtually all of the mercury production in Yugoslavia came as usual from the Idria mines in Slovenia. An annual output of approximately 15,000 flasks has been maintained by processing large quantities of ore, as mercury content has decreased from about 13 pounds per ton to 7 pounds per ton. Because of large potential mercury reserves, large-scale production is regarded as favorable; and, if mining capacities could be increased by modernization, it is believed that the country could produce 18,000 flasks a year.[8]

TABLE 20.—Exports of mercury from Yugoslavia, 1953–57, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Austria	360	366	577	1,829	953
Belgium-Luxembourg	347	330	90	----------	----------
Canada	----------	----------	200	----------	----------
France	300	585	510	612	410
Germany, West	2,289	3,874	1,662	816	2,742
Japan	----------	----------	----------	100	350
Netherlands	300	----------	236	379	----------
Sweden	336	260	40	165	60
Switzerland	195	977	4,967	2,405	1,010
United Kingdom	2,666	1,001	175	474	125
United States	5,972	4,353	4,753	1,821	1,201
Other countries	51	95	----------	----------	5
Total	12,816	11,841	13,210	8,601	6,856

[1] Compiled from Customs Returns of Yugoslavia.

[8] Djukic, Branko, Mercury in Yugoslavia: Mining Jour. (London), vol. 249, No. 6367, Aug. 30, 1957, p. 246.

WORLD RESERVES

Domestic.—According to the Federal Geological Survey,[9] mercury reserves of all classes of ore in the United States, minable at $250 a flask (approximately the 1957 price), totaled 315,300 flasks, distributed as follows:

Mercury reserves of the United States, in 76-pound flasks

	Measured and indicated	Inferred
Alaska	30, 000	10, 000
Arizona	2, 000	3, 000
Arkansas	-------	1, 000
California	64, 000	90, 000
Idaho	20, 000	6, 000
Nevada	31, 000	33, 000
Oregon	8, 000	7, 300
Texas	2, 000	7, 000
Utah and Washington	-------	1, 000
Total	157, 000	158, 300

Based on the grade of ore processed in 1957, reserves in the United States would average about 0.4 percent and those in Alaska about 1.5 percent mercury. Nearly all the measured and indicated ore is in mines that are now being operated; at the 1957 rate of mine production, these reserves would be adequate for 10 years. In addition, large quantities of lower grade ore are available.

Foreign.—Reserves [10] of mercury minable at $250 a flask estimated by the Geological Survey in 1957 were as follows:

Foreign mercury reserves, in 76-pound flasks

	Measured	Inferred and indicated
Canada	150, 000	150, 000
Mexico	30, 000	100, 000
South America	4, 000	10, 000
Spain	[1] 100, 000	1, 000, 000
Italy	500, 000	1, 000, 000
Yugoslavia	150, 000	300, 000
Czechoslovakia	10, 000	---------
U. S. S. R.	[2] 850, 000	500, 000
Japan	30, 000	50, 000
China	---------	500, 000
Turkey	---------	50, 000
Philippines	45, 000	45, 000
Total	1, 875, 000	3, 710, 000

[1] Data inadequate and reserves known to owners may be much larger.
[2] Based on U. S. S. R. estimate, which seems large for amount of exploration that had been done at time of estimate.

Most of the foreign ore reserves were of higher grade than those in the United States and probably averaged 0.8 percent mercury in Italy, 2.5 percent in Spain, 1.0 percent in Mexico, 0.4 percent in Yugoslavia, and 0.5 percent in other Free World countries. Information was not available on the grade of ore reserve in U. S. S. R.

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[9] Geological Survey, Mercury Reserves of the United States Estimated: Aug. 12, 1957, 2 pp.
[10] Bailey, Edgar H., Mercury Resources of the World; Materials Survey on Mercury (unpublished).

TECHNOLOGY

A report [11] was published by the Federal Bureau of Mines on the Idaho-Almaden mercury mine. This deposit, which was mined by underground methods before it was closed in 1942, was reopened in 1955 as an open pit. New and modern processing facilities, including a 150-ton-per-day rotary furnace, were installed, which permitted economic treatment of the low-grade material.

A Federal Geological Survey report describing mineral deposits of Central America gave information on quicksilver deposits in the region.[12]

Through atomic radiation, a superpure mercury containing just one isotope, 198, was made from gold. Mercury–198 has unusually fine and sharp spectral lines, desirable in the light source of optical instruments.[13] In the process the gold picked up one neutron and formed radioactive gold, which decayed to mercury. The value of the mercury was placed at about $3,000 compared with about $1 for the gram of gold.

A vertical retort consisting of a fused-silica flask fitted with a delivery tube and receiver in one piece was developed [14] to determine the mercury content of mercury compounds by distillation. The mercury-bearing material was distilled in the presence of iron filings, and the gases were passed through a mixture of iron filings and calcium oxide. Zinc wool in the receiver formed an amalgam with the mercury, which was dissolved in nitric acid and titrated with 0.1 normal ammonium thiocyanate. Addition of sucrose assisted in the distillation by providing the correct atmosphere and enough gas to drive all the mercury into the receiver within 15 minutes.

Several other new analytical procedures were reported for determining mercury.[15]

During a study [16] of the reactions that occur in retorting cinnabar in the presence of lime, it was determined that the reaction $4HgS+4CaO=4Hg+3CaS+CaSO_4$ was accurate. As long as CaO was present, the ratio of 3 moles of CaS to 1 mole of $CaSO_4$ was attained.

A novel method [17] of preparing a beryllium amalgam by electrolysis of beryllium from a NaCl-$BeCl_2$ fused-salt mixture into a mercury

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[11] Lickes, Margaret R., Mining, Processing, and Costs, Idaho Almaden Mercury Mine, Washington County, Idaho: Bureau of Mines Inf. Circ. 7800, September 1957, 33 pp.

[12] Roberts, R. J., and Irving, E. M., Mineral Deposits of Central America (with a section on manganese deposits of Panama, by F. S. Simons): Geol. Survey Bull. 1034, 1957, 205 pp.

[13] Industrial and Engineering Chemistry, Modern Alchemy: Vol. 49, No. 11, November 1957, pp. 28A–30A.

[14] Chemical Age, Mercury Determination by Direct Distillation: Vol. 78, No. 1996, Oct. 12, 1957, pp. 595–596.

[15] Leroux, Jean, Maffett, Patricia A., and Monkman, J. L., Microdetermination of Heavy Elements Such as Mercury and Iodine, in Solution, by X-Ray Absorption: Anal. Chem., vol. 29, No. 7, July 1957, pp. 1089–1092.

Miller, V. L., and Swanberg, Frank, Jr., Determination of Mercury in Urine: Anal. Chem., vol. 29, No. 3, March 1957, pp. 391–393.

Menis, Oscar, Ball, Robert G., and Manning, D. L., Amperometric Titration at Mercury (II) With Tetraphenylarsonium Chloride: Anal. Chem., vol. 29, No. 2, February 1957, pp. 245–248.

Parry, E. P., Determination of Mercury in Presence of Halides: Anal. Chem., vol. 29, No. 4, April 1957, pp. 546–549.

Ueno, Keihei, Simultaneous Complexometric Determination of Copper and Mercury: Anal. Chem., vol. 29, No. 11, November 1957, pp. 1668–1669.

[16] Peretti, E. A., Textbook Errors; The Production of Mercury: Jour. Chem. Educ., vol. 34, No. 3, March 1957, pp. 135–136.

[17] Journal American Chemical Society, The Preparation of Beryllium Amalgam: Vol. 79, No. 14, July 20, 1957, p. 3925.

cathode was developed and applied to the preparation of beryllium metal.

The development, characteristics, and uses of various types of batteries, including mercury cells, were described [18] and compared. Long shelf life, low internal resistance, voltage stability, high temperature stability, and a wide variety of sizes and shapes were cited as advantageous characteristics of mercury batteries.

The growing trend in the use of transistors for tubes in radios caused a study [19] to be made of the type and characteristics of available batteries that will be required. An evaluation of the mercury cell and the LeClanche cell, the zinc-carbon unit used in flashlights and the most common type of dry cell for radio use, showed that the mercury unit offered many advantages. The shelf life of zinc-carbon batteries was only 8 to 12 months compared with 2 years or more for mercury batteries stored under the same conditions. Under the same operating conditions, the useful output of the mercury type was five times that of the LeClanche type. Thus, despite a larger initial cost, the mercury type provided more favorable cost-per-hour ratios than the zinc-carbon type.

An appraisal of the development technology of chlorine-caustic soda manufacture in the United States and Europe, showed a trend in use of the mercury cell.[20] For Europe as a whole about 85 percent of the chlorine was manufactured in mercury cells whereas, in the United States, mercury cells' share of United States production has risen from 4.3 percent in 1946 to an expected 18.7 percent in 1958. The reasons for the trend are complex but in general were due to larger cells, lower capital and operating costs, simplicity, and purity of product. The evaluations contained descriptions and operating characteristics of the various cells and a list of chlorine-caustic soda producers.

In another report [21] diaphragm and mercury cells used in producing chlorine and caustic soda were analyzed. The study included design, operation, power and labor requirements, feed material, costs, and other pertinent factors of each type of cell.

An investigation [22] of the influence of graphite particles on the mercury-cell process for producing chlorine and caustic soda revealed that the effect of less than 3 grams a liter of graphite was small in pure brine but that, in the presence of magnesium or aluminum, the loss of current efficiency was appreciable. The simultaneous presence of graphite and iron, calcium, or less than 0.1 mg. a liter of vanadium did not affect the electrolysis process; silicates and stannates inhibited the action of the graphite particles.

An electrode consisting of a tiny drop of mercury hanging from a platinum wire was the basis of a new method developed for determining the metal content of solutions.[23] Any metal that will form an alloy

[18] Look, Arnold E., Jr., New Horizons for Battery Power: Electronic Ind. and Tele-Tech., vol. 16, No. 7, July 1957, pp. 34–37, 118–119.
[19] Radio and TV News, Batteries for Transistor Radios: Vol. 57, No. 6, June 1957, pp. 40–41.
[20] Sommers, H. A., Chlorine Caustic Cell Development: Chem. Eng. Prog., vol. 53, No. 9, September 1957, pp. 409–417; vol. 53, No. 10, October 1957, pp. 506–510.
[21] Hardy, Walter L., Chlorine Manufacture: Ind. Eng. Chem., vol. 49, No. 9, September 1957, pp. 55A–56A.
[22] Angel, Gösta, Brännland, Rolf, and Dahlerus, Stig, Influence of Impurities in the Electrolyte in Chlorine-Caustic Electrolysis by the Mercury-Cell Process: Electrochem. Soc. Jour., vol. 104, No. 3, March 1957, pp. 167–170.
[23] Chemistry, Sensitive Test for Metals: Vol. 31, No. 3, November 1957, p. 45.

with mercury can be tested, and concentrations as low as 1 part of lead in 5 trillion parts of solution can be determined.

By changing from an incandescent system to a new mercury-vapor lighting system at a large foundry,[24] production was increased, safety was improved, and more comfortable working conditions were obtained with the better lighting. Other advantages included easy economical maintenance, less cleaning, longer life, reduced power needs, reduction of transformers and switching panels, and use of smaller electrical conductors.

The substitution of mercury-vapor lamps for incandescent types not only cut costs but also solved a constant maintenance problem due to vibration and delivered more light to working areas in a jet-engine-testing building.[25] During engine testing the entire installation was subjected to high-frequency vibrations, which caused the filament of incandescent lamps to fail but had little adverse effect on the mercury-vapor-type lamp.

Because of high efficiency, rugged design, and competitive price, mercury-arc rectifiers provide one of the principal methods of converting electricity from alternating to direct current.[26] Improved electromagnetic rectifier control equipment also has been developed. These include transductors and magnetic amplifiers designed for either fixed direct-current output or varied output voltages.

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[24] Factory Management and Maintenance, New Light for Heavy Work: Vol. 115, No. 1, January 1957, pp. 96–97.
[25] Davis, W. L., Mercury Lamps Solve Vibration: Elec. West, vol. 118, No. 3, March 1957, p. 126.
[26] Spooner, F. E., Mercury-Arc Rectifier Control: Elec. Rev., vol. 161, No. 17, Oct. 25, 1957, pp. 741–746.

Mica

By Milford L. Skow [1] and Gertrude E. Tucker [2]

DOMESTIC sheet mica sold or used in the United States in 1957 decreased 22 percent in quantity and 10 percent in value, compared with 1956. Most of the decrease in quantity occurred in sales of punch mica. The yield of full-trimmed block from sales of domestic mica to the Government was 12 percent below that in 1956. Sales of scrap and flake mica increased to the highest value on record and to a tonnage second only to that in 1955, the peak year. Consumption of sheet mica decreased 9 percent to 11.4 million pounds, and consumption of scrap mica (as indicated by the quantity of ground mica sold) was 6 percent higher than in 1956. Total imports were down 13 percent, but total exports increased 9 percent to a new record.

TABLE 1.—Salient statistics of the mica industry, 1948–52 (average) and 1953–57

(Quantity and total value in thousands)

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Domestic mica sold or used by producers:						
Total sheet mica:						
Pounds	531	849	669	642	888	690
Value	$274	$2,154	$2,393	$3,370	[1] $2,757	$2,492
Average per pound	$0.52	$2.54	$3.58	$5.25	[1] $3.11	$3.61
Scrap and flake mica:						
Short tons	60	73	81	95	86	92
Value	$1,494	$1,824	$1,734	$2,058	$1,850	$2,111
Average per ton	$24.77	$24.90	$21.39	$21.57	$21.43	$22.82
Ground mica: [2]						
Short tons	68	73	80	106	91	96
Value	$3,630	$4,192	$4,889	$6,558	$6,228	$6,073
Consumption of block and film mica:						
Pounds	(3)	4,379	3,229	4,093	3,822	3,340
Value	(3)	[3] $11,541	$4,322	$5,607	$5,708	$4,651
Consumption of splittings:						
Pounds	10,083	10,346	6,733	8,998	8,662	8,037
Value	$8,704	$7,902	$4,132	$4,388	$4,435	$4,018
Imports for consumption short tons	16	11	9	16	14	12
Exports do	2	2	3	3	5	5
Apparent consumption of sheet mica [4] pounds	21,272	14,413	8,424	13,881	12,711	12,564
World: Production do	226,000	255,000	285,000	330,000	310,000	350,000

[1] Revised figure.
[2] From domestic and some imported scrap mica.
[3] Available data are not comparable with data for succeeding years.
[4] Sheet mica sold or used plus imports of unmanufactured and manufactured sheet mica minus exports of sheet mica.

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LEGISLATION AND GOVERNMENT PROGRAMS

Exploration, purchasing, and research programs for mica were continued by various Government agencies under authority delegated by the Office of Defense Mobilization (ODM). ODM closed the expansion goal on proved substitutes for strategic natural mica in June. This goal was established in January 1956, but industry showed little interest.

Defense Minerals Exploration Administration.—Decreased activity in exploration was indicated by the smaller number of contracts in force at the end of the year—14 in 1957, compared with 28 at the end of 1956. From the beginning of the program in 1951 through December 31, 1957, 285 contracts for strategic mica were executed. Of these, 7 were canceled, and 264 were terminated by the end of 1957. The total value of the 264 contracts terminated was $1,507,624; the Government advanced $911,023. Certificates of discovery or development were issued on 62 of these contracts, which had a total value of $453,261.

TABLE 2.—Defense Minerals Exploration Administration mica contracts in force during 1957, by States, counties, and mines

State and operator	Property	County	Contract		
			Date	Total value [1]	Status, Dec. 31, 1957
GEORGIA					
Boone, Homer	Taylor Prospect	Hart	July 1957	$5,252	In force.
Phillips, John	Bray Prospects 1 & 2.	do	September 1956	6,276	Terminated.
Wood, E. B	Wood	do	August 1956	6,348	Do.
Boone & Phillips	Mercer Prospect	Upson	November 1957	5,696	In force.
Medford, Lee	Mathis Prospect	do	do	6,680	Do.
MONTANA					
Barham, Daniel T	Thumper Lode & Thumper Lode No. 2.	Gallatin	October 1955	14,000	Do.
NORTH CAROLINA					
Duncan and Smith Mining Co.	Little Mines	Ashe	June 1957	9,480	Terminated.
Aldridge, L., et al	Johnson	Avery	January 1957	6,644	Do.
Phillips, John	Ed Burleson Prospect.	do	November 1956	4,580	Do.
Do	John Prospect	do	September 1956	6,940	Do.
Smith, Sam G	Doe Hill No. 2	do	July 1956	5,164	Do.
Vance, Joe C	Leaning Locust	do	May 1956	8,902	Do.
Phillips, S. L	Black Mountain	Buncombe	May 1957	5,376	In force.
Beam, J. R	Back Prospect	Cleveland	November 1956	4,840	Terminated.
Charlie Blanton Mining Co.	Charlie Blanton	do	May 1957	6,216	Do.
Huskins, Ed	Falls Prospect	do	June 1957	6,316	Do.
Phillips & Beam	Mauney	do	August 1957	6,064	Do.
Carolina Mining Co	Upper Clark	Jackson	November 1956	5,240	In force.
Do	Wilson Prospect	do	December 1956	5,068	Terminated.
Do	Moody	Macon	December 1957	4,492	In force.
Crawford, E	Setzer	do	November 1956	5,484	Terminated.
Arnold Young Mining Co.	Arnold Young	Mitchell	May 1957	7,600	Do.
Black Jack Mining Co	Black Jack	do	February 1956	4,416	Do.
Boone, Jeter, et al	Paul McMahan Prospect.	do	October 1957	6,288	In force.
Buchanan, C. D	Boone	do	December 1956	5,552	Terminated.
Buchanan, G	Chestnut Branch	do	January 1957	6,296	Do.

See footnote at end of table.

TABLE 2.—Defense Minerals Exploration Administration mica contracts in force during 1957, by States, counties, and mines—Continued

State and operator	Property	County	Contract		
			Date	Total value [1]	Status, Dec. 31, 1957
NORTH CAROLINA—con.					
Gouge, M., et al	Turbyfill Prospect.	Mitchell	November 1956	$5,500	Terminated.
Gouge, W. G	Dinkey Line	do	March 1957	4,992	Do.
Grindstaff, G	Grover	do	October 1956	3,388	Do.
Grindstaff & Greene	Johnson	do	October 1957	6,624	In force.
Huskins, Ed	Bill Prospects 1 & 2.	do	December 1956	4,936	Terminated.
Huskins, Ed. & Gage, Fred.	Briggs	do	October 1956	2,696	Do.
Huskins, Ed	George	do	July 1956	4,104	Do.
Huskins, Paul	Big Ridge	do	October 1957	4,208	In force.
Jarrett, J	Hensley	do	January 1957	6,348	Terminated.
Jarrett, J. & Grindstaff, F.	McBee Prospect	do	May 1956	10,662	Do.
McKinney, Howard	McKinney Prospect.	do	May 1957	5,652	In force.
Mitch-Lincoln Mining Co.	Mitch-Lincoln	do	April 1957	6,856	Terminated.
Phillips, John, et al	Hawk	do	July 1956	6,760	Do.
Phillips, John	Roby	do	September 1956	6,612	Do.
Phillips, S. L	Old Buchanan	do	June 1956	6,640	Do.
Phillips, S. L., and Ellis, C. W.	Avery Prospect	do	November 1957	6,080	In force.
Pitman, E., et al	Pitman Tract	do	January 1957	5,496	Terminated.
Stevenson, Ted, et al	Stevenson	do	February 1956	6,716	Do.
Toney, F. & G	Claude Blanton	Rutherford	July 1956	5,412	Do.
Mines & Mining, Inc	Farlow Gap	Transylvania	July 1955	5,136	Do.
Beam, J. R., & Phillips, J.	Little Ray	Yancey	November 1955	12,735	Do.
Bennet, Y., & Phillips, S. L.	Palen Ridge Prospect.	do	January 1957	5,692	Do.
Boone, H	Pete Prospect	do	February 1957	5,048	Do.
Boone, J	Riddle Prospects 1, 2, & 3.	do	December 1956	5,472	Do.
Brown, C. L., & Rathburn, G. C.	Fox	do	August 1954	5,788	Do.
McMurry, G., et al	Mitchell Branch	do	November 1956	5,876	Do.
Moody Rock Mining Co	Moody Rock	do	May 1957	8,910	In force.
Murphy Mining Co	Murphy	do	December 1956	4,236	Do.
Rathbone, C. W., et al	Crip Ogle	do	January 1957	5,712	Terminated.
SOUTH CAROLINA					
King, H. B., Sr	Clinkscales No. 2	Abbeville	May 1956	5,948	Do.
Burdette, Ralph	Knight No. 2	Greenville	June 1957	5,480	Do.

[1] Government participation, 75 percent. Total actual expenditures by the Government on terminated and certified contracts often were less than the obligated funds.

Defense Materials Service.—Government mica purchases at 3 mica-purchasing depots of General Services Administration (GSA) yielded 191,671 pounds of full-trimmed muscovite block mica (over 0.007 inch thick), comprising 138,564 pounds of ruby and 53,107 pounds of nonruby. The total yield of full-trimmed mica was 12 percent lower than in 1956. Good Stained or better qualities constituted about 30 percent of the ruby and 42 percent of the nonruby; Stained quality made up about 48 percent of the ruby and 40 percent of the nonruby. The Spruce Pine, N. C., depot furnished 73 percent of the total yield of ruby block mica and 95 percent of the nonruby.

The total quantity of Stained or better qualities of full-trimmed muscovite block obtained from Government purchases of domestic mica in 1957 was equivalent to 8.4 percent of the total fabrication in 1957 of muscovite block and film of these qualities, irrespective of grades.

Domestically produced mica purchased by the Government since the program was begun in July 1952 has yielded 1,066,121 pounds of full-trimmed mica, 76 percent of which was the ruby variety.

In May, GSA invited offers on new long-term contracts for delivery of mica from foreign sources to the stockpile. These 5-year contracts permitted the importer to deliver up to 1 pound of Heavy Stained ruby block mica for each pound of Stained A/B or better qualities of ruby muscovite block mica meeting stockpile specifications.

TABLE 3.—Yield of full-trimmed muscovite ruby and nonruby block mica from domestic purchases by GSA, 1957, by quality, grade, and depot, in pounds

Depot and grade	Ruby				Nonruby			
	Good Stained or better	Stained	Heavy Stained	Total	Good Stained or better	Stained	Heavy Stained	Total
Spruce Pine, N. C.:								
2 and larger	185	189	114	488	129	31	7	167
3	460	537	233	1,230	308	127	27	462
4	1,012	1,137	510	2,659	708	357	99	1,164
5	5,037	6,030	2,733	13,800	3,626	2,250	681	6,557
5½	3,681	4,399	1,980	10,060	2,370	1,749	747	4,866
6	22,244	34,552	16,570	73,366	14,689	15,697	7,091	37,477
Total	32,619	46,844	22,140	101,603	21,830	20,211	8,652	50,693
Franklin, N. H.:								
2 and larger	9	124	42	175	------	------	------	------
3	55	259	78	392	(1)	(1)	------	(1)
4	142	394	135	671	1	(1)	------	1
5	1,138	2,103	759	4,000	4	3	} 1	15
5½	938	1,513	629	3,080	3	4	}	
6	5,889	9,310	3,263	18,462	7	10	1	18
Total	8,171	13,703	4,906	26,780	15	17	2	34
Custer, S. Dak.:								
2 and larger	2	12	18	32	4	10	16	30
3	4	38	53	95	11	26	25	62
4	6	159	194	359	21	48	49	118
5	51	830	774	1,655	83	226	159	468
5½	68	816	660	1,544	56	167	120	343
6	435	3,486	2,575	6,496	234	717	408	1,359
Total	566	5,341	4,274	10,181	409	1,194	777	2,380
Grand total	41,356	65,888	31,320	138,564	22,254	21,422	9,431	53,107

[1] Less than 1 pound.

TABLE 4.—Yield of byproducts from domestic purchases of ruby and nonruby mica by GSA, 1957, by depots, in pounds

Depot	Ruby			Nonruby		
	Miscellaneous [1]	Punch	Scrap	Miscellaneous [1]	Punch	Scrap
Spruce Pine, N. C	5,612	85,606	1,218,174	5,542	21,554	444,557
Franklin, N. H	10,054	21,717	522,536	1	------	(2)
Custer, S. Dak	821	12,007	129,544	201	1,068	48,685
Total	16,487	119,330	1,870,254	5,744	22,622	493,242

[1] Includes some full-trimmed thins and block of lower than Heavy Stained qualities.
[2] Less than 1 pound.

TABLE 5.—Yield of full-trimmed muscovite ruby and nonruby mica and by-products from domestic purchases by GSA, 1953–57, by depots, in pounds

Category and depot	1953	1954	1955	1956	1957	Total
Full-trimmed:						
Spruce Pine, N. C.	113,270	139,872	188,915	176,942	152,296	771,295
Franklin, N. H.	25,303	35,046	29,257	23,003	26,814	139,423
Custer, S. Dak.	26,125	23,894	18,433	[1] 18,875	12,561	99,888
Total	164,698	198,812	236,605	[1] 218,820	191,671	1,010,606
Other:						
Spruce Pine, N. C.			16,069	12,739	11,154	39,962
Franklin, N. H.	1,821	12,566	19,785	36,914	10,055	81,141
Custer, S. Dak.	7,995	1,623	27,081	[1] 2,382	1,022	40,103
Total	9,816	14,189	62,935	[1] 52,035	22,231	161,206
Punch:						
Spruce Pine, N. C.	16	8,940	119,333	97,744	107,160	333,193
Franklin, N. H.	23,052	93,229	69,786	28,878	21,717	236,662
Custer, S. Dak.	193,505	44,388	8,149	[1] 18,320	13,075	277,437
Total	216,573	146,557	197,268	[1] 144,942	141,952	847,292
Scrap:						
Spruce Pine, N. C.	47	15,255	1,607,165	934,672	1,662,731	4,219,870
Franklin, N. H.	21,708	193,363	367,208	466,078	522,536	1,570,893
Custer, S. Dak.	157,505	363,174	270,622	[1] 350,958	178,229	1,320,488
Total	179,260	571,792	2,244,995	[1] 1,751,708	2,363,496	7,111,251

[1] Revised figure.

GSA signed contracts during the year with Battelle Memorial Institute, Frankford Arsenal, General Electric Co., Arthur D. Little, Inc., Sylvania Electric Products, Inc., and Synthetic Mica Corp. for studies on reconstituting synthetic mica. The contract with Frankford Arsenal was for continuing the work begun under the contract signed in 1956. By December 31, seven contracts were in effect for research and development of substitutes for strategic natural mica under the industry-Government program certified by the Office of Defense Mobilization.

Commodity Credit Corporation.—No additional contracts were negotiated in 1957. Small quantities of muscovite block and film and sizable quantities of muscovite splittings were delivered under old contracts.

DOMESTIC PRODUCTION

Sheet Mica.—The quantity of crude sheet mica sold or used by producers was 22 percent lower than in 1956. However, the value dropped only 10 percent, as 85 percent of the decrease in quantity was attributed to sales of punch mica, and the average value for sheet mica sold to the Government was slightly higher than in 1956. North Carolina, with 84 percent of the total output of domestic sheet mica, continued to be the principal producing State. New Hampshire, Maine, Georgia, and South Dakota were other leading producers.

Scrap and Flake Mica.—The quantity of scrap and flake mica sold or used by grinders increased 7 percent over 1956 to the second highest tonnage on record. The value increased 14 percent to a record high. North Carolina again produced over half the tonnage, and South Carolina, Georgia, and Alabama furnished considerable quantities.

TABLE 6.—Mica sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Sheet mica						Scrap and flake mica [3]		Total	
	Uncut punch and circle mica		Uncut mica larger than punch and circle [1]		Total sheet mica [2]					
	Pounds	Value	Pounds	Value	Pounds	Value	Short tons	Value	Short tons	Value
1948–52 (average)	476,681	$81,895	54,464	$192,589	531,145	$274,484	60,296	$1,493,694	60,562	$1,768,178
1953	667,241	98,010	182,153	2,055,574	849,394	2,153,584	73,259	1,823,840	73,684	3,977,424
1954	450,105	51,947	218,683	2,341,094	668,788	2,393,041	81,073	1,733,772	81,407	4,126,813
1955	383,401	41,290	258,712	3,329,107	642,113	3,370,397	95,432	2,058,035	95,754	5,428,432
1956:										
Alabama	(4)	(4)	(4)	(4)	1,122	6,812	(4)	(4)	(4)	(4)
Colorado			8	126	8	126	517	7,596	517	7,722
Connecticut			310	2,064	310	2,064			(5)	2,064
Georgia	(4)	(4)	(4)	(4)	20,149	149,459	(4)	(4)	(4)	(4)
Maine	(4)	(4)	(4)	(4)	19,913	146,437	114	3,213	124	149,650
Montana			56	525	56	525			(5)	525
New Hampshire	(4)	(4)	(4)	(4)	50,873	177,376	305	10,243	330	187,619
New Mexico			6,247	52,566	6,247	52,566	767	22,213	770	74,779
North Carolina	565,618	48,205	205,285	2,086,852	770,903	2,135,057	47,125	1,064,631	47,510	3,199,688
South Carolina	2,991	358	2,409	13,426	5,400	13,784	(4)	(4)	(4)	(4)
South Dakota			12,494	[6] 67,053	12,494	[6] 67,053	1,268	31,224	1,274	[6] 98,277
Virginia			396	5,814	396	5,814			(5)	5,814
Undistributed [7]	25,011	5,351	67,046	474,733			36,213	710,453	36,228	880,508
Total	593,620	53,914	294,251	[6] 2,703,159	887,871	[6] 2,757,073	86,309	1,849,573	86,753	[6] 4,606,646
1957:										
Arizona							1,650	16,500	1,650	16,500
Colorado			14	52	14	52	312	6,400	312	6,452
Georgia	4,923	592	12,010	157,291	16,933	157,883	(4)	(4)	(4)	(4)
Idaho			1,240	9,239	1,240	9,239	40	1,200	41	10,439
Maine	106	11	25,347	202,075	25,453	202,086	6	168	19	202,254
Montana			13	88	13	88			(5)	88
New Hampshire	(4)	(4)	(4)	(4)	53,554	459,976	522	17,301	549	477,277
New Mexico			2,134	15,645	2,134	15,645	1,347	46,865	1,348	62,510
North Carolina	418,306	32,998	159,301	1,542,101	577,607	1,575,099	53,452	1,173,215	53,741	2,748,314
South Carolina	(4)	(4)	(4)	(4)	2,278	12,311	(4)	(4)	(4)	(4)
South Dakota			9,093	45,507	9,093	45,507	1,626	43,142	1,631	88,649
Virginia			529	6,401	529	6,401			(5)	6,401
Undistributed [7]	2,402	740	54,634	479,722	1,204	8,175	33,523	805,872	33,532	984,241
Total	425,737	34,341	264,315	2,458,121	690,052	2,492,462	92,478	2,110,663	92,823	4,603,125

[1] Includes the full-trimmed mica equivalent of hand-cobbed mica, 1952–57.
[2] Includes small quantities of splittings in certain years.
[3] Includes finely divided mica recovered from mica and sericite schist, and as a byproduct of feldspar and kaolin beneficiation.
[4] Included under "Undistributed" to avoid disclosing individual company operations.
[5] Less than 1 ton.
[6] Revised figure.
[7] Figures include Alabama (1957), California, Connecticut (1957), Maryland (1957), Pennsylvania, Tennessee, and States indicated by footnote 4.

Ground Mica.—Sales of ground mica increased 6 percent in tonnage but decreased more than 2 percent in value, compared with 1956. Dry-ground mica constituted 86 percent of the total tonnage and was used principally for roofing materials, joint cement, well drilling, and paint. Wet-ground mica was used chiefly in paint and rubber. Production was reported by 25 grinders in 21 dry-grinding and 8 wet-grinding plants.

During 1957 Imperial Milling Co. ground mica schist at Ogilby, Calif., in the plant operated by Western Non-Metallics in 1956. Robert K. Foster, Imperial County, Calif., reported production at the wet-grinding mill operated by John Humer in 1956. Buckeye Mica Co., Buckeye, Ariz., which last reported in 1955, again produced dry-ground mica. Robert E. Osthoff, Santa Fe, N. Mex., and Sunshine Mica Co., Los Nietos, Calif., dry ground mica in 1956 but reported no production in 1957.

TABLE 7.—Ground mica sold by producers in the United States, 1948–52 (average) and 1953–57, by methods of grinding

Year	Dry-ground		Wet-ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	57,486	$2,216,227	10,157	$1,413,776	67,643	$3,630,003
1953	60,127	2,438,628	12,945	1,753,792	73,072	4,192,420
1954	67,618	3,134,277	12,454	1,754,845	80,072	4,889,122
1955	91,695	4,541,482	14,490	2,016,157	106,185	6,557,639
1956	77,665	4,150,996	13,605	2,077,062	91,270	6,228,058
1957	83,025	4,015,353	13,307	2,058,055	96,332	6,073,408

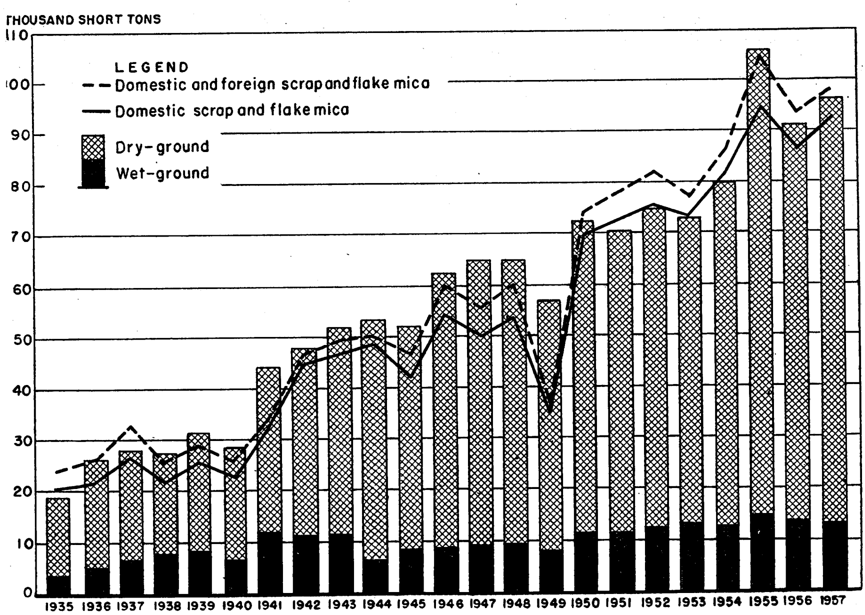

FIGURE 1.—Scrap, flake, and ground mica sold in the United States, 1935–57.

CONSUMPTION AND USES

Sheet Mica.—Consumption of sheet mica (block, film, and splittings) in the United States in 1957 decreased 9 percent compared with 1956.

Domestic fabricators consumed more than 3.3 million pounds of muscovite block and film mica—13 percent below the 1956 consumption. Stained quality constituted 49 percent of the total; lower than Stained qualities, 46 percent; and Good Stained or better, 5 percent. Electronic applications used 65 percent of the total muscovite block and film fabricated, distributed by qualities as follows: 7 percent, Good Stained or better; 73 percent, Stained; and 20 percent, lower than Stained. Of the mica fabricated for electronic uses, tubes consumed 91 percent, capacitors, 6 percent, and other uses, 3 percent. Grade 6 block mica constituted 52 percent of the muscovite block and film consumed, compared with 46 percent in 1956.

Fabrication of muscovite block and film mica was reported by 24 companies in 9 States. About 55 percent (1.8 million pounds) of the total was reported by 13 companies in 3 States—New Jersey (5), New York (4), and North Carolina (4).

The quantity of mica splittings consumed was 7 percent less and had a value 9 percent less than in 1956. Most of the splittings used were from India (94 percent by weight); the remainder was principally phlogopite splittings from Madagascar. Consumption of splittings for producing built-up mica was reported for 12 operations in 9 States. Allis-Chalmers Manufacturing Co., Milwaukee, Wis., reported no fabrication of splittings in 1957.

TABLE 8.—Fabrication of muscovite ruby and nonruby block and film mica and phlogopite block mica, by qualities and end-product uses in the United States, 1957, 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	310	19,188	386	19,884	6,519	940	7,459	27,343
Stained	10,259	1,541,709	34,343	1,586,311	4,905	50,911	55,816	1,642,127
Lower than Stained	17	404,395	23,290	427,702	115	[1] 1,099,976	1,100,091	1,527,793
Total	10,586	1,965,292	58,019	2,033,897	11,539	[1] 1,151,827	1,163,366	3,197,263
Film:								
First quality	25,051			25,051		310	310	25,361
Second quality	99,546			99,546		150	150	99,696
Other quality	2,813			2,813				2,813
Total	127,410			127,410		460	460	127,870
Block and film:								
Good Stained or better [2]	124,907	19,188	386	144,481	6,519	1,400	7,919	152,400
Stained [3]	13,072	1,541,709	34,343	1,589,124	4,905	50,911	55,816	1,644,940
Lower than Stained	17	404,395	23,290	427,702	115	1,099,976	1,100,091	1,527,793
Total	137,996	1,965,292	58,019	2,161,307	11,539	1,152,287	1,163,826	3,325,133
Phlogopite: Block (all qualities)						14,796	14,796	14,796

[1] Includes punch mica.
[2] Includes first- and second-quality film.
[3] Includes other-quality film.

TABLE 9.—Fabrication of muscovite ruby and nonruby block and film mica in the United States, 1957, 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	4,784	1,812	1,355	18,443		26,394
Stained	20,011	70,734	116,343	1,272,339	50,723	1,530,150
Lower than Stained	140,892	92,622	74,358	334,544	378,055	1,020,471
Total	165,687	165,168	192,056	1,625,326	428,778	2,577,015
Nonruby:						
Good Stained or better	892	57				949
Stained	155	4,512	2,408	96,953	7,949	111,977
Lower than Stained	40,445	12,235	5,063	7,375	442,204	507,322
Total	41,492	16,804	7,471	104,328	450,153	620,248
Film:						
Ruby:						
First quality	4,626	10,833	3,464	5,788		24,711
Second quality	21,040	35,229	15,944	25,084		97,297
Other quality					2,813	2,813
Total	25,666	46,062	19,408	30,872	2,813	124,821
Nonruby:						
First quality			650			650
Second quality	691	568	824	316		2,399
Other quality						
Total	691	568	1,474	316		3,049

[1] Figures for block mica include "all smaller than No. 6" grade and "punch" mica.

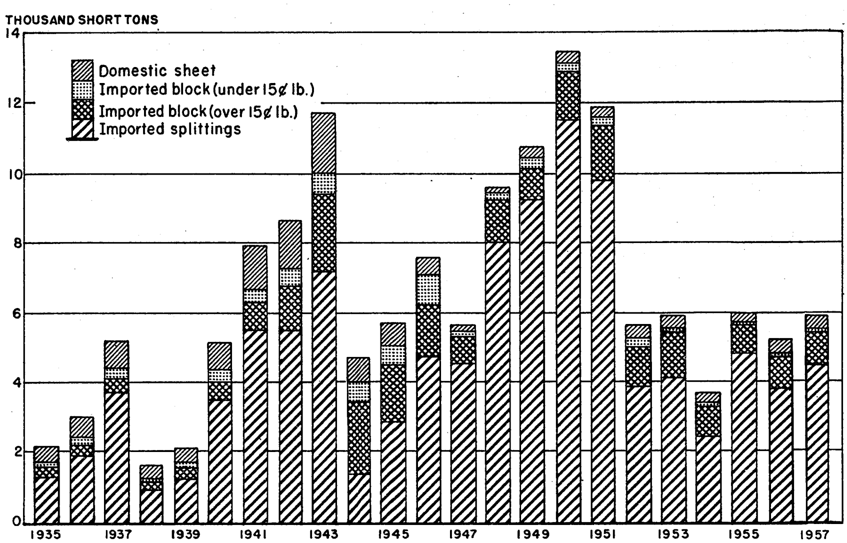

FIGURE 2.—Block mica and splittings imported for consumption in the United States and sales of domestic sheet mica, 1935–57.

Built-Up Mica.—Consumption of domestically produced built-up mica was 12 percent less in quantity and 8 percent lower in value than in 1956. The various forms were used principally for electrical insulation. A total of 11 companies at 12 plants reported domestic production of built-up mica in 1957.

TABLE 10.—Consumption and stocks of mica splittings in the United States, 1948–52 (average) and 1953–57, by sources

	1948-52 (average)		1953		1954	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	[1,2,3] 15,079	[1,2,3] $6,621				
Canadian	[2,3] 173,567	[2,3] 96,207	158,343	$98,738	67,311	$37,505
Indian	9,240,353	8,122,243	9,443,645	7,225,899	6,158,769	3,727,441
Madagascan	654,068	478,546	744,171	577,595	506,639	367,472
Mexican	(2)	(2)				
Total	10,083,067	8,703,617	10,346,159	7,902,232	6,732,719	4,132,418
Stocks (Dec. 31):						
Domestic	(4)	(4)				
Canadian	[4,5] 116,628	[4,5] 68,794	39,354	20,423	(6)	(6)
Indian	6,093,362	6,002,975	6,688,997	6,110,975	5,206,178	3,901,194
Madagascan	460,100	407,763	387,905	316,610	[6] 330,900	[6] 256,767
Mexican	(5)	(5)				
Total	6,670,090	6,479,532	7,116,256	6,448,008	5,537,078	4,157,961

	1955		1956		1957	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic						
Canadian	(6)	(6)			(6)	(6)
Indian	8,204,210	$3,844,745	7,995,956	$3,945,461	7,530,646	$3,616,929
Madagascan	[6] 793,464	[6] 543,671	665,627	489,916	[6] 506,188	[6] 400,841
Mexican						
Total	8,997,674	4,388,416	8,661,583	4,435,377	8,036,834	4,017,770
Stocks (Dec. 31):						
Domestic						
Canadian	(6)	(6)	(6)	(6)	(6)	(6)
Indian	6,191,472	3,622,764	5,076,672	2,814,261	4,942,549	2,594,444
Madagascan	[6] 400,710	[6] 302,405	[6] 374,024	[6] 303,918	[6] 324,851	[6] 266,548
Mexican						
Total	6,592,182	3,925,169	5,450,696	3,118,179	5,267,400	2,860,992

1 Average for 1948 only.
2 Mexican included with domestic in 1948, and with domestic and Canadian in 1950–51.
3 Domestic included with Canadian, 1949–51.
4 Domestic included with Canadian, 1948–50.
5 Mexican included with domestic and Canadian, 1949–50.
6 Canadian included with Madagascan.

TABLE 11.—Consumption of mica splittings in the United States, 1957, by States

State	Number of consumers	Quantity (pounds)
Indiana, Michigan, and Ohio	4	1,896,439
Massachusetts	1	1,091,183
New Hampshire and New York	3	3,221,903
North Carolina, Pennsylvania, and Virginia	4	1,827,309
Total	12	8,036,834

Reconstituted Mica.—This sheet material, which is formed by papermaking procedures from specially delaminated natural mica scrap, can substitute for built-up mica in many applications. Two companies continued to produce reconstituted mica commercially in 1957: General Electric Co. at Coshocton, Ohio, and Samica Corp. (sub-

TABLE 12.—Built-up mica [1] sold or used in the United States, 1955–57, by kinds of product

Product	1955		1956		1957	
	Pounds	Value	Pounds	Value	Pounds	Value
Molding plate	1,664,239	$3,337,871	1,776,361	$3,909,668	1,470,474	$3,519,655
Segment plate	2,151,471	4,278,900	1,933,896	4,237,062	1,771,580	3,673,241
Heater plate	639,127	1,730,629	718,537	2,018,061	640,327	1,863,233
Flexible (cold)	564,007	1,689,908	622,172	1,869,837	588,095	1,850,723
Tape [2]	1,595,129	6,759,207	2,021,815	8,373,565	1,716,515	8,089,146
Other	310,433	1,088,274	228,826	1,300,131	228,021	1,002,887
Total	6,924,406	18,884,789	7,301,607	21,708,324	6,415,012	19,998,885

[1] Consists of a composite of alternate layers of a binder and irregularly arranged and partly overlapped splittings.
[2] Includes a small quantity of built-up mica for "Other combination materials."

sidiary of Minnesota Mining & Manufacturing Co.) at Rutland, Vt. Total output, appreciably greater than in 1956, was the largest since production began in 1952.

Other Substitutes for Sheet Mica.—Finely divided natural mica can be bonded with water-soluble aluminum phosphate to form a heat-resistant electrical insulation. Farnam Manufacturing Co., Inc., Asheville, N. C., produced this material commercially in the form of rigid sheets and various shapes.

Ground Mica.—Increased sales of ground mica to many of the principal consumers resulted in a 6-percent rise in total quantity of ground mica sold. Roofing materials and well-drilling compounds took a larger portion of the total than in 1956, but joint cement used a smaller percentage. Roofing materials and paint continued to be the leading consumers of ground mica.

TABLE 13.—Ground mica sold by producers in the United States, 1956–57, by uses

Use	1956			1957		
	Short tons	Percent of total	Value	Short tons	Percent of total	Value
Roofing	25,487	28	$955,628	29,629	31	$1,009,742
Wallpaper	728	1	107,428	774	1	112,608
Rubber	7,021	8	669,974	8,579	9	779,687
Paint	20,756	23	1,910,084	22,619	23	1,856,026
Plastics	1,968	2	167,400	2,203	2	193,121
Welding rods	2,944	3	203,972	2,822	3	196,899
Joint cement	17,681	19	1,254,776	13,435	14	1,051,399
Miscellaneous [1]	14,685	16	958,796	16,271	17	873,926
Total	91,270	100	6,228,058	96,332	100	6,073,408

[1] Includes mica used for molded electric insulation, house insulation, Christmas-tree snow, annealing, well drilling, and other purposes.

PRICES AND SPECIFICATIONS

Prices offered by mica fabricators for domestic sheet mica (roughly trimmed) were unchanged from 1956.

The Government continued to purchase domestically produced full-trimmed and half-trimmed muscovite mica at prices established in May 1956. Government prices for hand-cobbed mica have not changed since 1954, although purchasing procedures have varied.

North Carolina scrap mica was quoted throughout the year at $25 to $30 per short ton, depending on quality.

Prices of dry- and wet-ground mica were steady throughout the year, the same since March 1956.

TABLE 14.—Prices for various grades of clear and sheet mica in North Carolina district, December 1957 [1]

[E&MJ Metal and Mineral Markets]

Grade (size)	Price per pound	Grade (size)	Price per pound
Punch	$0.07 to $0.12	3- x 4-inch	$2.00 to $2.60
1½- x 2-inch	.70 to 1.10	3- x 5-inch	2.60 to 3.00
2- x 2-inch	1.10 to 1.60	4- x 6-inch	2.75 to 4.00
2- x 3-inch	1.60 to 2.00	6- x 8-inch	4.00 to 8.00
3- x 3-inch	1.80 to 2.30		

[1] Stained or electric—sold at approximately 10 to 20 percent lower than clear sheet.

TABLE 15.—Prices for domestically produced muscovite mica purchased by the Government, 1957, 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	$31.90	$14.80	$12.00	$8.00
No. 4 and No. 5	40.00	18.25	6.85	5.00	4.00
No. 5½ and No. 6	17.70	7.55	4.00	3.00	2.00
Nonruby:					
No. 3 and larger	70.00	25.55	11.85	9.60	6.40
No. 4 and No. 5	40.00	14.60	5.45	4.00	3.20
No. 5½ and No. 6	17.70	6.55	4.00	2.40	1.60

Hand-cobbed mica:	*Per short ton*
Ruby	$600
Nonruby	540

The tentative specifications for visual qualities of muscovite mica again were revised and accepted by the American Society for Testing Materials (ASTM).[3] Standards of muscovite block mica for each of the visual qualities V–2 through V–7 were selected, framed, and accepted by the ASTM for deposit at headquarters.

[3] American Society for Testing Materials, Tentative Specifications for Natural Muscovite Mica Based on Visual Quality: D 351–57T, Supplement to Book of Standards, Including Tentative, pt. 6, 1957, pp. 153–161.

TABLE 16.—Price of dry- and wet-ground mica in the United States, 1957 [1]

[Oil, Paint and Drug Reporter]

	Cents per pound		Cents per pound
Dry-ground:		Wet-ground: [2]—Con.	
Paint, 100-mesh	4	Paint or lacquer, less than carlots [3]	9
Plastic, 100-mesh	4	Rubber	8
Roofing, 20- to 80-mesh	3	Rubber, less than carlots [3]	8¾
Wet-ground: [2]		Wallpaper	8¾
Biotite	6½	Wallpaper, less than carlots [3]	9
Biotite, less than carlots [3]	7¼	White, extra fine	8¼
Paint or lacquer	8¼	White, extra fine, less than carlots [3]	9

[1] In bags at works, carlots, unless otherwise noted.
[2] Freight allowed east of the Mississippi River, ½ cent higher west of the Mississippi River, 1 cent higher west of the Rockies.
[3] Exwarehouse or freight allowed east of the Mississippi River.

FOREIGN TRADE [4]

Imports.—Imports of mica were 13 percent lower in tonnage and 3 percent lower in value compared with 1956. The large drop in imports of scrap (28 percent) and the moderate decrease in imports of uncut sheet and punch (6 percent) were not counteracted by the increase in uncut films and splittings (7 percent).

Imports of muscovite block and film were 18 percent lower than in 1956, according to compilations of general imports by the Tariff Commission. Brazil and India furnished 51 percent and 46 percent respectively, of the total block and film imports. Of the Stained and better qualities of these imports, 57 percent came from India and 40 percent from Brazil.

Exports.—Total exports of mica and mica products were 9 percent greater than in 1956. Ground-mica exports were 4 percent greater than in 1956 and again constituted most of the total. Exports of other manufactured mica and of unmanufactured mica increased 58 percent and 67 percent, respectively.

TABLE 17.—Mica imported into and exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Imports for consumption								Exports	
	Uncut sheet and punch		Scrap		Manufactured		Total		All classes	
	Pounds	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948-52 (average)	2,935,089	$3,011,859	5,140	$77,625	9,614	$16,060,368	16,222	$19,149,852	1,685	$853,981
1953	2,599,007	4,279,273	3,927	72,100	5,763	10,910,292	10,990	15,261,665	2,402	1,109,865
1954	1,829,457	[1] 3,197,918	4,647	[1] 63,341	3,363	[1] 5,448,706	8,924	[1] 8,709,965	3,328	1,514,738
1955	1,747,106	3,333,721	9,461	121,343	6,156	[1] 7,814,400	16,490	[1] 11,269,464	3,314	1,707,629
1956	1,958,907	[1] 3,747,682	7,218	78,897	5,411	[1] 7,925,802	13,608	[1] 11,752,381	4,896	1,716,731
1957	1,841,840	[1] 3,358,889	5,187	56,888	5,766	[1] 8,031,626	11,874	[1] 11,447,403	5,355	1,550,394

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

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

TABLE 18.—Mica imported for consumption in the United States, 1948–52 (average), 1953–56 [1] (totals), and 1957, by kinds and by countries of origin

[Bureau of the Census]

Country	Unmanufactured									
	Waste and scrap, valued at not more than 5 cents per pound				Untrimmed phlogopite mica from which no rectangular piece exceeding 1 by 2 inches in size may be cut		Other			
	Phlogopite		Other				Valued not above 15 cents per pound n. e. s.		Valued above 15 cents per pound	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1948-52 (average)	1,557,132	$11,761	8,723,139	$65,864	175,572	$30,435	423,067	$46,463	2,336,450	$2,934,961
1953	1,205,633	13,793	6,647,233	58,307	251,811	46,727	128,401	11,404	2,218,795	4,221,142
1954	549,476	7,521	8,744,446	[1] 55,820	40,050	9,448	132,530	11,194	1,656,877	[1] 3,177,276
1955	270,200	2,822	18,651,490	118,521			139,843	11,034	1,607,263	3,322,687
1956	365,794	3,050	14,070,144	75,847			209,274	16,858	1,749,633	[1] 3,730,824
1957:										
North America:										
Canada									160	984
Mexico									4,199	4,192
Total									4,359	5,176
South America:										
Argentina							220,460	16,424	8,224	9,254
Brazil									796,221	1,671,210
Total							220,460	16,424	804,445	1,680,464
Europe:										
Netherlands									2,438	5,143
United Kingdom									112	2,638
Total									2,550	7,781
Asia:										
India			9,236,106	47,304					755,464	1,523,614
Japan									12,300	15,636
Total			9,236,106	47,304					767,764	1,539,250

Africa:										
Angola			778,690	5,720					25,794	59,659
British East Africa									6,115	23,445
Madagascar									9,935	23,170
Mozambique									18	172
Union of South Africa			358,375	3,864					400	3,348
Total			1,137,065	9,584					42,262	109,794
Total unmanufactured			10,373,171	56,888			220,460	16,424	1,621,380	[1] 3,342,465

See footnote at end of table.

TABLE 18.—Mica imported for consumption in the United States, 1948–52 (average), 1953–56[1] (totals), and 1957, by kinds and by countries of origin—Continued

Country	Manufactured—films and splittings							
	Not cut or stamped to dimensions				Cut or stamped to dimensions		Total films and splittings	
	Not above 12/10,000 inch thick		Over 12/10,000 inch thick					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1948–52 (average)	17,057,634	$13,357,614	1,127,539	$1,938,857	35,678	$456,355	18,220,851	$15,752,826
1953	8,377,873	4,041,972	2,645,230	5,069,044	69,349	1,218,721	11,092,452	10,329,737
1954	4,807,338	[1] 1,657,784	1,592,224	[1] 2,743,725	30,277	660,035	6,429,839	[1] 5,061,544
1955	9,622,464	[1] 2,620,989	2,520,390	3,821,161	51,558	964,543	12,194,412	[1] 7,406,693
1956	7,708,637	2,684,774	2,757,479	3,651,949	62,918	[1] 1,064,288	10,529,034	[1] 7,401,011
1957:								
North America:								
Canada					40	1,068	40	1,068
Mexico			25,970	41,643	11,703	203,185	37,673	244,828
Total			25,970	41,643	11,743	204,253	37,713	245,896
South America:								
Argentina			4,860	5,409			4,860	5,409
Brazil	1,482	1,866	824,891	853,586	2,628	8,297	829,001	863,749
Total	1,482	1,866	829,751	858,995	2,628	8,297	833,861	869,158
Europe:								
Austria	3,125	484					3,125	484
France	21,657	12,758			59	947	21,716	13,705
Germany, West			16,535	15,387	2,129	42,398	18,664	57,785
Italy					3,744	67,941	3,744	67,941
Netherlands			8,258	9,067			8,258	9,067
Spain					2,831	37,128	2,831	37,128
United Kingdom	35,391	10,804	986	4,311	7,406	177,265	43,783	192,380
Total	60,173	24,046	25,779	28,765	16,169	325,679	102,121	378,490
Asia:								
India	8,579,822	3,470,221	934,500	1,495,934	25,852	198,539	9,540,174	5,164,694
Indonesia			500	853			500	853
Japan	21,600	6,108	3,391	5,335	15,260	314,031	40,251	325,474
Total	8,601,422	3,476,329	938,391	1,502,122	41,112	512,570	9,580,925	5,491,021
Africa:								
Angola			2,205	1,961			2,205	1,961

British East Africa			1,070	2,418			1,070	2,418
Egypt	298	841					298	841
French West Africa			3,638	7,420			3,638	7,420
Madagascar	610,922	367,346	136,637	126,144			747,559	493,490
Union of South Africa	990	1,187					990	1,187
Total	612,210	369,374	143,550	137,943			755,760	507,317
Total films and splittings	9,275,287	[1] 3,871,615	1,963,441	[1] 2,569,468	71,652	[1] 1,050,799	11,310,380	[1] 7,491,882

Country	Manufactured—cut or stamped to dimensions, shape, or form		Manufactured: Mica plates and built-up mica		Manufactured: All mica manufactures of which mica is the component material of chief value		Manufactured: Ground or pulverized	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1948–52 (average)	97,246	$116,616	14,170	$52,132	29,797	$106,300	866,440	$32,494
1953	45,186	82,679	42,635	374,112	26,542	104,608	320,000	19,156
1954	27,776	51,920	23,593	[1] 141,523	43,401	181,719	200,000	12,000
1955	37,492	[1] 46,896	32,005	[1] 192,449	48,020	168,362		
1956	59,518	[1] 79,273	110,963	[1] 200,130	54,703	[1] 241,248	69,000	4,140
1957:								
North America:								
Canada							46,000	2,760
Mexico	680	1,254	6,165	12,251	30,260	66,129		
Total	680	1,254	6,165	12,251	30,260	66,129	46,000	2,760
South America: Brazil	2,612	7,839			25,108	78,208		
Europe:								
Belgium-Luxembourg					11,831	9,655		
Germany, West			204	1,684	2,957	14,347		
Italy					57	1,818		
Netherlands					75	747		
Spain			50	650	55	565		
Switzerland					478	5,993		
United Kingdom	112	251	25,133	62,782	17,418	158,012		
Total	112	251	25,387	65,116	32,871	191,137		
Asia:								
India	28,500	34,755	6,314	8,566	14,131	22,854		
Japan					1,554	48,624		
Total	28,500	34,755	6,314	8,566	15,685	71,478		
Total manufactured: Other	31,904	[1] 44,099	37,866	[1] 85,933	103,924	[1] 406,952	46,000	2,760

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

TABLE 19.—Muscovite block and film mica, United States general imports, 1956–57, by qualities and principal sources,[1] in pounds

Quality	Countries						Total	
	India		Brazil		Other			
	1956	1957	1956	1957	1956	1957	1956 [2]	1957
Block:								
Good Stained and better	68, 541	40, 562	167, 748	194, 306	33, 352	37, 456	269, 641	272, 324
Stained	1, 646, 599	1, 409, 152	913, 192	909, 928	101. 229	46, 553	2. 661, 020	2, 365, 633
Heavy Stained	220, 264	67, 037	641, 882	556, 036	3, 462	6, 464	865, 608	629, 537
Lower	96, 872	31, 428	316, 266	206, 250		1, 219	413, 138	238, 897
Total	2, 032, 276	1, 548, 179	2, 039, 088	1. 866, 520	138, 043	91, 692	4, 209, 407	3, 506, 391
Film:								
First quality	91, 276	40, 090				2, 679	91, 276	42, 769
Second quality	141, 126	97, 386			1, 390	935	142, 516	98, 321
Other quality	2, 962	11, 890				85	2, 962	11, 975
Total	235, 364	149, 366			1, 390	3, 699	236, 754	153, 065
Block and film:								
Good Stained and better [3]	300, 943	178, 038	167, 748	194, 306	34, 742	41, 070	503, 433	413, 414
Stained [4]	1, 649, 561	1, 421, 042	913, 192	909, 928	101, 229	46, 638	2, 663, 982	2, 377, 608
Heavy Stained	220, 264	67, 037	641, 882	556, 036	3, 462	6, 464	865, 608	629, 537
Lower	96, 872	31, 428	316, 266	206, 250		1, 219	413, 138	238, 897
Total	2, 267, 640	1. 697, 545	2, 039, 088	1, 866, 520	139, 433	95, 391	4, 446, 161	3, 659, 456

[1] Compiled by U. S. Tariff Commission from official documents of the U. S. Bureau of Customs.
[2] Does not include imports of mixed grades and qualities from Belgium, Ethiopia, Federation of Rhodesia, Japan, Mozambique, and United Kingdom—total 10,651 pounds.
[3] Includes first- and second-quality film.
[4] Includes other-quality film.

TABLE 20.—Mica block and film imported into the United States, 1956–57, by variety and principal sources, in pounds

	U. S. Tariff Commission data		Bureau of the Census data	
	1956	1957	1956	1957
Muscovite block:				
India	2, 032, 276	1, 548, 179	679, 169	755, 464
Brazil	2, 039, 088	1, 866, 520	2, 041, 167	1, 621, 112
Other	138, 043	91, 692	120, 406	67, 333
Total	4, 209, 407	3, 506, 391	[1] 2, 840, 742	[1] 2, 443, 909
Muscovite film:				
India	235, 364	149, 366	[2] 1, 588, 473	[2] 934, 500
Brazil				
Other	1, 390	3, 699		
Total	236, 754	153, 065	1, 588, 473	934, 500

[1] Includes imports of unmanufactured mica valued above 15 cents per pound, minus phlogopite valued above 15 cents per pound, plus imports from Brazil of manufactured films and splittings, not cut or stamped to dimension, over 12/10,000 inch thick.
[2] Manufactured films and splittings, not cut or stamped to dimensions, over 12/10,000 inch thick, from India (includes split block).

TABLE 21.—Mica and manufactures of mica exported from the United States, 1948–52 (average), 1953–56 (totals), and 1957, by countries of destination

[Bureau of the Census]

Country	Unmanufactured		Manufactured			
			Ground or pulverized		Other	
	Pounds	Value	Pounds	Value	Pounds	Value
1948–52 (average)	356,010	$68,932	2,813,578	$161,988	200,591	$623,061
1953	45,046	27,978	4,560,883	240,356	197,370	841,531
1954	318,518	79,310	6,058,118	342,860	280,415	1,092,568
1955	447,491	35,241	5,808,347	332,293	372,548	1,340,095
1956	546,673	91,991	8,901,497	485,879	343,159	1,138,861
1957:						
North America:						
Canada	13,300	4,210	3,230,371	152,523	427,724	586,253
Cuba			282,000	16,130	1,144	2,974
Dominican Republic			21,000	1,445		
Jamaica	1,900	1,500			10	2,330
Mexico	39,707	12,970	232,500	12,057	3,005	15,100
Netherlands Antilles			240,000	9,046		
Nicaragua			86,900	8,641		
Trinidad and Tobago					10	1,250
Total	54,907	18,680	4,092,771	199,842	431,893	607,907
South America:						
Argentina					4,674	8,815
Bolivia			7,500	472		
Brazil					6,741	29,628
Chile			44,000	1,960	3,972	16,145
Colombia			90,270	6,061	3,698	6,672
Ecuador			10,000	800		
Peru	2,000	2,000	45,500	2,027		
Uruguay					865	6,101
Venezuela	350,000	6,347	2,136,069	102,110	4,561	8,703
Total	352,000	8,347	2,333,339	113,430	24,511	76,064
Europe:						
Belgium-Luxembourg			569,600	42,608	30	1,174
France	2,024	640	760,760	61,069	36,615	123,717
Germany, West			446,000	35,433	65	690
Iceland	10,000	675	30,000	2,025		
Italy	85,000	2,338	467,000	25,607	10,290	34,168
Netherlands					9,503	18,593
Spain			83,600	5,993	2,488	14,300
Sweden					12,753	49,188
United Kingdom			42,000	3,677	5,084	32,497
Total	97,024	3,653	2,398,960	176,412	76,828	274,327
Asia:						
India	741	4,223	107,500	5,146	1,049	4,921
Israel			10,000	800		
Japan	405,894	10,028	120,000	6,110	463	1,590
Kuwait			10,000	635		
Philippines			106,600	10,656	300	693
Taiwan					2,993	4,252
Thailand					1,549	2,937
Turkey			7,500	476		
Total	406,635	14,251	361,600	23,823	6,354	14,393
Africa:						
Belgian Congo	440	1,460			391	2,006
Egypt			1,500	1,725	10	540
Union of South Africa			68,000	5,325	211	574
Total	440	1,460	69,500	7,050	612	3,120
Oceania: Australia					1,234	7,635
Grand total	911,006	46,391	9,256,170	520,557	541,432	983,446

WORLD REVIEW

The world production of mica was estimated to be the highest on record in 1957, totaling 13 percent greater than in 1956 and 6 percent greater than in 1955, the former record year. A 7-percent increase in production of scrap mica in the United States and a 42-percent increase in total exports of sheet and scrap mica from India were responsible for the gain.

TABLE 22.—World production of mica, by countries,[1] 1948–52 (average) and 1953–57, in thousand pounds [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada (sales):						
Block	322	280	71	57	79	1,426
Splittings	9	9	2	------	2	
Ground	2,174	666	937	944	1,493	
Scrap	1,947	1,312	699	639	269	
United States (sold or used by producers):						
Sheet	531	849	669	642	888	690
Scrap	120,592	146,518	162,146	190,864	172,618	184,956
Total	125,575	149,634	164,524	193,146	175,349	187,072
South America:						
Argentina:						
Sheet	527	540	529	99	322	[3] 310
Scrap				139	2	------
Brazil	4,010	4,347	3,962	3,051	2,926	[3] 3,100
Uruguay	2	2	------	------	------	------
Total	4,539	4,889	4,491	3,289	3,250	[3] 3,410
Europe:						
Austria	450	------	------	------	------	------
Italy	11	------	------	------	------	------
Norway, including scrap	1,127	2,185	3,968	3,086	2,646	2,205
Spain	24	29	260	443	227	26
Sweden:						
Block	33	7	4	------	------	------
Ground	262	379	331	368	392	[3] 400
Total [1] [3]	46,600	59,000	60,000	60,000	60,000	60,000
Asia:						
Ceylon	4	13	------	(4)	------	------
India (exports):						
Block	2,200	3,840	3,609	4,802	6,065	67,983
Splittings	22,582	12,211	10,855	16,479	14,663	
Scrap	14,568	11,444	23,031	25,699	27,282	
Taiwan:						
Sheet	7	53	44	------	29	11
Scrap	214					
Total [1] [3]	40,300	32,000	48,600	62,400	63,500	90,000
Africa:						
Angola:						
Sheet	35	42	24	33	53	46
Scrap and splittings	273	243	362	518	968	844
Kenya	7	------	------	2	------	------
Madagascar (phlogopite):						
Block	551	115	101	62	77	[3] 2,100
Splittings	1,351	1,684	1,056	534	1,109	
Morocco, Southern Zone:						
Sheet	203	(4)	11	------	------	------
Scrap		29	18			
Mozambique, including scrap	71	7	2	29	26	66

See footnotes at end of table.

TABLE 22.—World production of mica, by countries,[1] 1948–52 (average) and 1953–57, in thousand pounds [2]—Continued

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Africa—Continued						
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia, Sheet	11	18	7	4	7	(4)
Southern Rhodesia:						
Block	276	148	183	141	123	71
Scrap	655	201				
South-West Africa, Scrap	77					
Tanganyika (exports):						
Block	157	165	174	146	128	150
Ground	51					
Scrap	11	115	62	613	280	
Uganda	2		(4)			
Union of South Africa:						
Sheet	11	11	4	11	(4)	2
Scrap	3,624	4,284	4,107	7,818	5,038	4,226
Total	7,366	7,062	6,111	9,911	7,809	7,505
Oceania: Australia [5]	1,296	1,069	1,316	1,054	1,087	1,371
World total (estimate) [1 2]	226,000	255,000	285,000	330,000	310,000	350,000

[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 the total.
[2] This table incorporates a number of revisions of data published in previous Mica chapters. Data do not add to totals shown because of rounding where estimated figures are included in detail.
[3] Estimate.
[4] Less than 500 pounds.
[5] These figures include the following tonnages of damourite produced in South Australia, in thousand pounds: 1948–52 (average): 1,217; 1953: 996; 1954: 1,151; 1955: 977; 1956: 1,058; 1957: 1,294.

Argentina.—Unrestricted sale of mica was authorized in September by an executive decree. Instituto Argentino de Promocion del Intercambio, which for a number of years controlled the purchase and export of mica, continued its liquidation, which began in October 1955.[5]

Exports of mica, mostly to the United States, totaled 134 short tons, valued at US$40,000. Corresponding figures for 1956 were 293 short tons and US$217,000.[6]

Australia.—Imports of all categories of mica were less in 1956 than in 1955. Exports of block, 51 percent of which went to the United Kingdom, totaled 6,490 pounds compared with 7,784 pounds in 1955.[7]

Canada.—Preliminary estimates of quantity and value of mica production in 1957, by Provinces, were reported as follows: [8]

Unit	Quebec	Ontario	British Columbia	Total
Thousand pounds	1,056	191	180	1,427
Thousand U. S. dollars	85.9	8.7	1.2	95.8

[5] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 35.
U. S. Embassy, Buenos Aires, Argentina, State Department Dispatch 345: Sept. 11, 1957, p. 1.
[6] U. S. Embassy, Buenos Aires, Argentina, State Department Dispatch 1240: Feb. 14, 1958, p. 5.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, p. 32.
[8] Dominion Bureau of Statistics, Industry and Merchandising Division, Preliminary Report on Mineral Production, 1957 (Ottawa): P. 7.

Although the total quantity was 23 percent lower, the value was virtually unchanged from the final figures reported for 1956. Phlogopite—still the predominant variety produced—came mostly from Quebec. Mica continued to be recovered from schist in British Columbia.[9]

TABLE 23.—Salient statistics of the Canadian mica industry, 1955–56 [1]

	1955		1956	
	Pounds	Value	Pounds	Value
Production (primary sales):				
Trimmed	24,317	$26,019	22,355	$26,641
Splittings			2,000	3,480
Sold for mechanical splitting	8,000	2,080	16,000	4,160
Rough, mine-run, or rifted	25,275	2,272	40,826	841
Ground or powdered	943,158	42,837	1,493,410	58,083
Scrap	639,958	4,313	269,220	2,461
Total	1,640,708	77,521	1,843,811	95,666
Imports:				
Unmanufactured	198,900	105,810	324,900	200,779
Manufactured		482,853		538,227
Total		588,663		739,006
Exports:				
Unmanufactured:				
Rough, untrimmed	2,000	195	24,500	6,059
Trimmed	46,900	41,318	41,800	39,981
Scrap	313,000	4,060	119,500	3,236
Total unmanufactured	361,900	45,573	185,800	49,276
Manufactured:				
Manufactures		42		1,919
Ground	900	45	92,000	5,520
Total manufactured		87		7,439
Total exports		45,660		56,715

[1] Source: Dominion Bureau of Statistics.

India.—In February the Export Promotion Committee was appointed by the Government and held its first meeting. This committee was to undertake a comprehensive study of all Government export promotional measures, including those of the Export Promotion Councils for various commodities, including mica.[10]

Occurrences of mica on the southern slopes of the Jabar Range in the Purulia district, West Bengal, were reported.[11]

The number of active mica mines in South India dwindled from 144 in 1951 to 40 in 1957; about 6 of the 40 were considered economical.[12]

The Andhra Legislative Assembly passed a bill to control trade in mica. Provisions include a system of licenses to control the possession and sale of mica and a system of permits to control its removal and transport.[13]

The mica belt of Nellore, which spreads over 7,000 acres, produces approximately 2,500 pounds of mica daily. Production probably

[9] Dominion Bureau of Statistics, Industry and Merchandising Division, The Miscellaneous Non-Metal-Mining Industry, 1956 (Ottawa): Pp. P-26—P-27.
[10] U. S. Embassy, New Delhi, India, State Department Dispatch 1075: Mar. 4, 1957, 2 pp.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, p. 29.
[12] Mining Journal (London), Fall in Mica Exports: Vol. 250, No. 6392, Feb. 21, 1958, p. 218.
[13] U. S. Consulate, Madras, India, State Department Dispatch 830: May 9, 1957, p. 1.

could be increased 2,000 pounds daily if temporarily suspended mines were worked.[14]

Pakistan.—The discovery of muscovite mica of excellent quality was reported in Chitral at Mogh, Sirnik, and 8 miles north of Drosh.[15]

Tanganyika.—Exports of sheet mica totaled 150,000 pounds valued at $195,000, compared with 128,000 pounds valued at $164,000 in 1956. African cooperative societies furnished about half of this mica; 4 European companies supplied the remainder.[16]

Growth of the membership of the Uluguru Mica Mining Cooperative Society, Ltd., to over 1,000 members resulted in a division into 2 separate societies with the lease area divided between them. Both had successful years.[17]

Union of South Africa.—Production of 1,318 pounds of sheet mica was reported; local sales of 1,206 pounds were valued at US$3,346. Scrap mica production was 2,113 short tons, local sales were 840 short tons valued at US$13,730, and exports were 1,923 short tons valued at US$50,700.[18]

TECHNOLOGY

Natural Mica.—An article described the occurrence, properties, and uses of mica.[19] The location, geology, economic aspects, and descriptions of some individual prospects were reported for mica deposits in Alaska [20] and Central America.[21] The effect of geological environment on polymorphism of micas was studied by X-ray diffraction.[22]

In a brief review of the mineral deposits of Bihar, India, future trends in their use were discussed, and the geographical distribution of mica was indicated.[23] The geology, mining, processing, marketing, and economics of muscovite deposits in Southern Rhodesia were described.[24]

Data were given on the rigid requirements for mica films in capacitors used with transatlantic telephone cables.[25] An electronic machine to sort mica according to thickness [26] and a method for detecting oil on punched mica parts [27] aided fabricators of mica for electronic uses.

The use of mica as a window in equipment for high-vacuum work above 100° C. was reported.[28]

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[14] Central Glass & Ceramic Research Institute Bulletin (Calcutta), Mica Mining in Nellore: Vol. 3, No. 4, October–December 1956, p. 198.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, p. 28.
[16] U. S. Consulate, Dar es Salaam, British East Africa, State Department Dispatch 157: Feb. 19, 1958, p. 3.
[17] South African Mining and Engineering Journal (Johannesburg), Mining in Tanganyika—Mica: Vol. 69, pt. I, No. 3396, Mar. 14, 1958, p. 433.
[18] U. S. Consulate, Johannesburg, South Africa, State Department Dispatch 223: Mar. 10, 1958, p. 3.
[19] Tilden, P. M., That Remarkable Mineral Called Mica: Nature Mag., vol. 50, No. 9, November 1957, pp. 487–489, 498.
[20] Sainsbury, C. L., Some Pegmatite Deposits in Southeastern Alaska: Geol. Survey Bull. 1024–G, 1957, pp. 141–161.
[21] Roberts, R. J., and Irving, E. M., Mineral Deposits of Central America: Geol. Survey Bull. 1034, 1957, pp. 142–160.
[22] Hurst, V. J., Polymorphism of Micas in the Mineral Bluff and Epworth Quadrangles, Ga.: Bull. Geol. Soc. America, vol. 68, No. 11, November 1957, pp. 1581–1583.
[23] Jacob, K., and Mahadevan, T. M., Mineral Wealth of Bihar: Indian Min. Jour. (Calcutta), vol. 5, No. 10, October 1957, pp. 47–57.
[24] Benusan, A. M., Notes on Muscovite Mining in Southern Rhodesia: Trans. Inst. Min. Met. (London), vol. 66, pt. 4, 1956–57, pp. 155–164; vol. 66, pt. 7, 1956–57, pp. 341–348; vol. 66, pt. 12, 1956–57, pp. 621–622.
[25] Lamb, H. A., and Heffner, W. W., Repeater Production for the North Atlantic Link: Bell System Tech. Jour., vol. 36, No. 1, January 1957, pp. 103–138.
[26] Electronics, Electronic Gage Sorts Mica Automatically: Vol. 30, No. 7, July 1, 1957, pp. 228–229.
[27] Electronics, Detecting Oil on Punched Mica Parts: Vol. 30, No. 1, January 1957, pp. 234, 236.
[28] Sterzer, F., Simple High-Temperature Vacuum-Tight Mica Window: Rev. Sci. Instruments, vol. 28, No. 3, March 1957, pp. 208–209.

The mechanism of the action of dilute aqueous acid, alkaline, and neutral solutions on muscovite mica was investigated.[29] The weathering of muscovite was explained on the basis of crystal structure,[30] an explanation of spiral cleavage in mica was proposed,[31] and chemical and optical data were reported for several micas.[32]

Data on equipment and processing were reported for a plant recovering mica from the silt that accumulated behind a TVA dam.[33]

An ultrasonic method of delaminating mica to a product comparable with wet-ground mica was reported as superior to the usual wet-grinding processes in economics and technical operation.[34] Another process for wet-grinding mica used more conventional methods of producing a ground and purified material.[35] Dry-grinding mica in a fluid-energy mill was described.[36]

Additional studies of latex paints containing wet-ground mica demonstrated the need for reporting the surface condition of the test panels as an additional factor in evaluating adhesion characteristics.[37] Outdoor latex with varying proportions of wet-ground mica in their formulations were found to have moisture-sealing properties under rigorous exposure.[38] Wet-ground mica as a component of the pigments of alkyd paints increased the density of the paint film; greatest densities resulted from mixtures of large and small sizes of platy mica.[39] Organic dispersing agents and antisettling additives improved the mixing characteristics of wet-ground mica pigment in an alkyd vehicle. Phenolic varnish paints containing wet-ground mica, with or without surface pretreatment, had better storage properties than paints using other extenders.[40] Incorporating 325-mesh wet-ground mica in the pigments of traffic paints based on vehicles of either phenolic varnish or chlorinated rubber resulted in paints having improved storage properties and good reflectance before and after accelerated weathering.[41] Initial results of tests subjecting the chlorinated rubber paints to the wear of heavy traffic indicated that wet-ground mica increased the resistance of these paints to chipping.[42]

[29] Gaines, G. L., Jr., Ion-Exchange Properties of Muscovite Mica: Jour. Phys. Chem., vol. 61, No. 10, October 1957, pp. 1408–1413.
Gaines, G. L., Jr., and Rutkowski, C. P., Extraction of Aluminum and Silicon From Muscovite Mica by Aqueous Solutions: Jour. Phys. Chem., vol. 61, No. 10, October 1957, pp. 1439–1441.

[30] Uchiyama, Nobuo, [Discussion and Aluminum-Substitution Ratio in Tetrahedral Layer and Relation Between Contents of Magnesia and Potassium Oxide of Mica Minerals]: Tohoku Jour. Agric. Res., vol. 7, 1956, pp. 1–7; Chem. Abs., vol. 51, No. 11, June 10, 1957, p. 7963c.

[31] Kinoshita, Koreo, and Nakayama, Jun, [Spiral Cleavage of Mica]: Jour. Phys. Soc. Japan, vol. 11, 1956, pp. 1055–1058; Chem. Abs., vol. 51, No. 17, Sept. 10, 1957, p. 12762e.

[32] Emeliani, Francesco, [Crystal Chemical Studies of Micas. I. Chemical and Optical Study of Some Muscovite of the Pegmatitic Orthogneiss of Val Venosta]: Acta Geologica Alpina, No. 6, 1956, pp. 79–104; Chem. Abs., vol. 51, No. 13, July 10, 1957, p. 9426g.

[33] Herod, B. C., Mica Reclaimed, Processed in New Tennessee Plant of International Minerals: Pit and Quarry, vol. 50, No. 10, October 1957, pp. 76–78.

[34] Kunz, E. C., and Ensminger, Dale, Method and Apparatus for Treating Mica: U. S. Patent 2,798,673, July 9, 1957.

[35] Ram, Atma, and Roy, S. B. (assigned to Council of Scientific and Industrial Research), Wet-Grinding of Mica: Indian Patent 55,454, Aug. 8, 1957.

[36] Rock Products, Mica Processing; The Story of One Plant's Operation: Vol. 60, No. 9, September 1957, pp. 112–114.
Engineering and Mining Journal, Santa Fe Firm Mines and Processes Ground Mica: Vol. 158, No. 7, July 1957, p. 160.

[37] Wet-Ground Mica Association, Inc., Supplement 1 to Studies on the Influence of Wet-Ground Mica on the Adhesion Characteristics of Latex Paint: Tech. Bull. 28A, January 1957, 2 pp.

[38] Wet-Ground Mica Association, Inc., Some Studies on the Moisture-Sealing Characteristics of Mica in Polyvinyl Acetate Latex Paints for Outdoor House Use: Tech. Bull. 31, June 1957, 3 pp.

[39] Wet-Ground Mica Association, Inc., A Study of the Effect of Platy Wet-Ground Mica on the Density of the Paint Film: Tech. Bull. 32, September 1957, 3 pp.

[40] Wet-Ground Mica Association, Inc., Studies on the Sedimentation Characteristics During Storage of Pigmented Organic Coating Materials: Tech. Bull. 29, January 1957, 4 pp.

[41] Wet-Ground Mica Association, Inc., Studies on the Use of Wet-Ground Mica in Traffic Paints: Tech. Bull. 30, May 1957, 4 pp.

[42] Wet-Ground Mica Association, Inc., Further Studies on the Use of Wet-Ground Mica in Traffic Paints: Tech. Bull. 33, November 1957, 4 pp.

Ground mica was an essential ingredient for imparting moisture and thermal-shock resistance to an encapsulating composition for electrical equipment.[43]

Synthetic Mica.—Research on synthetic mica by the Bureau of Mines at the Electrotechnical Experiment Station, Norris, Tenn., was summarized for the 8-year period ended in May 1955. This work included developing the internal electric-resistance melting process, studies of crystallization, and discovery of machinable synthetic-mica ceramic materials.[44] Studies continued during 1957 on compositions, properties, crystal growth, and production of synthetic mica.

Research under the industry-Government program (see section on Defense Materials Service) to develop substitutes for strategic natural mica was in its preliminary stages. Developing a satisfactory method of delaminating flake synthetic mica for reconstitution into a sheet material was emphasized at first.

Substitutions of gallium for aluminum and of nickel for magnesium in the phlogopite lattice were studied for effects on structure and decomposition temperature.[45] A mica with germanium in place of silicon was synthesized by solid-state reaction and its structure determined.[46] The influence of cooling rate on the crystal size of synthetic mica was studied on melts prepared in a graphite crucible.[47]

A furnace with a melting capacity of 30 kilograms and precise temperature control at high temperatures was designed and constructed for preparing synthetic mica.[48] Autoclaving an agglomerate mass of synthetic mica crystals with water or alkaline solutions made it easier to separate the individual crystals.[49] A method of hot rolling was proposed for improving the mechanical and electrical properties of sheets reconstituted from synthetic mica flake.[50]

Commercial production of synthetic mica flake for use in glass-bonded mica ceramic materials was continued by two companies. Development of the process was reviewed briefly,[51] and recent operations of one of the producers were described.[52]

Built-Up and Reconstituted Products From Natural and Synthetic Mica.—Reconstituted mica, with its uniform thickness and smooth surface, made possible an automatic process for manufacturing commutators used in automobile generators and starters.[53] A heat-resistant, nonhygroscopic insulation suitable for high-voltage applications was formed by impregnating reconstituted mica paper with a

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[43] Bolson, H. B. (assigned to General Electric Co.), Encapsulating and Coating Composition and Products Treated Therewith: U. S. Patent 2,809,952, Oct. 15, 1957.

[44] Hatch, R. A., Humphrey, R. A., Eitel, W., and Comeforo, J. E., Synthetic Mica Investigations IX: Review of Progress From 1947 to 1955: Bureau of Mines Rept. of Investigations 5337, 1957, 79 pp.

[45] Klingsberg, Cyrus, and Roy, Rustum, Synthesis, Stability, and Polytypism of Nickel and Gallium Phlogopite: Am. Mineral., vol. 42, No. 9-10, September-October 1957, pp. 629-634.

[46] Mullers, S., and Brasseur, H., [Synthesis of Germanium-Bearing Mica]: Bull. soc. franc. mineral. et cust., vol. 79, 1956, pp. 582-590; Chem. Abs., vol. 51, No. 11, June 10, 1957, p. 7922h.

[47] Noda, Tokiti, and others, [Medium-Scale Experiment for the Preparation of Synthetic Mica Crystals]: Kogyo Kagaku Zasshi, vol. 59, 1956, pp. 352-355; Chem. Abs., vol. 51, No. 14, July 25, 1957, p. 10319b.

[48] Noda, Tokiti, Ishida, Yoshihiro, Tamura, Kojiro, and Kanatsu, Shinsaku, [Carbon-Particle Electric Resistance Furnace Designed for the Preparation of Synthetic Mica Crystals]: Jour. Ceram. Assoc. Japan, vol. 64, No. 721, 1956, pp. 45-53; Ceram. Abs., vol. 40, No. 9, Sept. 1, 1957, p. 207.

[49] Noda, Tokiti, Hydrothermal Treatment of an Agglomerate of Synthetic Mica Crystals: U. S. Patent 2,778,713, Jan. 22, 1957.

[50] Barr, F. A. (assigned to Sylvania Electric Products, Inc.), Process for Preparing Synthetic Mica Products: U. S. Patent 2,788,837, Apr. 16, 1957.

[51] Chemical Trade Journal & Chemical Engineering (London), Synthetic Mica: Vol. 141, No. 3664, Aug. 23, 1957, p. 436.

[52] Chemical Engineering News, Synthetic Mica Moves Ahead: Vol. 35, No. 31, Aug. 5, 1957, pp. 110, 134. Chemical Week, Man-made Mica Mountain: Vol. 81, No. 5, Aug. 3, 1957, p. 50.

[53] Journal of the Franklin Institute, Current Topics, Mica Mat Insulation: Vol. 264, No. 5, November 1957, pp. 430-431.

hydrocarbon oil and polymerizing the absorbed oil by a two-stage heating process.[54] A method was developed for forming a heat-resistant, dielectric sheet of mica flakes bonded with a cellular skeleton of silica.[55] The strength and water resistance of reconstituted mica paper were increased by depositing an adhesive form of silica either during or after formation of the sheet.[56] Synthetic mica was used in a new ceramic material having excellent electrical properties, dimensional stability, heat resistance, and a thermal expansion matching that of steel.[57]

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[54] Heyman, M. D., Integrated Mica Oil-Impregnated Sheet: U. S. Patent, 2,781,819, Feb. 19, 1957.
[55] Heyman, M. D., Mica Base Insulating Sheet and Method for Producing the Same: U. S. Patent 2,810,425, Oct. 22, 1957.
[56] Budnik, F. (assigned to Mica Insulator Co.), Sized Mica Paper and Process of Preparing the Same: U. S. Patent 2,791,262, May 7, 1957.
[57] Ceramic News, On the Ceramic Scene, New Ceramic Materials: Vol. 6, No. 9, September 1957, p. 8.

Molybdenum

By Wilmer McInnis[1] and Mary J. Burke[2]

DOMESTIC production of molybdenum concentrate during 1957 was 6 percent higher than during 1956, despite a sharp decrease in output from several byproduct sources. Shipments of concentrate increased slightly, but consumption decreased compared with 1956, largely because of a strike that kept a conversion plant at Langeloth, Pa., closed during the last 6 months of the year.

Molybdenum was used chiefly to alloy iron and steel, but it also had a large variety of smaller uses, including several relatively new applications.

Industry stocks of molybdenum concentrate at the close of 1957 were the highest since 1953.

Exports of molybdenum concentrate, including roasted concentrate, increased 42 percent compared with 1956 to an alltime high.

Prices quoted for molybdenum concentrate and molybdenum products were unchanged. Import duty on ore and concentrate was reduced under terms of the General Agreement on Tariffs and Trade.

TABLE 1.—Salient statistics of molybdenum in the United States, 1948–52 (average) and 1953–57, thousand pounds of contained molybdenum

	1948–52 (average)	1953	1954	1955	1956	1957
Concentrate:						
Production	31,966	57,243	58,668	61,781	57,462	60,753
Shipments [1]	35,633	53,823	64,021	64,709	57,126	57,143
Value of shipments, thousand dollars [2]	30,900	52,362	64,070	66,919	[3] 63,901	67,605
Shipments for export	[4] 4,473	5,893	12,974	12,046	14,736	17,543
Consumption	27,510	31,193	24,710	38,799	42,652	38,954
Imports for consumption	21		154	134		27
Stocks, end of year [5]	11,321	11,326	5,317	2,730	2,920	7,093
Primary products: [6]						
Production	26,915	30,283	24,328	37,774	41,208	37,639
Shipments to domestic destinations	26,324	29,595	23,717	35,935	39,082	34,662
Shipments for export [7]	1,543	1,107	1,640	2,671	3,738	2,244
Total shipments	27,867	30,702	25,357	38,606	42,820	36,906
Consumption	(8)	(8)	(8)	(8)	33,497	30,018
Stocks [9]	5,258	3,894	3,430	3,156	2,812	5,789

[1] Includes exports.
[2] Largely estimated by Bureau of Mines.
[3] Revised.
[4] Includes roasted concentrate for 1948.
[5] At mines and at plants making molybdenum products.
[6] Comprises ferromolybdenum, molybdic oxide, and molybdenum salts and metal.
[7] Reported by producers to the Bureau of Mines.
[8] Data not available.
[9] Producers' stocks, end of year.

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DOMESTIC PRODUCTION

In 1957 production from ores mined chiefly for molybdenum more than offset an 8-percent decrease in output from byproduct sources. Production was from six States: Colorado led, followed by Utah, Arizona, California, New Mexico, and Nevada. Total domestic mine output for the year was 61 million pounds compared with 57 million pounds in 1956. Molybdenite was the source of all molybdenum produced in 1957, except for a small quantity of powellite recovered from tungsten ores at the Pine Creek Tungsten mill in California.

Molybdenum Mines.—The Climax Molybdenum Co. Climax mine in Lake County, Colo., was the only domestic mine operated chiefly for molybdenum in 1957. Production from this mine increased 13 percent during 1957 compared with output in 1956. The increase was due largely to a new milling unit placed in operation during February that enabled the company to treat more than 10 million short tons of ore during the year. The contract between Climax Molybdenum Co. and the Federal Government, which had required the firm to mine and mill daily a minimum of 5,000 tons of low-grade ore, was terminated by agreement during 1957.

Climax Molybdenum Co. reported that:[3]

> On the basis of extensive diamond drilling and other methods of exploration, Climax now estimates that its proven ore reserves which are commercially minable at present cost and price levels total 418 million short tons of an average grade of 0.43 percent molybdenum sulfide. However, the full extent of the ore body and its grades have not been defined.

Climax Molybdenum Co. and American Metal Co., Ltd., were merged on January 1, 1958. The name of the new firm is American Metal Climax, Inc., and Climax Molybdenum Co. became a subsidiary of the new company.

The Questa deposit was explored further by Molybdenum Corp. of America under a DMEA (Defense Minerals Exploration Administration) contract. This was the only contract executed by DMEA in 1957 covering exploration for molybdenum. Tailing from previous operations of the Questa mine was treated in the Questa mill during late 1957.

Byproduct Sources.—Production of molybdenum as a byproduct of copper and tungsten mining comprised about 30 percent of the total output in 1957 compared with 35 percent in 1956. Compared with 1956, American Smelting and Refining Co. increased molybdenum production 64 percent in 1957; Bagdad Copper Corp., 5 percent; San Manuel Copper Corp., 145 percent; and Union Carbide Nuclear Co., 51 percent. The substantial increase in production by both American Smelting and Refining Co. and San Manuel Copper Corp. resulted from the first full year's output by these firms, but the large increase by Union Carbide Nuclear Co. was due to milling of higher molybdenum bearing tungsten ores. A reduced demand for copper in 1957 led to a decrease in molybdenum output by Kennecott Copper Corp., Miami Copper Co., and Phelps Dodge Corp. compared with production by these firms in 1956.

Shipments of Concentrate.—Shipments of molybdenum contained in concentrate comprised 39.6 million pounds to domestic destinations

[3] Climax Molybdenum Co., Notice of Special Meeting of Stockholders: Nov. 27, 1957, pp. 20, 21.

and 17.5 million pounds for export. The shipments to domestic destinations include concentrate shipped to Canada for conversion to molybdic oxide and returned to the United States. The quantity converted in Canada is included in total domestic shipments to prevent disclosing individual company data.

Primary Products.—Production of molybdenum products during 1957 decreased 9 percent compared with 1956. The decreased production was due mainly to a strike that kept the Langeloth, Pa., conversion plant closed during the latter half of 1957.

TABLE 2.—Production, shipments, and stocks of molybdenum products in the United States in 1957, thousand pounds of contained molybdenum

Product	Received from other producers	Gross production during year	Used to make other products listed here	Net production	Shipments: Domestic consumers	Shipments: Export	Shipments: Total	Producers' stocks, end of year
Molybdic oxide [1]	2,288	34,687	7,068	27,619	25,079	1,917	26,996	4,681
Ammonium molybdate	59	579	384	195	270		270	65
Metal powder	5	1,125		1,125	1,119	1	1,120	156
Sodium molybdate		280	2	278	301		301	12
Other [2]		8,423	1	8,422	7,893	326	8,219	875
Total	2,352	45,094	7,455	37,639	34,662	2,244	36,906	5,789

[1] Includes molybdic oxide briquets, molybdic acid, and molybdenum trioxide.
[2] Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, and molybdenum disulfide.

CONSUMPTION AND USES

Domestic consumption of molybdenum contained in concentrate during 1957 decreased 9 percent compared with 1956. Of 38,954,000 pounds consumed during 1957, 91 percent was estimated to have been converted to molybdic oxide, and the rest was used for direct addition to steels, manufacture of molybdenum disulfide lubricants, and miscellaneous applications such as antifriction materials. The decreased consumption of concentrate was due mainly to a strike from July 1 to near the end of November that idled the large Langeloth, Pa., conversion plant. The strike also caused a temporary shortage of molybdic oxide and other molybdenum products.

Consumption of molybdenum contained in primary products totaled 30 million pounds compared with 33.5 million pounds consumed in 1956. These data, given in tables 3 and 4, are estimated to comprise only about 90 percent of the total molybdenum consumed in the United States during the year, because many small consumers were not canvassed.

Molybdenum consumed in steels totaled 22.4 million pounds, of which 80 percent was used in low-alloy and stainless steels, 10 percent in high-speed steel, and 10 percent in steel castings. Molybdenum was added to low-alloy steels to improve such mechanical properties as uniform hardness and strength. It was added to stainless steels primarily to aid in resistance to corrosion and to high-speed steels to impart red hardness that prevents softening at the high temperatures developed during cutting operations.

Eight percent of the total molybdenum consumed was added to gray and malleable castings to improve hardenability, strength, and resistance to chipping, and 5 percent was added to special alloys designed for use at high temperatures; in addition, a substantial quantity of the molybdenum powder consumed was used in melting arc-cast ingots designed principally for high-temperature applications. It was reported that molybdenum and its alloys were used in manufacturing guided-missile parts, such as nozzles and vanes.[4]

The effect of the purity of molybdenum-base alloys in the future of high-temperature metallurgy was discussed.[5] The Wolverine Tube, Division of Calumet & Hecla, Inc., announced that it had developed a process for extruding molybdenum tubing.[6]

The extruded tubing is expected to be suitable for use in nuclear heat exchangers because of molybdenum's resistance to liquid metals such as sodium. Sintered molybdenum was used principally in producing wire, rod, and sheet for manufacturing electronic parts, heating elements, and heat-radiation shields and for various miscellaneous applications. Molybdenum powder reported used in manufacturing electrical contacts during 1957 totaled 8,000 pounds.

A relatively new use of molybdenum was in titanium alloys, to which 6,000 pounds was reported to have been added during 1957. The effect of molybdenum on the properties of titanium alloys was discussed.[7]

Purified molybdenum disulfide was used in manufacturing lubricants and as an additive to such solid materials as rubber, plastic, and brake linings. In 1957, 13,000 pounds of molybdenum was reported consumed in friction materials, 9,000 pounds in brake linings, and 2,000 pounds in packings; 1,000 pounds was used in rubber products. Molybdenum disulfide was reported to impart antiseize characteristics and lower surface friction to rubber, supply stable frictional properties to asbestos brake linings, and provide a combination of lubrication characteristics and strength to plastics.[8]

TABLE 3.—Consumption of molybdenum products in the United States and stocks at plants of consumers in 1957, thousand pounds of contained molybdenum

Product	Consumption	Stocks, Dec. 31	Product	Consumption	Stocks, Dec. 31
Molybdic oxide [1]	21,045	1,922	Sodium molybdate	229	38
Calcium molybdate	158	25	Other [3]	644	190
Ferromolybdenum [2]	6,778	800			
Molybdenum-metal powder	1,105	112	Total	30,018	3,097
Ammonium molybdate	59	10			

[1] Includes molybdic oxide briquets, molybdic acid, and molybdenum trioxide.
[2] Includes molybdenum silicide.
[3] Includes molybdenum disulfide, thermite molybdenum, molybdenite concentrate added direct to steel, etc.

[4] American Metal Market, Predicts Coated Moly Will Have Considerable Life at About 2,000° F.: Vol. 64, No. 59, Mar. 27, 1957, p. 1.
[5] Jahnke, L. P., The Future of High-Temperature Metallurgy: Metal Prog., vol. 72, No. 4, October 1957, pp. 113–118.
[6] American Metal Market, Calumet & Hecla Now Extruding Moly Tubing: Vol. 64, No. 132, July 11, 1957, p. 1.
[7] Margolin, Harold, Molybdenum as an Alloy Addition for Titanium: Metal Prog., vol. 71, No. 2, February 1957, pp. 86–91.
[8] Industrial and Engineering Chemistry, Moly Disulfide Fillers Reduce Wear in Plastics: Vol. 45, No. 1, January 1957, pp. 148–149, 151.

TABLE 4.—Consumption of molybdenum by class of manufacture in 1957, thousand pounds of contained molybdenum

Steel:		Molybdenum metal (wire, rod, and sheet)	868
High speed	2,335	Chemicals:	
Other alloy including stainless	17,891	Catalysts	492
Castings	2,196	Colors	660
Gray and malleable castings	2,274	Other	75
Rolls (steel mill)	832	Lubricants	192
Welding rods	237	Miscellaneous [1]	321
High-temperature alloys	1,401	Total	30,018
Corrision- and heat-resisting castings	244		

[1] Includes research and magnetic alloys.

STOCKS

Stocks of molybdenum concentrate at mines and at plants making molybdenum products increased 143 percent during 1957. Stocks of molybdenum products at producers' plants increased 106 percent during the year, but those held by consumers decreased 29 percent.

PRICES AND SPECIFICATIONS

There was no change in the quoted prices for molybdenum concentrates or primary products during 1957. The quoted price for molybdenum contained in concentrate grading 90 percent or more MoS_2 was $1.18 a pound, plus the cost of container, f. o. b. Climax, Colo., and $1.23 a pound, f. o. b. Washington, Pa. Prices of the principal molybdenum products based on the contained molybdenum, f. o. b. producers' plants, were: Ferromolybdenum, 58–64 percent Mo, powdered $1.74, all other sizes $1.68 a pound; calcium molybdate, $1.42 a pound; technical molybdic oxide, bagged $1.38, canned $1.39, and briquets packed, $1.41 a pound; and carbon-reduced molybdenum powder, $3.35 a pound.

National Stockpile Purchase Specification P–74–R, covering ferromolybdenum, molybdenum disulfide, and molybdic oxide, was revised to P–74–RI on September 6, 1957. The new specification required the use of 55-gallon, 16-gage, steel drums, hot-dipped galvanized after fabrication, for packaging ferromolybdenum, and the same size and type of drums, except they may be made of 18-gage steel, for packaging molybdenum disulfide and molybdic oxide. Chemical requirements under the revised specification were unchanged; these were reported in table 6 of the 1956 Minerals Yearbook Molybdenum chapter.

FOREIGN TRADE [9]

Exports of 25.5 million pounds of molybdenum contained in concentrate and molybdic oxide during 1957 were the highest in any year. However, a large part of the concentrate exported to Canada was converted to molybdic oxide that was shipped to the United States. The exports went to 13 countries; West Germany received 23, United Kingdom 20, Canada 18, Japan 14, France 13, Sweden 8, and 7 countries combined 4 percent of the total.

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

Ferromolybdenum exports during 1957 totaled 383,271 pounds (gross weight), valued at $447,098. Of the total exports, 62 percent was shipped to Canada, 11 to Italy, 10 to Brazil, and 6 to Denmark; the remainder was shipped to 7 other countries. Exports of molybdenum wire totaled 13,750 pounds (gross weight), valued at $230,798, and exports of metals and alloys in crude form and scrap were 98,513 pounds (gross weight), valued at $182,381.

Imports of molybdenum ores and concentrates for consumption during 1957 totaled 27,461 pounds of contained molybdenum valued at $54,943, all from Canada. Imports of ferromolybdenum, molybdenum metal and powder, calcium molybdate and other compounds, and alloys of molybdenum totaled 1,496,465 pounds of contained molybdenum valued at $2,047,540; molybdenum ingots, shot, bars, or scrap totaled 15,957 pounds (gross weight), valued at $29,212; and molybdenum sheets, wire, or other forms totaled 24,327 pounds (gross weight), valued at $449,052.

TABLE 5.—Molybdenum ore and concentrate (including roasted concentrate) exported from the United States, 1948–52 (average) and 1953–57, by countries of destination

[Bureau of the Census]

Country	1948–52 (average)		1953		1954	
	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value
North America:						
Canada	255,661	$254,445	404,626	$454,294	232,287	$248,305
Canal Zone	323	304	590	881		
Jamaica						
Mexico	3,667	3,316	3,119	3,050	2,716	3,096
Total	259,651	258,065	408,335	458,225	235,003	251,401
South America: Brazil						
Europe:						
Austria	16,243	16,738	80,020	91,823	305,588	351,833
Belgium-Luxembourg	4,631	5,594	13,400	15,745	15,480	18,392
Denmark	600	780				
Finland	1,471	2,712				
France	1,189,281	1,078,435	1,368,112	1,386,909	2,306,383	2,321,539
Germany	850,465	837,250	[1] 1,028,275	[1] 1,087,912	[1] 3,725,351	[1] 3,872,874
Italy	100,047	104,444	7,056	8,700	145,860	164,835
Netherlands	26,162	27,849	4,410	5,027	710,945	774,619
Norway	12,000	11,284				
Spain	1,998	2,690				
Sweden	360,753	333,944	339,208	379,062	806,247	847,576
Switzerland	495	624	595	1,050		
Trieste					33,919	38,390
United Kingdom	2,219,528	1,957,338	3,420,028	3,465,136	4,717,073	4,770,026
Total	4,783,674	4,379,682	6,261,104	6,441,364	12,766,846	13,160,084
Asia:						
Japan	60,410	67,173	366,547	406,368	540,661	572,701
Philippines						
Taiwan			350	578		
Total	60,410	67,173	366,897	406,946	540,661	572,701
Africa: Rhodesia and Nyasaland, Federation of					4,000	4,700
Oceania:						
Australia	11,817	13,514	1,100	1,254		
New Zealand	2,016	2,298				
Total	13,833	15,812	1,100	1,254		
Grand total	5,117,568	4,720,732	7,037,436	7,307,789	13,546,510	13,988,886

See footnote at end of table.

TABLE 5.—Molybdenum ore and concentrate (including roasted concentrate) exported from the United States, 1948–52 (average) and 1953–57, by countries of destination—Continued

Country	1955		1956		1957	
	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value
North America:						
Canada	529,359	$599,082	636,312	$783,384	4,567,836	$5,439,899
Canal Zone						
Jamaica					528	367
Mexico	1,000	1,250				
Total	530,359	600,332	636,312	783,384	4,568,364	5,440,266
South America: Brazil			4,136	5,736	1,652	1,148
Europe:						
Austria	585,405	724,297	863,280	1,206,601	314,722	469,278
Belgium-Luxembourg	1,998	2,650	732	1,336	24,100	35,083
Denmark						
Finland						
France	2,368,726	2,470,469	3,383,634	3,870,034	3,371,629	4,140,673
Germany	[1] 3,621,486	[1] 3,953,999	[1] 5,562,604	[1] 6,399,830	[1] 5,807,870	[1] 7,200,117
Italy	157,324	174,445	204,949	241,134	572,070	754,786
Netherlands	217,900	327,442	272,543	381,661	162,612	194,190
Norway						
Spain						
Sweden	1,465,222	1,647,137	1,569,844	1,811,866	2,073,864	2,636,519
Switzerland			2,948	5,400		
Trieste						
United Kingdom	5,354,342	5,542,038	3,719,668	4,239,817	5,044,886	6,199,113
Total	13,772,403	14,842,477	15,580,202	18,157,679	17,371,753	21,629,759
Asia:						
Japan	277,196	339,171	1,752,486	2,338,216	3,514,545	5,342,209
Philippines	400	1,220				
Taiwan						
Total	277,596	340,391	1,752,486	2,338,216	3,514,545	5,342,209
Africa: Rhodesia and Nyasaland, Federation of						
Oceania:						
Australia			7,871	10,547	9,201	14,715
New Zealand						
Total			7,871	10,547	9,201	14,715
Grand total	14,580,358	15,783,200	17,981,007	21,295,562	25,465,515	32,428,097

[1] West Germany.

Tariff.—Under authority of the General Agreement on Tariffs and Trade, the duty on several molybdenum products was reduced further in 1957. The tariff on molybdenum ores and concentrates in 1957 was 33 cents a pound of contained molybdenum to June 30 and 31½ cents a pound during the remainder of the year. Forms containing over 50 percent molybdenum, molybdenum carbide, or combinations not specially provided for were: Ingots, shots, bars or scrap molybdenum carbide, 23.5 percent ad valorem to June 30 and 22.5 percent ad valorem during the remainder of the year; and sheet, wire, or other forms of molybdenum or molybdenum carbide, 28.5 percent ad valorem to June 30 and 27 percent ad valorem the rest of the year.

The duty on ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum remained at 25 cents a pound of contained molybdenum plus 7.5 percent ad valorem throughout the year.

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TABLE 6.—Molybdenum reported by producers as shipments for export from the United States, 1955–57, thousand pounds of contained molybdenum

	1955	1956	1957
Concentrate (not roasted)	[1] 12,046	[1] 14,736	17,543
Roasted concentrate (oxide)	2,401	3,082	1,917
All other primary products	270	656	327

[1] Revised figure.

TABLE 7.—Molybdenum products exported from the United States, 1955–57, gross weight in pounds

[Bureau of the Census]

Product	1955	1956	1957
Ferromolybdenum [1]	349,193	944,671	383,271
Metal and alloys in crude form and scrap	22,564	35,240	98,513
Wire	11,482	11,440	13,750
Powder	21,173	20,735	28,222
Semifabricated forms (mainly rods, sheets, and tubes)	3,952	4,853	4,289

[1] Ferromolybdenum contains about 60–65 percent molybdenum.

WORLD REVIEW

World production of molybdenum during 1957 was estimated at 66.8 million pounds, of which 91 percent was produced in the United States.

Canada.—All production of molybdenum in Canada during 1957 was from the La Corne mine about 22 miles Northwest of Val d'Or, Quebec, owned and operated by Molybdenite Corporation of Canada, Ltd. The firm produced 873,000 pounds of molybdenum contained in concentrate during 1957. The concentrate was converted to molybdic oxide before shipment.

TABLE 8.—World production of molybdenum in ores and concentrates, by countries,[1] 1948–52 (average) and 1953–57, thousand pounds [2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Australia	4	2	(3)	2	(3)	----------
Austria	29	----------	----------	18	2	----------
Canada	157	194	452	833	842	873
Chile	2,403	3,007	2,663	2,817	3,122	2,998
Hong Kong	(3)	2	(3)	(3)	----------	----------
Japan	71	397	450	439	527	600
Korea, Republic of	11	20	22	24	31	31
Mexico	----------	(3)	159	55	33	29
Norway	207	317	335	379	366	390
Peru	4	11	2	----------	----------	----------
Portugal	----------	2	4	11	11	11
Sweden	4	----------	----------	----------	----------	----------
United States	31,966	57,243	58,668	61,781	57,462	60,753
Yugoslavia	611	1,920	441	948	(4)	(4)
World total (estimate) [1]	36,300	64,200	64,300	68,400	63,500	66,800

[1] Molybdenum is also produced in China, North Korea, Rumania, Spain, and U. S. S. R., but production data are not available. Estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Molybdenum chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Less than 500 pounds.
[4] Data not available; estimate by senior author of chapter included in total.

The proved ore reserve of the La Corne deposit at the beginning of 1957 was estimated at 184,861 tons grading 0.50 percent molybdenite, compared with 176,166 tons averaging 0.438 percent MoS_2 a year earlier.[10]

The Preissac Molybdenite Mines, Ltd., continued to explore its molybdenite and bismuth property about 25 miles northwest of the La Corne mine by surface diamond drilling. Quebec Metallurgical Industries, Ltd., carried out diamond drilling and development work at its Kirkham Molybdenum Prospect near Shawville, Quebec. Acme Molybdenite Mining Co., Ltd., was reported to have failed to obtain a $300,000 loan for development of its molybdenum properties in Quebec and British Columbia.[11]

Climax Molybdenum Co. continued to explore a molybdenum prospect on Boss Mountain 32 miles northeast of Lac la Hache in the Cariboo district of British Columbia. The 1957 exploration program was directed mainly to outlining the area of mineralization, which was said to be quite extensive. Beattie-Duquesne mines roasting plant at Duporquet, Quebec, was reported to have been rehabilitated by Climax Molybdenum Co. and used to convert molybdenite concentrate to oxide for shipments to the United States and overseas markets.[12]

Chile.—All of the 3 million pounds of molybdenum produced in Chile during 1957 was recovered from the copper sulfide ores of the Braden mine. The Anaconda Co. was constructing a molybdenum-recovery unit at its Chuquicamata copper property at the year end and expected to have it in operation early in 1958.

TABLE 9.—Exports of molybdenite concentrate [1] from Chile, 1953–57, by countries of destination, thousand pounds [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
France	462	368	458	52	394
Germany, West	771	392	400	330	502
Netherlands	676	438	516	156	666
Sweden	147	156	330	358	392
United Kingdom	3,581	3,192	3,964	4,062	3,602
Total	5,637	4,546	5,668	4,958	5,556

[1] Dry concentrate containing approximately 96 percent MoS_2 with 58 percent contained molybdenum.
[2] Compiled from Customs Returns of Chile.

Italy.—A molybdenum deposit was reported to have been discovered in Sardinia, but the molybdenum mineral or minerals and grades were not given.[13]

Japan.—Molybdenum was produced from several small mines in Japan during 1957, but mine output was not enough to supply the country's needs for the metal. Japan imported more molybdenum from the United States during 1957 than in any preceding year. However, the Japanese industry had accumulated fairly large stocks of

[10] Northern Miner (Toronto), Molybdenite Corp. Earns Profit; Operation's Outlook Improving: Vol. 43, No. 6, May 2, 1957, pp. 1, 7.
[11] Metal Bulletin (London), Molybdenite: No. 4219, Aug. 16, 1957, p. 26.
[12] Northern Miner (Toronto), Beattie Duquesne Roasts Molybdenite: Vol. 43, No. 38, Dec. 12, 1957, p. 1.
[13] Chemical Age (London), Molybdenum in Sardinia: Vol. 78, No. 2000, Nov. 9, 1957, p. 764.

molybdenum by the third quarter of 1957; and, in order to prevent a further build-up, the Japanese Ministry of Trade removed molybdenum from the list of goods that could be imported freely under the automatic approval system.

Norway.—Molybdenum was produced from the Knaben mine near Egersund near the southwest coast of Norway.

Rhodesia and Nyasaland, Federation of.—It was reported that a molybdenite deposit was discovered near Selukwe, Southern Rhodesia, but the size and grade of the deposit had not been determined.[14]

Sierra Leone.—A molybdenite deposit was reported to have been discovered in the area of the Wankatayna River on the west side of the Sula Mountain in Sierra Leone.[15]

Turkey.—Turkish Molybdenum Co. continued to explore the molybdenite deposit near the village of Gelemic, district of Bursa, Turkey, during 1957. It was reported that the deposit contained an estimated 500,000 tons of ore averaging 0.4 percent Mo and that a flotation plant would be built to treat the ore.[16]

TECHNOLOGY

Molybdenum technologic news included construction of increased production capacity and investigation of new methods for producing the metal and protecting it from oxidation.

The Climax ore body was mined by large-scale caving that consists of undercutting sections of about 68 by 100 feet and allowing the broken ore to flow by gravity through finger raises into concrete-lined slusher drifts.

Development of another level at the Climax mine was begun in 1957. The mine was being deepened by a 900-foot vertical shaft 20 feet in diameter. It was estimated the new level would be ready for production in about 8 years and would coincide with depletion of the ore above the Phillipson level, which is at 11,470 feet elevation.[17] Other improvements at Climax included enlargement of the byproducts plant, where tungsten concentrate, pyrite, and cassiterite were recovered from the rougher-concentrate-circuit tailing. This plant was being expanded from about 20,000 tons a day capacity to about 34,000 tons, and the expansion was expected to be completed early in 1958.

Inspiration Copper Co. was installing a molybdenum flotation unit at its copper plant at Inspiration, Ariz., that was expected to be in operation early in 1958. Exploration of copper-molybdenum mineral deposits near Tucson, Ariz., by Duval Sulphur & Potash Co. was reported to have resulted in the discovery of 49 million tons of ore.[18] The company announced a $20 million expansion program that included constructing a 10,000-ton-a-day concentrator plant.

The flotation process employed at the American Smelting and Refining Co. Silver Bell, Ariz., plant to increase overall molybdenum recovery was described.[19]

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[14] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 17.
[15] Mining World, Africa: Vol. 19, No. 13, December 1957, p. 79.
[16] Mining World, vol. 19, No. 2, February 1957, p. 37.
[17] Mining Congress Journal, Climax Retains Production Title: Vol. 43, No. 6, June 1957, p. 123.
[18] Mining Journal (London), vol. 249, No. 6359, July 5, 1957, p. 14.
[19] Engineering and Mining Journal, How AS&R Raised Molybdenite Recovery on Copper Concentrate: Vol. 158, No. 8, August 1957, pp. 105–106.

A process for recovering molybdenum from ore material containing sulfides of molybdenum by mixing alkali metal and alkali-metal carbonate with the material and causing an exothermic reaction followed by water leaching to recover the molybdenum values was patented.[20] Laboratory experiments conducted at Brigham Young University, Provo, Utah, demonstrated that autotrophic bacteria can oxidize molybdenite.[21]

The Bureau of Mines continued research on the preparation of ductile molybdenum by bomb reduction of molybdenum oxides. Other Bureau work included studies of the recovery of molybdenum from uranium-plant solutions, preparation of ultrapure molybdenum, and the study of rock mechanics and ground movement in mining. A survey containing both technical and economic data on molybdenum was published by the Bureau.[22]

A process for producing molybdenum metal in pure, dense form was patented.[23] A method for sintering compressed molybdenum powder to an ingot having a uniform density and a uniform grain size suitable for forming into lamp filaments, with resistance to breaking or cracking, was patented.[24] Another patent covered a method for heat-treating molybdenum and its alloys.[25] Other patents issued during the year included: Producing an adherent molybdenum coating on a metal substrate capable of forming a diffusion bond with cobalt;[26] forming a protective coating on molybdenum-base alloys by using a powder-fed metal spray gun employing a mixture of the powders of different metals;[27] molybdenum-containing catalysts produced by impregnating inorganic inert material with molybdenum compound-oxalic acid solution containing a strong mineral acid;[28] and removal of molybdenum heteroploy acids from ether solutions containing both the acids and uranyl nitrate.[29]

The effect of small quantities of alloying elements on the ductility of cast molybdenum was investigated.[30] A method for making molybdenum welds that are moderately ductile at room temperature was described.[31]

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20 Brennan, Joseph H. (assigned to Union Carbide & Carbon Corp., New York, N. Y.), Process for Recovering Molybdenum: U. S. Patent 2,796,344, June 18, 1957.

21 Bryner, Loren C., and Anderson, Ralph, Microorganisms in Leaching Sulfide Minerals: Ind. and Eng. Chem., vol. 49, No. 10, October 1957, pp. 1721–1724.

22 McInnis, Wilmer, Molybdenum, a Materials Survey: Bureau of Mines Inf. Circ. 7784, 1957, 77 pp.

23 Kelly, John, C. R., Jr., and Caterson, Alan G. (assigned to Westinghouse Electric Corp., East Pittsburgh, Pa.), Preparation of Molybdenum: U. S. Patent 2,776,887, Jan. 8, 1957.

24 Cuthbert, Stuart V., and Marden, John W. (assigned to United States of America), Process of Sintering Molybdenum: U. S. Patent 2,793,116, May 21, 1957.

25 Cuthbert, Stuart V., and Sutherlin, Lee (assigned to United States of America), Method of Heat-Treating Molybdenum and Molybdenum-Base Alloys: U. S. Patent 2,789,929, Apr. 23, 1957.

26 Hill, Morse (assigned to National Research Corp., Cambridge, Mass.), Method of Coating a Metal Substrate Molybdenum: U. S. Patent 2,783,164, Feb. 26, 1957.

27 Deuble, Norman L. (assigned Climax Molybdenum Co., New York, N. Y.), Method of Forming a Protective Coating on Molybdenum-Base Articles: U. S. Patent 2,788,290, Apr. 9, 1957.

28 De Rosset, Armand J. (assigned to Universal Oil Products Co., Des Plaines, Ill.), Manufacture of Molybdenum-Containing Catalysts: U. S. Patent 2,799,661, July 16, 1957.

29 Wibbles, Howard L., and Miller, Earl I. (assigned to United States of America), Purification Process: U. S. Patent 2,819,944, Jan. 14, 1958.

30 Olds, L. E., and Rengstroff, G. W. P., Effect of Small Amounts of Alloying Elements on the Ductility of Cast Molybdenum: Jour. Metals, vol. 9, No. 4, April 1957, pp. 468–471.

31 Freeman, R. R., and Briggs, J. Z., How to Weld Molybdenum: Steel, vol. 141, No. 2, July 8, 1957 pp. 101–102.

Nickel

By Hubert W. Davis [1]

NICKEL available in the second half of 1957 exceeded industrial demand for the first time since 1950. The supply-demand position was reversed, principally because of increased production, virtually complete stockpile deferments, and decreased requirements for nickel in the United States. Despite the improved supply, intense activity continued in exploring for new sources, developing new mines, and expanding and increasing the efficiency of smelting and refining facilities. In anticipation that the supply of nickel will continue to be abundant, activity was accelerated in developing new and larger uses for the metal and its alloys. A program was launched to restore the use of nickel in applications where other metals were substituted during the period of nickel shortage and also to increase the nickel content of alloys in which the nickel content had been reduced. A number of patents were issued on processes for recovering nickel and cobalt from various types of ores and for separating the two metals.

The Attorney General publicized the results of a study of the competitive problems of the nickel industry in relation to the Defense Production Act. The report [2] discussed the preemergency status of the industry, the expansion of the supply base necessary for defense and civilian purposes, and the problems of distributing the available nickel supply to preserve competitive elements within the user industries; it also analyzed the competitive status of the industry. One important conclusion stated that:

> From an antitrust point of view, the total effects of the defense expansion of nickel supply have resulted in significant contributions to the creation of truly competitive status in this industry.

The Office of Defense Mobilization announced that the nickel-expansion goal, for the purpose of providing the United States with an annual supply of 220,000 short tons by 1961, was closed June 28. Expansion and development programs in progress, mainly in Canada and Cuba, were scheduled to raise the Free World nickel-production capacity to at least 325,000 tons and possibly to 340,000 tons annually by the end of 1961.

The Government, through General Services Administration (GSA), supported certain research done by the Bureau of Mines and industry. The objective was to improve extraction of nickel from the deposits in Cuba owned by the United States Government and at its recovery plant at Nicaro, Cuba.

[1] Commodity specialist.
[2] Committee on Banking and Currency, The Nickel Industry: U. S. Senate, 85th Cong., 1st Sess., Aug. 28, 1957, pp. 3–43.

TABLE 1.—Salient statistics of nickel, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Mine production ---------- short tons --	----------	11	2,006	4,411	7,392	12,900
Plant production:						
Primary:						
Byproduct of copper refining short tons --	795	591	639	451	623	502
Metal from domestic ore mined ---------- short tons --	----------	11	192	3,356	6,099	9,568
Secondary ---------- do ----	7,881	8,352	8,605	11,540	14,860	[1] 12,017
Imports ---------- do ----	96,172	118,737	131,784	142,117	142,642	140,000
Exports (gross weight) ---------- do ----	[2] 5,573	15,168	14,245	20,601	44,526	13,415
Consumption ---------- do ----	90,252	105,681	94,733	110,100	127,578	122,466
Price per pound [3] ---------- cents --	33¾–56½	56½–60	60–64½	64½	64½–74	74
Canada:						
Production ---------- short tons --	132,510	143,693	161,279	174,928	[4] 178,515	188,962
Exports ---------- do ----	130,767	[4] 145,117	158,719	173,880	176,837	178,656
World production ---------- do ----	173,000	218,000	238,000	263,000	283,000	314,000

[1] Preliminary figure.
[2] Excludes "Manufactures" weight not recorded.
[3] 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 1¼ cents.
[4] Revised figure.

World production of nickel advanced for the seventh consecutive year to a new peak and was 11 percent greater than in 1956. Domestic production made a new record, increasing 50 percent, but equaled only 8.2 percent of consumption in the United States in 1957, compared with 5.3 percent in 1956.

The 7-year uptrend in imports of nickel into the United States was reversed in 1957; however, imports were only 2 percent less than in the record year 1956.

The price of nickel remained unchanged throughout 1957.

DOMESTIC PRODUCTION

Domestic production of nickel (other than from imported matte and oxide) continued to be small; it comprised nickel contained in ore (produced at Riddle, Oreg., Fredericktown, Mo., and Cobalt, Idaho), primary nickel recovered from copper refining, and nickel recovered from scrap (nickel anodes and nickel-silver and copper-nickel alloys, including Monel metal).

MINE PRODUCTION

Domestic mine output of nickel contained in ore was 75 percent more in 1957 than in 1956. The larger output was necessary, mainly to supply ore for the 4 furnaces at the Hanna smelter near Riddle, Oreg.; during the early part of 1956 only 2 furnaces were operated. In 1957 Hanna Coal & Ore Corp. mined 813,000 dry short tons of ore averaging 1.51 percent nickel from its deposit near Riddle, Oreg. The output of ore was 86 percent more than in 1956. The method of mining ore at the Riddle deposit and transporting it to the smelter stockpile was described.[3] National Lead Co. produced a pyrite concentrate containing 4.9 percent nickel near Fredericktown, Mo.,

[3] Foster, W. A., Open Pit on Nickel Mountain: Min. Eng., vol. 9, No. 8, August 1957, pp. 903–904.

in 1957. The output of contained nickel was 23 percent more than in 1956. Calera Mining Co. recovered nickel as a byproduct of cobalt ore produced at its Blackbird mine in Lemhi County, Idaho.

PLANT PRODUCTION

Hanna Nickel Smelting Co. treated ore from the nearby deposit at its four furnaces near Riddle, Oreg., in 1957. In 1957, 781,456 dry short tons of ore, averaging about 1.5 percent nickel, was used at the smelter, and 20,564 short tons of ferronickel, averaging 44 percent nickel, was produced. The output of ferronickel was 66 percent more than in 1956. Although the refinery of National Lead Co. at Fredericktown, Mo., did not attain capacity operation in 1957, it produced 30 percent more nickel metal than in 1956. National Lead Co. continued to reduce Cuban nickel oxide sinter to nickel metal at its refinery at Crum Lynne, Pa. The metal was produced under a Government contract.

Substantial quantities of nickel-bearing ferrous scrap were recovered and used chiefly in producing engineering alloy steels and stainless steels in 1957, but no figures are available. However, the importance of scrap as a supplement to the supply of nickel in the fiscal year ended June 30, 1956, is shown in table 2.

TABLE 2.—Receipts of nickel by melters July 1, 1955–June 30, 1956, in thousand pounds of nickel content

[Business and Defense Services Administration]

Melter	Primary nickel	Purchased scrap (5 percent or higher nickel content)	Melter	Primary nickel	Purchased scrap (5 percent or higher nickel content)
Iron and steel alloy producers	100,469	37,225	Nonferrous-ingot makers	92	9,385
Nickel-alloy producers, except plating anodes	59,198	9,157	Aluminum-base-alloy producers	1,595	
Copper-base-alloy producers (brass mills and brass and bronze foundries)	7,954	3,222	Total	169,308	58,989

In all, 502 short tons of nickel, in the form of sulfate, was recovered in 1957 as a byproduct of copper refining at Carteret and Perth Amboy, N. J.; El Paso, Tex.; and Laurel Hill, N. Y. Shipments contained 461 tons of nickel. All of the nickel recovered as a byproduct of copper refining is credited to domestic production, but some was actually recovered from imported raw materials, largely blister copper.

In addition to the nickel sulfate recovered as a byproduct of copper refining in 1957, refined nickel salts (chiefly sulfate) containing 2,571 short tons of nickel was produced in the United States from nickel shot, powder, oxide, and scrap.

Thus, total production of nickel contained in refined nickel salts in the United States was 3,073 tons in 1957; shipments to consumers for electroplating, catalysts, and ceramics were 2,958 tons.

TABLE 3.—Nickel produced in the United States, 1948–52 (average) and 1953–57

	Primary (nickel content, in short tons)[1]		Secondary	
	Byproduct of copper refining	Domestic ore	Nickel content, in short tons	Value
1948–52 (average)	795		7,881	$7,762,469
1953	591	11	8,352	10,399,910
1954	639	2,006	8,605	10,821,648
1955	451	4,411	11,540	15,445,000
1956	623	7,392	14,860	20,132,000
1957	502	12,900	[2] 12,017	[2] 18,862,000

[1] Value withheld to avoid disclosing individual company operations.
[2] Preliminary figure.

Secondary Nickel.—The recovery of nickel from nonferrous scrap in the United States totaled 12,000 short tons in 1957, a 19-percent decrease from 1956. The decrease was chiefly in nickel recovered from nickel-base scrap. The loss in products was chiefly in secondary nickel recovered in ferrous and high-temperature alloys.

The apparent increase in nickel-alloy scrap and the decrease in nickel-residue scrap consumption by smelters in 1957, shown in table 5 and the corresponding table in the 1956 Minerals Yearbook, indicate only reclassification of material. The 19 percent decrease in total 1957 nickel scrap consumption involved only the foundries and manufacturers, consisting chiefly of iron and steel plants and chemical works. The total nickel scrap consumption by smelters was virtually the same in 1957 as in 1956. The latter group included 45 plants, chiefly secondary copper smelters.

TABLE 4.—Nickel recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1956–57, short tons

Kind of scrap	1956	1957 (preliminary)	Form of recovery	1956	1957 (preliminary)
New scrap:			As metal	3,762	3,187
Nickel-base	4,568	3,557	In nickel-base alloys	3,122	3,332
Copper-base	1,466	1,416	In copper-base alloys	2,399	1,969
Aluminum-base	310	325	In aluminum-base alloys	424	442
Total	6,344	5,298	In lead-base alloys	3	
			In ferrous and high-temperature alloys[1]	4,153	2,466
Old scrap:			In chemical compounds	997	621
Nickel-base	7,900	6,182			
Copper-base	486	402	Grand total	14,860	12,017
Alluminum-base	130	135			
Total	8,516	6,719			
Grand total	14,860	12,017			

[1] Includes only nonferrous nickel scrap added to ferrous and high-temperature alloys.

TABLE 5.—Stocks and consumption of new and old nickel scrap in the United States in 1957 (preliminary), gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New	Old	Total	
Smelters and refiners:						
Unalloyed nickel	892	3,699	2,329	1,670	3,999	592
Monel metal	274	1,813	480	1,309	1,789	298
Nickel silver	[1] 453	[1] 3,582	[1] 751	[1] 2,690	[1] 3,441	[1] 594
Miscellaneous nickel alloys	4	2,772	12	2,761	2,773	3
Nickel residues	7	146	4	94	98	55
Total	1,177	8,430	2,825	5,834	8,659	948
Foundries and plants of other manufacturers:						
Unalloyed nickel	1,316	1,345	604	1,386	1,990	671
Monel metal	286	659	172	699	871	74
Nickel silver	[1] 2,244	[1] 6,400	[1] 6,360	[1] 109	[1] 6,469	[1] 2,175
Miscellaneous nickel alloys	33	452	28	422	450	35
Nickel residues	330	1,449	1,034	360	1,394	385
Total	1,965	3,905	1,838	2,867	4,705	1,165
Grand total:						
Unalloyed nickel	2,208	5,044	2,933	3,056	5,989	1,263
Monel metal	560	2,472	652	2,008	2,660	372
Nickel silver	[1] 2,697	[1] 9,982	[1] 7,111	[1] 2,799	[1] 9,910	[1] 2,769
Miscellaneous nickel alloys	37	3,224	40	3,183	3,223	38
Nickel residues	337	1,595	1,038	454	1,492	440
Total	3,142	12,335	4,663	8,701	13,364	2,113

[1] Excluded from totals because it is copper-base scrap, although containing considerable nickel.

CONSUMPTION AND CONSUMERS' STOCKS

Total consumption of nickel in 1957 was 4 percent less than in 1956 and second largest on record. Of the 1957 total consumption, 35 percent was used in stainless and engineering alloy steels. Usage of nickel in stainless and engineering alloy steels was 18 and 9 percent, respectively, smaller than in 1956. Consumption of nickel in nonferrous alloys, high-temperature and electrical resistance alloys, cast irons, ceramics, and magnets was also smaller; losses ranged from 3 to 16 percent. Usage of nickel for electroplating and in catalysts was 44 and 6 percent, respectively, greater than in 1956.

TABLE 6.—Nickel (exclusive of scrap) consumed and in stock in the United States, 1956–57, by forms, in short tons of nickel

Form	1956			1957		
	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]	96,403	9,684	154	94,765	21,082	48
Oxide powder and oxide sinter	20,742	1,976	56	17,049	3,037	1
Matte	8,875	424	----------	9,047	787	----------
Salts [2]	1,558	588	----------	1,605	376	2
Total	127,578	12,672	210	122,466	25,282	51

[1] Includes a relatively small but undetermined quantity of secondary nickel (ingot or shot remelted from scrap nickel and scrap-nickel alloys).
[2] Figures for consumption estimated to represent about 62 percent of total.

TABLE 7.—Nickel (exclusive of scrap) consumed in the United States, 1948–52 (average) and 1953–57, by forms, in short tons of nickel

Form	1948–52 (average)	1953	1954	1955	1956	1957
Metal	66,621	73,773	67,241	83,357	96,403	94,765
Oxide powder and oxide sinter	13,100	19,997	16,191	18,785	20,742	17,049
Matte	9,175	10,470	9,710	6,219	8,875	9,047
Salts [1]	1,356	1,441	1,591	1,739	1,558	1,605
Total	90,252	105,681	94,733	110,100	127,578	122,466

[1] Figures estimated to represent about 60 percent of total in 1948–55 and 62 percent in 1956–57.

TABLE 8.—Nickel (exclusive of scrap) consumed in the United States, 1953–57, by uses, in short tons of nickel

Use	1953	1954	1955	1956	1957
Ferrous:					
Stainless	22,274	20,399	26,520	32,883	26,986
Other steels	18,959	13,637	18,977	17,413	15,882
Cast iron	4,214	4,115	5,431	5,819	5,534
Nonferrous [1]	33,657	31,197	29,361	35,840	33,449
High-temperature and electrical resistance alloys	8,221	6,597	8,669	11,373	9,837
Electroplating:					
Anodes [2]	13,274	13,460	14,627	15,952	23,354
Solutions [3]	972	1,323	1,357	1,074	1,131
Catalysts	1,435	1,344	1,525	2,001	2,113
Ceramics	251	304	417	425	358
Magnets	798	681	882	933	902
Other	1,626	1,676	2,334	3,865	2,920
Total	105,681	94,733	110,100	127,578	122,466

[1] Comprises copper-nickel alloys, nickel-silver, brass, bronze, beryllium alloys, magnesium and aluminum alloys, Monel, Inconel, and malleable nickel.
[2] Figures represent quantity of nickel put into process for producing rolled anode bars, plus nickel used in casting anodes and nickel cathodes used as anodes in plating operations. Therefore, figures do not represent quantity of nickel anodes consumed by platers.
[3] Figures estimated to represent about 50 percent of total in 1953–55 and 60 percent in 1956–57.

SUBSTITUTES

Interest in the search for substitute materials for nickel was diminishing because of the favorable supply position of the metal in 1957 and of the outlook for adequate future supplies. However, despite the outlook for adequate future supplies of nickel, the use of stainless steels containing less nickel, nickel-free stainless steels, and electro-nickel-clad products probably will continue to grow. Production of stainless steels containing 1- to 5-percent nickel increased from 19,454 short tons in 1956 to 25,528 tons in 1957.

Some practical suggestions for conserving nickel in electroplating and in overcoming the lack of uniformity associated with nickel coatings were made.[4]

Certain copper-base alloys, such as Strenicor containing 4.5 percent nickel, 1 percent silicon, 0.5 percent iron, and the remainder essentially copper, modified with zinc or aluminum, were found to make an effective substitute for 18-percent nickel silver at operating temperatures up to 1,000° F.[5]

[4] McEnally, V. L., Jr., and Brune, F. G., Conservation of Nickel: Metal Ind., vol. 90, No. 6, Feb. 8, 1957, pp. 109–111.
[5] Hannon, C. H., Copper-Base Alloy Compares With Nickel Silver: Iron Age, vol. 180, No. 21, Nov. 21, 1957, pp. 134–136.

PRICES AND SPECIFICATIONS

Prices.—Throughout 1957 the contract price to United States buyers of electrolytic nickel in carlots, f. o. b. Port Colborne, Ontario, was 74 cents a pound, including duty of 1¼ cents. For nickel oxide sinter (no duty) the price remained at 70¼ cents a pound (nickel content) f. o. b. Copper Cliff, Ontario. Cuban nickel oxide powder and nickel oxide sinter likewise remained at 69 and 70¼ cents a pound (nickel content) in bags f. o. b. Philadelphia, Pa.

Nickel scrap prices quoted in the American Metal Market declined in 1957. Prices paid by dealers for nickel clippings averaged about $1.80 a pound in January compared with $0.45 in December. The spot-delivered price of Grade F nickel ingot or shot at New York was 78.48 cents a pound throughout 1957.

Specifications.—Specifications listed in table 9 also were those commonly used by industry.

TABLE 9.—Nickel purchase specifications for National Stockpile, in percent, by weight

[General Services Administration, Emergency Procurement Service][1]

Constituent	Metal				Oxide	
	Electrolytic	Ingots	Briquets	Shot	Powder	Sinter
Nickel plus cobalt, minimum	99.50	98.50	99.50	98.90	76.50	[2] 76.50
Cobalt, maximum	1.00	1.00	1.00	1.00	1.00	1.10
Iron, maximum	.25	.90	.25	.60	.50	3.00
Sulfur, maximum	.02	.07	.02	.05	.05	.08
Carbon, maximum	.10	.30	.10	.25	.10	.10
Copper, maximum					.30	.30

[1] National Stockpile Specification P-36-R1, Dec. 27, 1957.
[2] When the nickel plus cobalt content of sintered nickel oxide exceeds the minimum requirement, the cobalt, iron, sulfur, carbon, and copper may increase proportionately.

FOREIGN TRADE [6]

Imports of nickel into the United States reversed a 7-year uptrend in 1957 and declined 2 percent from the alltime high in 1956. Imports comprised chiefly metal, oxide powder, oxide sinter, and sintered matte. As heretofore, Canada was the principal source of imports. The sintered matte was refined to Monel metal and other products at the plant of International Nickel Co., Inc., Huntington, W. Va. Some Cuban nickel oxide sinter was reduced to metal at Crum Lynne, Pa.

The nickel content of refined nickel, oxide powder, oxide sinter, matte, and slurry imported into the United States was estimated at 140,000 short tons in 1957, compared with 142,600 tons in 1956.

[6] Figures on U. S. imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

TABLE 10.—Nickel products (excluding residues) imported for consumption in the United States, 1955–57

[Bureau of the Census]

Class	1955		1956 [1]		1957 [1]	
	Short tons (gross weight)	Value	Short tons (gross weight)	Value	Short tons (gross weight)	Value
Nickel ore and matte	9,088	$3,264,015	12,820	$4,591,578	13,177	$5,201,946
Nickel pigs, ingots, shot, cathodes, etc.[2]	109,404	148,925,269	106,534	152,408,971	99,676	156,212,811
Nickel scrap [2]	464	692,733	1,078	1,479,117	410	573,091
Nickel oxide powder and oxide sinter	32,896	29,893,660	[3] 32,955	[3] 31,776,346	[4] 37,080	[4] 42,925,411
Total		182,775,677		190,256,012		204,913,259

[1] Nickel containing material in powder, slurry, or any other form, derived from ore by chemical, physical, or any other means, and requiring further processing for the recovery therefrom of nickel or other metals was imported as follows: 1956, 37 tons valued at $45,961; 1957, 211 tons valued at $97,562. Not provided for in import schedule before July 1, 1956.
[2] Separation of metal from scrap is on basis of unpublished tabulations.
[3] Includes 1,524 tons valued at $1,905,354 received from Cuba in December but not included in figures of Bureau of the Census until 1957.
[4] Excludes figures given in footnote 3.

TABLE 11.—New nickel products imported for consumption in the United States, 1956–57, by countries, in short tons

[Bureau of the Census]

Country	Metal		Oxide powder and oxide sinter				Slurry [1]			
	1956	1957	1956		1957		1956		1957	
	Gross weight	Gross weight	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content
North America:										
Canada	92,601	90,774	14,163	10,569	12,762	9,620			211	62
Cuba			[2] 18,791	[2] 16,434	[3] 24,318	[3] 21,598				
Mexico	1	1								
Total	92,602	90,775	[2] 32,954	[2] 27,003	[3] 37,080	[3] 31,218			211	62
Europe:										
France	66									
Germany, West	516	165	1	1						
Netherlands	66									
Norway	12,208	8,442								
Sweden		25								
United Kingdom	317	112								
Total	13,173	8,744	1	1						
Asia: Japan	759	157					37	25		
Total	106,534	99,676	32,955	27,004	37,080	31,218	37	25	211	62

Country	Ore and matte				Refinery residues [4]			
	1956		1957		1956		1957	
	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content
North America:								
Canada	12,820	8,647	13,177	9,103	1,946	572		

[1] See footnote 1, table 10.
[2] Includes 1,524 tons of oxide sinter containing 1,359 tons of nickel received in December but not included in figures of Bureau of the Census until 1957.
[3] Excludes figures given in footnote 2.
[4] Reported to Bureau of Mines by importers.

TABLE 12.—New nickel products imported for consumption in the United States, 1948–52 (average) and 1953–57, in short tons

[Bureau of the Census]

Year	Gross weight					Total	
	Metal	Ore and matte	Oxide powder and oxide sinter	Refinery residues[1]	Slurry[2]	Gross weight	Nickel content (estimated)
1948–52 (average)	73,633	12,675	17,290	(3)	(4)	[5] 103,598	[6] 96,172
1953	84,714	14,605	31,850	516	(4)	131,685	118,737
1954	97,263	14,135	32,264	211	(4)	143,873	131,784
1955	109,404	9,088	32,896	89	(4)	151,477	142,117
1956	106,534	12,820	[7] 32,955	1,946	37	154,292	142,642
1957	99,676	13,177	[8] 37,080		211	150,144	140,000

[1] Reported to Bureau of Mines by importers.
[2] See footnote 1, table 10.
[3] Data not available.
[4] Not provided for in import schedule before July 1, 1956.
[5] Excludes "Refinery residues."
[6] Includes nickel content of "Refinery residues."
[7] See footnote 3, table 10.
[8] Excludes 1,524 tons received in 1956 but included in figure of Bureau of the Census in 1957.

From January 1, 1948, through December 31, 1957, the rate of duty on refined nickel imported into the United States has been 1¼ cents a pound. Nickel ore, oxide powder, oxide sinter, matte, and slurry entered the United States duty free.

The nickel exported from the United States was principally contained in nickel and nickel alloys in ingots, bars, rods, sheets, plates, and other crude forms and scrap. Canada (3,904 tons), West Germany (3,684 tons), and United Kingdom (2,908 tons) were the chief foreign markets in 1957.

Owing to the improved supply of primary nickel and slackening demand in 1957, restrictions on exports of nickel-bearing copper-base alloy scrap were relaxed in directives announced by the Bureau of Foreign Commerce early in March.

TABLE 13.—Nickel products exported from the United States, 1955–57, by classes

[Bureau of the Census]

Class	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Ore, concentrate, and matte			27,331	$555,660		
Nickel and nickel-alloy metals in ingots, bars, rods, and other crude forms, and scrap	19,317	$14,098,863	15,116	15,262,575	11,940	$11,965,309
Nickel and nickel-alloy metal sheets, plates, and strips	647	1,511,441	1,245	2,756,171	816	2,124,371
Nickel and nickel-alloy semifabricated forms, not elsewhere classified	429	1,480,935	626	1,877,705	508	1,796,505
Nickel-chrome electric resistance wire, except insulated	208	773,180	208	836,036	151	631,625
		17,864,419		21,288,147		16,517,810

WORLD REVIEW

World output of nickel continued upward for the seventh consecutive year to a new high of 314,000 short tons in 1957, an 11-percent increase over 1956 and more than double the quantity produced in 1947. Record outputs were again made in all of the principal producing countries. Canada supplied 60 percent of the 1957 total and has supplied 64 percent of the total from 1953–57.

NORTH AMERICA

Canada.—Virtually all the Canadian output was derived from copper-nickel ores of the Sudbury district, Ontario; Lynn Lake area, Manitoba; and Rankin Inlet area, Northwest Territories. Some nickel was also recovered as a byproduct from silver-cobalt ores of Cobalt, Ontario. Virtually the entire production came from the

TABLE 14.—World mine production of nickel, by countries, 1948–52 (average) and 1953–57, in short tons of contained nickel [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada [2]	132,510	143,693	161,279	174,928	178,515	188,962
Cuba (content of oxide)	1,785	13,844	14,545	15,138	16,062	22,245
United States:						
Byproduct of copper refining	795	591	639	451	623	502
Recovered nickel in domestic ore refined		11	192	3,356	6,099	9,568
Total	135,090	158,139	176,655	193,873	201,299	221,277
South America:						
Bolivia (content of ore)					4	
Brazil (content of ferronickel)	(3)	55	(3)	57	70	(3)
Total	(3)	55	(3)	57	74	(3)
Europe:						
Finland (content of nickel sulfate)	(3)	[4] 309	89	134	164	89
Greece					386	(3)
U. S. S. R.[5] [6] (content of ore)	31,000	44,000	46,000	48,000	52,000	55,000
Total	(3)	44,309	46,089	48,134	52,550	(3)
Asia:						
Burma (content of speiss)	154	16	116	72	115	72
Iran (content of speiss)[7]			1	1	1	(3)
Total	154	16	117	73	116	(3)
Africa:						
French Morocco (content of cobalt ore)	40	132	162	167	142	93
Rhodesia and Nyasaland, Federation of: Southern Rhodesia (content of ore)		(8)	(8)	(8)	(8)	(8)
Union of South Africa (content of matte and refined nickel)	951	1,891	2,112	2,598	3,624	4,562
Total	991	2,023	2,274	2,765	3,766	4,655
Oceania: New Caledonia [9]	5,784	13,000	13,000	18,000	25,000	33,000
World total (estimate)	173,000	218,000	238,000	263,000	283,000	314,000

[1] This table incorporates a number of revisions of data published in previous Nickel chapters. Data do not add to totals shown because of rounding where estimated figures are included in the detail.
[2] Comprises refined nickel and nickel in oxide produced and recoverable nickel in matte exported.
[3] Data not available; estimate by author included in the total.
[4] Includes 233 tons in matte.
[5] According to the 44th annual issue of Metal Statistics (Metallgesellschaft), except 1957.
[6] Estimate.
[7] Year ended Mar. 21 of year following that stated.
[8] Data not available. Production of ore was in 1953, 63 tons; 1954, 62 tons; 1955, 18 tons; 1956, 200 tons; and 1957, 359 tons.
[9] Comprises nickel content of matte and ferronickel produced in New Caledonia and estimate (by author) of recoverable nickel in ore exported. Mine production (nickel content) was as follows: 1948–52 (average), 6,073 tons; 1953, 18,800 tons; 1954, 15,100 tons; 1955, 27,200 tons; 1956, 32,500 tons; and 1957, 47,000 tons.

following six companies: International Nickel Co. of Canada, Ltd., Falconbridge Nickel Mines, Ltd., Nickel Rim Mines, Ltd., and Nickel Offsets, Ltd., all in the Sudbury district; Sherritt Gordon Mines, Ltd., in the Lynn Lake area; and North Rankin Nickel Mines, Ltd., on the shore of Rankin Inlet. Nickel production in Canada was 189,000 short tons, a 6-percent gain over 1956 and a new high. Exports of nickel from Canada were 178,700 short tons, also a new peak and 1 percent more than in 1956.

International Nickel Co. of Canada, Ltd., operated at capacity in 1957 for the eighth consecutive year. Its deliveries of nickel in all forms approximated the alltime high of 1955 and totaled 145,000 short tons, compared with 143,000 tons in 1956.[7]

Continued progress of conversion from open pit to almost entirely underground mining at the Inco Sudbury mines was reflected in the new record of 14.9 million tons mined underground in 1957, compared with 14.3 million tons in 1956. The quantity of ore mined at open pits was 1.1 million tons, compared with 1.2 million tons in 1956. The total of ore mined in 1957 was a record 16 million tons, compared with 15.5 million tons in 1956. By far the greater part of underground ore was again mined by block-caving and blast-hole methods. According to the company, the proved ore reserve in its Sudbury district holdings at the end of 1957 was 264 million tons containing 8 million tons of nickel-copper, or about the same as at the end of 1956. At the end of 1957 underground development in the active mines in the Sudbury district was brought to a cumulative total of 427 miles, compared with 410 miles in 1956.

The following information concerning exploration, developments, and expansions was abstracted from the Annual Report of International Nickel Co. of Canada, Ltd., for 1957.

In the Sudbury district systematic investigation of the extensions of ore zones and favorable structures at the five active underground mines—Creighton, Frood-Stobie, Garson, Levack, and Murray—was continued from both surface and underground with satisfactory results. Work proceeded toward preparing the Crean Hill mine for production. At the Thompson mine in the Mystery-Moak Lakes region of Manitoba, completing the 1,057-foot development shaft and sinking the 2,100-foot production shaft, to be completed in late 1958, proceeded on schedule. The 30-mile branch line that links the mine with the Hudson Bay line of Canadian National Railways was completed in October. Development was also done at the Moak Lake mine.

Favorable progress in the exploration program at the Thompson mine resulted in a decision to bring it into production before the Moak Lake mine. Consequently, the scheduled output of 37,500 tons of nickel annually from Manitoba will come first from the Thompson mine. Production was expected to begin in 1960.

Substantial exploratory programs were also conducted by Inco in Saskatchewan and Quebec, Canada, and Australia. Tests of the ore possibilities were continued in the area which includes the company Coppermine River concession in the Northwest Territories. Property examinations were made in Africa, the East Indies, the West Indies, and elsewhere.

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[7] International Nickel Co. of Canada, Ltd., Annual Report: 1957, pp. 7, 9.

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During 1957 Inco spent $8.9 million in search for new nickel ore, half of it for exploration in Manitoba.

Falconbridge Nickel Mines, Ltd., set new records in production of ore and matte for the eighth consecutive year. Its six mines—Falconbridge, McKim, Mount Nickel, Hardy, East, and Longvack—in the Sudbury district were again in production. Some development ore was obtained from the Fecunis mine. The Mount Nickel mine ceased production in November because of depletion of ore. Ore and concentrate delivered from company mines to treatment plants totaled 2 million short tons in 1957, compared with 1.9 million tons in 1956.

The following information concerning developments, exploration, expansions, and reserves was abstracted from the 29th Annual Report of Falconbridge Nickel Mines, Ltd., for 1957.

Deepening of the openings at the Falconbridge and East mines was continued. The internal shaft at the McKim mine was completed; four new levels were being developed to mine a separate ore known as the "track ore body." At the Fecunis mine the underground crushing, loading, and hoisting systems and surface conveyers to the main storage bin were placed in service in November, when the first level was turned over to International Nickel in preparation for mining on Falconbridge account. The Fecunis concentrator began operating at partial capacity in May, treating production from the Longvack mine and development ore from the Fecunis mine. Development continued at the Boundary and Onaping mines. Near the Falconbridge plant a small, proved ore body owned by Emtwo Mines, Ltd., will be mined by Norduna Mines, Ltd. Funds were advanced by Falconbridge, which contracted to purchase the ore. Regular ore production was planned for 1958.

The ore reserve of Falconbridge in the Sudbury district was increased half a million tons. There was also a slight increase in the grade of both nickel and copper. The total ore reserve was 45.8 million short tons on December 31, 1957. The reserve comprised 23.4 million tons of developed ore averaging 1.54 percent nickel and 0.86 percent copper in the Falconbridge, East, McKim, Hardy, Longvack, and Fecunis mines and 22.4 million tons of indicated ore averaging 1.33 percent nickel and 0.72 percent copper in Sudbury district holdings.

Falconbridge explored in Quebec (Ungava), western Ontario, and southeastern and northern Manitoba. No discoveries of substantial importance were made. In the Kenora area, Ontario, work on the Kenbridge property was suspended about midyear. The results of exploration and the economic prospects did not warrant additional development at this time.

The Sherritt Gordon Mines, Ltd., produced a record 20,067,400 pounds of nickel metal at its refinery in Fort Saskatchewan, Alberta, compared with 19,239,600 pounds in 1956.[8] The metal was refined from company concentrate produced at its mines and mill at Lynn Lake, Manitoba. In addition to its own production, 2,419,800 pounds of nickel was produced on a toll basis in 1957, compared with 152,900 pounds in 1956. The capacity of the refinery was increased

[8] Sherritt Gordon Mines, Ltd., Annual Report: 1957, p. 3.

to 27.5 million pounds of nickel annually, providing substantial capacity for the treatment of custom concentrate or matte. Ore was also produced at a higher rate than in 1956. Ore hoisted at the A and EL mines was 833,400 short tons in 1957, compared with 752,800 tons in 1956. Shaft sinking at the Farley property continued throughout 1957 and reached 1,862 feet, with stations at 150-foot intervals. This shaft will be completed in 1958 to a depth of 2,350 feet and equipped with headframe, hoisting machinery, and other surface facilities. Exploration was conducted at an accelerated rate at properties in northern Manitoba and the Northwest Territories, but no significant ore discoveries were made. Location of a new ore body (found by Sherritt Gordon during 1957) together with extensions of known ore bodies resulted in a net increase of 570,000 tons in the ore reserve. Ore reserves totaled 13.6 million tons averaging 1.064 percent nickel and 0.561 percent copper on December 31, 1957.

Other Canadian companies—Nickel Rim Mines, Ltd., and Nickel Offsets, Ltd., both in the Sudbury district—again shipped to Falconbridge Nickel Mines, Ltd.; Nickel Rim also again shipped to the Sherritt Gordon refinery. Nickel Rim Mines, Ltd., Eastern Mining & Smelting Corp., Ltd., and Canalask Nickel Mines were merged into Nickel Mining & Smelting Co.[9] Plans were reported to be progressing satisfactorily for beginning production of ore in November by Arcadia Nickel Corp., also in the Sudbury district; construction of a mill was in progress.[10] North Rankin Nickel Mines, Ltd., on the shore of Rankin Inlet, Northwest Territories, began producing nickel concentrate in May; the concentrate averaged 13.5 percent nickel and 2.58 percent copper. Proved ore reserves to the 300-foot level total 460,000 tons containing 3.3 percent nickel, 0.8 percent copper, and 0.03 and 0.06 ounce, respectively, of platinum and palladium a ton. Much information, including a description of the mining and milling methods, on the North Rankin operation was published.[11] The 1957 production was reported sold to overseas buyers at premium prices.[12] The mine of Western Nickel, Ltd., at Choate, British Columbia, was being rehabilitated and a concentrator constructed; the concentrate will be shipped to Sherritt Gordon for refining.[13] Much publicity was given to discoveries of nickel-copper deposits in the Ungava area in Quebec, where the Quebec Government had granted exploration permits to many companies. Exploration work by Asarco Nickel Co., subsidiary of American Smelting and Refining Co., on a nickel-copper prospect in the Ungava area failed to indicate enough potential tonnage and grade to justify an integrated nickel operation based on deposits in this isolated area.[14]

Cuba.—Production of nickel in Cuba increased progressively after the recovery plant at Nicaro, Cuba, was rehabilitated in 1952. It reached a new high in 1957 and was 38 percent greater than in 1956. Output of oxide powder and oxide sinter was 24,983 short tons (22,245

[9] Northern Miner (Toronto), Nickel Rim Okays Merger Agreement, But Tempers Flare: Vol. 43, No. 37, Dec. 5, 1957, p. 2.
[10] Canadian Mining Journal (Gardenvale), Arcadia Nickel Corporation: Vol. 78, No. 9, September 1957, pp. 157–158.
[11] Canadian Mining Journal (Gardenvale), North Rankin Nickel Mines: Vol. 78, No. 8, August 1957, pp. 93–97.
[12] Northern Miner (Toronto), North Rankin Nickel to Start Production Before End of April: Vol. 43, No. 2, Apr. 4, 1957, p. 1.
[13] Northern Miner (Toronto), vol. 43, No. 14, June 27, 1957, p. 25.
[14] American Smelting and Refining Co., Annual Report: 1957, p. 14.

tons of nickel plus cobalt content) in 1957, compared with 18,285 tons (16,062 tons of nickel plus cobalt content) in 1956. The 1957 output consisted of 3,040 tons of oxide powder averaging 78.35 percent nickel plus cobalt and 21,943 tons of oxide sinter averaging 90.52 percent nickel plus cobalt.

Exports of nickel from Cuba in 1957 were 24,323 short tons (21,603 tons of nickel plus cobalt content) and consisted of 3,169 tons of oxide powder averaging 78.32 percent nickel plus cobalt and 21,154 tons of oxide sinter averaging 90.39 percent nickel plus cobalt.

Production of ore was 2.2 million dry short tons in 1957, compared with 1.5 million tons in 1956. Ore fed to the driers was 2.15 million dry short tons averaging 1.37 percent nickel in 1957, compared with 1.5 million tons averaging 1.40 percent nickel in 1956.

The 75-percent expansion of the nickel-producing facilities at the United States Government-owned plant at Nicaro was completed in March 1957, increasing its rated annual capacity to at least 50 million pounds of nickel.[15]

During 1957 Moa Bay Mining Co., a subsidiary of Freeport Sulphur Co., began constructing ore-processing facilities at Moa Bay, Cuba.

Dominican Republic.—Minera y Beneficiadora Falconbridge Dominicana C. por A. (subsidiary of Falconbridge Nickel Mines, Ltd.) continued exploration on the 300-square-mile concession in the Dominican Republic. Delimiting of the nickeliferous laterite deposits within the concession was completed, and work was being concentrated on determining the tonnage and grade of two deposits considered to have the best ore potential.

SOUTH AMERICA

Brazil.—The Jeoro nickel silicate ore deposit in the Jacupiranga district, São Paulo, was under development, and 500 tons of ore was shipped to Japan in February for experimental study.[16]

EUROPE

Finland.—The nickel content of ores of the Outokumpu copper mine and the Nivala nickel-copper mine was recovered as nickel sulfate at the Pori metal works of Outokumpu Oy. Nickel sulfate production was about 400 short tons containing 89 tons of nickel in 1957, compared with 744 tons containing 164 tons of nickel in 1956.

Discovery of large nickel deposits in the vicinity of Kotalahti, 20 miles from Kuopio, was announced by Outokumpu Oy.[17]

France.—The only nickel refinery in France was that of Société le Nickel at Le Havre, which refined matte imported from New Caledonia. Production of nickel metal was 6,600 short tons in 1957, compared with 5,677 tons in 1956.

An expansion program of Société le Nickel provided for increasing the refinery capacity at Le Havre from 7,000 tons to 14,000–15,000 tons by 1960.[18]

Greece.—A much higher grade of ferronickel was expected to be produced at the nickel plant at Larymna; an electric furnace was to

[15] Engineering and Mining Journal, Nicaro Expands Nickel Capacity: Vol. 158, No. 9, September 1957, pp. 82–89.
[16] Mining World, vol. 19, No. 7, June 1957, p. 109.
[17] Mining World, vol. 19, No. 12, November 1957, p. 106.
[18] Mining Journal (London), vol. 249, No. 6378, Nov. 15, 1957, p. 587.

be put in operation in August 1957 to replace another facility.[19] The Karditsa mine near Larymna was the source of the ore.

Norway.—Output of nickel at the refinery of Falconbridge Nickel Mines, Ltd., at Kristiansand established a new high of 23,500 short tons in 1957, a 7.5-percent increase over 1956. The metal was produced from matte from Canada. Deliveries of nickel to customers were 23,440 short tons in 1957, compared with 21,692 tons in 1956. Nickel-refining capacity was further increased in 1957.

ASIA

Burma.—Nickel in the form of speiss was produced in Burma as a byproduct of lead-zinc mining at the Bawdwin mine of the Burma Corporation, Ltd.

Japan.—Production in Japan consisted of 7,994 short tons of pure nickel and 37,184 tons of ferronickel in 1957, compared with 6,243 tons of pure nickel and 23,045 tons of ferronickel in 1956. New Caledonia was the main source of nickel ore.

AFRICA

Rhodesia and Nyasaland, Federation of.—An option to purchase the mineral rights of the Empress nickel claims near Gatooma, Southern Rhodesia, was exercised by the Rio Tinto Mining Co. of Central Africa, Ltd.[20] About £500,000 had been spent on development, which included sinking a 400-foot shaft to obtain bulk samples and building a pilot plant in which to develop the most economical method of separating the nickel and copper.[21] The pilot plant consists of a small crusher, a ball mill, 46 flotation cells, and accessory equipment.

A deposit of nickel-bearing ore, 3 miles long and varying in width from 150 to 650 feet, was reported to have been discovered on claims owned by Trojan Nickel Mine in the Bindura area of Southern Rhodesia.[22]

Union of South Africa.—From 1938–57 there was a small annual production of nickel from the sulfide ore in the Rustenburg district by Rustenburg Platinum Mines, Ltd. Production comprised 3,700 short tons of matte and 862 tons of electrolytic nickel in 1957, compared with 2,773 tons of matte and 851 tons of electrolytic nickel in 1956.

OCEANIA

New Caledonia.—Production of nickel ore (containing about 26 percent moisture) in New Caledonia established an alltime high of 1,983,000 short tons containing about 47,000 tons of nickel in 1957, compared with 1,367,000 tons containing 32,500 tons of nickel in 1956.

Production of nickel in matte and ferronickel by Société le Nickel was 7 percent more in 1957 than in 1956.

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19 Metal Bulletin (London), New Plant at Larymna: No. 4209, July 9, 1957, p. 30.
20 Mining World, Rio Tinto Purchases Rhodesian Nickel Mines: Vol. 19, No. 6, May 1957, p. 91.
21 Rhodesian Mining and Engineering Review (London), Tour of the Empress Nickel Prospect Near Gatooma: Vol. 22, No. 5, May 1957, pp. 28–31.
22 Metal Industry (London), vol. 91, No. 12, Sept. 20, 1957, p. 243.

TABLE 15.—Production of nickel matte and ferronickel by Société le Nickel, 1956–57, in short tons

[New Caledonia Mines Service]

Product	1956		1957	
	Gross weight	Nickel content	Gross weight	Nickel content
Matte	8,639	6,669	10,647	7,802
Ferronickel	15,347	3,973	14,747	3,569
Total	23,986	10,642	25,394	11,371

Exports of nickel ore at an alltime high in 1957 were 44 percent more than in 1956; those of matte and ferronickel were greater by 55 and 12 percent, respectively. Of the 1957 exports of ore, 1,122,954 short tons was shipped to Japan, 22,021 tons to Australia, and 73,629 tons to France. All of the matte and ferronickel was shipped to France.

TABLE 16.—Nickel ore and nickel products exported from New Caledonia, 1956–57, in short tons

[New Caledonia Mines Service]

Product	1956		1957	
	Gross weight	Nickel content	Gross weight	Nickel content
Ore	848,988	19,600	1,218,604	28,000
Matte	7,628	5,892	11,839	8,715
Ferronickel	14,193	3,691	15,903	3,849

Tasmania.—An occurrence of nickel-copper sulfide ore, averaging 1.5 percent nickel, was reported discovered by Montana Silver Lead N. L. at Zeehan, Tasmania.[23] A unique feature of the find, according to the company, was the occurrence of dense sulfide nickel-copper ore assaying 8 to 14 percent nickel and 4 to 5 percent copper.

TECHNOLOGY

Nickel research by the Bureau of Mines for GSA included improving the extraction of nickel and cobalt from the United States Government-owned deposits in Cuba and at its recovery plant at Nicaro, Cuba. The Bureau also conducted large-scale tests for GSA in reducing nickel oxide to metal and in separating nickel and cobalt by selective leaching and electrolysis. In addition, the Bureau continued its research in recovering nickel from Missouri ores. The results of smelting tests by the Bureau on samples of Cuban nickeliferous serpentine and laterite were published.[24] The tests on nickeliferous serpentine demonstrated that over 91 percent of the nickel can be

[23] Industrial and Mining Standard (Melbourne), Montana Strikes Rich Nickel-Copper Lode at Zeehan Property: Vol. 112, No. 2832, Apr. 18, 1957, p. 17.
[24] Anable, W. E., and Banning, L. H., Electric Smelting of Cuban Serpentine and Laterite Nickel Ores: Bureau of Mines Rept. of Investigations 5346, 1957, 24 pp.

recovered in a low-carbon ferronickel product containing 25 percent or more nickel.

In connection with Bureau of Mines research on utilization of Cuban lateritic ores, a comprehensive review was made of the chemical literature on nickel and cobalt. As a result, a bibliography of 1,600 references was published.[25]

Industry was active in developing new processes for recovering nickel and new uses for nickel and its alloys, and in producing improved nickel-base high-temperature alloys. International Nickel Co. of Canada, Ltd. (Inco), made an important advance in chemical metallurgy by developing a new process for recovering nickel by direct electrolysis of nickel matte. A section of its existing electrolytic units at the Port Colborne, Ontario, refinery was modified to use the process. The process contrasts with the usual electrorefining methods, including those employed in the nickel industry, in which a metal anode is used. The new method eliminates high-temperature oxidation and reduction processes with attendant losses of metals and sulfur and selenium. Instead, nickel sulfide of low copper content from the Bessemer converter or other source can be cast directly to sulfide anodes and electrolyzed to produce high-quality nickel. Another unique feature of the process is that it permits commercial recovery of elemental sulfur and selenium as valuable byproducts, in addition to cobalt and precious metals conventionally recovered.

Inco intensified its efforts to develop new and more diversified uses for nickel and its alloys in anticipation that abundant supplies of the metal will continue to be available. Emphasis was placed on those research projects that promised important increases in the use of nickel. Prominent among the uses were new nickel steels offering economy and special properties for gears, heavy forgings and service at subzero temperatures, and high-nickel alloys for automotive gas turbines and for atomic powerplants.

Incoloy T, a new nickel-chromium-iron high-temperature alloy, was developed by International Nickel Co., Inc., for use in highly stressed parts of jet-engine combustion systems and in airframes used for hypersonic flight.[26] The alloy contains 30 to 34 percent nickel and cobalt, 19 to 22 percent chromium, 40 to 47 percent iron, and 0.75 to 1.5 percent titanium. As a result of the titanium addition, the alloy exhibits improved tensile and rupture properties and has excellent oxidation resistance up to 1,600°–1,700° F.

Falconbridge Nickel Mines, Ltd., continued research at Falconbridge and Richvale, Ontario, and Kristiansand, Norway. Metallurgical investigations were directed principally to improving practices in concentration, smelting, and refining. Laboratory investigation and development of spectrographic and other instrumental methods were continued, and mineralogical and chemical studies were conducted for the purpose of developing more efficient operations and improved quality of products. The expanded metallurgical laboratory and pilot plant completed early in 1957 at Richvale were devoted largely to investigation of lateritic nickel ore, over 100 tons of which was partly processed by methods under development.

[25] Bauder, R. B., Bibliography on Extractive Metallurgy of Nickel and Cobalt, January 1929–July 1955: Bureau of Mines Inf. Circ. 7805, 1957, 159 pp.

[26] Materials and Methods, Improved Nickel-Alloy Sheet Can Be Used up to 1,600° F.: Vol. 45, No. 4, pril 1957, p. 173.

Sherritt Gordon Mines, Ltd., conducted research on problems connected with its own operations and also conducted extensive pilot-plant work in the treatment of nickel matte for a prospective licensee. This latter work demonstrated that nickel matte is amenable to treatment by its leaching and reduction processes.

A description was given [27] of the reaction by which nickel can be precipitated from aqueous ammoniacal nickel sulfate solutions by hydrogen at elevated pressures and temperatures.

Patents were issued for processes for recovering nickel from laterite ore,[28] garnierite ore,[29] and mixed sulfide matte [30] and from an ore also containing iron, sulfur, and at least one metalloid selected from arsenic, antimony, selenium, and tellurium.[31]

Patents were issued for processes for separating nickel and cobalt [32] and hydrometallurgical precipitation of the two metals.[33]

Patents pertaining to plating of nickel included the following:[34]

A patent was issued for a process of preparing high-purity nickel for use as a cathode material in an electron tube.[35]

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[27] Mackiw, V. N., Lin, W. C., and Kunda, W., Reduction of Nickel by Hydrogen From Ammoniacal Nickel Sulfate Solutions: Jour. Metals, Trans. AIME, vol. 9, No. 6, June 1957, pp. 786–793.

[28] Donaldson, J. W. (assigned to Quebec Metallurgical Industries, Ltd.), Method for Recovering Nickel and Cobalt From Ores: U. S. Patent 2,816,015, Dec. 10, 1957.

Simons, C. S., III (assigned to Freeport Sulphur Co.), Process of Preparing Limonitic Ores for Separation of Metal Content: U. S. Patent 2,798,804, July 9, 1957.

Mancke, E. B. (assigned to Bethlehem Steel Co.), Treatment of Iron Ores: U. S. Patent 2,776,207, Jan. 1, 1957.

Mond Nickel Co., Improvements in the Recovery of Nickel From Lateritic Ores: British Patent 782,242, Sept. 4, 1957.

[29] Schaufelberger, F. A. (assigned to Chemical Construction Corp.), Recovery of Nickel and Cobalt Values From Garnierite Ores: U. S. Patent 2,778,729, Jan. 22, 1957.

[30] Kenworthy, Heine, Process For Obtaining Nickel and Cobalt From a Mixed Sulphide Matte: U. S. Patent 2,790,713, Apr. 30, 1957.

[31] Bennedsen, H. O., Process for Extracting Cobalt and Nickel From Their Ores: U. S. Patent 2,805,940, Sept. 10, 1957.

[32] Schaufelberger, F. A., and Czikk, A. M. (assigned to American Cyanamid Co.), Separation of Cobalt From Nickel: U. S. Patent 2,777,753, Jan. 15, 1957.

Roy, T. K., and Bocckino, H. G. (assigned to Chemical Construction Corp.), Hydrometallurgical Separation of Nickel and Cobalt: U. S. Patent 2,778,728, Jan. 22, 1957.

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[33] Shaw, J. J., and Schaufelberger, F. A. (assigned to Chemical Construction Corp.), Process for the Hydrometallurgical Precipitation of Nickel and Cobalt: U. S. Patent 2,796,343, June 18, 1957.

[34] Du Rose, A. H., and Little, J. D. (assigned to Harshaw Chemical Co.), Electrodeposition of Nickel: U. S. Patents 2,782,152, 2,782,153, 2,782,154, and 2,782,155, Feb. 19, 1957.

Ellis, D. G. (assigned to Harshaw Chemical Co.), Electrodeposition of Nickel: U. S. Patent 2,784,152, Mar. 5, 1957.

Brown, Henry (assigned to Udylite Research Corp.), Electrodeposition of Nickel: U. S. Patents 2,781,305 and 2,781,306, Feb. 12, 1957; 2,795,540, June 11, 1957; 2,800,440 and 2,800,442, July 23, 1957.

Brown, Henry, and Clauss, R. J. (assigned to Udylite Research Corp.), Electrodeposition of Nickel: U. S. Patent 2,800,441, July 23, 1957.

Foulke, D. G., and Kardos, Otto (assigned to Hanson-Van Winkle-Munning Co.), Nickel Plating: U. S. Patent 2,818,376, Dec. 31, 1957.

[35] Moore, J. H., Clough, P. J., and Franks, A. E. (assigned t National Research Corp.), Process of Preparing High-Purity Nickel: U. S. Patent 2,815,279, Dec. 3, 1957

Nitrogen Compounds

By E. Robert Ruhlman [1]

EXPANDED facilities of the atmospheric nitrogen industry raised United States capacity to about 4.75 million short tons of equivalent nitrogen compared with 3.9 million for 1956. The 1957 output was 82 percent of the year-opening capacity.

TABLE 1.—Salient statistics of the nitrogen compounds industry, 1948–52 (average) and 1953–57, in thousand short tons

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Production of anhydrous ammonia, nitrogen equivalent	1,468	2,096	2,432	2,895	2,985	3,266
Imports of nitrogen compounds, gross weight	1,387	2,218	1,927	1,605	1,493	1,428
Exports of nitrogen compounds, gross weight	700	133	433	828	1,038	1,127
Consumption of nitrogen compounds, nitrogen equivalent, for years ending June 30	1,750	2,585	2,956	3,178	3,350	3,550
World: Production of nitrogen compounds, nitrogen equivalent, for years ending June 30	4,593	5,840	7,122	8,062	8,909	9,396

DOMESTIC PRODUCTION

Anhydrous ammonia production continued its upward trend and reached a new high in 1957 that amounted to 9 percent more than in 1956. Ammonium sulfate output increased slightly but did not reach the previous record of 1955. The production of ammonium nitrate in 1957 was 16 percent above that in the preceding year. Synthetic sodium nitrate was produced by Allied Chemical & Dye Corp., Hopewell, Va., and Olin Mathieson Chemical Corp., Lake Charles, La.

A urea plant was being constructed by Hercules Powder Co. at Hercules, Calif. This 10,000-ton-per-year plant was scheduled for completion by late 1958.

Mississippi Chemical Corp. was expanding its nitric acid facilities by adding a 150-ton-per-day unit.

Monsanto Chemical Co. began to construct a 100-ton-per-day urea plant adjoining the ammonia and carbon dioxide plants at El Dorado, Ark. This plant was to make both prilled and solution forms.

[1] Commodity specialist.

TABLE 2.—Principal nitrogen compounds produced in the United States, 1948–52 (average) and 1953–57, in short tons

Commodity	1948–52 (average)	1953	1954	1955	1956	1957 [1]
Ammonia (NH_3):						
Synthetic plants [2]	1,555,720	2,287,785	2,736,478	3,251,599	3,378,362	3,710,916
Coking plants	229,525	261,379	221,809	269,607	[3] 251,292	260,684
Total anhydrous ammonia	1,785,245	2,549,164	2,958,287	3,521,206	[3] 3,629,654	3,971,600
Total N equivalent	1,467,935	2,096,076	2,432,481	2,895,347	[3] 2,984,519	3,265,688
Principal ammonium compounds:						
Aqua ammonia, 100 percent NH_3:						
Synthetic plants [2]	(4)	33,676	53,943	39,341	40,719	(4)
Coking plants	23,566	24,846	16,104	16,621	17,681	16,458
Total aqua ammonia	(4)	58,522	70,047	55,962	58,400	(4)
Ammonium sulfate, 100 percent $(NH_4)_2SO_4$:						
Synthetic plants [2]	736,654	576,232	943,825	1,172,779	1,095,782	1,073,423
Coking plants	823,836	946,133	822,818	981,326	882,700	909,995
Total ammonium sulfate	1,560,490	1,522,365	1,768,643	2,154,105	1,978,482	1,983,418
Ammonium nitrate, 100 percent NH_4NO_3 solution [2]	1,206,949	1,558,457	1,885,463	2,099,504	2,203,672	2,561,886
Ammonium chloride, 100 percent NH_4Cl, gray and white [2]	(4)	33,341	28,443	30,192	29,712	(4)
Ammoniating solutions, 100 percent N [2]	(4)	360,720	444,705	[3] 468,519	490,320	(4)
Diammonium phosphate, NH_3 content	----------	----------	----------	(4)	6,067	9,629

[1] Preliminary figures.
[2] Data from Bureau of the Census Facts for Industry series.
[3] Revised figure.
[4] Data not available.

The Sohio Chemical Co. utilized the Swiss Invento process for urea production at its Lima, Ohio, plant. The urea section had a capacity of 120 tons per day.[2]

Spencer Chemical Co. completed a urea plant at Vicksburg, Miss., and planned another urea plant at Henderson, Ky.

St. Paul Ammonia Products, Inc., began operations about midyear. This company, owned by the Central Farmers Fertilizer Co., will supply anhydrous ammonia and nitrogen solution to the 16 member-cooperatives.

Nitric acid capacity in the United States was 3.7 million tons per year at the end of 1957, a 100-percent increase in 6 years.[3] A total of 49 nitric acid plants were operating at the end of year, more than half adjacent to ammonia plants.

Guano production from Bat Cave, on the south rim of the Grand Canyon some 60 miles north of Kingman, Ariz., was begun during 1957 by Randall Mills Corp. The guano was conveyed from the cave, 600 feet above the Colorado River, to the north rim by a 1½-mile aerial tramway, where it was packaged for sale by the United States Guano Corp. The material was marketed with a minimum content of 10 percent nitrogen. Both companies were subsidiaries of New Pacific Coal & Oils, Ltd., of Toronto, Canada. The reserve was estimated to exceed 100,000 short tons.

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[2] Grindrod, John, New U. S. Fertiliser Plant: Fertiliser and Feeding Stuffs Jour. (London), vol. 46, No. 13, June 19, 1957, pp. 592, 595, 597, 601.

[3] Chemical Week, Nitric Capacity—Doubled Since '51—More Needed by '60?: Vol. 80, No. 28, July 13, 1957, pp. 46–47.

CONSUMPTION AND USES

Agriculture continued to be the leading consumer of nitrogen compounds. Over 2.1 million short tons of contained nitrogen was consumed by agriculture, a 10-percent increase over the previous year. The principal nitrogen materials, in order of importance as fertilizers, were: (1) Ammonium nitrate and ammonium nitrate-limestone mixtures, (2) anhydrous and aqua ammonia, (3) ammonium sulfate, (4) sodium nitrate, (5) nitrogen solutions, (6) urea, (7) calcium cyanamide, and (8) calcium nitrate.

According to the United States Departmeut of Agriculture, for the year ended June 30, 1957, consumption of nitrogen solutions, ammonium sulfate, aqua ammonia, urea, ammonium nitrate, and anhydrous ammonia as fertilizers increased 87, 25, 21, 16, 15, and 12 percent, respectively, whereas consumption of sodium nitrate decreased 11 percent.

The United States Department of Agriculture, in addition to its regular fertilizer reports, released a bulletin on fertilizer production in the United States since 1880, by types of fertilizer.[4]

Chemical and industrial uses of ammonia continued to expand and accounted for about 25 percent of consumption.[5]

The chemical industry, while using a small quantity of elemental nitrogen, requires most of its nitrogen in various compounds. The major industrial uses included the manufacture of explosives, chemicals, rocket propellants, dyes, resins, and paper; processing of rubber, metal ores, and metals; in water treatment; and as a refrigerant. It was estimated that 175,000 tons of ammonium nitrate was used in field-compounded explosives in the calendar year 1956.

New nonagricultural uses of gaseous nitrogen resulted in a doubling of production in the United States in 1956–57 compared with 1955–56.[6] Food processing and military application consumed a major part of the increase. Foodstuffs, such as coffee, edible oils, wine, nuts, potato chips, and various dehydrated fruits and vegetables, are kept fresh by the use of nitrogen.

PRICES

Prices of Chilean nitrate, synthetic sodium nitrate, ammonium nitrate, and anhydrous ammonia all increased during 1957. Coke-oven ammonium sulfate prices, which dropped 25 percent early in 1956, remained steady during 1957.

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[4] Mehring, A. L., Adams, J. R., and Jacob, K. D., Statistics on Fertilizers and Liming Materials in the United States: U. S. Dept. of Agriculture Statistical Bull. 191, 1957, 182 pp.

[5] Industrial and Engineering Chemistry, Ammonia Wins New Industrial Market Outlets: Vol. 49, No. 10, October 1957, pp. 32A, 34A.

[6] Chemical and Engineering News, Nitrogen's Above-Ground Market: Vol. 35, No. 7, Feb. 18, 1957, pp. 136–137.

TABLE 3.—Prices of major nitrogen compounds in 1957, per short ton

[Oil, Paint and Drug Reporter of the dates listed]

Commodity	Jan. 7, 1957	Dec. 30, 1957	Effective date of change
Chilean nitrate, port, warehouse, bulk	$46.00	[1] $46.25	Oct. 7.
Sodium nitrate, synthetic, domestic, c. l. works, crude, bulk	43.50	45.25	Oct. 7.
Ammonium sulfate, coke ovens, bulk	32.00	32.00	
Cyanamide, fertilizer-mixing grade, 21 percent N, granular, Niagara Falls, Ontario, bagged.	55.00	55.00	
Ammonium nitrate, fertilizer grade, 33.5 percent N:			
Canadian, eastern, c. l., shipping point, bags	64.00	68.00	Oct. 7.
Western, domestic, works, bags	64.00	64.00	
Anhydrous ammonia, fertilizer, tanks, works	75.00	[2] 84.00	Oct. 7.
Ammonium-nitrate-dolomite compound, 20.5 percent N, Hopewell, Va., bags	51.00	[3] 49.75	Oct. 7.

[1] Quoted at $44.50 per ton from May 20 to Oct. 7.
[2] Quoted at $80 per ton from Jan. 14 to Oct. 7.
[3] Quoted at $48 per ton from Sept. 30 to Oct. 7.

FOREIGN TRADE [7]

Imports of major nitrogen compounds in 1957 continued their downward trend and were 4 percent less than in 1956. Chilean nitrate imports increased 17 percent in 1957 over 1956.

Exports continued to increase and were 9 percent above 1956 exports.

TABLE 4.—Major nitrogen compounds imported for consumption into and exported from the United States, 1954–57, in short tons

[Bureau of the Census]

	1954	1955	1956	1957
Imports:				
Industrial chemicals: Anhydrous ammonia			26	
Fertilizer materials:				
Ammonium nitrate mixtures: Containing 20 percent or more nitrogen	524,938	405,246	437,580	352,805
Ammonium phosphates	164,133	234,523	190,574	169,471
Ammonium sulfate	305,012	173,118	197,650	164,729
Calcium cyanamide	84,211	81,708	67,185	57,928
Calcium nitrate	68,637	56,362	65,291	60,055
Nitrogenous materials, n.e.s.:				
Organic	17,748	11,194	6,011	3,334
Inorganic and synthetic, n.e.s	16,991	8,494	8,931	9,160
Potassium nitrate, crude	732	1,118	924	642
Potassium-sodium nitrate mixtures, crude	13,228	19,300	19,451	25,393
Sodium nitrate	731,530	614,186	500,012	584,945
Exports:				
Industrial chemicals:				
Anhydrous ammonia	39,257	44,054	53,324	67,946
Ammonium nitrate	7,560	5,996	6,991	7,897
Fertilizer materials:				
Ammonium nitrate	9,402	71,919	126,054	109,492
Ammonium sulfate	202,249	612,407	762,751	781,938
Nitrogenous chemical materials, n. e. s	48,871	82,116	85,109	155,935
Sodium nitrate	25,316	11,625	4,078	3,581

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

TABLE 5.—Sodium nitrate and potassium-sodium nitrate imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries

[Bureau of the Census]

	1948–52 (average)		1953		1954	
	Short tons	Value	Short tons	Value	Short tons	Value
Sodium nitrate:						
North America: Canada	70	$4,274	1	$45		
South America: Chile	683,075	25,213,334	568,872	23,268,068	731,530	$26,817,842
Europe:						
France	6	643				
Germany	3	381				
Poland	3	193				
Total	12	1,217				
Grand total	683,157	25,218,825	568,873	23,268,113	731,530	26,817,842
Potassium-sodium nitrate, mixtures:						
North America: Canada	(1)	30				
South America: Chile	10,465	482,673	12,516	626,149	13,228	599,230
Europe:						
France						
Germany, West						
Total						
Grand total	10,465	482,703	12,516	626,149	13,228	599,230

	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Sodium nitrate:						
North America: Canada	50	$2,306	101	$5,983		
South America: Chile	614,136	21,925,596	499,911	16,330,892	584,945	$17,107,478
Europe:						
France						
Germany						
Poland						
Total						
Grand total	614,186	21,927,902	500,012	16,336,875	584,945	17,107,478
Potassium-sodium nitrate, mixtures:						
North America: Canada						
South America: Chile	19,252	789,799	19,437	713,879	25,112	872,268
Europe:						
France	13	1,324	14	1,324		
Germany, West	35	3,779			281	12,406
Total	48	5,103	14	1,324	281	12,406
Grand total	19,300	794,902	19,451	715,203	25,393	884,674

[1] Less than 1 ton.

WORLD REVIEW

According to the report of Aikman (London), Ltd., world production and consumption of nitrogen (excluding U. S. S. R.) in 1957–58 increased 10 and 7 percent, respectively, compared with 1956–57. Detailed data in table 7 show that the United States supplied 28 percent of the world production and consumed 33 percent of the world total of fertilizer nitrogen.

TABLE 6.—Revised estimates of world production and consumption of nitrogen, years ended June 30, 1954–58, in thousand short tons

[Aikman (London), Ltd.]

Year	Estimated production		Estimated consumption	
	For agriculture	For industry	In agriculture	In industry
1953–54	5,967	1,155	5,933	1,155
1954–55	6,780	1,282	6,537	1,282
1955–56	7,526	1,383	7,056	1,383
1956–57	7,875	1,521	7,659	1,521
1957–58	8,674	1,681	8,132	1,681

[1] Exclusive of U. S. S. R.

TABLE 7.—World production and consumption of fertilizer nitrogen compounds, years ended June 30, 1956–58, by principal countries, in thousand short tons of contained nitrogen

[Converted and rounded from United Nations Food and Agriculture Organization]

Country	Production			Consumption		
	1955–56	1956–57 [1]	1957–58 [2]	1955–56	1956–57 [1]	1957–58 [2]
Australia	18	26	26	20	32	32
Austria	142	142	(3)	35	41	44
Belgium	249	257	(3)	94	96	105
Brazil	4	4	4	26	26	26
Canada	224	233	241	52	53	53
Ceylon	------	------	------	23	23	23
Chile	198	206	224	28	35	36
Denmark	------	------	------	98	108	109
Egypt	29	37	37	127	136	136
Finland	19	23	(3)	40	48	48
France	441	473	(3)	420	444	474
Germany: East	320	320	(3)	264	264	264
West	829	970	(3)	520	581	606
Greece	------	------	------	46	61	61
India	90	90	90	156	170	228
Indonesia	------	------	------	27	24	24
Israel	2	11	13	13	13	13
Italy	378	423	(3)	280	295	309
Japan	776	849	951	639	647	679
Korea, (South)	------	------	------	161	172	172
Mexico	14	14	14	124	159	152
Netherlands	332	364	(3)	203	209	209
Norway	197	235	(3)	42	50	55
Peru	46	37	37	48	41	41
Philippines	7	9	9	33	40	40
Portugal	25	26	(3)	52	52	52
Spain	49	50	(3)	189	186	220
Sweden	29	36	(3)	92	99	107
Switzerland	12	12	(3)	12	12	13
Taiwan (Formosa)	19	19	33	83	93	98
Union of South Africa	9	14	17	29	29	30
United Kingdom	341	369	(3)	327	343	387
United States	2,178	2,229	2,251	1,875	1,875	1,875
Yugoslavia	14	14	(3)	42	74	74
World total [4]	7,372	7,872	(3)	6,926	7,275	7,546

[1] Preliminary figures.
[2] Forecast.
[3] Forecasts for 1957–58 not available for Europe.
[4] Exclusive of U. S. S. R.; includes quantities for minor producing and consuming countries not listed above.

SOUTH AMERICA

Brazil.—The ammonium nitrate plant of Petroleras, S. A., at the Cubatão Refinery, began operation in 1957, and the nitrate plant of Fertisa Fertilizanto Minas Gerais, S. A., was being constructed at Vespasiano, Minas Gerais. The Nitrogenie, S. A., was planning a nitrogenous plant near the Mataripe refinery in Bahia.[8]

[8] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 6, June 1957, p. 26.

Chile.—Nitrate production increased 14 percent in 1957 compared with 1956, and totaled 1,456,000 tons, about three-quarters by the Guggenheim process and one-quarter by the Shanks process.[9] Exports totaled 1.4 million tons and local sales were nearly 110,000 tons.

Expansion and modernization of facilities by the two major producers, Anglo-Lautaro Nitrate Co. and Cia Salitrera y Antofagasta, were ahead of schedule. Independent producers continued to have financial difficulties, and further shutdowns were reported imminent.

The 1957 sodium nitrate and potassium nitrate prices were $34.48 and $43.56, respectively, per short ton, f. a. s., Chilean port.

TABLE 8.—Exports of nitrate from Chile, 1957, by countries of destination, in thousand short tons

Country of destination:	*Thousand short tons*
Argentina	36
Australia and New Zealand	11
Belgium	47
Brazil	60
Denmark	25
Egypt	68
France	96
India	18
Italy	78
Japan	23
Netherlands	32
Peru	19
Spain	110
Sweden	32
United Kingdom	24
United States	613
Other countries	91
Total	1, 383

Colombia.—Output of nitric acid, ammonium nitrate, urea, and ammonia from the plant of Acerías Paz del Rio, S. A., totaled about 30,000 short tons of contained nitrogen. The Industria Colombiana de Fertilizantes, S. A., announced plans for a nitrogenous fertilizer plant at Barrancabermeja.[10]

Peru.—The nitrogenous fertilizer plant of Fertilizantes Sinteticos, S. A., was scheduled for completion by late 1958.[11] Products were to include anhydrous ammonia, ammonium nitrate, ammonium sulfate, and nitric acid.

EUROPE

Austria.—The nitrogen plant of the Oesterreichische Stickstoffwerke at Linz employed over 4,400 people and produced, in addition to nitrogenous fertilizers, more than 80 other chemicals in 1957. Over 80 percent of the production was exported. Plans called for expansion to 700,000 tons by 1959 from the 635,000 tons produced in 1955. The expansion program included plans for a urea plant.

France.—The Office Nationale Industriel de l'Azote announced plans for expanding its ammonia plant. The new facilities were to use petroleum as the raw material.

Germany, West.—A fertilizer and chemical nitrogen plant was under construction at Krefeld by Stickstoffwerk Krefeld G. m. b. H.[12]

[9] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, pp. 29–33.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 31.
[11] Chemical Age (London), Peruvian Fertiliser Plant on Stream by End-1958: Vol. 78, No. 1991, Sept. 7, 1957, p. 364.
[12] Chemical Trade Journal (London), New German Fertiliser Plant: Vol. 140, No. 3652, May 31, 1957, p. 1296.

This company is jointly owned by the Wasag Chemie A. G. of Essen and the Union Rheinische Braunkohlen Kraftstoffwerk of Cologne.

Netherlands.—The Netherlands State Mines completed the urea plant and expansion of the ammonia plant at Limburg at the beginning of 1957. The nitrogen plant expansion at Ijmuiden of N. V. Mij tot Exploitatie van Kooksovengasseb was completed, increasing capacity about 33 percent.

Portugal.—The Sociedade Portuguesa de Petroquimica was formed to build a nitrogenous fertilizer plant adjoining the SACOR petroleum refinery.[13]

Spain.—Amoniaco Espânol, S. A., announced plans for an ammonium sulfate and ammonium nitrate plant in Seville.[14]

United Kingdom.—The new nitrogenous fertilizer plant of Shell Chemical Co., Ltd., at Shell Haven, Essex, was scheduled for completion late in 1958. Products were to include ammonia, nitric acid, and ammonium nitrate.[15] Expansion of facilities to recover nitrogen from coking operations were completed by Dorman Long (Steel), Ltd., at South Bank, Middlesbrough, and by the National Coal Board at the Avenue Carbonisation and Chemical Plant near Chesterfield, Derbyshire.[16]

U. S. S. R.—Ammoniation was under investigation to increase plant-food content and improve physical conditions of phosphatic fertilizers.[17] This work was being done by the Chirchiksk Electro-Chemical Combine Research Institute (N. I. U. I. F.) and Chemistry Institute of the Academy of Science, U. S. S. R.

Yugoslavia.—Expansion of ammonium nitrate and ammonium sulfate facilities was planned by the Yugoslav Government.[18] Production of ammonium nitrate in the first 6 months of 1957 was 10,000 tons—47 percent above the same period of 1956.

ASIA

China.—Nitrogenous fertilizer production in 1957 totaled 747,000 short tons. Planned expansion programs by the fertilizer industry totaled 1.8 million tons additional annual capacity of nitrogenous fertilizer.

India.—The ammonium sulfate industry in India was comprised of 8 plants with an annual rated capacity of 425,000 tons, the largest being the Government-owned plant at Sindri. Output continued below capacity owing to sulfur shortages.[19] Construction of the ammonium nitrate plant at Nangal was begun and scheduled for completion in 1960.

Iraq.—Natural gas was to be one of the raw materials for a proposed ammonium sulfate plant at Basra. The plant will have an annual capacity of 250,000 tons.

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[13] Chemical Trade Journal and Chemical Engineer, Fertilisers in Portugal: Vol. 141, No. 3671, Oct. 11, 1957, p. 871.
[14] Chemical Week, Fertilizer/Spain: Vol. 81, No. 21, Nov. 23, 1957, p. 24.
[15] Commercial Fertilizer, Shell-Fisons $50,000,000 Plant Ready Late 1958: Vol. 2, No. 8, August 1957, p. 48.
[16] Fertiliser and Feeding Stuffs Journal (London), Ammonium Sulfate: Vol. 46, No. 8, Apr. 10, 1957, pp. 357–358, 361; Ammonia Recovery: Vol. 47, No. 1, July 3, 1957, p. 18.
[17] Ivanov, R. N., Khimicheskaya Promyshlennost: No. 2, 1957, pp. 79–82.
[18] Chemical Age (London), Yugoslavia's Fertiliser Plans: Vol. 78, No. 1985, July 27, 1957, p. 144. Chemical and Engineering News, Fertilizers, Agricultural Chemicals: Vol. 35, No. 36, Sept. 9, 1957, pp. 64–65.
[19] Oil, Paint and Drug Reporter, vol. 172, No. 23, Dec. 2, 1957, p. 51.

Israel.—Production of ammonium sulfate totaled 65,000 tons in 1956, of which 7,000 tons was exported. Estimated production in 1957 was 88,000 tons. Facilities were being built for handling anhydrous and aqua ammonia for agricultural use.

Japan.—A new atmospheric ammonia plant at Noboeka, on Kyushu Island was being constructed by Ashi Chemical Industry Co., Ltd.[20] Output will go for fertilizer and various chemicals. Increased production goals for calcium cyanamide were reported by the Japanese Ministry of International Trade and Industry.

Pakistan.—In addition to the ammonium sulfate plant at Daudkhel, with an annual capacity of 50,000 tons, plans were underway for 2 more nitrogenous fertilizer plants to produce 200,000 tons per year.[21]

Philippine Islands.—Plans were announced to construct a 150-ton-per-day ammonium sulfate plant which will include hydrogen, nitrogen, ammonia, and sulfuric acid facilities.[22]

AFRICA

Angola.—An ammonia plant was planned near Luanda by the Companhia Fabril Commercial Do Ultramar with a capacity of 40,000 tons per year.[23]

Union of South Africa.—The Sasol oil-from-coal plant began producing nitrogen compounds as a byproduct, for use in fertilizers. African Explosives and Chemical Industries, Ltd., expanded facilities of its nitrogenous fertilizer plant at Modderfontein.[24]

TECHNOLOGY

The nitrate deposits in California and the uses of nitrogen were reviewed.[25] The absence of economic nitrate deposits in California stimulated growth of the atmospheric nitrogen industry. In all, five plants produce ammonia from hydrogen and atmospheric nitrogen.

The use of prilled ammonium nitrate field-compounded explosives continued to attract attention.[26] The advantages of this material were given as lower cost than for standard explosives, greater rock breakage, and increased safety.[27] Improved equipment in ammonium nitrate plants was described.[28]

A flowsheet of the single-step Stengel process for producing granular ammonium nitrate was published.[29] Utility requirements per ton of product by this process were 1,000 tons of steam, 2,000 gallons of water, and 19 kw.-hr. of electricity. The cost of a 225 ton-per-day plant was quoted at from $1 million to $1.25 million.

[20] Chemical and Engineering News, Ammonia Plant for Japan: Vol. 35, No. 2, Jan. 14, 1957, p. 50.
[21] Chemical Age (London), Fertiliser Factories in Pakistan: Vol. 77, No. 1967, Mar. 2, 1957, p. 511.
[22] Fertiliser and Feeding Stuffs Journal (London), Ammonia Plant for the Philippines: Vol. 66, No. 11, May 22, 1957, p. 523.
[23] Agricultural Chemicals, vol. 12, No. 7, July 1957, p. 92.
[24] Fertiliser and Feeding Stuffs Journal (London), Southern Africa Fertilisers: Vol. 46, No. 2, Jan. 16, 1957, p. 60.
[25] Ver Planck, W. E., Nitrogen Compounds: Chap. in Mineral Commodities of California, Dept. of Natural Resources, Div. of Mines, Bull. 176, pp. 401–402.
[26] Cook, M. A., Large-Diameter Blasting With High Ammonium Nitrate-Nonnitroglycerin Explosives: Pres. at 3d Ann. Symposium on Mining Research, Rolla, Mo., Nov. 14–15, 1957.
Cooley, C. M., Properties and Recommended Practices for Use of Ammonium Nitrate in Field Compounded Explosives: Pres. at 3d Ann. Symposium on Mining Research, Rolla, Mo., Nov. 14–15, 1957.
Parrott, F. M., Use of Ammonium Nitrate Blasting Agent in Strip Mine Operation: Pres. at 3d Ann. Symposium on Mining Research, Rolla, Mo., Nov. 14–15, 1957.
[27] Engineering and Mining Journal, At Berkley Pit, Blasting Is an Art: Vol. 158, No. 12, December 1957 pp. 107–110.
Intermountain Industry and Mining Review, Blasting With Ammonium Nitrate: Vol. 59, No. 4, April 1957, pp. 41–42.
Western Mining and Industry News, Use of Fertilizer as Blasting Agent Beyond Test Stages: Vol. 25, No. 8, August 1957, pp. 6–7.
[28] Industrial and Engineering Chemistry, Ammonium Nitrate: Vol. 49, No. 9, pt. II, September 1957, pp. 1580–1581.
[29] Petroleum Processing, Granular Ammonium Nitrate: Process Data Sheet 22, vol. 12, No. 9, September 1957, pp. 171–173.

The production of ammonium sulfate in areas lacking ample supplies of sulfur or sulfuric acid was accomplished by the use of gypsum or anhydrite.[30] This process was being used in Germany, the United Kingdom, and India.

Research with various types of nitrogenous fertilizers enabled the development of guides for selecting a type best suited for various crops.[31] Studies in progress on ammoniation and granulation resulted in compilation of numerous physical and chemical properties of nitrogenous materials.[32]

The progress and problems in the use of liquid fertilizers in the United States [33] and the possible use of liquid fertilizers in the United Kingdom were discussed.[34]

Results of experiments with liquid nitrogenous fertilizers in the U. S. S. R. and present practices were published.[35]

It was reported that use of diammonium phosphate (DAP) would reduce costs in the manufacture of granular fertilizers.[36] Although it was manufactured in Germany in the 1930's, only in the last few years has DAP received serious consideration in the United States or the United Kingdom.

Investigations continued on means of improving the demand for certain low- and intermediate-grade nitrogen compounds. The conversion of ammonium sulfate to higher-grade nitrogenous materials was suggested.[37]

Ammonium perchlorate generated more gas and eliminated the smoke problem of potassium perchlorate used as a solid rocket propellant. The increased demand for ammonium perchlorate resulted in industry expansion and development of new production techniques.[38]

Experimental work with high-pressure techniques resulted in development of a nitrogen pump capable of withstanding 10,000 pounds per square inch and delivering 40,000 cubic feet per minute.[39]

A new method of nitrogen purification was developed by scrubbing with sodium dithionite.[40] The purified nitrogen was used to purge oxygen from emulsion polymerization reactors.

The safety precautions necessary for handling various nitrogen compounds were published.[41]

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[30] Hardy, W. L., Ammonium Sulfate by the Gypsum Process: Ind. Eng. Chem., vol. 49, No. 2, February 1957, pp. 57A–58A.

[31] Wehunt, R. L., and Bergeaux, P. J., Factors to Consider in Comparing Nitrogen Fertilizers: Comm. Fert., vol. 94, No. 4, April 1957, pp. 32–33.

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[35] Cass, W. G., Liquid Nitro-Fertilisers—Progress in the Soviet Union: Fertiliser and Feeding Stuffs Jour. (London), vol. 47, No. 9, Oct. 23, 1957, pp. 409–412, 424.

[36] Fertiliser and Feeding Stuffs Journal (London), DAP—Major Material for Future Compounding: Vol. 47, No. 4, Aug. 14, 1957, pp. 149-150, 153.

[37] Agricultural Chemicals, Ammonium Sulfate—Its Current Status: Vol. 12, No. 12, December 1957, pp. 49, 105.

Chemical Engineering, How to Upgrade Coke Oven Ammonia: Vol. 64, No. 12, December 1957, pp. 142, 144.

[38] Schumacher, J. C., and Stern, D. R., Large-Scale Continuous Production of Ammonium Perchlorate: Chem. Eng. Prog., vol. 53, No. 9, September 1957, pp. 428–432.

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[40] Reich, Murray, and Kapenkas, Harry, Nitrogen Purification: Ind. Eng. Chem., vol. 49, No. 5, May 1957, pp. 869–873.

[41] Franklin, C. E., Safe Handling of Ammonia, Ammonium Nitrate, and Nitrogen Solutions: Comm. Fert., vol. 94, No. 4, April 1957, pp. 46–48, 50.

Perlite

By L. M. Otis[1] and James M. Foley[2]

IN EACH of the 11 years since 1946 domestic production of crude perlite increased steadily.

DOMESTIC PRODUCTION

Crude Perlite.—There were 12 companies in 1957 operating 14 mines in 6 States, the same as in 1956.

TABLE 1.—Crude and expanded perlite produced and sold or used by producers in the United States, 1953–57

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
1953	213,532	141,282	$1,072,065	57,469	$367,593	175,234	174,461	$9,254,374
1954	261,024	154,531	1,375,706	65,172	386,394	196,447	195,499	10,278,745
1955	335,187	198,446	1,778,894	87,711	502,738	246,730	246,343	12,585,297
1956	350,224	207,436	1,940,162	103,364	609,894	262,815	263,627	13,122,473
1957	422,346	194,211	1,730,149	107,394	832,076	249,139	245,433	12,511,467

Of the 422,346 short tons of crude perlite produced in the United States in 1957, the 256,265 tons from New Mexico was 61 percent of the total mined, compared with 48 percent in 1956. Other producing States, in order of output, were Colorado, Nevada, and Arizona.

Expanded Perlite.—Perlite was expanded by 70 companies at 83 plants in 29 States. California with 12 plants had the largest number of operations; followed by Illinois, Pennsylvania, and Texas, each with 5 plants; and New York and New Jersey, 4 plants each.

Expanded perlite sold or used in 1957 totaled 245,433 short tons, 7 percent less than 1956.

Mine and Plant Developments.—A new crude perlite mine was reported in New Mexico, 6 miles from Magdalena, in Socorro County. This is the second perlite mine in this county and the fourth in the State.

Since 1950, Great Lakes Carbon Co. has mined perlite by open pit south of Socorro, N. Mex.; underground mining will soon be used, in conjunction with the present methods.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

TABLE 2.—Expanded perlite produced and sold by producers in the United States, 1956–57, by States

State	1956				1957			
	Produced (short tons)	Sold			Produced (short tons)	Sold		
		Short tons	Value	Average value per ton		Short tons	Value	Average value per ton
California	24,556	24,158	$1,308,381	$54.16	23,668	23,521	$1,287,850	$54.75
Florida	7,083	7,137	379,058	53.11	8,235	8,241	474,279	57.55
Illinois	22,424	22,399	1,209,014	53.98	22,500	22,500	1,213,522	53.93
Iowa	10,721	10,721	510,553	47.62	(1)	(1)	(1)	(1)
Kansas	(1)	(1)	(1)	(1)	1,191	1,290	63,915	49.55
Michigan	(2)	(2)	(2)	(2)	8,836	8,836	420,256	47.56
Missouri	(1)	(1)	(1)	(1)	4,500	4,500	289,820	64.40
New Jersey	7,395	7,395	367,732	49.73	6,597	6,600	358,728	54.35
New York	22,024	22,006	955,063	43.40	19,509	19,495	840,676	43.12
Ohio	10,044	10,779	712,534	66.00	(2)	(2)	(2)	(2)
Pennsylvania	18,178	18,113	988,509	54.57	16,711	16,858	975,398	57.86
Texas	9,927	9,941	537,577	54.08	8,664	8,664	488,369	56.37
Utah	3,468	3,468	158,981	45.84	(1)	(1)	(1)	(1)
Other Western States [3]	54,868	55,512	2,227,647	40.13	51,174	49,377	2,208,519	44.73
Other Eastern States [4]	72,127	71,998	3,767,424	52.33	77,554	75,551	3,890,135	51.49
Total	262,815	263,627	13,122,473	49.78	249,139	245,433	12,511,467	50.98

[1] Included under "Other Western States" to avoid disclosing individual company confidential data.
[2] Included under "Other Eastern States" to avoid disclosing individual company confidential data.
[3] Includes Arizona, Colorado, Iowa (1957 only), Kansas (1956 only), Louisiana, Minnesota, Missouri (1956 only), Nebraska, Nevada, New Mexico, Oklahoma (1956 only), Oregon, and Utah (1957 only).
[4] Includes Indiana, Maryland, Massachusetts, Michigan (1956 only), North Carolina, Ohio (1957 only), Tennessee, Virginia, and Wisconsin.

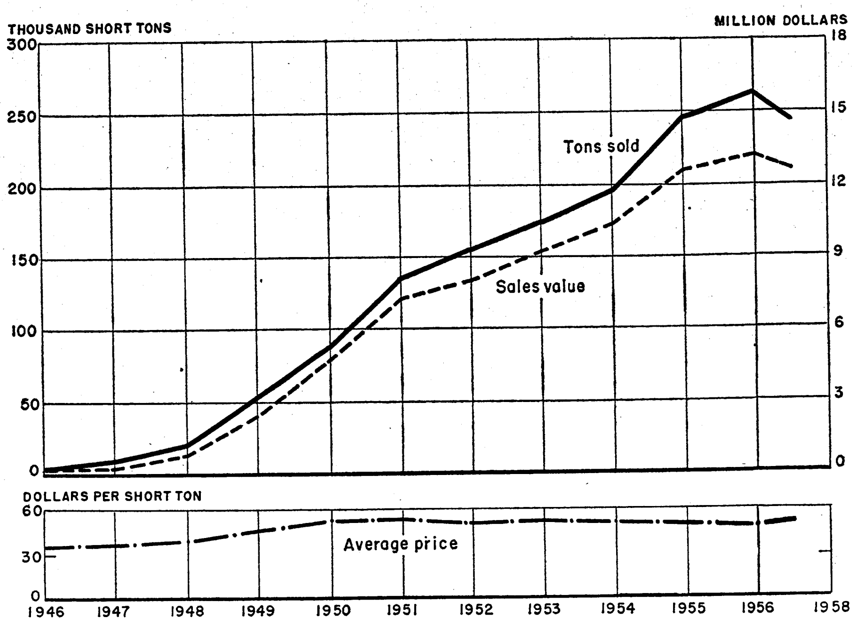

FIGURE 1.—Sales and value of expanded perlite and average price per ton, 1946–57.

A brief description of the only active perlite mine in Colorado during 1957 appeared in the press.[3] The mine is in Custer County near Rosita; its product was sent to Florence, Colo., for crushing, cleaning, sizing—ready to ship to expanding plants. Production was reported ranging from 5,000 to 18,000 tons a month in 1956.

The Great Lakes Carbon Co. Dicalite and Perlite Divisions were consolidated into the Mining and Mineral Products Division. Administrative headquarters of the new division will be at Los Angeles. In the past, the Dicalite Division handled diatomite production, sales, and research.

The Zonolite Co. increased its perlite-expanding facilities at its Atlanta, Ga., plant.[4]

Great Lakes Carbon Corp. Mining and Mineral Products Division began limited mining at its No Agua deposit of crude perlite in northern New Mexico. A new crushing and sizing plant near the mine was scheduled for completion in 1958. In the meantime ore was treated at the Great Lakes Florence, Colo., plant.

CONSUMPTION AND USES

Expanded Perlite.—The following percentages were computed from processors' estimates of end uses for their expanded perlite during 1957: 69 percent in building plaster aggregate, 15 percent for concrete aggregate, 3 percent in fillers, 1 percent in filter aids, and 12 percent in miscellaneous uses; the last item included oil-well drilling muds, oil-well concrete, loose fill insulation, horticulture, insecticides, catalysts, refractory brick, and absorbents. In 1956 building plaster consumed 76 and concrete aggregate 10 percent.

An account of the annual meeting of the Perlite Institute[5] included percentages of perlite used in 1956, produced by their members only, as follows: Plaster aggregate, 63; insulating concrete for roof-deck construction, 19; insulation board, gypsum wallboard, acoustical plaster and tile, pipe insulation, loose fill insulation, soil conditioning, paint filler, filtration medium, and as a carrier for insecticides and herbicides, 18.

PRICES

The average value f. o. b. processing plants for crude perlite, crushed, cleaned, sized, and sold by producers to expanders was \$8.91 per ton, 5 percent less than in 1956. The average price of this material used by prime producers in their own expanding operations was \$7.75 per ton, compared with \$5.90 in 1956. A weighted average of these 2 classifications of crude perlite was \$8.50 compared with \$8.20 per ton in 1956.

The slight but consistent decline in the average annual unit price of expanded perlite since 1953 was reversed in 1957; the annual unit price averaged \$50.98 per ton, an increase of 2 percent. In 1953 this average price was \$53.05 per ton.

[3] Mining Record, Colorado Perlite Property Is Quiet But Large Producer: Vol. 68, No. 3, Jan. 17, 1957, p. 8.
[4] Rock Products, Expands Perlite Plant: Vol. 60, No. 1, January 1957, p. 41.
[5] Western Mining and Industrial News, Perlite Industry Uptrend Predicted, Institute Elects New Directors: Vol. 25, No. 10, October 1957, p. 27.

FOREIGN TRADE

Crude perlite may be imported duty-free under paragraph 1719 of the Tariff Act of 1930. Expanded perlite has been dutiable at 15 percent ad valorem since January 1, 1948, when it was reduced from 30 percent under paragraph 214 of the Tariff Act of 1930.

Crude perlite was exported to Canada in 1957. Usually expanded perlite is exported to Canada, Cuba, and Venezuela.

WORLD REVIEW

NORTH AMERICA

Canada.—Large deposits of perlite have been found in British Columbia on Francois Lake near Uncha Lake in Empire Valley and on Graham Island in the Queen Charlottes. These deposits were too remote from markets to have economic importance. A perlite-expanding plant at New Westminister, British Columbia, imported crude perlite, precrushed and sized, from Colorado and New Mexico for processing. Crude perlite was not produced in Canada. The consumption of expanded perlite during 1956 was 2,317,000 cubic feet, an increase of 34 percent over 1955 and considerably greater than the increase for any other lightweight aggregate used commercially in Canada.[5a]

TECHNOLOGY

Research was conducted by perlite expanders in manufacturing filter aids. For this purpose minus-200-mesh expanded perlite is required. A hammer mill was used for comminution in closed circuit with air cyclones. Early in the processing, unexpanded, high-density particles were removed, because reducing the size of these harder pieces can produce an excessive quantity of ultrafine expanded perlite from attrition of the softer expanded material. Ultrafine fragments in the filtering medium tend to clog the filter cake at the screen cloth.

Twenty to sixty microns is generally considered the maximum to minimum size range for filter-aid particles covering the range from rapid to slow filtering. The size range for any 1 filtering rate is closer, for example, 20 to 30 microns.

Although a small percentage of 6- to 10-micron expanded perlite particles does not seem to affect the filter flow rate, even 4 or 5 percent of 2-micron particles may reduce the flow rate drastically and should therefore be avoided.

A brief summary of the perlite industry was published.[6] It referred to the history of the industry, current sources, mining, milling, expanding, shipping, physical characteristics, uses, and reserves.

At the 8th annual meeting of the Perlite Institute, a special committee was appointed to study more efficient techniques for building

[5a] Department of Mines and Technical Surveys, Ottawa, Lightweight Aggregates in Canada, 1956 (prelim.): Bull. 27, pp. 1–5.

[6] Leppla, P. W., Perlite and Other Lightweight Aggregates: Min. Cong. Jour., vol. 43, No. 9, September 1957, pp. 73–74.

perlite concrete roof decks and to develop methods of training contractors in using these newer methods of roof-deck construction.[7]

A paper by the administrative secretary of the Perlite Institute was presented before the American Institute of Mining, Metallurgical and Petroleum Engineers.[8] It outlined a history of perlite in the United States, the properties of perlite, its sources, commercial growth, mining, milling, expanding, uses, and reserves.

Perlite concrete was sprayed on three 27- by 18-foot-diameter fuel-oil tanks as a protection against fire, evaporation losses, and weather corrosion by U. S. Gypsum Co. at its Philadelphia plant. Multiple layers of perlite concrete totaling 6 inches were sprayed onto paper-backed wire lath attached to a Trussteel stud-framework built around the cylindrical surface of the tank, with a 1¾-inch dead-air space between tank and concrete. The tank tops were covered with a 6-inch built-up layer of perlite concrete. All outside concrete tank surfaces were waterproofed with a special wax preparation.[9]

Patents.—A method of expanding perlite by high-frequency induction was patented. Better control of the operating variables is claimed as compared with methods using combustion fuels.[10]

A patent covered a horizontal kiln apparatus for expanding perlite or other earthy materials and included the use of borax to produce a glaze on the expanded particles.[11]

A patented composition for making highly porous cutting and grinding wheels is claimed to result in cooler, faster operation. Expanded perlite is specified as one of the suitable ingredients.[12]

Perlite was specified as one of the suitable mineral fillers in a patented fireproofing composition for coating wood structural units.[13]

A method of manufacturing lightweight gypsum board, lath, or sheathing was patented. It consists of calcined gypsum, expanded perlite, and an air-entraining agent.[14]

Two patents were granted covering methods of comminuting expanded perlite to sizes suitable for filter aids.[15]

A claimed improvement in the permeability of oil-well concrete to liquids was patented. It consists of a slurry of portland cement, a pozzolan, and a mixture of lightweight aggregates having different particle size. Perlite is one of several suitable aggregates.[16]

A high-temperature insulation material was patented and is made by bonding a mixture of expanded perlite, long-fiber asbestos, and

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[7] Pit and Quarry, Increased Sales Predicted at Eighth Annual Meeting of Perlite Institute: Vol. 49, No. 11, May 1957, p. 33.

[8] Funk, Richard S., Perlite: Its Production and Use: Perlite Inst., New York, N. Y., February 1957, 6 pp.

[9] Engineering and Mining Journal, Perlite Concrete Protects Tanks: Vol. 158, No. 11, November 1957, p. 110.

[10] White, E. B., Apparatus for Expanding Finely Divided Particles of Obsidian-Like Material: U. S. Patent 2,810,810, Oct. 22, 1957.

[11] Pierce, H. L., Apparatus for Expanding Earth Materials: U. S. Patent 2,807,453, Sept. 24, 1957.

[12] Robie, N. P. (assigned to Electro Refactories & Abrasives Corp., Buffalo, N. Y.), Abrasive Bodies: U. S. Patent 2,806,772, Sept. 17, 1957.

[13] Hooks, R. M. (assigned to Southwestern Petroleum Co., Inc., Fort Worth, Tex.), Method of Preserving and Fireproofing a Structural Member and Resultant Article: U. S. Patent 2,804,398, Aug. 27, 1957.

[14] Riddell, W. C., and Kirk, G. B. (assigned to Kaiser Gypsum Co., Inc., Oakland, Calif.), Gypsum Board: U. S. Patent 2,803,575, Aug. 20, 1957.

[15] Denning, P. S. (assigned to F. E. Schundler & Co., Joliet, Ill.), Filter Aid & Its Preparation: U. S. Patent 2,798,674, July 9, 1957.

Goldberg, J. Z. (assigned to International Minerals & Chemical Corp., Chicago, Ill.), Apparatus for Comminuting Exfoliated Perlite: U. S. Patent 2,808,212, Oct. 1, 1957.

[16] Mangold, G. B., Dyer, J. A., and Hart, J. T. (assigned to Petroleum Engineering Associates, Inc., Pasadena, Calif.), Permeable Concrete: U. S. Patent 2,793,957, May 28, 1957.

diatomite with lime. It can be used in both high- and low-temperature applications.[17]

An apparatus used for bagging lightweight particulate materials, especially perlite, was patented.[18]

A patent covered a furnace for heating finely divided materials and a method of operation particularly adapted to expansion of perlite. The fluidizing principle, whereby hot gases are injected from the bottom of the furnace, keeping the particles in motion while in contact with the heat, was used.[19]

An insulating wall structure was patented and formed by applying to a metal or plastic screen a composition comprising sodium silicate, aluminum powder, and an insulating mineral aggregate, such as perlite. After implacement, the composition foams, leaving airspaces.[20]

A patented soil-conditioning fertilizer is made by absorbing essential fertilizer chemicals onto expanded perlite, mixing with an organic material such as peat moss, and drying.[21]

A method and apparatus for the continuous, large-scale manufacture of lightweight, reinforced, insulating concrete roof and floor slabs was patented. Expanded perlite may be used as one of the suitable lightweight aggregates.[22]

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[17] Denning, P. S. (assigned to F. E. Schundler & Co., Joliet, Ill.), Manufacture of High-Temperature Insulating Materials: U. S. Patent 2,784,085, Mar. 5, 1957.

[18] Bradford, J. H. (one-half assigned to Combined Metals Reduction Corp., a corporation of Utah), Bag-Filling Apparatus: U. S. Patent 2,781,799, Feb. 19, 1957.

[19] Bradford, J. H. (one-half assigned to Combined Metals Reduction Corp., a corporation of Utah), Method of Heat-Processing Finely Divided Materials and Furnace Therefor: U. S. Patent 2,782,018, February 1957.

[20] Rasmussen, P. D. (assigned to Invention Development Corp., a corporation of Illinois), Insulating Structure: U. S. Patent 2,780,090, Feb. 5, 1957.

[21] Burkell, A. LeR. (assigned to Combined Minerals, Inc., Denver, Colo.), Soil-Conditioning and Fertilizing Compounds and Methods of Manufacture: U. S. Patent 2,779,670, Jan. 29, 1957.

[22] Sterrett, R. W. (assigned to Southern Zonolite Co., Atlanta, Ga.), Manufacture of Roofing Slabs and the Like: U. S. Patent 2,778,088, Jan. 22, 1957.

Phosphate Rock

By E. Robert Ruhlman[1] and Gertrude E. Tucker[2]

ALTHOUGH marketable production of phosphate rock decreased 11 percent in 1957, total sales continued to rise and were 3 percent more than in 1956. World production declined 4 percent.

LEGISLATION AND GOVERNMENT PROGRAMS

The phosphate mineral-leasing act was amended during 1957 to permit leasing a maximum of 10,240 acres of Federal land without geographic limitation. Previously, a company could lease only 5,120 acres in 1 State and a total of 10,240 acres in the United States.

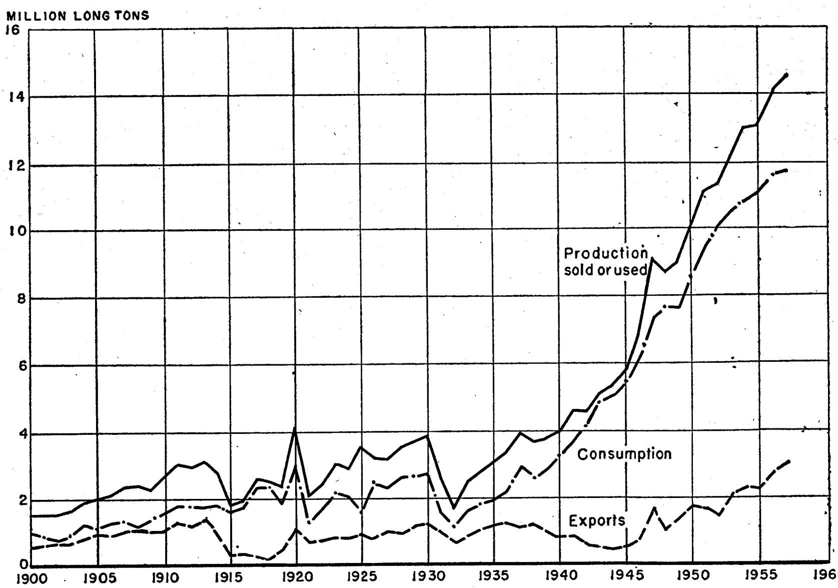

FIGURE 1.—Marketed production, apparent consumption, and exports of phosphate rock, 1900–57.

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

TABLE 1.—Salient statistics of the phosphate-rock industry, 1956–57

	1956				1957			
	Thousand long tons		Value at mines		Thousand long tons		Value at mines	
	Rock	P_2O_5 content	Thousand dollars	Average per ton	Rock	P_2O_5 content	Thousand dollars	Average per ton
United States:								
Mine production	52,198	5,752	(1)	(1)	45,460	6,435	(1)	(1)
Marketable production [2]	15,747	4,960	[3] 97,922	[3] $6.22	13,976	4,356	[3] 87,689	[3] $6.27
Sold or used by producers:								
Florida:								
Land pebble	10,366	3,425	64,354	6.21	10,508	3,467	66,863	6.36
Soft rock	59	12	376	6.40	56	12	401	7.15
Hard rock	103	36	872	8.45	80	28	682	8.59
Total Florida	10,528	3,473	65,602	6.23	10,644	3,507	67,946	6.38
Tennessee	1,663	434	12,792	7.69	1,778	459	11,857	6.67
Western States:								
Idaho	1,206	314	6,044	5.01	1,418	374	6,589	4.65
Montana	714	211	4,794	6.72	575	166	4,129	7.18
Wyoming					182	58	1,197	6.60
Total Western States	1,920	525	10,838	5.64	2,175	598	11,915	5.48
Total United States	14,111	4,432	89,232	6.32	14,597	4,564	91,718	6.28
Imports	110	(1)	[4] 2,626	[4] 23.90	110	(1)	[4] 3,090	[4] 28.21
Exports [5]	2,685	876	15,649	5.83	3,010	977	20,070	6.67
Apparent consumption	11,536	(1)			11,697	(1)		
World: Production	33,750	(1)			32,350	(1)		

[1] Data not available.
[2] See table 3 for kind of material produced.
[3] Derived from reported value of "sold or used."
[4] Market value (price) at port of shipment and time of exportation to the United States.
[5] As reported to the Bureau of Mines by domestic producers.

DOMESTIC PRODUCTION

Production of phosphate-rock ore and marketable phosphate rock decreased in 1957—13 and 11 percent, respectively. The decreased output in 1957, compared with 1956, did not reflect a lower demand. The high output in 1956 was to rebuild normal working stocks, depleted during 1955, when activities in the Florida land-pebble field were curtailed by a labor strike. Florida continued to be the leading producer, followed by the Western States. Statistics on crude ore and marketable ore production have been expanded to show further detail, beginning with the 1957 chapter.

American Cyanamid Co. began operating its new Orange Park mine, washer, and flotation plant 4 miles northeast of Lakeland, Fla. This mine replaced the Saddle Creek operation.

Florida Lightweight Products Co. announced plans to construct at Bartow, Fla., an 80,000-ton-per-year lightweight-aggregate plant that will use phosphatic slimes as raw material.[3]

Victor Chemical Works acquired phosphate-rock deposits formerly owned by Federal Chemical Co. near Mount Pleasant, Tenn., increasing its holdings in Tennessee to more than 10,000 acres.[4] This company also announced plans to construct a phosphate-chemical

[3] Chemical Week, vol. 81, No. 11, Sept. 14, 1957, p. 27.
[4] Victor Chemical Works, 1957 Annual Report, p. 4.

TABLE 2.—Mine production of crude phosphate-rock ore in the United States, 1953–57, by States, in thousand long tons

Year	Florida		Tennessee [1]		Western States		Total United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1953	35,972	4,096	2,465	541	1,702	465	40,139	5,102
1954	41,232	4,729	2,571	527	1,783	489	45,586	5,745
1955	34,491	3,884	2,980	510	2,200	590	39,671	4,984
1956	47,250	4,530	2,524	576	2,424	646	52,198	5,752
1957	40,584	5,293	2,752	587	2,124	555	45,460	6,435

[1] Includes brown rock, white rock, and blue rock in 1954–57.

TABLE 3.—Marketable production of phosphate rock in the United States, 1948–52 (average) and 1953–57, by States, in thousand long tons

Year	Florida [1]		Tennessee [2]		Western States [3]		United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1948–52 (average)	7,979	2,666	1,449	398	1,016	295	10,444	3,359
1953	9,331	3,133	1,519	399	1,654	455	12,504	3,987
1954	10,437	3,454	1,633	422	1,751	484	13,821	4,360
1955	8,747	2,934	1,466	389	2,052	564	12,265	3,887
1956	11,822	3,910	1,685	438	2,240	612	15,747	4,960
1957	10,191	3,352	1,812	469	1,973	535	13,976	4,356

[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 1954–57, and white rock in 1953–57.
[3] Mine production of ore (rock), plus a quantity of washer and drier production.

plant at Richmond, Calif., a laboratory at Chicago Heights, Ill., and an organic-phosphate chemical plant at Mount Pleasant, Tenn.[5]

The Bear Creek Mining Co., subsidiary of Kennecott Copper Co., explored phosphate-rock deposits in northeastern North Carolina.

Interest in reestablishing phosphate-rock production in South Carolina was reported; output in Beaufort County, S. C., stopped in 1904.

A new beneficiation plant of San Francisco Chemical Co. at Leefe, Wyo., began operating at the close of 1957. This plant enabled mining of a phosphate bed formerly not considered economic. The company acquired 360 acres of phosphate-bearing land in the Swan Lake mining district in southeastern Idaho under a Federal lease and planned early development. Elemental-phosphorus production was considered as a means to exploit the Humphreys phosphate deposit near Vernal, Utah. The 15,000 acre deposit was estimated to contain 700 million tons averaging 21 percent P_2O_5.

Plans to mine phosphate rock in the vicinity of Drummond, Mont., were announced by Midas Minerals, Inc.[6]

Central Farmers Fertilizer Co. began open-pit mining at Georgetown, Idaho; the processing plant was nearly completed by December. The 8-mile railroad spur from Georgetown to the plant site was com-

[5] Agricultural Chemicals, Victor Plans Expansions: Vol. 12, No. 8, August 1957, p. 75.
[6] Mining World, vol. 19, No. 7, June 1957, p. 86.

pleted. Yet to be constructed were the elemental phosphorus and calcium metaphosphate plants.

The Huskey Oil Co. and J. A. Terteling & Sons explored for phosphate rock on Federal land in southeastern Idaho.

CONSUMPTION AND USES

Apparent consumption of phosphate rock again set a new record, rising 1 percent above 1956.

Phosphate rock was sold or used primarily for ordinary superphosphate (33 percent in 1957 and 36 percent in 1956), elemental phosphorus (23 percent in 1957 and 1956), exports (21 percent in 1957 and 19 percent in 1956), triple superphosphate including wet-process phosphoric acid (16 percent in 1957 and 14 percent in 1956), and direct application to the soil (5 percent in 1957 and 1956).

The United States Department of Agriculture, in addition to its regular fertilizer reports, released a bulletin on fertilizer production in the United States since 1880 by types of fertilizer.[7]

TABLE 4.—Apparent consumption [1] of phosphate rock in the United States, 1948–52 (average) and 1953–57

Year	Thousand long tons	Year	Thousand long tons
1948–52 (average)	8,712	1955	11,120
1953	10,558	1956	11,536
1954	10,887	1957	11,697

[1] Quantity sold or used by producers plus imports minus exports.

TABLE 5.—Phosphate rock sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Thousand long tons	Value at mines	
		Thousand dollars	Average per ton
1948–52 (average)	10,066	59,045	$5.87
1953	12,518	76,597	6.12
1954	13,044	81,510	6.25
1955	13,186	82,904	6.29
1956	14,111	89,232	6.32
1957	14,597	91,718	6.28

[7] Mehring, A. L., Adams, J. R., and Jacob, K. D., Statistics on Fertilizers and Liming Materials in the United States: U. S. Dept. of Agriculture Statistical Bull. 191, 1957, 182 pp.

TABLE 6.—Florida phosphate rock sold or used by producers, 1948–52 (average) and 1953–57, by kinds

Year	Hard rock			Soft rock [1]		
	Thousand long tons	Value at mines		Thousand long tons	Value at mines	
		Thousand dollars	Average per ton		Thousand dollars	Average per ton
1948–52 (average)	60	458	$7.63	79	395	$4.99
1953	82	644	7.88	76	470	6.19
1954	74	585	7.88	90	554	6.12
1955	92	739	8.04	72	466	6.47
1956	103	872	8.45	59	376	6.40
1957	80	682	8.59	56	401	7.15

Year	Land pebble			Total		
	Thousand long tons	Value at mines		Thousand long tons	Value at mines	
		Thousand dollars	Average per ton		Thousand dollars	Average per ton
1948–52 (average)	7,605	43,702	$5.75	7,744	44,555	$5.75
1953	9,009	54,498	6.05	9,167	55,612	6.07
1954	9,566	58,891	6.16	9,730	60,030	6.17
1955	9,401	57,974	6.17	9,565	59,179	6.19
1956	10,366	64,354	6.21	10,528	65,602	6.23
1957	10,508	66,863	6.36	10,644	67,946	6.38

[1] Includes material from waste-pond operations.

TABLE 7.—Tennessee phosphate rock [1] sold or used by producers, 1948–52 (average) and 1953–57

Year	Thousand long tons	Value at mines	
		Thousand dollars	Average per ton
1948–52 (average)	1,382	9,761	$7.06
1953	1,622	12,251	7.55
1954	1,701	12,012	7.06
1955	1,699	12,579	7.40
1956	1,663	12,792	7.69
1957	1,778	11,857	6.67

[1] Includes small quantity of Tennessee blue rock in 1954–57, white rock in 1952–57, and Virginia apatite in 1949.

TABLE 8.—Western States phosphate rock sold or used by producers, 1948–52 (average) and 1953–57

Year	Idaho [1]			Montana [2]		
	Thousand long tons	Value at mines		Thousand long tons	Value at mines	
		Thousand dollars	Average per ton		Thousand dollars	Average per ton
1948–52 (average)	559	2,016	$3.61	290	2,153	$7.42
1953	1,071	4,091	3.82	658	4,643	7.06
1954	879	4,300	4.89	734	5,168	7.04
1955	1,122	5,551	4.95	799	5,595	7.00
1956	1,206	6,044	5.01	714	4,794	6.72
1957	1,418	6,589	4.65	575	4,129	7.18

Year	Wyoming			Total		
	Thousand long tons	Value at mines		Thousand long tons	Value at mines	
		Thousand dollars	Average per ton		Thousand dollars	Average per ton
1948–52 (average) [3]	91	560	$6.15	940	4,729	$5.03
1953	(2)	(2)	(2)	1,729	8,734	5.05
1954	(2)	(2)	(2)	1,613	9,468	5.87
1955	(2)	(2)	(2)	1,921	11,146	5.80
1956	(2)	(2)	(2)	1,920	10,838	5.64
1957	182	1,197	6.60	2,175	11,915	5.48

[1] Idaho includes Utah in 1948 and 1950–52, and Wyoming in 1949–50.
[2] Montana includes Utah in 1953–55, and Wyoming in 1953–56.
[3] Includes Wyoming data for 1948 and 1951–52 only.

TABLE 9.—Phosphate rock sold or used by producers in the United States in 1956–57, by grades and States

Grades—B. P. L.[1] content (percent)	Florida		Tennessee		Western States		Total United States	
	Thousand long tons	Percent of total	Thousand long tons	Percent of total	Thousand long tons	Percent of total	Thousand long tons	Percent of total
1956								
Below 60	191	2	1,311	79	1,139	59	2,641	19
60 to 66 }	2,546	24	174	11	334	18	689	5
68 basis, 66 minimum }			174	10			4,222	30
70 minimum	1,236	12			447	23		
72 minimum	1,124	10					1,124	8
75 basis, 74 minimum	4,088	39	4	(2)			4,092	29
77 basis, 76 minimum	1,343	13					1,343	9
Total	10,528	100	1,663	100	1,920	100	14,111	100
1957								
Below 60	142	1	1,506	85	1,237	57	2,885	20
60 to 66	245	2	(3)	(3)	(3)	(3)	372	2
68 basis, 66 minimum	2,170	20	77	4	637	29	2,884	20
70 minimum	1,246	12	[3] 172	[3] 10	[3] 301	[3] 14	1,592	11
72 minimum	2,013	19	23	1			2,036	14
75 basis, 74 minimum	3,596	34					3,596	25
77 basis, 76 minimum	1,232	12					1,232	8
Total	10,644	100	1,778	100	2,175	100	14,597	100

Note: in 1956, bracketed values cover two grades: Florida, 60 to 66 and 68 basis, 66 minimum; Tennessee (174, 10), 68 basis, 66 minimum and 70 minimum; Western States (334, 18), 60 to 66 and 68 basis, 66 minimum; Total United States (4,222, 30), 68 basis, 66 minimum and 70 minimum.

[1] Bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Less than 0.5 percent.
[3] Some 60 to 66 grade included with 70 minimum grade.

TABLE 10.—Phosphate rock sold or used by producers in the United States, 1956–57, by uses and States, in thousand long tons

Uses	Florida		Tennessee		Western States		Total United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1956								
Domestic:								
Agricultural:								
Ordinary superphosphate	5,024	1,683	(1)	(1)	115	37	5,139	1,720
Triple superphosphate [2]	1,534	503	[1] 164	[1] 41	273	87	1,971	631
Nitraphosphate	(3)	(3)	-------	-------	-------	-------	(3)	(3)
Direct application to soil	637	198	131	41	7	2	775	241
Stock and poultry feed	229	73	-------	-------	1	(4)	230	73
Fertilizer filler	-------	-------	101	21	-------	-------	109	23
Other [5]	8	2			-------	-------		
Total agricultural	7,432	2,459	396	103	396	126	8,224	2,688
Industrial:								
Elemental phosphorus, ferrophosphorus, phosphoric acid	701	229	1,262	330	1,234	308	3,197	867
Other [6]	-------	-------	5	1	-------	-------	5	1
Total industrial	701	229	1,267	331	1,234	308	3,202	868
Exports [7]	2,395	785	-------	-------	290	91	2,685	876
Grand total	10,528	3,473	1,663	434	1,920	525	14,111	4,432
1957								
Domestic:								
Agricultural:								
Ordinary superphosphate	4,611	1,542	(1)	(1)	(1)	(1)	4,786	1,598
Triple superphosphate	[2] 1,813	[2] 597	[1] 132	[1] 33	[1, 2] 503	[1, 2] 160	[2] 2,273	[2] 734
Nitraphosphate	(3)	(3)	-------	-------	-------	-------	(3)	(3)
Direct application to soil	623	192	84	26	5	1	712	219
Stock and poultry feed	280	92	-------	-------	1	(4)	281	92
Fertilizer filler	-------	-------	93	19	-------	-------	98	21
Other [5]	5	2			-------	-------		
Total agricultural	7,332	2,425	309	78	509	161	8,150	2,664
Industrial:								
Elemental phosphorus, ferrophosphorus, phosphoric acid	705	231	1,446	374	1,261	311	3,412	916
Other [6]	2	(4)	23	7	-------	-------	25	7
Total industrial	707	231	1,469	381	1,261	311	3,437	923
Exports [7]	2,605	851	-------	-------	405	126	3,010	977
Grand total	10,644	3,507	1,778	459	2,175	598	14,597	4,564

[1] Rock for ordinary superphosphate and triple superphosphate are combined.
[2] Rock for phosphoric acid (wet process) included with triple superphosphate.
[3] Included with "Other" agricultural.
[4] Less than thousand long tons.
[5] Includes phosphate rock used in calcium metaphosphate, fused tricalcium phosphate, nitraphosphate, and other applications.
[6] Includes phosphate rock used in pig-iron blast furnaces, parting compounds, research, defluorinated phosphate rock, refractories, and other applications.
[7] As reported to the Bureau of Mines by domestic producers.

STOCKS

Producers' stocks on hand at the end of 1957 were 14 percent less than in 1956; they did not include quantities of matrix reported by producers, except as noted.

TABLE 11.—Stocks of phosphate rock in the United States, 1956–57, in thousand long tons

Source	In producers' hands, Dec. 31 [1]			
	1956		1957	
	Rock	P_2O_5 content	Rock	P_2O_5 content
Florida	2,785	929	2,332	775
Tennessee [2]	251	69	285	79
Western States [2]	[3] 1,394	[3] 360	1,192	296
Total	[3] 4,430	[3] 1,358	3,809	1,150

[1] As reported to the Bureau of Mines by domestic producers.
[2] Includes a quantity of washer-grade ore (matrix).
[3] Revised figure.

PRICES

The year opening and closing prices of Florida land-pebble phosphate rock, as quoted by the Oil, Paint and Drug Reporter, continued their upward trend and averaged 5 percent higher at the end of 1957 than at the close of 1956. Price changes were announced at various times during the year. Prices for Tennessee and Western States phosphate rock were not quoted in the trade journals.

TABLE 12.—Prices per long ton of Florida land pebble unground, washed, and dried phosphate rock, in bulk, carlots, at mine, in 1957, by grades

[Oil, Paint and Drug Reporter of dates listed]

Grades (percent B. P. L.)[1]	Jan. 7	Dec. 30
68/66	$4.94–4.99	$5.26
70/68	5.34–5.39	5.66
72/70	5.99	6.31
75/74	6.99	7.31
78/76	7.99	8.31

[1] B. P. L. signifies bone phosphate of lime, $Ca_3(PO_4)_2$ (P_2O_5=0.458 times B. P. L.).

FOREIGN TRADE [8]

Imports.—Crude-phosphate-rock imports into the United States were the same as in the previous year. Curaçao (Netherlands Antilles) supplied 99 percent of the imports into the continental United States. Makatea Islands (French) continued to furnish phosphate rock to Hawaii. Imports of normal, concentrated, and ammoniated superphosphates, all from Canada, increased 16 percent over 1956. Imports of fertilizer-grade ammonium phosphate, originating mostly from Canada, decreased 11 percent. A small quantity was imported from West Germany and Mexico. Other phosphatic fertilizer materials were imported from Belgium, Canada, Cuba, Luxembourg, Peru, and the United Kingdom.

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

TABLE 13.—Phosphate rock and phosphatic fertilizers imported for consumption in the United States, 1956–57

[Bureau of the Census]

Fertilizer	1956		1957	
	Long tons	Value	Long tons	Value
Phosphates, crude, not elsewhere specified	109.891	$2,626.226	109,546	$3,090,481
Superphosphates (acid phosphate):				
Normal (standard), not over 25 percent P_2O_5 content	272	[1] 17,457	71	3,196
Concentrated (treble), over 25 percent P_2O_5 content	39	3,218	598	38,909
Ammoniated	642	41,394	433	27,806
Total superphosphates	953	62,069	1,102	69,911
Ammonium phosphates, used as fertilizer	170,155	13,034,579	151.313	11,504,968
Bone dust, or animal carbon and bone ash, fit only for fertilizer	11,536	[1] 656,576	9,592	530,670
Guano	11,157	949,180	16,685	1,542,385
Slag, basic, ground, or unground	5,049	16,109	111	1,354
Dicalcium phosphate (precipitated bone phosphate) all grades	3,556	222,492	1,685	101,545

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with earlier years.

Exports.—Total exports of phosphate rock in 1957 were over 3 million long tons, a 9-percent increase over 1956. Florida land-pebble exports increased 5 percent and went mainly to Japan (40 percent), Netherlands (10 percent), United Kingdom (9 percent), Spain (9 percent), and Canada (8 percent). Shipments of "Other phosphate rock," mainly to Canada increased 39 percent in 1957 compared with 1956. A major part of the phosphate exported to Canada was reimported into the United States in the form of manufactured fertilizers. Superphosphates exported mostly to Canada, Brazil, Republic of Korea, and Cuba, increased 14 percent over 1956.

TABLE 14.—Phosphate rock exported from the United States, 1956–57, by grades and countries of destination

[Bureau of the Census]

Grade and country	1956		1957	
	Long tons	Value	Long tons	Value
Florida:				
High-grade hard rock:[1]				
North America:				
Canada	45	$754	69	$924
Cuba			101	1,274
Mexico	1,205	12,246	1,373	15,040
Nicaragua			45	1,832
Total	1,250	13,000	1,588	19,070
South America:				
Brazil	3,237	49,155	482	6,660
Chile	1,969	30,864		
Ecuador			256	3,662
Total	5,206	80,019	738	10,322
Total high-grade hard rock [1]	6.456	93,019	2,326	29,392

See footnotes at end of table.

TABLE 14.—Phosphate rock exported from the United States, 1956–57, by grades and countries of destination—Continued

Grade and country	1956		1957	
	Long tons	Value	Long tons	Value
Florida—Continued				
Land pebble:				
North America:				
Canada	234,479	$2,452,206	223,983	$2,346,251
Cuba	18,431	123,218	24,611	179,347
Mexico	58,632	404,704	63,454	435,897
Total	311,542	2,980,128	312,048	2,961,495
South America:				
Brazil	61,598	740,724	47,370	490,945
Chile	4,908	76,958	1,989	18,029
Colombia	1,003	15,291	1,004	15,715
Peru			2,933	26,400
Uruguay	19,595	214,228	14,078	132,560
Venezuela	91	1,604		
Total	87,195	1,048,805	67,374	683,649
Europe:				
Austria	3,578	27,550		
Denmark	24,834	218,151	31,322	267,129
Germany:				
East	36,474	222,364		
West	96,921	750,677	163,949	1,317,398
Italy	118,724	1,171,148	152,889	1,534,051
Netherlands	189,777	1,697,763	282,165	2,440,185
Spain	145,846	1,283,428	232,445	2,078,786
Sweden	38,335	383,371	64,822	656,961
Switzerland			2,980	26,224
United Kingdom	269,342	2,339,774	240,246	2,008,191
Total	923,831	8,094,226	1,170,818	10,328,925
Asia:				
Japan	1,168,131	8,688,854	1,067,229	7,752,285
Korea, Republic of	1,600	12,320		
Philippines			3,752	34,448
Taiwan	50,056	458,790	49,437	444,897
Vietnam, Laos, and Cambodia			447	6,175
Total	1,219,787	9,159,964	1,120,865	8,237,805
Africa:				
Egypt			3,278	32,780
Union of South Africa	19,980	199,780	16,690	166,870
Total	19,980	199,780	19,968	199,650
Total land pebble	2,562,335	21,482,903	2,691,073	22,411,524
Other phosphate rock:[2]				
North America:				
Canada	304,201	4,002,839	421,279	5,582,680
Costa Rica			228	2,588
Cuba	89	1,271	44	640
El Salvador	223	3,633	357	5,453
Total	304,513	4,007,743	421,908	5,591,361
South America:				
Brazil	7,162	119,331	9,228	130,925
Venezuela			36	745
Total	7,162	119,331	9,264	131,670
Asia:				
Japan			1,626	23,752
Philippines			18	1,300
Total			1,644	25,052
Africa: Liberia	18	1,050		
Total other phosphate rock	311,693	4,128,124	432,816	5,748,083
Grand total	2,880,484	25,704,046	3,126,215	28,188,999

[1] Assumed by the Bureau of Mines to be land pebble.
[2] Includes colloidal matrix, sintered matrix, soft phosphate rock, and Tennessee, Idaho, and Montana rock.

TABLE 15.—Superphosphates (acid phosphates) exported from the United States, 1956–57, by countries of destination

[Bureau of the Census]

Destination	1956		1957	
	Long tons	Value	Long tons	Value
North America:				
Bahamas	9	$556	259	$6,522
British Honduras			201	12,704
Canada	190,903	5,452,288	190,281	5,294,049
Costa Rica	2,328	129,303	2,322	119,553
Cuba	63,670	1,424,932	63,507	1,670,948
Dominican Republic	3,339	193,108	6,944	319,500
El Salvador	585	36,013	804	49,642
Guatemala	263	16,197	262	13,291
Mexico	8,277	524,456	13,396	816,648
Nicaragua	421	31,142	346	25,987
Panama			18	1,053
Trinidad and Tobago	120	7,526	912	59,017
Other	21	552	219	14,590
Total	269,936	7,816,073	279,471	8,403,504
South America:				
Bolivia			134	11,550
Brazil	94,457	[1] 3,807,508	107,173	5,012,552
British Guiana			135	8,396
Chile	2,968	170,600	5,484	338,965
Colombia	9,325	558,043	28,995	1,896,509
Ecuador	318	20,135	119	7,999
Peru	979	41,059	5,920	138,437
Venezuela	8,539	387,052	7,888	335,190
Total	116,586	[1] 4,984,397	155,848	7,749,598
Europe: Greece			9,498	553,967
Asia:				
Indonesia	596	40,205	246	16,797
Iran			62	4,243
Korea, Republic of	102,657	3,972,874	102,385	5,913,463
Pakistan			4,591	254,080
Philippines	1,071	50,434	2,204	139,651
Saudi Arabia	150	18,360		
Vietnam, Laos, and Cambodia	708	44,554		
Total	105,182	4,126,427	109,488	6,328,234
Africa:				
Belgian Congo			1,322	2,800
Rhodesia and Nyasaland, Federation of			3,125	161,480
Union of South Africa	2,321	39,780	2,672	160,509
Total	2,321	39,780	7,119	324,789
Grand total	494,025	[1] 16,966,677	561,424	23,360,092

[1] Revised figure.

TABLE 16.—"Other phosphate material" [1] exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Long tons	Value	Year	Long tons	Value
1948–52 (average)	1,807	$244,142	1955	4,923	$556,779
1953	8,477	178,168	1956	10,587	954,110
1954	5,243	456,330	1957	13,963	1,344,641

[1] Class includes animal carbon, apatite, basic slag, bone-ash dust, bone meal, char dust, defluorinated phosphate rock, duplex basic phosphate, permanente thermosphos (granular), tricalcium phosphate (fused).

WORLD REVIEW

World consumption of fertilizer from 1951 to 1956 was reviewed, and some analyses of changes in supply-demand pattern were given.[9]

NORTH AMERICA

Canada.—The Electric Reduction Co. of Canada, an elemental phosphorus producer, announced plans for a new plant at Port Maitland, Ontario.[10] The plant will have facilities for producing phosphoric acid from elemental phosphorus and from phosphate rock by the wet process.

Mexico.—Investigation of the phosphate-rock deposits in northern Zacatecas continued, and the estimated reserve was 6 million tons containing 18 to 20 percent P_2O_5.[11] Deposits containing 20 percent P_2O_5 were reported in the Carbonera area of Nueva Leon.

The phosphatic sand deposits in Santo Domingo containing a mixture of collophane, quartz, feldspar, zircon, and ilmenite, extend for over 45 miles along the coast of Baja California. The clean sand as mined, about ¾ minus 60-plus 100-mesh, contains about 3 percent P_2O_5 and is suitable for beneficiation. In addition to producing 31-percent P_2O_5 phosphate-rock concentrate, the recovery of quartz, ilmenite, and zircon byproducts was also being investigated.[12]

SOUTH AMERICA

Brazil.—Fosphorita Olinda operated the phosphate rock mine at Olinda near Recife, Pernambuco. The 2,400-ton-per-day washing plant began producing during the second half of the year. The planned distribution of this material is 70 percent to southern and 30 percent to northeast Brazil.

Venezuela.—Reserves of phosphate rock in deposits in the State of Falcon were estimated at 3 million tons containing 31 percent P_2O_5 and 2 million tons containing 25–27 percent P_2O_5.[13]

EUROPE

Germany, West.—The Third World Fertilizer Congress was held at Heidelberg, Germany, from September 9 to 12, 1957. This convention, held every fifth year, was organized by the International Confederation of Agricultural Engineers and Technicians (Paris, France) and the International Center of Chemical Fertilizers (Zurich, Switzerland).

U. S. S. R.—Expansion of the Kara-Tau phosphate-rock deposits as part of the fertilizer 5-year plan was underway.[14] The hygroscopic nature of superphosphate made from Kara-Tau rock caused considerable difficulty. One way of improving the physical condition of the material was ammoniation.

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9 Ewald, D. U., Recent Developments of the World Fertiliser Market: Institut fur Weltwirtschaft an der Universitat Kiel, Kiel, Germany, 1957, 227 pp.
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12 Smiley, W. D., Schellinger, A. K., and Elkind, Charles, Mexican Phosphate's Role in the Pacific Basin: Pres. at Pacific Southwest Mineral Industry Conference, Reno, Nev., Apr. 5–6, 1957, 9 pp.
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14 Ivanov, R. N., Khimicheskaya Promyshlennost: No. 2, 1957, pp. 79–82.

TABLE 17.—World production of phosphate rock by countries,[1] 1948–52 (average) and 1953–57, in thousand long tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
United States	10,444	12,504	13,821	12,265	15,747	13,976
West Indies:						
Jamaica (guano)	[3] 1	1	1	(4)	(4)	(4)
Netherlands Antilles (exports)	93	95	124	109	104	105
Total	10,538	12,600	13,946	12,374	15,851	14,081
South America:						
Brazil	12	[5] 12	[5] 64	[5] 123	[5] 123	[5] 123
Chile:						
Apatite	39	58	41	52	58	[5] 54
Guano	37	[5] 30	[5] 30	[5] 30	[5] 30	[5] 30
Peru (guano)	[5] 295	257	289	285	331	280
Venezuela	-------	-------	-------	-------	30	30
Total [5]	383	357	424	490	572	517
Europe:						
Belgium	69	35	26	19	13	16
France	89	86	117	101	66	[5] 69
Spain	23	22	22	23	8	1
Sweden (apatite)	7	9	-------	-------	-------	-------
U. S. S. R.:						
Apatite [5]	2,030	2,760	3,100	3,445	3,690	3,940
Sedimentary rock [5]	900	1,205	1,330	1,425	1,575	1,720
Total [1] [5]	3,390	4,370	4,850	5,260	5,600	6,000
Asia:						
British Borneo (guano)	1	1	1	(4)	(4)	(4)
China [5]	45	150	200	250	250	300
Christmas Island (Indian Ocean) (exports)	271	280	351	390	341	336
India (apatite)	1	4	2	6	9	9
Indonesia	[5] 2	1	6	[5] 6	[5] 6	[5] 6
Israel	[3] 9	23	54	84	118	148
Jordan	[6] 7	39	74	161	205	258
Philippines (guano)	10	1	2	(4)	8	4
Total [1] [5]	350	510	710	920	960	1,080
Africa:						
Algeria	686	609	761	740	596	596
Egypt	423	477	526	636	605	[5] 590
French West Africa (aluminum phosphate)	22	[7] 93	[7] 77	[7] 111	[7] 72	[7] 89
Madagascar	(4)	2	1	2	3	[5] 3
Morocco: Southern Zone	3,831	4,090	4,940	5,245	5,435	5,480
Seychelles Islands (exports)	10	9	12	4	4	6
South-West Africa (guano)	1	2	1	2	1	3
Tunisia	1,727	1,691	1,795	2,067	2,044	2,035
Uganda	2	5	3	3	3	3
Union of South Africa	64	79	93	134	154	166
Total	6,766	7,057	8,209	8,944	8,917	[5] 8,970
Oceania:						
Angaur Island (exports)	145	[5] 111	122	137	-------	-------
Australia	3	3	6	6	7	[5] 10
Makatea Island (French Oceania) (exports)	229	247	225	216	250	300
Nauru Island (exports)	890	1,160	1,178	1,401	1,333	1,105
Ocean Island (exports)	226	282	292	309	297	292
Total	1,493	1,803	1,823	2,069	1,887	1,707
World total (estimate) [1] [2]	22,920	26,750	29,950	30,050	33,750	32,350

[1] In addition to the countries listed, a negligible quantity is produced in Angola, British Somaliland, Canada, Japan, Southern Rhodesia, and Tanganyika; estimates by the author of the chapter for Austria, Ireland, North Korea, and Poland are included in the total.
[2] This table incorporates a number of revisions of data published in previous Phosphate Rock chapters. Data do not add to totals shown, owing to rounding where estimated figures are included in the detail.
[3] Average for 1951–52.
[4] Less than 500 tons.
[5] Estimate.
[6] Exports.
[7] Includes calcium phosphate, production of which is reported in thousand long tons, as follows: 1953, 41; 1954, 5; 1955, 8; 1956, 5; 1957, 1.

ASIA

Israel.—The Negev Phosphate, Ltd., further expanded phosphate-ore production from the Oron district in the Negev Desert. The ore averaging 24 percent P_2O_5, was processed in an air separation plant to 28.5 percent P_2O_5 with less than 50-percent recovery. By the end of 1957 marketable output was reported at the rate of 200,000 tons per year. The major cost continued to be transportation to Haifa. Joint surveys with foreign groups were underway to extend phosphate-rock reserves and improve recovery methods.[15]

Jordan.—The Jordan Phosphate Co. Ltd., Roseifa (Ruseifeh) mine, continued to be the only producer in 1957. Recent reserve estimates disclosed 2.7 million tons proved and 25 million tons probable, 32 to 34 percent P_2O_5, at Roseifa and 10 to 20 million tons probable, 29 to 32 percent P_2O_5, at Al Hasa.[16] A Yugoslav company was exploring for phosphate rock in southern Jordan under a concession from the Government. Improvement of transportation and port facilities was underway further to increase exports.[17]

AFRICA

French Equatorial Africa.—The Société des Phosphates du Congo reported reserves of 3.5 million tons in a narrow phosphate belt nearly 100 miles long. Exploration was stopped in early 1957, pending availability of electric power.[18]

French West Africa.—The Société Minière du Benin began developing phosphate deposits in Southern Togo under 50-year concessions granted by the Togo Government.[19]

Plans were reported for phosphate production from the deposits near Taïba in Serregal during 1959, by the Compagnie Sénégalaise des Phosphates de Taïba. This company was owned by Bureau Minier de la France d'Outre-Mer, Pierrefitte, Péchiney, the Phos-

TABLE 18.—Exports of phosphate rock from Egypt, 1952–56, by countries of destination, in long tons [1] [2]

[Compiled by Corra A. Barry]

Country	1952	1953	1954	1955	1956
Belgium-Luxembourg		1,500	600	(4)	(4)
Ceylon	33,909	31,749	34,949	38,299	36,899
Czechoslovakia		12,500	52,204	62,164	70,969
Finland	23,325	10,137	5,019	(3) 9,744	
Germany, West	37,156		3,899	(3) 2,067	(4)
Greece	11,732			(4)	(4)
India	28,498	5,100	27,470	18,199	18,133
Indonesia	4,675	3,986	3,133	(4)	3,440
Italy	38,976	39,894	33,834	32,912	3,956
Japan	173,593	202,585	210,997	231,534	236,358
Netherlands		49,030	16,733		(3) 1,511
Spain				(3) 19,155	31,099
Union of South Africa	60,265	16,648		(4)	(4)
Other countries	4,000		3	231	6,173
Total	416,129	373,129	388,841	414,305	408,538

1 Compiled from Customs Returns of Egypt.
2 This table incorporates a number of revisions of data published in the previous phosphate-rock chapter.
3 Detail shown by country of importation.
4 Data not available.

15 Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, p. 28.
Mining Journal (London), Phosphate and Potash in Israel: Vol. 249, No. 6376, Nov. 1, 1957, p. 510.
16 Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 1, January 1957, pp. 26–27.
17 Chemical Trade Journal and Chemical Engineer (London), Jordanian Phosphate: Vol. 140, No. 3631 Jan. 4, 1957, p. 23.
18 U. S. Consulate, Elisabethville, Belgian Congo, State Department Dispatch 15: Feb. 20, 1958, p. 7.
19 Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 5, May 1957, p. 31.

phates de l'oceanie, the Phosphates de Constantine, and the Territoire du Sénégal.[20]

Rhodesia and Nyasaland, Federation of.—The Dorowa deposits in Southern Rhodesia, explored by African Explosives and Chemical Industries, Ltd., were reported to contain 20 million tons of phosphate rock. Plans for constructing a pilot processing plant were announced.[21] Another deposit at Shawa, 16 miles from Dorowa, was explored during 1957.

The Anglo-American Corp. planned exploration of phosphate deposits near Mlanje in southern Nyasaland.[22]

Tunisia[23].—Phosphate-rock production in Tunisia came mainly from the Southern Basin around Gafsa, where the Compagnie des Phosphates et du Chemin de Fer de Gafsa operated mines and beneficiation plants at Metlaoui, Moulares, and Redeyef, and the Compagnie Tunisienne des Phosphate du Djebel M'Dilla operated a mine and beneficiation plant at M'Dilla. The Gafsa company normally produced 75 percent and the M'Dilla company 15 percent of the Tunisian output. The remaining 10 percent came from the Kalaa Djerda mine in the Central Basin in east central Tunisia.

In the Southern Basin, the ore, averaging 27 percent P_2O_5, was mined underground and upgraded by washing to 29.7 percent P_2O_5. Output by the Gafsa and M'Dilla companies was shipped about 155 miles to Sfax on the Gafsa-owned railroad. The beneficiated rock at Sfax was either used for manufacturing triple superphosphate or hyperphosphate (finely ground for direct application), or exported crude. In 1957 the annual capacity of the triple superphosphate plant was 100,000 tons of 44 percent P_2O_5 material, and that of the hyperphosphate plant was 150,000 tons.

A total of 8,500 Tunisians and 500 Europeans mined and processed phosphate rock in Tunisia.

Both the Gafsa and M'Dilla plants were investigating further beneficiation methods to produce a 34-percent P_2O_5 phosphate rock.

Exports in 1957 were 4 percent less than in 1956.

Uganda.—Investigation of the Sukulu apatite deposits near Tororo by the Sukulu Mines, Ltd., continued during 1957. A pilot plant began recovering apatite concentrate in November 1956, and the market was being studied in early 1957.[24]

Union of South Africa.—The Fosfaat Ontginningskorporasie (FOSKOR) resumed mining apatite at its Phalaborwa mine early in 1957. Fertilizer manufacturers expressed a preference for sedimentary phosphate rock for acidulation, and the company (FOSKOR) experienced difficulty in disposing of its output.[25]

African Metals Corp., Ltd., and Pretoria North Development Co. (Pty.), Ltd., produced small tonnages of phosphate rock.

OCEANIA

Australia and New Zealand.—The British Phosphate Commission began a 3-year exploration program for phosphate-rock deposits in Australia, New Zealand, and many coastal islands.

[20] Chemistry and Industry, Exploitation of the Phosphates at Taïba in Sénégal: No. 27, July 6, 1957 p. 945.
[21] Chemical Week, vol. 80, No. 8, Feb. 23, 1957, p. 25.
[22] Rhodesian Mining Review (Salisbury), Prospects of Mining Development in Nyasaland: Vol. 21, No. 3, March 1956, p. 29.
[23] U. S. Embassy, Tunis, Tunisia, State Department Dispatch A-277: Feb. 12, 1958, 17 pp.; Dispatch 402: Jan. 8, 1958, pp. 21, 24; enclosure 1, pp. 3, 6.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, pp. 41–42.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 1, January 1957, pp. 27–30. Fertiliser and Feeding Stuffs Journal (London), vol. 66, No. 8, Apr. 10, 1957, p. 367.

TABLE 19.—Exports of phosphate rock from North Africa, 1955–57, by countries of destination, in long tons [1]

[Compiled by Corra A. Barry]

Country	1955	1956	1957
North America:			
Canada	6,457	4,921	
French West Indies	738		
South America:			
Argentina	3,475	888	
Brazil	61,881	68,098	46,757
Chile	22,250	7,642	12,795
Uruguay	16,840	17,616	11,564
Europe:			
Austria	25,901	6,154	40,353
Belgium	342,598	416,132	436,309
Czechoslovakia	67,614	21,993	21,544
Denmark	205,483	228,591	207,264
Finland	40,963	99,636	127,603
France	1,435,376	1,460,763	1,505,286
Germany	632,858	631,174	668,707
Greece	141,500	139,581	101,791
Hungary	5,904	14,019	
Ireland	111,836	118,180	68,319
Italy	1,211,007	1,195,711	1,121,892
Netherlands	363,007	351,642	375,554
Norway	62,573	53,606	75,524
Poland	280,503	305,135	254,982
Portugal	223,693	257,052	248,916
Spain	694,225	727,270	622,110
Sweden	252,528	289,550	243,038
Switzerland	21,719	24,318	23,587
United Kingdom	859,601	792,961	729,118
Yugoslavia	65,950	34,182	54,693
Asia:			
Ceylon	1,000		
India	9,590	8,308	3,100
Indonesia	13,730	17,416	14,592
Japan	138,849	97,767	90,288
Malaya	3		
Philippines	115		
Taiwan	38,997	25	
Thailand	2,116		
Turkey	48,301	26,687	8,449
Vietnam, Laos, and Cambodia	25,836	10,150	2,953
Africa:			
Canary Islands		3,223	14,916
Madagascar	408		
Morocco: Northern Zone	3,130		
South Africa (including Rhodesia)	341,698	343,854	379,394
Oceania:			
Australia	11,108		
New Zealand	5,950		
Local shipments [2]	(3)	357,245	415,278
Total	7,797,311	8,131,490	7,926,676
Algeria	711,709	621,560	602,916
Morocco: Southern Zone	5,165,172	4,481,576	5,385,859
Tunisia	1,920,430	2,028,354	1,937,901

[1] Compiled from Customs Returns of Algeria, Morocco, and Tunisia.
[2] Trade between Algeria, Morocco, and Tunisia.
[3] Data not available.

Albright & Wilson (Australia) Pty., Ltd., the only elemental-phosphorus producer in Australia, began constructing its third electric furnace at the Yarraville plant near Melbourne.[26]

Christmas Island.—Administration of Christmas Island was transferred from Singapore to the Australian Government. The British Phosphate Commission announced that increased mechanization and processing facilities were planned and would enable production to reach 800,000 tons of phosphate rock by 1961.[27]

Makatea Island.—Exports of phosphate rock in 1957 went to

[26] Chemical Trade Journal and Chemical Engineer (London), Phosphorus Products in Australia: Vol. 141, No. 3664, Aug. 23, 1957, p. 453.
[27] Fertiliser and Feeding Stuffs Journal (London), vol. 47, No. 6, Sept. 11, 1957, p. 263.
Industrial and Mining Standard (Melbourne), Phosphate Outpost: Vol. 112, No. 2836, June 20, 1957, p. 2.

Japan, 202,100; New Zealand, 56,000; India, 27,500; Formosa, 10,500; and Hawaiian Islands, 3,675 long tons.

Solomon Islands.—Phosphate rock was reported from Bellona Island. Grade and extent of the deposits were not known.[28]

TECHNOLOGY

Studies of the Federal Geological Survey in Beaufort and Hyde Counties, N. C., disclosed extensive phosphate-rock deposits. The phosphate-bearing sands, ranging from a few feet up to 90 feet in thickness, were overlain by 45 to 250 feet of overburden. The sands, ranging from 8 to 31 percent P_2O_5, occurred in an area of more than 450 square miles.

Phosphate-rock deposits in Florida were divided into the "pebble district," "outlying pebble districts," and the "hard-rock district." Industry was active mainly in the pebble district.[29] Phosphate deposits in the northern part of the hard-rock district in Alachua County were investigated.[30]

Methods employed in mining Tennessee brown-rock phosphate were described.[31] Stripping was accomplished by bulldozers and draglines. Ore was recovered with draglines.

The research on mechanized, underground phosphate-rock mining was continued by the Federal Bureau of Mines. A new phosphate planer was built and tested with encouraging results. Test work in the southeast Idaho area was planned.

Occurrences of phosphate rock in California were described.[32]

Belt concentrators were used in the Florida land-pebble phosphate field to upgrade and recover minus-20-, plus-48-mesh rock.[33]

Beneficiation investigations of phosphate-rock deposits in the Wind River Mountains of Wyoming disclosed that 40 to 50 percent of calcite in phosphate rock could be eliminated by calcining, slaking, and washing.[34]

Problems of elemental-phosphorus production and means of solving them in a United States plant were described.[35] Operation of the largest elemental phosphorus plant in England, Albright & Wilson, Ltd., at Portishead, was described. The plant capacity was 20,000 tons per year from 6 electric furnaces.[36]

The Clinker process for manufacturing phosphoric acid eliminated the evaporation step used in the wet process and enabled production of phosphoric acid containing about 33 percent P_2O_5.[37] Improvement of the wet process was also reported.[38]

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[28] Mining Magazine (London), Phosphate on Bellona Island: Vol. 96, No. 1, January 1957, pp. 36–37.
[29] LeBaron, I. M., The Phosphate Industry in Florida: Farm Chemicals, vol. 120, No. 8, August 1957, pp. 49–52.
[30] Pirkle, E. C., Economic Consideration of Pebble Phosphate Deposits of Alachua County, Florida: Econ. Geol. and Bull. of Soc. of Econ. Geol., vol. 52, No. 4, June–July 1957, pp. 354–378.
[31] Mining Magazine (London), Overburden Removal at an American Phosphate Pit: Vol. 97, No. 4, October 1957, pp. 219–220.
Mining World (London), Recovering Phosphate From Hillside Deposits in Tennessee: Vol. 19, No. 12, November 1957, p. 83.
[32] Kundert, C. J., Phosphates: Chap. in Mineral Commodities of California, Dept. of Natural Resources, Division of Mines, Bull. 176, 1957, pp. 425–429.
[33] Engineering and Mining Journal, How Coronet Uses Belt Concentrator: Vol. 158, No. 12, December 1957, pp. 81–83.
[34] Duncan, W. E., and Fisk, H. G., Central Wyoming Phosphate Rock—Character, Processing and Economics: Univ. of Wyoming, Coll. of Eng., Natural Resources Research Inst., Laramie, Wyo., Bull. 6, September 1957, 60 pp.
[35] Antaki, V. N., Production of Elemental Phosphorus: Min. Eng., vol. 9, No. 3, March 1957, pp. 339–341.
[36] Chemical Trade Journal and Chemical Engineer (London), Phosphorus Manufacture at Portishead: Vol. 140, No. 3643, Mar. 29, 1957, pp. 739–740.
[37] Legal, C. C., Jr., Pryor, J. N., Tongue, T. O., and Veltman, P. L., Phosphoric Acid by the Clinker Process: Ind. Eng. Chem., vol. 49, No. 3, March 1957, pp. 334–337.
[38] Chemical Trade Journal and Chemical Engineer (London), Phosphoric Acid: Vol. 140, No. 3640, Mar. 8, 1957, p. 569.

Facilities for using fluorine liberated in processing phosphate rock were increased.[39]

Processes for extracting uranium from phosphate rock were based mainly on solvent extraction or ion exchange. Moroccan phosphate rock contained 105 parts per million of U_3O_8, and the fertilizer industry in the United Kingdom was investigating possible recovery methods.[40]

Additional information on properties and production methods of "superphosphoric acid" was published.[41]

Research continued on the use of liquid fertilizers.[42]

Several articles concerning the advantages of various types of phosphates,[43] the solubility of phosphates,[44] and analyses for phosphate content [45] were published in 1957.

Granulation and ammoniation continued to play an important role in new fertilizer technology.[46] Recent developments, including methods of producing ammonium phosphate-nitrate and ammonium phosphate-urea, were described.[47]

Safety in handling phosphate insecticides was stressed as an important factor in the expanding complex insecticide market.[48]

A new technique in manufacturing sodium-phosphate glass was using colloidal platinum in separating 2 liquid phases before crystallization.[49]

Trace elements in phosphatic and other fertilizers continued to receive considerable attention during the year.[50]

Continued research by the synthetic-detergent industry developed a bar detergent for home use.[51] This development, together with food processing and other new chemical uses for synthetic detergents, will increase the demand for phosphate chemicals produced from elemental phosphorus.

39 Farm Chemicals, OM Recovers Fluoride From P_2O_5 at Pasadena: Vol. 120, No. 5, May 1957, p. 8.
Mining Congress Journal, Big Fluorine Contract Set: Vol. 43, No. 12, December 1957, p. 79.

40 Stedman, R. E., The Recovery of Uranium From Phosphate Rock: Chem. Ind. (London), No. 6, Feb. 9, 1957, pp. 150–153.

41 Commercial Fertilizer, Data on 76 Percent P_2O_5 "Superphosphoric Acid" for Granular and Liquid Mixes: Vol. 95, No. 4, October 1957, pp. 57–58.

42 Commercial Fertilizer, TVA Liquid-Fertilizer Experiments With Wet-Process Acids, Interim Rept.: Vol. 94, No. 4, April 1957, pp. 28–29.

43 Agricultural Chemicals, Di-Calcium Phosphate as a Phosphatic Fertilizer: Vol. 12, No. 9, September 1957, pp. 57–58; Calcium Phosphates: No. 7, July 1957, pp. 40–41, 47; No. 8, August 1957, pp. 30–32, 95, 97.
Boylan, D. R., New Developments in Fertilizer Technology: Com. Fert., vol. 94, No. 5, May 1957, pp. 24–33.
Nordengren, S., New Theories of Phosphate Reactions in the Soil: Fertiliser and Feeding Stuffs Jour. (London), vol. 47, No. 8, Oct. 9, 1957, pp. 345–346, 348–352.

44 Cook, R. L., Lawton, K., Robertson, L. S., and Hansen, C. M., Phosphorus Solubility, Particle Size and Placement as Related to the Uptake of Fertilizer Phosphorus and Crop Yields: Com. Fert., vol. 94, No. 6, June 1957, pp. 41–43, 46, 47.
Sauchelli, Vincent, Water Solubility of Phosphates: Agr. Chem., vol. 12, No. 2, February 1957, pp. 49–50; No. 3, March 1957, p. 55.

45 Journal of the Association of Official Agricultural Chemists, Report on Phosphorus in Fertilizers: Vol. 40, No. 3, August 1957; Jacob, K. D., and Hoffman, W. M. I, Preparation of Solution of Sample for Total Phosphorus Determination, pp. 690–700; Epps, E. A., Jr., and Jacob, K. D., II, Photometric Determination of Phosphorus, pp. 700–711; Jacob, K. D., and Hoffman, W. M., III, Mechanical Analysis of Phosphate Rock, pp. 711–722.
Marshall, H. L., and Replogle, M. H., Volumetric Analysis of Triple Superphosphate: Agr. Chem., vol. 12, No. 4, April 1957, pp. 48–50, 120–122.

46 Hignett, T. P., The Changing Technology of Granulation and Ammoniation: Agr. Chem., vol. 12, No. 1, January 1957, pp. 30–33, 107, 109, 111.
Chemical Age (London), New Developments in Fertiliser Granulation: Vol. 78, No. 2003, November 1957, p. 877.

47 Rapp, H. F., and Hardesty, J. O., Granulation of Mixed Fertilizers in Experimental Equipment and Determination of Storage and Drilling Characteristics of the Products: Agr. Food Chem., vol. 5, No. 6, June 1957, pp. 426–433.

48 Shaffer, C. B., Safety with Phosphate Insecticides: Agr. Chem., vol. 12, No. 1, January 1957, pp. 34–35, 99.

49 Rindone, G. E., and Ryder, R. J., Phase Separation Induced by Platinum in Sodium Phosphate Melts: Glass Ind., vol. 38, No. 1, January 1957, pp. 29–31, 51.

50 Fertiliser and Feeding Stuffs Journal (London), Trace-Element Symposium: Vol. 46, No. 7, Mar. 27, 1957, p. 305; Effect of Phosphate and Molybdenum on the Provision of Nitrogen for Pasture: Vol. 47, No. 5, Aug. 28, 1957, pp. 197–198, 201; No. 4, Aug. 14, 1957, p. 162.
Fisher, T. R., and McIntyre, C. K., Jr., Boron Additions to Liquid Fertilizers: Com. Fert., vol. 94, No. 6, June 1957, pp. 34–35.
Wallace, T., Trace Elements in Plant Nutrition: Fertiliser and Feeding Stuffs Jour. (London), vol. 46, No. 6, Mar. 13, 1957, pp. 243–244, 247, 250.

51 Snell, F. D., Synthetic Detergents: Petrol. Processing, vol. 12, No. 9, September 1957, p. 114.

Platinum-Group Metals

By J. P. Ryan [1] and Kathleen M. McBreen [2]

RECORD world production, declining demand, and growing oversupply featured the platinum-group-metal industry in 1957. Supply and demand were reversed from last year, when domestic consumption reached an alltime high and prices remained relatively stable. Reflecting the falling demand and increased world supply, platinum prices declined steadily from a high of $103–$107 at the beginning of the year to a low of $76–$80 at the end of the year. Both net imports and domestic consumption of platinum declined sharply from the alltime high of 1956 owing principally to the drop in demand from the petroleum-refining industry, the leading consumer of the metal. Substantial quantities of platinum continued to be offered on the open market by the U. S. S. R. and contributed to the decline in prices.

Rustenburg Platinum Mines, Ltd., the world's leading producer of platinum, continued the expansion of production facilities begun in 1956 at its mines in the Union of South Africa. Full-scale development of the large deposits of platinum-bearing nickel deposits in Manitoba, Canada, begun last year was continued during 1957 by International Nickel Co. of Canada, Ltd., which ranked second in the world as a producer of platinum-group metals.

LEGISLATION AND GOVERNMENT PROGRAMS

The regulations established on March 23, 1953, under the Defense Materials System by Business and Defense Services Administration of the United States Department of Commerce included platinum-group metals and remained in effect throughout 1957. Orders for military or atomic-energy uses had priority ratings and took precedence over unrated orders.

All platinum-group metals and their manufactures required a validated license for export to Soviet Bloc countries—Communist China, Hong Kong, and Macao, and Communist-controlled areas of Viet-Nam and Laos.

Platinum-group metals were eligible for 50-percent financial assistance under the Defense Minerals Exploration Administration (DMEA) program; no projects were active in 1957.

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

TABLE 1.—Salient statistics of platinum-group metals in the United States 1948–52 (average) and 1953–57, in troy ounces

	1948–52 (average)	1953	1954	1955	1956	1957
Production:						
Mine production from crude platinum placers, and byproduct platinum-group metals recovered largely from domestic gold and copper ores [1]	30,655	26,072	24,235	23,170	21,398	18,531
Value	(2)	$1,860,000	$1,767,995	$1,874,271	$1,884,487	$1,428,642
Refinery production:						
New metal:						
Platinum	42,064	46,963	47,421	52,011	50,516	37,109
Palladium	7,100	6,347	4,605	6,123	4,389	4,031
Other	4,872	6,957	4,740	3,347	3,745	6,088
Total	54,036	60,267	56,766	61,481	58,650	47,228
Secondary metal:						
Platinum	37,051	29,547	31,330	32,901	60,916	49,022
Palladium	28,067	30,494	31,190	26,124	37,774	31,294
Other	4,366	4,816	3,179	5,311	7,579	7,205
Total	69,484	64,857	65,699	64,336	106,269	87,521
Consumption:						
Platinum	215,498	276,580	320,215	467,065	430,644	347,983
Palladium	172,285	231,525	234,537	351,663	399,991	367,287
Other	25,851	25,193	27,194	32,083	28,277	30,278
Total	413,634	533,298	581,946	850,811	858,912	745,548
Stocks in hands of refiners, importers, and dealers, Dec. 31: [3]						
Platinum	172,663	203,413	243,040	304,462	353,778	306,988
Palladium	141,381	130,206	115,299	153,092	163,730	154,005
Other	40,796	41,727	43,538	45,534	47,025	46,196
Total	354,840	375,346	401,877	503,088	564,533	507,189
Imports for consumption:						
Unrefined materials	42,983	48,525	52,528	50,953	[4] 41,221	33,180
Refined metals	351,578	585,563	553,916	958,987	[4] 992,656	653,803
Total	394,561	634,088	606,444	1,009,940	[4] 1,033,877	686,983
Exports:						
Ore and concentrates	197	30	29			
Refined metals and alloys, including scrap	39,903	25,728	28,423	[5] 28,968	[5] 42,072	[5] 40,354
Manufactures (except jewelry)	(6)	(6)	(6)	(6)	(6)	(6)

[1] Includes Alaska.
[2] Figure not available.
[3] Figures for 1948–56 are revised.
[4] Revised figure.
[5] Due to changes in classifications data not strictly comparable with years before 1955.
[6] Beginning January 1, 1952, quantity not recorded.

DOMESTIC PRODUCTION

CRUDE-PLATINUM PRODUCTION

Mine returns and refinery reports indicate a domestic recovery of 18,500 troy ounces of platinum-group metals from crude platinum in 1957 compared with 21,400 ounces in 1956, a decrease of 13 percent. This metal was recovered from crude platinum mined at placer-platinum deposits in the Goodnews Bay district in Southwestern Alaska, from gold placers in California that yielded byproduct crude platinum, from some gold and copper ores that contained small quantities of platinum-group metals, and as a byproduct in smelting and refining operations.

REFINED PLATINUM-GROUP METALS

New Metals Recovered.—Reports from refiners indicate recovery in the United States of 47,230 ounces of new platinum-group metals in 1957, compared with 58,650 ounces in 1956, a drop of nearly 20 percent. Of the total new metals refined in 1957, 89 percent was recovered from crude platinum, both domestic and foreign, and 11 percent was recovered as a byproduct of gold and copper ores; comparable figures in 1956 were 90 and 10 percent, respectively.

Secondary Metals Recovered.—Refiners in the United States recovered 87,500 ounces of platinum-group metals, chiefly from scrap, sweeps, and outmoded jewelry, in 1957, compared with 106,300 in 1956. In addition, about 800,000 ounces of platinum-group metals in wornout catalysts, spinnerets, laboratory ware, and other forms was returned to refiners for reworking or refining on toll; the metals so recovered (or their equivalent in refined metals) are returned to consumers for reuse and are not included in the total for secondary metals.

Domestic-refinery production of platinum, palladium, and iridium (new and secondary) in 1957 dropped 23, 16, and 3 percent, respectively, below 1956 production. Refinery production (new and secondary) of osmium, rhodium, and ruthenium increased 84, 13, and 33 percent, respectively.

Refinery production of platinum-group metals from domestic ores and secondary materials furnished about 14 percent of domestic requirements.

TABLE 2.—New platinum-group metals recovered by refiners in the United States, 1948–52 (average), 1953–55, and 1956–57, by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1948–52 (average)	42,064	7,100	2,467	1,044	814	547	54,036
1953	46,963	6,347	3,857	1,192	891	1,017	60,267
1954	47,421	4,605	2,273	1,214	655	598	56,766
1955	52,011	6,123	2,056	689	324	278	61,481
1956							
From domestic—							
Crude platinum	13,942	92	1,780	282	19	32	16,147
Gold and copper refining	1,466	4,163					5,629
Total	15,408	4,255	1,780	282	19	32	21,776
From foreign—							
Crude platinum	35,108	134	696	218	344	374	36,874
Total	50,516	4,389	2,476	500	363	406	58,650
1957							
From domestic—							
Crude platinum	11,316	84	1,265	236	702	235	13,838
Gold and copper refining	1,172	3,798					4,970
Total	12,488	3,882	1,265	236	702	235	18,808
From foreign—							
Crude platinum	24,621	149	1,428	1,113	354	755	28,420
Total	37,109	4,031	2,693	1,349	1,056	990	47,228

TABLE 3.—Secondary platinum-group metals recovered in the United States, 1948–52 (average) and 1953–57, in troy ounces

	Platinum	Palladium	Iridium	Others	Total
1948–52 (average)	37,051	28,067	1,284	3,082	69,484
1953	29,547	30,494	853	3,963	64,857
1954	31,330	31,190	734	2,445	65,699
1955	32,901	26,124	1,499	3,812	64,336
1956	60,916	37,774	1,751	5,828	106,269
1957	49,022	31,294	1,406	5,799	87,521

CONSUMPTION AND USES

United States continued to consume about three-fourths of the world production of platinum-group metals, but in 1957 the quantity used was 13 percent less than in 1956. The decline in demand was attributed chiefly to the sharp cut in purchases of platinum by the petroleum-refining industry; this was the chief factor contributing to the oversupply during the second half of the year. The usefulness of platinum and allied metals in industry is based principally on high corrosion resistance in electrochemical operations, catalytic activity, and freedom of oxidation at high temperatures.

Catalytic uses, particularly in petroleum refining continued to provide the major market for platinum. Large quantities of platinum-group metals also were used as catalysts in producing nitric and sulfuric acids, hydrogenation and dehydrogenation, synthesis of hydrocarbons, and hydroxylation. Platinum catalysts in the petroleum-cracking industry partly made possible the growth in octane rating and production of high-octane gasoline in the United States. According to estimates by a leading producer of platinum-group metals,[3] catalytic cracking amounted to 10 percent of crude-oil production in 1955; and in 1956 the proportion was almost 14 percent. Market research indicates that the proportion should reach 30 percent in the next decade, with a corresponding increase in the use of platinum. Nearly 38 percent of the total platinum-group metals sold in 1957 went to the chemical industry. Palladium catalysts were used principally in producing pharmaceuticals and petrochemicals and in purifying industrial gases.

Electrical industries, the leading industrial consumers of platinum-group metals in 1957, furnished 46 percent of total sales. Platinum and palladium and their alloys were used for contacts in voltage regulators, relays, high-tension magnetos and sparkplugs, in thermocouples, and for many other electrical and thermal-regulating devices where high resistance to oxidation and spark erosion and high melting point are required.

Platinum-gold and platinum-rhodium alloys were used in spinnerets for manufacturing synthetic fibers and in nozzles for extruding fiber glass. Platinum-iridium alloys were utilized as anodes in electroplating; platinum and platinum-rhodium alloys were used for melting crucibles and other glass-handling equipment; and platinum utensils continued to be employed extensively in chemical laboratories. Platinum-iridium and platinum-ruthenium alloys continued to find nu-

[3] Process Industries Quarterly, International Nickel Co., Inc., Platinum Catalyst for Better Gasoline: Vol. 18, No. 1, 1957, pp. 8–9.

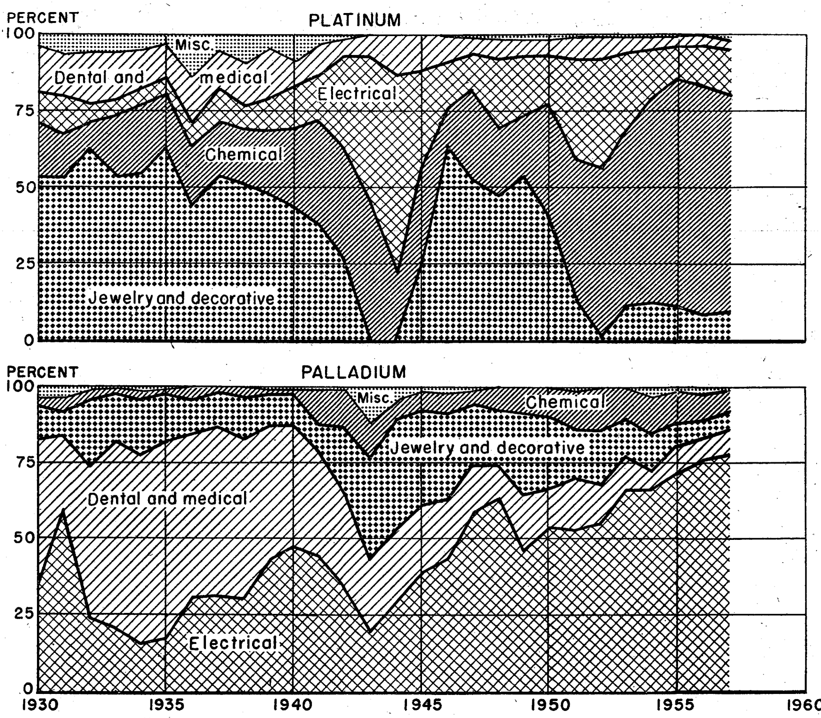

FIGURE 1.—Sales of platinum and palladium to various consuming industries in the United States, 1930–57, as percent of total.

merous applications in jewelry and as decorative materials. Palladium alloys also were used for jewelry and fountain-pen nibs. Both platinum and palladium are beaten into leaf for signs, bookbindings, and other decorative uses. Because of their strength, workability, and resistance to tarnish, alloys of platinum and palladium were widely consumed for appliances and fittings in dentistry. Rhodium was used chiefly in alloys with platinum for chemical and electrical equipment, and in electroplate for reflectors, electronic components, and jewelry, rhodium-platinum wire in resistance-wound laboratory furnaces for producing high temperatures. Osmium and ruthenium were employed principally in hard alloys for fountain-pen tips and phonograph needles.

In spite of their high cost, platinum-group metals have important advantages over other metals as construction materials in the chemical industry, especially for service under extremely severe conditions, because of their resistance to chemical attack and oxidation. The more important chemical applications of platinum-group metals and their alloys were described in a trade journal.[4]

Sales of platinum to consuming industries in 1957 were 19 percent lower and represented about 47 percent of the total sales of platinum-group metals, compared with 50 percent in 1956. The chemical

[4] Warwick, B. A., Noble Metals in Chemical Engineering: Chemical Age (London), vol. 78, No. 1994, September 1957, pp. 501–502.

industry, including petroleum refining, was again the leading consumer, purchasing 70 percent of the total platinum sold; this quantity was about 24 percent less than in 1956. Electrical and electronics industries requirements were slightly lower and comprised 15 percent of the total; platinum sold for jewelry and decorative uses was 12 percent lower in 1957 and represented 10 percent of the total; dental and medical uses accounted for 3 percent and miscellaneous uses 2 percent of the total.

Eight percent less palladium was sold in 1957 than in 1956, representing 49 percent of total domestic sales of platinum-group metals compared with 47 percent in 1956. The electrical industry purchased 78 percent of the total palladium sold; dental and medical, 8 percent; chemical, 7 percent; jewelry and decorative, 6 percent; and miscellaneous, 1 percent.

TABLE 4.—Platinum-group metals sold to consuming industries in the United States, 1956–57, in troy ounces

Industry	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1956				
Chemical	320,476	31,449	14,882	366,807
Electrical	53,872	304,990	3,704	362,566
Dental and medical	12,436	30,344	610	43,390
Jewelry and decorative	38,745	25,447	6,402	70,594
Miscellaneous and undistributed	5,115	7,761	2,679	15,555
Total	430,644	399,991	28,277	858,912
1957				
Chemical	243,226	25,936	13,644	282,806
Electrical	52,574	285,576	4,388	342,538
Dental and medical	11,514	29,131	736	41,381
Jewelry and decorative	34,102	21,257	3,975	59,334
Miscellaneous and undistributed	6,567	5,387	7,535	19,489
Total	347,983	367,287	30,278	745,548

Iridium, osmium, rhodium, and ruthenium sold to domestic consumers totaled 7 percent more in 1957 than in 1956 and represented 4 percent of total platinum-group metals sold, compared with 3 percent in 1956. About 45 percent of these minor platinum-group-metal sales, chiefly rhodium, went to the chemical industry, 15 percent for electrical uses, 13 percent for jewelry and decorative uses, 2 percent for dental and medical, and 25 percent for miscellaneous uses.

Newly developed uses for platinum are expected to lead to increased consumption and alleviation of the oversupply. Promising new applications include: (1) The use of platinum anodes in automatic electrical systems to protect the hulls and propellers of ships and submarines from corrosion, (2) platinum-metal bursting disks in protecting chemical-process equipment, (3) electroplated rhodium in coaxial radio-frequency circuits, (4) palladium high-resistance alloys for potentiometers and transducers, especially suitable for use in guided-missile instrumentation and industrial equipment, (5) platinum as the active element in "glow plugs" or reigniters to prevent "flame-out" in jet engines and insure continuity of combustion under extreme climatic conditions. The automatic reigniter called "Instalite" developed by Engelhard Industries is essentially a platinum-alloy rod, having high heat retentivity, that acts as a catalyst for jet-fuel combustion and a "pilot light" when flameout occurs.

A cobalt-platinum alloy which provides a more powerful permanent magnet than any other known material was developed. The alloy contains 23 percent cobalt and 77 percent platinum. The first practical application of this alloy was in the first electric watch designed by the Hamilton Watch Company. Radioactive iridium-192 was being used to a greater extent in radiography as a source of gamma-rays for examining castings and welds in steel construction for flaws.

STOCKS

Platinum-group-metal stocks in all forms in the hands of refiners, dealers, and importers at the end of 1957 were 507,200 ounces—a 10-percent drop from the preceding year. Substantial quantities of platinum-group metals also were held in Government stockpiles, but pertinent data are not available for publication.

TABLE 5.—Stocks of platinum-group metals held by refiners, importers, and dealers in the United States, December 31, 1953–57, in troy ounces

Year	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1953	203, 413	130, 206	41, 727	375, 346
1954	243, 040	115, 299	43, 538	401, 877
1955	304, 462	153, 092	45, 534	503, 088
1956	353, 778	163, 730	47, 025	564, 533
1957	306, 988	154, 005	46, 196	507, 189

PRICES

Oversupply and reduced demand from the petroleum-refining industry resulted in steadily falling prices on the platinum market during the year. This was the first time in recent years that supply substantially exceeded demand. Although supplies of platinum of Soviet origin were less than in the preceding year, they were, nevertheless, a contributing factor in lowering prices. In view of virtual fulfillment of major nonrecurring requirements of the domestic petroleum-refining industry, further price cuts on platinum may be expected unless new uses are developed and established uses expanded at an accelerated rate to absorb the supplies of newly mined metal coming on the market. The price of palladium eased slightly during the year, although demand was relatively steady compared with platinum.

Market prices of the platinum-group metals in 1957, as published by E&MJ Metal and Mineral Markets were as follows per fine troy

486221—58——60

ounce: Platinum declined steadily from $103–$107 at the beginning of the year to $96–$101 early in February, then to $92–$95 in the first week of March and $91–$95 in the first week in May, $89–$95 in early June, $88–$95 in July, and $83–$87 in the first week of August. After dropping to $81–$87 in the middle of August, the price of platinum remained unchanged until the first week in December, when it was lowered to $77–$80 and again to $76–$80 near the end of the year.

Palladium was $23–$24 for the first 6 months and $21–$22½ thereafter. Iridium, osmium, rhodium, and ruthenium prices remained unchanged at $100–$110, $80–$100, $118–$125, and $45–$55, respectively.

The platinum futures market continued to function throughout the year, but the quantities traded were too small to have an appreciable effect on the market price.

FOREIGN TRADE [5]

Imports.—More than 85 percent of domestic requirements of platinum-group metals was again supplied by foreign countries. United States imports of platinum-group metals in 1957 were one-third less than in 1956, reflecting the sharp drop in industrial demand. About two-thirds of the total imports were supplied by Canada and the United Kingdom; the remainder (probably of Soviet origin) was supplied chiefly by continental countries. Colombia furnished about 4 percent of the total imports, mostly as crude platinum.

Imports of refined platinum decreased 30 percent, palladium 38 percent, and iridium, osmium, rhodium, and ruthenium 38, 64, 18, and 16 percent, respectively, compared with 1956.

Imports included palladium acquired for the Government stockpile through exchange of agricultural products to friendly countries by the Commodity Credit Corporation of the United States Department of Agriculture.

Exports.—Exports of refined platinum (including scrap) decreased 28 percent in 1957 compared with 1956, but exports of other platinum-group metals (including scrap) increased 27 percent.

TABLE 6.—Platinum-group metals imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Troy ounces	Value	Year	Troy ounces	Value
1948–52 (average)	394,561	$22,378,206	1955	1,009,940	[1] $48,162,664
1953	634,088	39,447,072	1956	[2] 1,033,877	[1] [2] 57,755,225
1954	606,444	[1] 35,284,842	1957	686,983	[1] 35,731,332

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.
[2] Revised figure.

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

TABLE 7.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1956–57, by countries, in troy ounces [1]

[Bureau of the Census]

Country	Unrefined material [2]				Refined metals						
	Ores and concentrates of platinum metals	Platinum grain and nuggets (including crude, dust, and residues)	Platinum sponge and scrap	Osmiridium	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1956											
North America:											
Canada		8	(3)		[4] 128,358	141,645	200		15,644	1,620	[4] 287,475
Mexico					49	101	3				153
Total		8	(3)		[4] 128,407	141,746	203		15,644	1,620	[4] 287,628
South America:											
Argentina							12		15	1	28
Brazil			62			33					95
Colombia		32,947	1,936		70						34,953
Surinam			3								3
Total		32,947	2,001		70	33	12		15	1	35,079
Europe:											
France					4,033	75,752					79,785
Germany, West			2,606			6,375					8,981
Netherlands					[4] 42,483	128,431					[4] 170,914
Norway		950			1,524	5,393					7,867
Switzerland					87,610	82,647					170,257
U. S. S. R.					30,767	11,614					42,381
United Kingdom		111		971	141,660	78,689	2,108	347	4,664	599	229,149
Total		1,061	2,606	971	[4] 308,077	388,901	2,108	347	4,664	599	[4] 709,334
Asia:											
Japan			1,374								1,374
Lebanon					203						203
Total			1,374		203						1,577
Oceania: Australia			253			6					259
Grand total		34,016	[4] 6,234	971	[4] 436,757	530,686	2,323	347	20,323	2,220	[4] 1,033,877

See footnotes at end of table.

TABLE 7.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1956–57, by countries, in troy ounces [1]—Continued

Country	Unrefined material [2]				Refined metals						
	Ores and concentrates of platinum metals	Platinum grain and nuggets (including crude, dust, and residues)	Platinum sponge and scrap	Osmiridium	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1957											
North America:											
Canada		125			119,698	124,505			11,800	50	256,178
Mexico			9								9
Total		125	9		119,698	124,505			11,800	50	256,187
South America:											
Brazil			65			20					85
Colombia	1,397	24,267	153		408						26,225
Total	1,397	24,267	218		408	20					26,310
Europe:											
France					12,175	6,139					18,314
Netherlands					7,891	17,600			100		25,591
Norway	175	500			2,805	4,497					7,977
Switzerland					24,043	84,511					108,554
U. S. S. R.					7,094	17,716					24,810
United Kingdom		1,736		2,829	130,779	72,558	1,431	126	4,529	1,814	215,802
Total	175	2,236		2,829	184,787	203,021	1,431	126	4,629	1,814	401,048
Asia:											
Japan			1,559								1,559
Lebanon			343		1,302				200		1,845
Philippines						12					12
Total			1,902		1,302	12			200		3,416
Oceania: Australia				22							22
Grand total	1,572	26,628	2,129	2,851	306,195	327,558	1,431	126	16,629	1,864	686,983

[1] On the basis of detailed information received by the Bureau of Mines from importers, certain items recorded by the Bureau of the Census as "sponge and scrap" have been reclassified and included with "platinum refined metal" in this table.
[2] Bureau of the Census categories are in terms of metal content. It is believed, however, that in many instances, gross weight is actually reported.
[3] Revised to none.
[4] Revised figure.

TABLE 8.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1956–57 [1]

[Bureau of the Census]

Material	1956		1957	
	Troy ounces	Value	Troy ounces	Value
Unrefined materials: [2]				
Ores and concentrates of platinum metals			1,572	$119,420
Platinum grains and nuggets (including crude, dust, and residues)	34,016	$2,854,382	26,628	1,959,634
Platinum sponge and scrap	[3] 6,234	[3] 550,915	2,129	159,965
Osmiridium	971	55,614	2,851	167,563
Total	[3] 41,221	[3] 3,460,911	33,180	2,406,582
Refined metals:				
Platinum	[3] 436,757	[3] 40,982,280	306,195	25,141,313
Palladium	530,686	[4] 10,957,570	327,558	6,303,385
Iridium	2,323	203,126	1,431	108,612
Osmium	347	25,228	126	8,506
Rhodium	20,323	2,039,310	16,629	[4] 1,687,527
Ruthenium	2,220	86,800	1,864	75,407
Total	[3] 992,656	[3 4] 54,294,314	653,803	[4] 33,324,750
Grand total	[3] 1,033,877	[3 4] 57,755,225	686,983	[4] 35,731,332

[1] On the basis of detailed information received by the Bureau of Mines from importers, certain items recorded by the Bureau of the Census as "sponge and scrap" have been reclassified and included with "platinum refined metal" in this table.
[2] Bureau of the Census categories are in terms of metal content. It is believed, however, that in many instances gross weight is actually reported.
[3] Revised figure.
[4] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

TABLE 9.—Platinum-group metals exported from the United States, 1948–52 (average) and 1953–57 [1]

[Bureau of the Census]

Year	Ore and concentrates		Platinum (bars, ingots, sheets, wire, sponge, and other forms, including scrap)		Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metals and alloys including scrap)		Platinum-group manufactures except jewelry [2] (value)
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value	
1948–52 (average)	197	$24,050	12,232	$995,188	27,671	$782,420	$662,533
1953	30	580	2,522	237,853	23,206	591,439	1,555,046
1954	29	2,367	16,980	1,218,250	11,443	287,400	1,730,626
1955			[3] 17,073	[3] 1,306,011	[3] 11,895	[3] 469,774	[3] 1,208,784
1956			[3] 23,823	[3] 2,383,443	[3] 18,249	[3] 634,293	[3] 2,489,260
1957			[3] 17,199	[3] 1,328,551	[3] 23,155	373,728	[3] 1,960,062

[1] Quantities are gross weight.
[2] Beginning January 1, 1952, quantity not recorded. Quantity, troy ounces: 1948—4,874, 1949—20,702, 1950—12,640, 1951—17,348.
[3] Owing to changes in classification, data not strictly comparable with years before 1955.

TABLE 10.—Platinum-group metals exported from the United States, 1956–57, by countries of destination [1]

[Bureau of the Census]

Destination	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] (value)
	Troy ounces	Value	Troy ounces	Value	
1956					
North America:					
Canada	1,920	$172,822	9,564	$184,366	$1,584,504
Cuba	60	6,538	100	2,400	17,457
Mexico	1,272	45,960	986	22,906	17,350
Other North America	16	1,670			5,385
Total	3,268	226,990	10,650	209,672	1,624,696
South America:					
Brazil	547	57,036	38	800	3,057
Chile	48	5,585	48	1,170	11,816
Colombia	964	96,366	600	13,500	
Uruguay	128	14,054			
Venezuela	59	2,585	373	8,652	2,564
Other South America			16	525	13,640
Total	1,746	175,626	1,075	24,647	31,077
Europe:					
France	2,144	249,036	10	1,621	44,491
Germany, West	2,972	282,023	867	24,168	28,800
Netherlands	4,846	561,793			
Switzerland	816	87,948			25,160
United Kingdom	5,036	482,657	5,050	346,806	353,058
Other Europe			12	1,710	305,427
Total	15,814	1,663,457	5,939	374,305	756,936
Asia:					
India	150	15,300			660
Japan	2,769	293,093	585	25,669	40,521
Other Asia	76	8,977			24,335
Total	2,995	317,370	585	25,669	65,516
Africa					11,035
Grand total	23,823	2,383,443	18,249	634,293	2,489,260
1957					
North America:					
Canada	1,038	105,030	7,755	164,385	1,455,041
Cuba	38	3,972	100	2,390	116,525
Mexico	522	37,123	560	11,927	18,913
Other North America					5,521
Total	1,598	146,125	8,415	178,702	1,596,000
South America:					
Brazil	106	10,558			4,276
Chile	35	6,530	32	750	5,499
Colombia					615
Uruguay					577
Venezuela	82	8,637	212	4,657	15,514
Other South America			197	3,972	7,125
Total	223	25,725	441	9,379	33,606
Europe:					
France					20,402
Germany, West	209	3,953	381	26,282	2,411
Netherlands	522	48,099			
Switzerland	146	12,749	100	5,500	7,090
United Kingdom	8,220	535,678	12,646	57,630	7,941
Other Europe	27	3,733			236,135
Total	9,124	604,212	13,127	89,412	273,979

See footnotes at end of table.

TABLE 10.—Platinum-group metals exported from the United States, 1956–57, by countries of destination [1]—Continued

Destination	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] (value)
	Troy ounces	Value	Troy ounces	Value	
1957					
Asia:					
India	84	$9,108	25	$3,050	$7,319
Japan	5,961	523,630	1,127	91,585	23,560
Other Asia	209	19,751	20	1,600	24,878
Total	6,254	552,489	1,172	96,235	55,757
Africa					720
Grand total	17,199	1,328,551	23,155	373,728	1,960,062

[1] Quantities are in gross weight.
[2] Beginning January 1, 1952, quantity not recorded.

WORLD REVIEW

World production of platinum-group metals rose for the fifth consecutive year in 1957 and again reached a new high estimated at 1.19 million ounces—about 21 percent over 1956. The Union of South Africa and Canada, the leading producers, furnished 85 percent of the world output of platinum-group metals; the Soviet Union supplied most of the remainder. In contrast to the record output, world consumption of platinum-group metals declined as a result of lower demand for platinum from the United States petroleum-refining industry.

Canada.—The output of platinum-group metals in Canada, which ranked second as a world producer, was 409,400 ounces valued at $25.2 million, a gain of 30 percent over 1956. Platinum constituted about 48 percent of the total yield of platinum-group metals and palladium nearly all of the remainder. Canadian mines contributed about 34 percent of world production compared with 32 percent in 1956. Virtually all of the Canadian production was a byproduct of treating nickel-copper ores mined in the Sudbury district, Ontario.

Deliveries of platinum-group metals by International Nickel Co., Ltd., Canada's principal producer, declined about 9 percent to 339,400 ounces. Favorable progress was reported by the company on development of its Thompson mine (Northern Manitoba), which will become the second-ranking producer of platinum metals in Canada. Completion of underground development, concentrating plant, and smelting and refining facilities in Manitoba, scheduled for 1960, and completion of the long-range expansion of active mines in the Sudbury district will result in a substantial increase in the company productive capacity of platinum-group metals.

Eastern Mining and Smelting Co. continued development of the Gordon-Werner Lake property in Northwestern Ontario in 1957. About 3.5 million tons of nickel-copper ore containing appreciable amounts of platinum-group metals has been indicated.

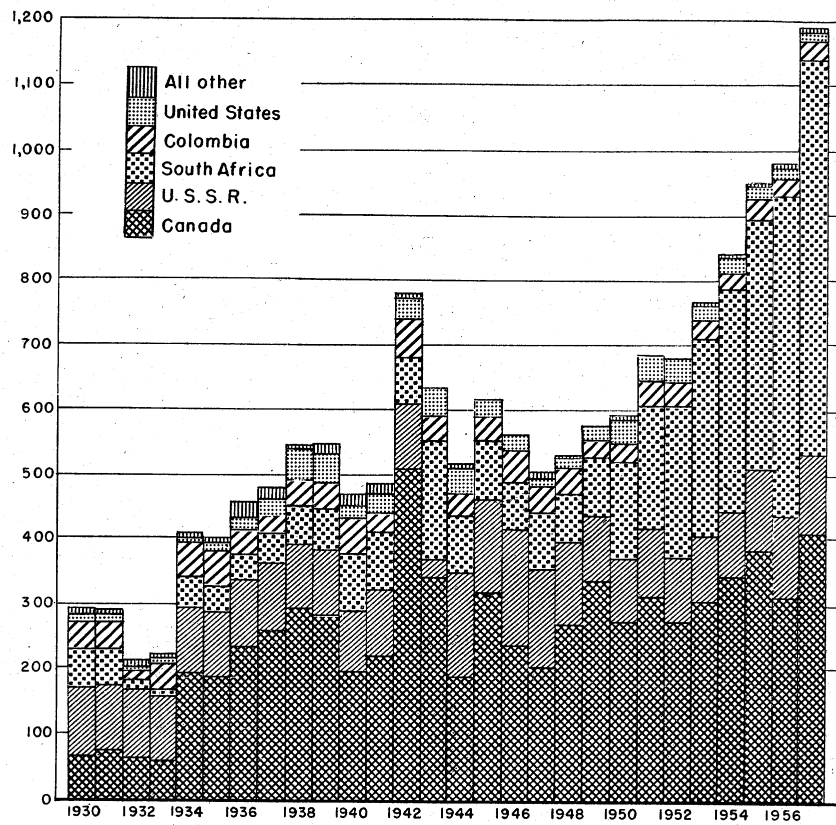

FIGURE 2.—World production of platinum-group metals, 1930–57.

Completed or progressing expansion of production facilities by Falconbridge Nickel Mines, Ltd., in the Sudbury district also may eventually result in increased output of platinum-group metals.

North Rankin Nickel Mines, Ltd., began producing platinum-bearing nickel-copper concentrate in 1957 from its mine at Rankin Inlet, Northwest Territories. About 5,400 tons of concentrate was shipped during the year.

Colombia.—Platinum-group-metal production in Colombia declined for the fifth successive year; however, output in 1957 was only slightly lower than in 1956. Crude platinum containing about 85 percent platinum-group metals was recovered chiefly by the bucket-line dredging of South American Gold & Platinum Co. in Choco.

Owing to a 15-percent export tax imposed by the Colombian Government, South American Gold & Platinum Co. withheld shipment of part of its platinum production pending negotiation of an agreement with the Government.

A special statute was drafted for the precious metal industry under which all platinum, silver, and gold is to be sold to the Banco de la Republica.

TABLE 11.—World production of platinum-group metals, 1948–52 (average) and 1953–57, in troy ounces [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada:						
Platinum: Placer platinum and from refining nickel-copper matte	135,112	137,545	154,356	170,494	151,357	196,077
Other platinum-group metals: From refining nickel-copper matte	160,326	166,018	189,350	214,252	163,451	213,285
United States: Placer platinum and from domestic gold and copper refining	30,655	26,072	24,235	23,170	21,398	18,531
Total	326,093	329,635	367,941	407,916	336,206	427,893
South America: Colombia: Placer platinum	30,598	29,201	28,465	27,526	26,215	26,000
Europe: U. S. S. R.: Placer platinum and from refining nickel-copper ores [2]	105,000	100,000	100,000	125,000	125,000	125,000
Asia: Japan:						
Palladium from refineries	234 (palladium and platinum)	71	248	221	218	200
Platinum from refineries		987	1,347	628	483	425
Total	234	1,058	1,595	849	701	625
Africa:						
Belgian Congo: Palladium from refineries [3]	63	-----	176	-----	160	325
Ethiopia: Placer platinum	332	566	230	[2] 350	[2] 300	[2] 300
Sierra Leone: Placer platinum	29	-----	-----	-----	-----	[4] 5
Union of South Africa:						
Platinum-group metals from platinum ores	47,858	90,292	101,921	109,267	484,574 (platinum ores and concentrates)	603,704
Concentrates (platinum-group metal content from platinum ores)	96,929	208,885	236,241	272,465		
Osmiridium from gold ores	6,409	6,966	6,266	7,021	6,696	5,361
Total	151,620	306,709	344,834	389,103	491,730	609,695
Oceania:						
Australia:						
Placer platinum	5	-----	23	7	12	20
Placer osmiridium	53	59	16	21	26	66
New Guinea	[5] 3	6	5	10	9	14
New Zealand: Placer platinum	2	2	1	-----	-----	-----
Papua: Placer platinum	1	-----	[6] 4	(7)	-----	-----
Total	64	67	49	38	47	100
World total (estimate) [1]	615,000	775,000	850,000	950,000	980,000	1,190,000

[1] This table incorporates a number of revisions of data published in previous Platinum chapters. Data do not add to totals shown because of rounding where estimated figures are included in the detail.
[2] Estimate.
[3] Includes platinum.
[4] Exports.
[5] Average for 4 years only, as 1949 was the first year of commercial production.
[6] Year ended June 30 of year stated.
[7] Less than 0.5 ounce.

Union of South Africa.—Output of platinum-group metals in the Union of South Africa, the world's leading producer, rose for the 10th successive year to an alltime high of 609,000 ounces—about 51 percent of world production of platinum-group metals; the corresponding figures for 1956 were 491,300 ounces and 50 percent.

Nearly all of the platinum-group metals were recovered from platinum ores in the Transvaal by Rustenburg Platinum Mines, Ltd. A relatively small quantity of platinum-group metals was recovered as an osmiridium byproduct of gold mining operations on the Rand. In the 10 years, 1948–57, production of osmiridium averaged about 6,500 ounces annually.

Expansion of production facilities completed by Rustenburg Platinum Mines, Ltd., in 1957 included sinking its fourth shaft to a depth of 1,500 feet and further extension to the treatment plant, which brought treatment capacity to 2.6 million from 2.2 million tons of ore annually; however the additional capacity will not be used until market conditions improve. Because of the oversupply, which was brought about chiefly by a sharp drop in requirements of petroleum refiners, the company announced plans to reduce output of platinum-group metals next year by 60 percent to reduce excessive stocks.

TECHNOLOGY

In producing high-octane gasoline by the re-forming process, improved techniques in using platinum catalysts have been a significant factor in reducing the amount of catalyst required and in extending the effective life of installed catalyst. Catalysts containing only 0.3 percent platinum were being used in preference to the type containing 0.6 percent platinum, with a corresponding reduction in the installed weight of platinum per barrel of capacity of the re-forming plants.

Re-forming processes using platinum catalysts, which have become of such major importance in petroleum refining during the past 7 years, were described and compared on an efficiency basis.[6]

An understanding of the mechanism of color formation in glass is of obvious importance in manufacturing decorative glasses and of interest to the maker of dense, colorless glasses. Studies and research investigations on the use of platinum metals in glass were described in a publication of a leading refiner.[7]

European metallurgists and chemists have endeavored for over a century and a half to produce pure, malleable platinum from crude platinum recovered from placer deposits. An interesting historical account of the development of techniques for treating crude platinum, which finally led to determining and separating other platinum-group metals from platinum, was published in a British technical journal.[8]

The operations of the world's largest platinum producer, Rustenburg Platinum Mines, Ltd., and a description of the geology of the platinum deposits, mining methods and reduction practice, were reviewed during the year.[9]

Increased antiknock properties of gasoline are obtained when naphthas are "re-formed" to increase the proportion of aromatics. An article [10] in a company publication related how this is accomplished

[6] Curry, S. W., Platinum Catalysts in Petroleum Refining: Platinum Metals Review, vol. 1, No. 2, April 1957, pp. 38–43.
[7] Hawes, M. G., The Platinum Metals in Glass: Platinum Metals Review, vol. 1, No. 2, April 1957, pp. 44–48, Johnson, Matthey & Co., Ltd., London.
[8] Schofield, M., The Long Struggle to Make Malleable Platinum: Metallurgia, vol. 55, No. 329, March 1957, pp. 137–139.
[9] Platinum Metals Review, Platinum Mining in the Transvaal: Vol. 1, No. 1, January 1957, pp. 3-8.
[10] Work cited in footnote 3.

by catalytic cracking and why platinum was found to be the most efficient and most economical metal for use as a catalyst.

The occurrence and method of recovering osmiridium from amalgam residues in the gold extraction process of South African mines were described in the publication [11] of a leading mining firm.

Over 100 United States and British patents were issued on preparing, applying, and methods of treating platinum catalysts in the chemical and petroleum-refining industries.[12] In addition, several patents were issued pertaining to platinum-group metals in the electrical field and for miscellaneous applications. A comprehensive list of abstracts of articles pertaining to the technology of platinum-group metals and their alloys also was published in the Review, which comprises a quarterly survey of research on platinum metals and development of new applications in industry.

[11] Optima, Osmiridium: Vol 7, No. 3, September 1957, insert between pages 158 and 159.
[12] Platinum Metals Review, vol. 1, Nos. 1-4, 1957.

Potash

By E. Robert Ruhlman[1] and Gertrude E. Tucker[2]

POTASH production in the United States increased 4 percent in 1957 over 1956, and exports increased 18 percent, but imports remained about the same. The total supply of potash (K_2O equivalent), including stocks, available in the United States in 1957 was 2.7 million short tons.

Worldwide expansion of the potash industry continued in 1957, with the greatest activity centered in the Canadian potash field. World production was 5 percent greater than in 1956.

The possibility of excess potash production in the United States and the world caused some concern among potash producers. Canadian potash, the soil-bank program, the softening market, United States imports, and growing United States capacity were factors cited as influencing the situation.[3]

TABLE 1.—Salient statistics of the potash industry in the United States, 1948–52 (average) and 1953–57, thousand short tons and thousand dollars

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Production of potassium salts (marketable) quantity	2,356	3,266	3,322	[1] 3,514	3,679	3,840
Approximate equivalent K_2O do	1,326	1,912	1,949	[1] 2,067	2,172	2,266
Value [2]	$47,743	$72,031	$72,950	$78,602	$82,107	$84,612
Sales of potassium salts by producers quantity	2,329	2,966	3,270	[1] 3,405	[1] 3,572	3,625
Approximate equivalent K_2O do	1,309	1,732	1,918	[1] 2,006	2,103	2,137
Value at plant	$47,152	$65,403	$71,819	[1] $76,176	[1] $79,768	$79,628
Average per ton	$20.25	$22.05	$21.96	[1] $22.37	$22.33	$21.97
Imports of potash materials quantity	282	251	225	331	334	339
Approximate equivalent K_2O do	150	134	119	178	181	182
Value	$10,135	$9,953	$8,387	$11,769	$12,018	$11,823
Exports of potash materials quantity	119	88	117	229	398	467
Approximate equivalent K_2O do	66	49	66	130	226	234
Value	$6,673	$3,936	$5,463	$9,203	$14,937	$17,506
Apparent consumption of potassium salts quantity	2,492	3,129	3,378	[1] 3,507	3,508	3,497
Approximate equivalent K_2O do	1,393	1,817	1,971	[1] 2,054	2,058	2,085
World: Production (marketable): Approximate equivalent K_2O quantity	5,000	6,500	7,300	7,900	8,300	8,700

[1] Revised figure.
[2] Derived from reported value of "Sold or used."

[1] Commodity specialist.
[2] Statistical assistant.
[3] Chemical Week, Five Factors for a Future Potash Squeeze: Vol. 80, No. 28, July 13, 1957, pp. 69–70, 72, 74.
Tanner, J. C., Potash Pile-Up: Wall Street Jour. (New York), vol. 150, No. 81, Oct. 23, 1957, pp. 1, 17.

DOMESTIC PRODUCTION

Marketable potassium salts production in the United States continued its upward trend and reached a new high in 1957 of more than 3.8 million short tons, a 4-percent increase above 1956 and more than twice that in 1947.

New Mexico, California, and Utah were the principal States producing domestic marketable potassium salts. New Mexico supplied 92 percent of the domestic output; small quantities were produced in Maryland and Michigan.

The plant locations of potash-producing companies in the United States in 1957, by States, were as follows:

California:
- The American Potash & Chemical Corp., Trona, San Bernardino County.
- A. M. Blumer, Davenport, Santa Cruz County.

Maryland: North American Cement Corp., Security, Washington County.
Michigan: The Dow Chemical Co., Midland, Midland County.
New Mexico:
- Duval Sulphur & Potash Co., Eddy County.
- International Minerals & Chemical Corp., Eddy County.
- National Potash Co., Lea County.
- Potash Company of America, Eddy County.
- The Southwest Potash Corp., Eddy County.
- United States Borax & Chemical Corp., United States Potash Division, Eddy County.

Utah: Bonneville, Ltd., Wendover, Tooele County.

TABLE 2.—Production and sales of potassium salts in New Mexico, 1948–52 (average) and 1953–57, thousand short tons

Year	Crude salts [1]		Marketable potassium salts					
	Mine production		Production			Sales		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Thousand dollars [2]	Gross weight	K_2O equivalent	Thousand dollars
1948–52 (average)	6,046	1,256	2,030	1,134	40,273	2,008	1,120	39,801
1953	9,101	1,908	2,938	1,721	64,106	2,662	1,553	58,076
1954	9,975	1,986	3,008	1,763	65,538	2,954	1,732	64,367
1955	10,956	2,159	3,221	1,899	71,839	3,122	1,841	69,641
1956	11,941	2,305	3,384	1,997	75,122	3,279	1,931	72,802
1957	12,893	2,313	3,528	2,080	77,197	3,353	1,977	73,243

[1] Sylvite and langbeinite.
[2] Derived from reported value of "Sold or used."

Mine production of potash ores in New Mexico (over 12.8 million tons, a new record) was 8 percent more than in 1956. The calculated grade of the crude salts mined decreased to 17.94 percent K_2O equivalent compared with 19.30 in 1956 and 20.7 percent in 1947.

All six companies operating in the Carlsbad region mined sylvinite (potassium and sodium chlorides) and processed the ore to yield various grades of muriate. International Minerals & Chemical Corp. also mined langbeinite and processed it to yield potassium sulfate and potassium-magnesium sulfate.

Changes in industry operations in the Carlsbad region included increased mechanization and installation of more facilities for granular products. Continuous mining machines and conveyor belts were being used in more mines.

National Potash Co., jointly owned by Freeport Sulphur Co. and Pittsburgh Consolidation Coal Co., began operating early in 1957. The facilities of this company, the 6th major producer in the New Mexico potash basin and the 1st in Lea County, included, two 1,800 foot shafts, a refinery, and storage for 100,000 tons of potash. The plant was closed from early June until mid-July because of a labor strike.

The Government Potash Reserve of 1,840 acres in Eddy County, N. Mex., was leased to National Potash Co. following competitive bidding.

The first shaft of the Farm Chemical Resources Development Corp. was completed at the end of the year. This company, owned by the National Farmers Union, Kerr-McGee Oil Industries, and Phillips Chemical Co., will be the seventh producer in the New Mexico potash basin and plans to mine potash from both Eddy and Lea Counties.

To meet market demands, The American Potash & Chemical Corp. doubled the capacity of its granular potash facilities. This company also expanded its research laboratories at Whittier, Calif.

Delhi-Taylor Oil Corp. reported reserves of 10 million tons of proved and probable ore. The company completed one pilot drill hole for a shaft location. Final development plans awaited results of a market survey and establishment of freight rates.

The American Potash Institute published a booklet describing its basic purposes and major accomplishments during its 22-year existence.[4]

CONSUMPTION AND USES

The domestic apparent consumption of K_2O in 1957 (producers' sales, plus imports, minus exports) was 1 percent greater than in 1956 (table 1).

The United States Department of Agriculture, in addition to its regular fertilizer reports, released a bulletin on fertilizer production in the United States since 1880 by types of fertilizer.[5]

The American Potash Institute stated that:[6]

Deliveries of potash for agricultural purposes in the United States, Canada, Cuba, Puerto Rico, and Hawaii by the eight principal American producers and also the importers totaled 3,461,578 tons of salts containing an equivalent of 2,026,239 tons K_2O during 1957, according to the American Potash Institute. This was an increase of less than 1% in salts and K_2O over the same period in 1956. Continental United States took 1,867,732 tons K_2O, Canada, 92,147 tons, Cuba, 18,059 tons, Puerto Rico, 21,899 tons, and Hawaii, 26,402 tons K_2O. These figures include imports from Europe of 219,903 tons K_2O. Exports to other countries were 205,168 tons K_2O, an increase of 28%. Deliveries of potash for non-agricultural purposes amounted to 129,517 tons K_2O, an increase of 1% over last year. Total deliveries for all purposes were 4,019,313 tons of salts containing an equivalent of 2,360,924 tons K_2O, an increase of 2% in salts and K_2O.

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[4] American Potash Institute, The American Potash Institute and How It Serves the Fertilizer Industry: Washington, D. C., 1957, 12 pp.

[5] Mehring, A. L., Adams, J. R., and Jacob, K. D., Statistics on Fertilizers and Liming Materials in the United States: U. S. Dept. of Agriculture Stat. Bull. 191, 1957, 182 pp.

[6] American Potash Institute, North American Deliveries of Potash Salts—Calendar Year and Fourth Quarter 1957: Press Release E-143, Washington, D. C., Mar. 14, 1958, pp. 1-2.

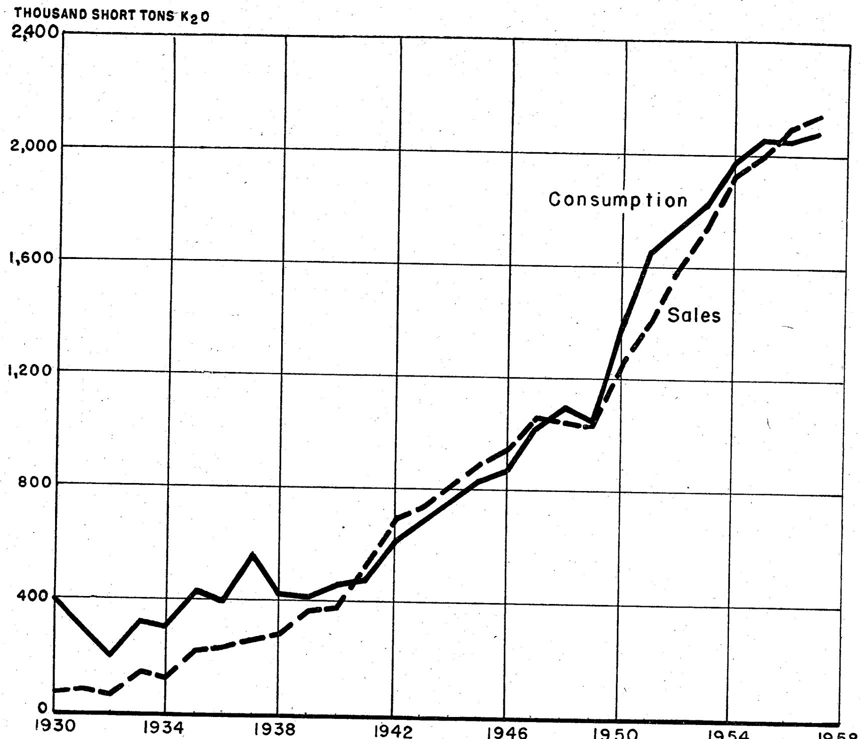

FIGURE 1.—Comparison of apparent domestic consumption of potash (K_2O) and sales of domestic producers of potash in the United States, 1930–57.

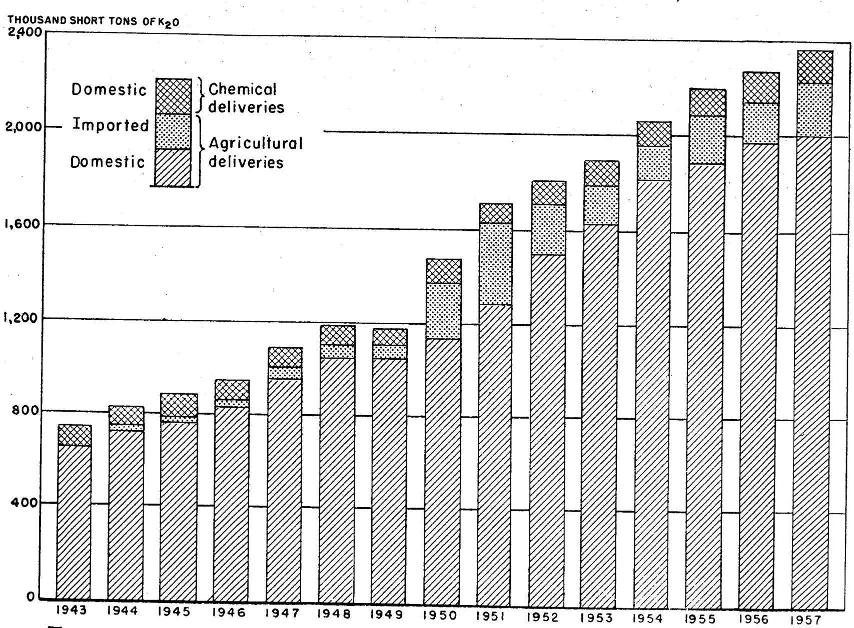

FIGURE 2.—Potash deliveries by use groups in North America, 1943–57.
[American Potash Institute.]

In the United States, agricultural potash was delivered in 46 states and the District of Columbia. Illinois with nearly 200,000 tons K_2O was the leading state followed in order by Ohio, Indiana, Georgia, Florida, and Virginia, each taking more than 100,000 tons K_2O during the year. Due to shipments across state lines, consumption does not necessarily correspond to deliveries within a state.

Agricultural potash accounted for nearly 95% of deliveries. Muriate of potash continued to be by far the most popular material, comprising over 93% of the total K_2O delivered for agricultural purposes, and sulphate of potash and sulphate of potash magnesia 7%.

Deliveries for nonagricultural purposes in 1957 were 194,171 tons of muriate of potash containing an equivalent of 122,002 tons K_2O, 9,998 tons of sulphate of potash containing 5,044 tons K_2O, and 10,591 tons of manure salts containing 2,471 tons K_2O. The total non-agricultural deliveries of 129,517 tons K_2O were about 5% of all potash deliveries, and 1,531 tons or 1% more than in 1956.

TABLE 3.—Deliveries of potash salts in 1957, by States of destination, in short tons of K_2O

[American Potash Institute]

State	Agricultural potash	Chemical potash	State	Agricultural potash	Chemical potash
Alabama	71,461	3,968	Nebraska	1,579	25
Arizona	1,200	------	Nevada	------	2,361
Arkansas	36,556	25	New Hampshire	21	45
California	22,236	6,868	New Jersey	32,565	1,715
Colorado	717	24	New Mexico	1,395	1,086
Connecticut	3,173	216	New York	38,774	69,745
Delaware	7,556	506	North Carolina	88,689	300
District of Columbia	412	------	North Dakota	3,102	------
Florida	117,581	724	Ohio	166,950	4,356
Georgia	128,992	354	Oklahoma	2,973	485
Idaho	472	------	Oregon	3,953	221
Illinois	197,099	1,864	Pennsylvania	39,348	1,810
Indiana	151,552	1,654	Rhode Island	2,200	------
Iowa	47,517	240	South Carolina	53,584	------
Kansas	2,571	485	South Dakota	497	------
Kentucky	38,086	3,653	Tennessee	67,091	25
Louisiana	25,531	795	Texas	53,842	6,947
Maine	11,309	------	Utah	260	40
Maryland	69,955	936	Vermont	1,819	------
Massachusetts	17,615	100	Virginia	107,157	679
Michigan	57,866	1,187	Washington	6,073	1,701
Minnesota	55,313	------	West Virginia	1,176	6,678
Mississippi	30,394	72	Wisconsin	56,914	174
Missouri	42,532	1,339	Wyoming	------	48
Montana	74	50	Total	1,867,732	123,501

STOCKS

Stocks (K_2O equivalent) reported by producers at the end of 1957 were 27 percent more than in 1956 and were equivalent to about one-quarter of the annual production. Year-end stocks in the potash industry are not entirely unsold output but include large inventories in anticipation of orders for the spring planting season that begins in February.

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TABLE 4.—Stocks of potassium salts in the United States, 1948–52 (average) and 1953–57, thousand short tons

Year	Number of producers	Stocks on hand Dec. 31	
		Potassium salts	Equivalent potash (K_2O)
1948–52 (average)	8	63	34
1953	10	472	279
1954	10	526	312
1955	11	[1] 633	372
1956	10	[1] 739	440
1957	11	[2] 939	[2] 560

[1] Revised figure.
[2] Figure includes an inventory adjustment during the year, as reported by the producers.

PRICES

The prices of domestic potash decreased about 5 percent in 1957–58 compared with 1956–57. Prices continued to vary with the date of order.

The American Potash & Chemical Corp. issued its price schedule for agricultural-grade Trona potash for the 1957–58 season on May 24, 1957. The prices for muriate of potash, 60 percent K_2O minimum, f. o. b. Trona, Calif., in bulk, in carlots of not less than 40 tons, were as follows: 44.5 and 46.5 cents per unit of K_2O for contracts made before July 1, 1957, and for July 1, 1957–June 30, 1958, respectively; and granular, 46 and 48 cents per unit for the same periods. The prices for Trona sulfate of potash, f. o. b. Trona, Calif., in bulk, in carlots of not less than 40 tons, were quoted for the 2 periods as 75.5 and 78.5 cents per unit K_2O.

Price schedules for New Mexico potash for agricultural purposes were issued during April, May, and June and were immediately followed by several revisions, reducing the price about 2 cents per unit of K_2O. The average final prices varied according to the month of sale and are shown in table 5. The additional cost for bagged material varied from $2 to $4.90 per ton.

TABLE 5.—Prices of agricultural potash quoted by producers, f. o. b. Carlsbad, N. Mex., for 1957–58 season, in bulk, minimum carlots of 40 tons, cents per short-ton unit K_2O

Effective period	Standard muriate, 60-percent K_2O minimum	Granular muriate, 60-percent K_2O minimum	Sulfate of potash	Manure salts
1957				
June	34	34		
July	34	34		
August	34	35		
September	34	35		
October	35	36		
November	35	36		
December	35	36	64	17.65
1958				
January	35	------------		
February	35	36		
March	35	36		
April	35	36		
May	35	36		
June	34	34		

FOREIGN TRADE[7]

Imports.—Imports of fertilizer and chemical potash materials in the United States were about the same as in 1956. West Germany, East Germany, France, Spain, and Chile continued to be the principal supplying countries. Latvia is not a potash-producing country, and the imports from Latvia may have been reexports of Russian origin.

Exports.—Exports of potash material in 1957 reached a new high and were 18 percent greater than in 1956. Japan continued to be the major market and received 61 percent of exports. Countries in the Western Hemisphere received 33 percent of United States exports of potash materials.

TABLE 6.—Potash materials imported for consumption in the United States, 1956–57

[Bureau of the Census]

Material	Approximate equivalent as potash (K_2O) (percent)	1956				1957			
		Short tons	Approximate equivalent as potash (K_2O)		Value	Short tons	Approximate equivalent as potash (K_2O)		Value
			Short tons	Percent of total			Short tons	Percent of total	
Used chiefly in fertilizers:									
Muriate (chloride)	59.0	250,638	147,876	81.6	$6,651,764	254,715	150,282	82.6	$6,777,814
Potassium nitrate, crude	40.0	924	370	.2	99,680	642	257	.1	74,005
Potassium-sodium nitrate mixtures, crude	14.0	19,451	2,723	1.5	715,203	25,393	3,555	2.0	884,674
Potassium sulfate, crude	50.0	[1] 53,136	[1] 26,568	14.6	[1] 1,919,485	48,441	24,221	13.3	1,699,941
Other potash fertilizer materials	6.0	10	1	------	255	------	------	------	------
Total fertilizer	------	[1] 324,159	[1] 177,538	97.9	9,386,387	329,191	178,315	98.0	9,436,434
Used chiefly in chemical industries:									
Bicarbonate	46.0	30	14		7,548	12	6		3,093
Bitartrate:									
Argols	20.0	3,085	617		479,778	3,361	672		516,739
Cream of tartar	25.0	819	205		364,834	512	128		242,021
Carbonate	61.0	------	------		------	5	3		748
Caustic	80.0	268	214		94,745	268	214		98,118
Chlorate and perchlorate	36.0	347	125		87,399	369	133		104,964
Chromate and dichromate	40.0	------	------	2.1	------	2	1	2.0	637
Cyanide	70.0	925	648		558,990	787	551		443,284
Ferricyanide	42.0	352	148		225,955	295	124		178,154
Ferrocyanide	44.0	559	246		221,172	685	301		267,250
Nitrate	46.0	1,332	613		150,301	1,610	741		184,300
Permanganate	29.0	671	195		240,228	394	114		164,178
Rochelle salts	22.0	10	2		4,805	16	4		7,353
All other	50.0	[1] 1,394	[1] 697		195,490	1,183	592		175,874
Total chemical	------	[1] 9,792	[1] 3,724	2.1	2,631,245	9,499	3,584	2.0	2,386,713
Grand total	------	[1] 333,951	[1] 181,262	100.0	12,017,632	338,690	181,899	100.0	11,823,147

[1] Revised figure.

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

TABLE 7.—Potash materials imported for consumption in the United States, 1956–57, by countries, in short tons

(Figures in parentheses in column headings indicate, in percent, approximate equivalent as potash (K_2O))

[Bureau of the Census]

Country	Bitartrate		Caustic (hydroxide)	Chlorate and perchlorate	Cyanide	Muriate (chloride)	Potassium nitrate, crude	Potassium sodium nitrate mixtures, crude	Potassium nitrate (saltpeter), refined	Potassium sulfate, crude	All other [1]	Total	
	Argols or wine lees (20)	Cream of tartar (25)	(80)	(36)	(70)	(59)	(40)	(14)	(46)	(50)		Short tons	Value
1956													
North America: Canada					94	42					3	139	$44,648
South America:													
Argentina	378											378	59,453
Chile				28				19,437				19,465	723,799
Total	378			28				19,437				19,843	783,252
Europe:													
Belgium-Luxembourg						4,766	60			1,605	193	6,624	331,193
Czechoslovakia					46						16	62	36,859
Denmark				9	31							40	27,845
France	511			11	100	43,203	752	14		[2] 10,607	[2] 71	[2] 55,269	1,953,020
Germany:													
East						50,304			55	5,512	72	55,943	1,478,701
West			70		433	123,476	112		1,277	35,412	210	160,990	[2] 4,918,927
Italy	568	455									10	1,033	286,151
Netherlands						1,509					2,380	3,889	[2] 655,674
Portugal	243											243	38,867
Spain		336				27,338						27,674	918,440
Sweden			198	134								332	114,815
Switzerland				165								165	41,412
United Kingdom		28			221						71	320	175,257
Total	1,322	819	268	319	831	250,596	924	14	1,332	[2] 53,136	[2] 3,023	[2] 312,584	10,977,161
Africa: Algeria	1,385											1,385	212,571
Grand total	3,085	819	268	347	925	250,638	924	19,451	1,332	[2] 53,136	[2] 3,026	[2] 333,951	12,017,632

1957													
North America: Canada					1							1	1,296
South America:													
Argentina	167											167	30,265
Chile				8				25,112				25,120	875,125
Total	167			8				25,112				25,287	905,390
Europe:													
Belgium-Luxembourg						2,100	22				143	2,265	150,555
Czechoslovakia					22						11	33	18,133
France	377			22	212	43,255	565			16,371	21	60,823	2,187,702
Germany:													
East						60,335			17		96	60,448	1,476,859
West			55		426	85,251	55	281	1,593	32,070	169	119,900	3,828,496
Italy	650	319									12	981	246,022
Latvia [3]						11,664						11,664	262,720
Netherlands			5								2,060	2,065	554,725
Portugal	915											915	131,845
Spain		113				52,110						52,223	1,531,991
Sweden			208	127								335	128,089
Switzerland				210								210	56,556
United Kingdom	8	80		2	126						80	296	136,059
Total	1,950	512	268	361	786	254,715	642	281	1,610	48,441	2,592	312,158	10,709,752
Africa:													
Algeria	943											943	159,580
Morocco	167											167	26,769
Tunisia	134											134	20,360
Total	1,244											1,244	206,709
Grand total	3,361	512	268	369	787	254,715	642	25,393	1,610	48,441	2,592	338.690	11,823,147

[1] Approximate equivalent as potash (K_2O): 1956, 34 percent; 1957, 42 percent.
[2] Revised figure.
[3] Believed to be country of shipment.

TABLE 8.—Potash materials exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Fertilizer		Chemical		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	105,424	$3,694,674	14,050	$2,978,181	119,474	$6,672,855
1953	83,412	2,893,946	4,796	1,042,469	88,208	3,936,415
1954	111,184	4,133,527	6,202	1,329,925	117,386	5,463,452
1955	222,499	7,958,862	6,804	1,244,103	229,303	9,202,965
1956	390,716	13,705,131	6,839	1,231,759	397,555	14,936,890
1957	459,699	16,096,123	7,796	1,409,841	467,495	17,505,964

TABLE 9.—Potash materials exported from the United States, 1956–57, by countries of destination

[Bureau of the Census]

Country	Fertilizer				Chemical			
	1956		1957		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	95,121	$3,368,052	86,731	$3,110,930	4,151	$649,873	5,495	$856,935
Costa Rica	545	24,600	1,536	77,135	8	2,025	20	10,752
Cuba	26,175	902,467	20,324	652,156	82	22,267	71	21,982
Dominican Republic	249	9,125	275	10,850			4	1,583
El Salvador	1,475	65,329	682	30,333	11	1,440	2	3,130
Guatemala	133	5,565	287	8,111	103	21,835	48	12,525
Honduras	80	4,240	80	4,418	8	3,470	7	2,070
Mexico	8,358	203,792	10,484	273,390	323	101,882	587	134,531
Panama			150	9,589				
Other North America	200	9,138	50	1,602	15	6,300	3	8,078
Total	132,336	4,592,308	120,599	4,178,514	4,701	809,092	6,237	1,051,586
South America:								
Argentina					5	6,151	8	5,601
Brazil	22,050	951,686	18,694	755,190	801	124,256	57	22,989
Chile			2,756	58,702	38	8,342	62	19,166
Colombia	552	23,626	675	28,307	118	38,172	84	28,532
Ecuador	110	5,862	55	2,435	67	14,890	24	7,560
Peru	89	4,265	450	23,433	3	5,713	2	5,198
Uruguay	1,580	54,284	2,917	107,232	154	19,281		
Venezuela	288	14,738	574	31,360	101	26,369	112	26,038
Other South America			20	1,540	([1])	176	3	5,130
Total	24,669	1,054,461	26,141	1,008,199	1,287	243,350	352	120,214
Europe:								
Belgium-Luxembourg							4	5,188
France							3	4,826
Germany, West							36	10,954
Italy					21	5,766	86	16,475
Sweden					440	20,720	601	29,810
United Kingdom	56	2,327			136	34,507	48	27,051
Other Europe						872	([1])	244
Total	56	2,327			597	61,865	778	94,548

See footnote at end of table.

TABLE 9.—Potash materials exported from the United States, 1956–57, by countries of destination—Continued

[Bureau of the Census]

Country	Fertilizer				Chemical			
	1956		1957		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Asia:								
India					46	$30,544	4	$2,967
Japan	$195,732	$6,738,004	$284,324	$9,832,804	1	1,880	1	4,000
Korea, Republic of	6,658	265,610	6,613	294,000	20	4,617	31	12,897
Philippines	2,523	97,349	2,420	128,224	122	37,780	262	75,572
Taiwan	13,756	448,540			6	2,740	8	2,400
Vietnam Laos and Cambodia	660	34,662	100	3,528				
Other Asia	240	11,493			17	10,966	6	3,194
Total	219,569	7,595,658	293,457	10,258,556	212	88,527	312	101,030
Africa:								
Belgian Congo					(1)	675	3	5,383
Union of South Africa					35	24,896	28	12,380
Other Africa	30	2,970					6	2,072
Total	30	2,970			35	25,571	37	19,835
Oceania:								
Australia					7	3,354	80	22,628
New Zealand	14,056	457,407	19,502	650,854				
Total	14,056	457,407	19,502	650,854	7	3,354	80	22,628
Grand total	390,716	13,705,131	459,699	16,096,123	6,839	1,231,759	7,796	1,409,841

[1] Less than 1 ton.

WORLD REVIEW

NORTH AMERICA

Canada.—Activity continued high in the Saskatchewan potash area, and at the end of 1957 the following 18 companies from Canada, United States, and Europe were engaged in exploration or development: Campana, Ltd., Continental Geological Corp., Continental Potash Corp., Dominion Potash, Ltd., Duval Sulphur & Potash Co., General Petroleum of Canada, Gordon Daly Corp., International Minerals & Chemical Corp., International Potash Minerals, Ltd., National Potash Co., Palmer Oils, Ltd., Potash Company of Amerca, Ltd., R. Campbell & Associates, S. A. M. Explorations, Ltd., Saxon Mining Co., Southwest Potash Corp., United States Borax & Chemical Corp., and Winsal of Canada.

The Potash Company of America, Ltd., which began Canadian exploration in 1952, reported that its 20-foot-diameter, 3,500-foot shaft near Floral, Saskatchewan, was more than 2,500 feet deep at the end of 1957 and was scheduled for completion in 1958. Construction for a refinery with an announced capacity of 1.5 million tons of ore annually was begun at mid-1957 and was scheduled to begin operating in late 1958.

International Minerals & Chemical Corp. began developing a deposit near Esterhazy, Saskatchewan, about 150 miles east of Regina and announced that production would be double the company New Mexico output. At the end of the year the shaft was 300 feet deep. Completion was scheduled for 1959.

Continental Potash Corp. resumed shaft sinking near Unity in August 1957 at the location previously controlled by Western Potash, Ltd., which suspended all operations in December 1954. Continental acquired the property in 1955. The original agreement between Western Potash, Ltd., and the Provincial Government was terminated during the year, and Continental again acquired control through competitive bidding.

S. A. M. Explorations conducted exploration near Moosomin in southeast Saskatchewan and also had potash permits in southern Manitoba.

TABLE 10.—World production of potash (marketable, unless otherwise stated) in equivalent K_2O, by countries,[1] 1948–52 (average) and 1953–57, short tons[2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America: United States	1,326,287	1,911,891	1,948,721	2,066,706	2,171,584	2,266,481
Crude (including brines) [3]	**1,448,180**	**2,098,736**	**2,170,969**	**2,326,946**	**2,479,463**	**2,498,558**
South America: Chile	4,009	330	550	11,000	12,000	[4] 11,000
Europe:						
France	922,315	996,575	1,192,083	1,310,961	1,462,722	[4] 1,529,000
Crude [3]	**1,041,498**	**1,135,657**	**1,361,734**	**1,490,764**	**1,653,465**	**1,736,800**
Germany:						
East [4]	1,271,000	1,488,000	1,488,000	1,580,000	1,598,000	1,650,000
Crude [3] [4]	**1,467,000**	**1,720,000**	**1,720,000**	**1,820,000**	**1,840,000**	**1,900,000**
West	998,961	1,459,309	1,783,394	1,870,848	1,823,000	1,862,000
Crude [3]	**1,190,820**	**1,743,000**	**2,135,000**	**2,227,000**	**2,166,000**	**2,212,000**
Spain	180,404	202,764	243,166	242,539	256,525	[4] 282,800
U. S. S. R. [4]	324,000	480,700	593,700	870,500	983,600	1,040,000
Asia:						
Israel	1,286	3,415	[4] 12,000	[4] 12,000	[4] 31,000	[4] 50,000
Japan	204	283	454	461	475	[4] 440
Africa: Eritrea	811	----------	----------	----------	----------	----------
Oceania: Australia	525	----------	----------	----------	----------	----------
World total (marketable) (estimate) [1] [2]	5,000,000	6,500,000	7,300,000	7,900,000	8,300,000	8,700,000

[1] In addition to countries listed, China, Ethiopia, Italy, and Korea are reported to produce potash salts, but statistics of production are not available; estimates by senior author of chapter included in totals.

[2] This table incorporates a number of revisions of data published in previous Potash chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.

[3] To avoid duplication of figures, data on crude potash are not included in the total.

Estimate.

EUROPE

Germany, East.—The Government of East Germany announced plans for a 40-percent expansion of the potash industry by 1960 by modernization of shafts and mining equipment and expansion of flotation and other processing equipment. It was anticipated that the expanded facilities would require only half of the 1957 labor force of

25,000 workers.[8] Planned output was not reached in 1957 owing to lack of mechanized equipment. Mine I, Glückauf Potash Plant at Sandershausen, was closed 17 months for repair and modernization.

TABLE 11.—Exports of potash materials from France, 1952–56, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1952	1953	1954	1955	1956
North America:					
Canada	20,975	34,167	11,514	31,750	15,311
Cuba	9,019	----	3,215	----	----
United States	70,363	54,789	28,606	66,580	64,092
South America:					
Argentina	147	----	----	123	----
Brazil	16,892	45,897	24,245	12,302	10,923
Colombia	3,142	----	5,219	----	----
Europe:					
Austria	14,323	6,618	8,706	12,831	30,046
Belgium-Luxembourg	185,555	144,394	164,451	127,407	175,738
Denmark	16,905	12,603	13,979	7,061	13,121
Finland	10,196	3,674	4,277	7,865	6,699
Ireland	3,619	33,304	28,192	30,072	36,418
Italy	19,441	24,707	38,798	48,155	57,798
Netherlands	227,490	208,256	153,589	150,286	182,204
Norway	17,653	11,344	12,494	15,748	17,728
Sweden	26,731	76,245	15,043	37,659	41,455
Switzerland	27,570	32,367	33,827	40,648	43,523
United Kingdom	131,832	172,374	258,787	208,840	297,662
Yugoslavia	5,022	9,480	89	----	5,512
Asia:					
Ceylon	9,762	23,626	31,139	23,687	26,240
China (incl. Taiwan)	----	----	10,913	10,050	32,659
India	31	5,075	10,360	10,873	10,389
Japan	60,130	155,649	178,742	159,360	242,787
Turkey	----	----	8,083	----	11,941
Africa:					
Algeria	16,359	17,186	21,059	16,409	16,810
Morocco: Southern Zone	8,971	7,624	----	12,002	2,743
Union of South Africa	8,660	5,923	3,677	8,814	6,560
Oceania:					
Australia	15,665	9,558	11,747	11,420	8,656
New Zealand	17,153	9,375	10,919	18,220	18,823
Other countries	37,920	45,288	65,623	65,152	78,966
Total	981,526	1,149,523	1,157,293	1,133,314	1,454,804

[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 preceding Potash chapter.

Germany, West.—The Salzdetfurth Potash Co. of Hanover announced plans to expand production facilities and voted to increase its capital investment by over $7.5 million.[9]

A Government subsidy, effective in 1956, was expected to increase domestic sales of agricultural potash 15 percent in 1957–58 over the 933,000 short tons of equivalent K_2O sold in 1955–56.[10]

[8] Chemical Week, East Germany's Five-Year Plan: Vol. 81, pt. I, No. 12, Sept. 21, 1957, pp. 137, 140, 142, 144.
Die Wirtschaft (Berlin, East), Des Kalibergbau: Vol. 12, No. 27, July 4, 1957.
[9] Chemical Week, vol. 80, No. 5, Feb. 2, 1957, p. 25.
[10] Commercial Fertilizer, West German Fertilizer Capacity Expanding: Vol. 95, No. 3, August 1957, p. 56.

TABLE 12.—Exports of potash materials from West Germany, 1953–57, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
North America:					
Canada	21,643	24,465	36,695	27,091	22,520
Puerto Rico	1,654	3,031	2,353	2,205	1,301
United States	51,445	91,057	104,350	114,957	113,516
South America:					
Brazil	8,295	25,874	45,290	33,452	27,757
Colombia	1,653	10,047	4,960	3,307	----------
Dominican Republic	551	1,653	1,435	3,329	8,278
Europe:					
Austria	38,832	48,345	42,077	33,118	29,291
Belgium-Luxembourg	162,527	148,544	100,216	168,582	165,473
Denmark	218,357	251,995	162,202	276,414	230,557
Greece	----------	3,318	2,205	8,030	11,814
Ireland	19,130	36,079	43,930	32,135	15,686
Italy	28,417	21,763	33,274	41,161	37,545
Netherlands	216,998	236,468	168,070	214,476	184,319
Norway	21,364	4,429	6,577	5,713	2,780
Poland	----------	----------	----------	----------	16,532
Portugal	----------	----------	----------	728	661
Sweden	62,543	56,082	43,811	72,395	32,815
Switzerland	20,947	19,287	20,285	25,999	29,719
United Kingdom	259,961	193,729	220,352	244,714	162,983
Yugoslavia	8,965	19,931	33,069	48,315	104,343
Asia:					
Ceylon	1,036	3,416	6,882	13,339	9,800
India	2,174	5,322	8,656	13,533	12,609
Indonesia	2,016	1,542	3,844	2,682	2,762
Japan	200,862	210,706	206,121	258,189	152,415
Korea, Republic of	----------	9,331	16,610	6,614	4,244
Malaya	1,064	2,127	4,216	1,844	5,614
Taiwan	----------	1,323	11,464	5,655	17,306
Turkey	9,733	9,370	----------	14,612	----------
Africa:					
Rhodesia and Nyasaland, Federation of	11,047	15,987	20,212	15,349	14,889
Union of South Africa	7,603	----------	26,744	28,118	14,574
Oceania:					
Australia	6,181	10,447	9,238	21,926	18,341
New Zealand	2,022	16,583	7,591	5,622	14,454
Other countries	19,899	41,832	18,661	22,894	44,343
Total	1,406,919	1,524,083	1,411,390	1,766,498	1,509,241

[1] Compiled from Customs Returns of West Germany. Data include crude salts, chloride, sulfate, magnesium sulfate, and beet ash.
[2] This table incorporates a number of revisions of data published in the preceding Potash chapter.

Italy.—Exploration of an area 70 miles long and averaging 12 miles wide from Cattolica Eraclea to Agira, Sicily, by the Montecatini Co. and the Edison Co. disclosed potash deposits at Racalmulto, Bosco San Cataldo, Santa Caterina, Salinella, Sambuco-Casazze, Capodarso-Scioltabino, and Mandre-Villadoro. Preliminary reserve estimates indicated 200 million tons of ore averaging 12 percent K_2O, mainly kainite, from beds 1,000 to 2,500 feet beneath the surface.[11] Tentative plans called for production of 150,000 tons of potash salts per year. A potash refinery was being constructed by the Montecatini Co. near Campofraneo.[12]

Poland.—Exploration in the Izbica-Klodawa-Leczycza area disclosed potash deposits 600 to 900 feet beneath the surface. Gravimetric, seismic, and radioactive-analysis exploration methods were used to determine the geology of the extensive salt formation and to locate the potash ore. Development was begun at Klodawa.[13]

[11] Mining World, Sicily Potash Reserves Undergoing Exploration: Vol. 19, No. 9, August 1957, p. 89.
[12] Chemical Age (London), Potassium Salts Factory: Vol. 77, No. 1956, Jan. 5, 1957, p. 14.
[13] Fertiliser and Feeding Stuffs Journal (London), Polish Rock Salt: Vol. 66, No. 10, May 8, 1957, p. 458.

Spain.—Potasas Ibericas S. A. and Potasas de Suria, S. A. reported expansion of potash-production facilities in the Province of Barcelona.[14]

Plans were reported to form a new company to produce potash in the Province of Navarra. The National Institute of Industry (I. N. I.) completed extensive exploration of the Navarra deposits in 1955 and was to participate in the new company.[15]

Exports of potash materials from Spain increased 6 percent in 1956 over 1955. European countries received the major portion—72 percent. Data for 1957 were not available.

TABLE 13.—Exports of potash materials from Spain, 1952–56, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1952	1953	1954	1955	1956
North America: United States	43,497	40,339	19,786	26,676	18,045
Europe:					
Belgium-Luxembourg	54,456	74,689	58,081	37,690	63,614
Ireland	5,557	5,243		4,543	970
Italy	10,367	14,545	15,041	18,607	19,407
Netherlands	10,086	9,199	21,924	16,462	12,644
Norway	9,190	8,047	23,115	25,530	40,619
Portugal	8,736	7,021	8,662	10,411	17,626
United Kingdom	46,878	59,800	24,605	31,442	48,831
Asia:					
China	10,023	2,645			
Japan	21,253	55,191	98,337	89,391	59,784
Korea	5,376				
Other countries	13,149			5,555	
Total	238,568	276,719	269,551	266,307	281,540

[1] Compiled from Customs Returns of Spain.

United Kingdom.—Fertilizer-grade potash from U. S. S. R. was being sold in the United Kingdom and Eire with guaranteed analyses of 50 and 60 percent K_2O.

ASIA

Israel.—Potash production at Sodom by the Dead Sea Potash Works averaged 7,000 tons per month by the end of the year. Expansion of the port facilities at Eilot, on the Red Sea, and construction of a pipeline to either the Red Sea or the Mediterranean were being considered as aids to expanded potash exports.[16]

A carnallite deposit on Mount Sodom, disclosed by oil prospecting, was being investigated.[17]

The United Kingdom continued to receive the major part of Israel's exports. Smaller quantities were shipped to Australia, Ceylon, and Japan.

Japan.—Investigation of a new recovery process to obtain potash from dolerite was reported.[18]

[14] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 3, March 1957, p. 30.
[15] Mining Journal (London), vol. 248, No. 6351, May 10, 1957, p. 590.
[16] Mining World (London), vol. 19, No. 12, November 1957, p. 105.
[17] Fertiliser and Feeding Stuffs Journal (London), Phosphate and Potash in Israel: Vol. 47, No. 10, Nov. 6, 1957, p. 479.
[18] Chemical Trade Journal and Chemical Engineer (London), vol. 140, No. 3634, Jan. 25, 1957, p. 212.

Jordan.—The multigovernment-owned Jordan Potash Co., Ltd., announced plans for a potash recovery plant at the north end of the Dead Sea.[19]

AFRICA

French Equatorial Africa.—Plans for exploring the potash deposits along the lower Ogooué River between Lambarene and Port Gentil were announced by the Syndicate for Potash Research in Gabon.[20]

OCEANIA

Australia.—Potash occurrences in Queensland, New South Wales, Victoria, South Australia, and Western Australia were described.[21]

TECHNOLOGY

The potash deposits in Saskatchewan occur in the upper part of the Elk Point geological group of Devonian age. The upper part of the Elk Point group, called the Prairie Evaporites, is made up of salt, anhydrite, and dolomite. It varies from 640 to 1,200 feet in thickness in a 200 mile-wide basin and extends some 800 miles northwestward from northern North Dakota across Saskatchewan and Alberta.[22]

The Federal Geological Survey continued to explore the potash-bearing saline deposits in the Searles Lake area of the Mojave Desert, Calif. Results of the drilling program were released.[23]

Occurrences of saline deposits, including potash, in California and the industrial recovery practices were discussed.[24]

Mechanization of a potash mine was the subject of an article.[25] Belt conveyors, portable crushers, electric shuttle cars, and diesel trucks and jeeps all were standard equipment.

Investigation of dry beneficiation of soluble potash minerals, although successful on a small scale, did not develop economic processes for producing high-grade potassium muriate.[26]

Application of ore-dressing techniques to soluble minerals was discussed in an article.[27] Topics covered included the solubility of surface-active agents in salt solutions, conditions for flotation in soluble salt systems, activators and depressants in soluble salt systems, correlation between flotation and heat of solution of a salt, and mechanisms of adsorption of collectors on soluble chlorides.

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21 Thomas, G. A., and Barrie, J., Potassium: Mineral Resources of Australia, Summary Rept. 34, Australian Bureau of Mineral Resources, Geology, and Geophysics, Canberra, 1956, 19 pp.
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Pumice[1]

By L. M. Otis[2] and James M. Foley[3]

THE OUTPUT of pumice and pumiceous materials increased substantially in 1957; production was influenced by a sharp rise in the demand for pumice as railroad ballast. The average price was considerably less than in 1956.

DOMESTIC PRODUCTION

Fifteen States plus the Territory of Hawaii reported pumice production from 79 companies, individuals, or Government agenices at 83 properties, compared with 73 different producers at 79 separate projects in 1956.

Total production of pumice and related materials in 1957 was 1.8 million short tons—23 percent more than in 1956.

For the fourth successive year California was the leading pumice-producing State. There were 34 active pumice pits in California during 1957, compared with 33 in 1956. New Mexico had 11 active mines, followed by Arizona with 4.

All output came from open-pit mines.

An excellent bulletin on pumice production in California was published.[4] The history of the industry, geological occurrence, origin of deposits, and detailed descriptions of many properties in California were included, as well as treatise on using pumiceous materials in construction and agriculture.

A publication on pumice and volcanic-cinder production in California described the various producing areas together with notes on processing, utilizing, and marketing.[5]

TABLE 1.—Pumice[1] sold or used by producers in the United States,[2] 1948–52 (average) and 1953–57

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	678,166	$2,510,386	1955	1,804,488	$3,369,006
1953	1,348,136	2,526,040	1956	1,482,214	[3] 4,748,507
1954	1,647,397	2,974,318	1957	1,826,978	4,627,552

[1] Includes volcanic cinder as follows—1953: 669,831 short tons valued at $565,846; 1954: 690,056 tons, $475,424; 1955: 961,526 tons, $926,816; 1956: 594,661 tons, $1,527,053; 1957: 772,384 tons, $1,536,935.
[2] Includes Alaska (1951 only) and Hawaii (1953–57).
[3] Revised figure.

[1] This chapter also covers pumicite, volcanic cinder, scoria, tuff, lapilli, cinder, and similar pumiceous materials.
[2] Commodity specialist.
[3] Supervisory statistical assistant.
[4] Chesterman, Charles W., Pumice, Pumicite, and Volcanic Cinders in California: California Div. Mines, Bull. 174, 1956, 119 pp.
[5] State of California, Department of Natural Resources, Pumice, Pumicite, and Volcanic Cinders in California: Mineral Info. Service, vol. 10, No. 1, Jan. 1, 1957, 8 pp.

TABLE 2.—Pumice sold or used by producers in the United States,[1] 1955–57, by States

States	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona	92,136	$372,735	114,609	$366,095	397,154	$640,305
California	797,306	1,099,459	634,356	2,333,809	459,089	1,510,131
Colorado	(2)	(2)	50,015	109,206	24,772	53,066
Hawaii	130,306	75,906	58,851	91,695	266,222	492,553
Idaho	(2)	(2)	101,913	206,064	100,197	167,942
Kansas	2,320	59,710	(2)	(2)	(2)	(2)
Montana	(2)	(2)	(2)	(2)		
Nevada	(2)	(2)	11,534	34,516	(2)	(2)
New Mexico	393,597	780,339	292,330	667,146	320,861	756,001
North Dakota	(2)	(2)	4,840	4,840	2,300	2,300
Oregon	(2)	(2)	(2)	(2)	123,644	294,374
Utah	2,041	20,011	44,769	329,603	35,794	148,154
Washington	(2)	(2)	5,291	14,757	(2)	(2)
Wyoming	(2)	(2)	45,517	37,859	49,254	40,388
Other States [3]	386,782	960,846	118,189	[4] 552,917	47,691	522,338
Total	[5] 1,804,488	[5] 3,369,006	[6] 1,482,214	[4 6] 4,748,507	[7] 1,826,978	[7] 4,627,552

[1] Includes Hawaii.
[2] Included with "Other States" to avoid disclosing individual company confidential data.
[3] Includes States indicated by footnote 2, and Nebraska, Oklahoma, and Texas.
[4] Revised figure.
[5] Includes 961,526 short tons of volcanic cinder valued at $926,816 from California, Hawaii, New Mexico, Nevada, and Texas.
[6] Includes 594,661 short tons of volcanic cinder valued at $1,527,053 from California, Hawaii, and Nevada.
[7] Includes 772,384 short tons of volcanic cinder valued at $1,536,935 from Arizona, California, Hawaii, Nevada, New Mexico, Oregon, Texas, and Utah.

CONSUMPTION AND USES

Pumice was formerly considered an abrasive, a major use until World War II, when a large-scale demand developed for pumiceous type materials as lightweight concrete aggregate for roads, railroad ballast, and fire-retardant plasters. Its effectiveness as insulation against sound and temperature also added materially to its phenomenal rise from 608,000 tons in 1948 to 1.8 million tons in 1957.

During 1957, 44 percent of all pumice consumed was used as railroad ballast and 34 percent as aggregate and admixtures in concrete. The remainder was used for road surfacing and various miscellaneous purposes.

TABLE 3.—Pumice[1] sold or used by producers in the United States, 1955–57, by uses

Use	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
Abrasive:						
Cleansing and scouring compounds and hand soap	19,979	$418,637	10,727	[2] $352,202	17,241	$499,904
Other abrasive uses	12,474	131,181	27,341	529,176	3,924	116,884
Acoustic plaster	3,313	71,726	2,434	79,197	3,872	67,365
Concrete admixture and concrete aggregate	799,360	2,007,987	745,684	2,229,285	628,366	1,884,234
Railroad ballast	(3)	(3)	(3)	(3)	797,881	1,062,541
Other uses [4]	969,362	739,475	696,028	1,558,647	375,694	996,624
Total	1,804,488	3,369,006	1,482,214	[2] 4,748,507	1,826,978	4,627,552

[1] Includes volcanic cinder as follows—1955: 961,526 short tons valued at $926,816; 1956: 594,661 tons, $1,527,053; 1957: 772,384 tons, $1,536,935.
[2] Revised figure.
[3] Included with "Other uses."
[4] Insecticide, insulation, brick manufacture, filtration, railroad ballast, roads (surfacing and ice control), absorbents, soil conditioner, and miscellaneous uses.

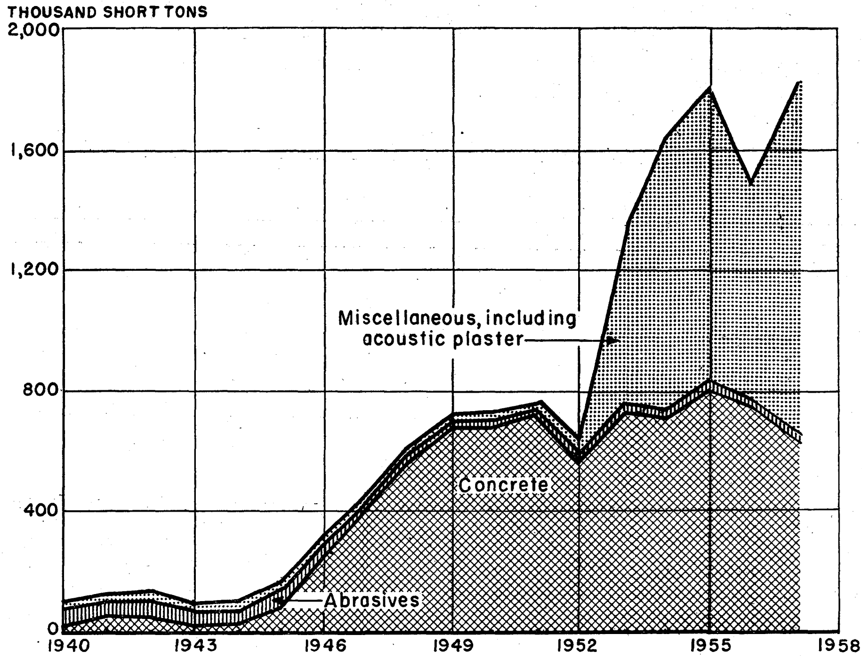

FIGURE 1.—Pumice trends, by uses, 1940–57.

TABLE 4.—Crude and prepared pumice[1] sold or used by producers in the United States in 1957

	Short tons	Value	
		Total	Average per ton
Crude	670,645	$1,189,567	$1.77
Prepared	1,156,333	3,437,985	2.97
Total	1,826,978	4,627,552	2.53

[1] Includes 772,384 short tons of volcanic cinder valued at $1,536,935.

PRICES

Trade publications regularly carry quotations of domestic and imported prepared pumice. The Oil, Paint and Drug Reporter quoted the following average prices for 1957, per pound, bagged, in ton lots: Domestic, coarse to fine, $0.03625; imported, Italian, silk-screened, coarse, $0.0650; the same, but fine, $0.0400. Imported, Italian, sun-dried, coarse, was quoted at $58 per ton.

E&MJ Metal and Mineral Markets quoted nominal year-end prices for 1957, per pound, f. o. b. New York or Chicago, in barrels, powdered, 3 to 5 cents; lump, 6 to 8 cents.

The weighted average value, per short ton, for both crude and prepared pumice, as reported to the Bureau of Mines in 1957, is shown in table 4 and was $2.53, 21 percent less than in 1956 owing principally to the higher proportion of low-priced ballast. The average price per ton for pumice used as concrete aggregate and admixtures in 1957 was virtually the same as in 1956, and that used for abrasive applications increased.

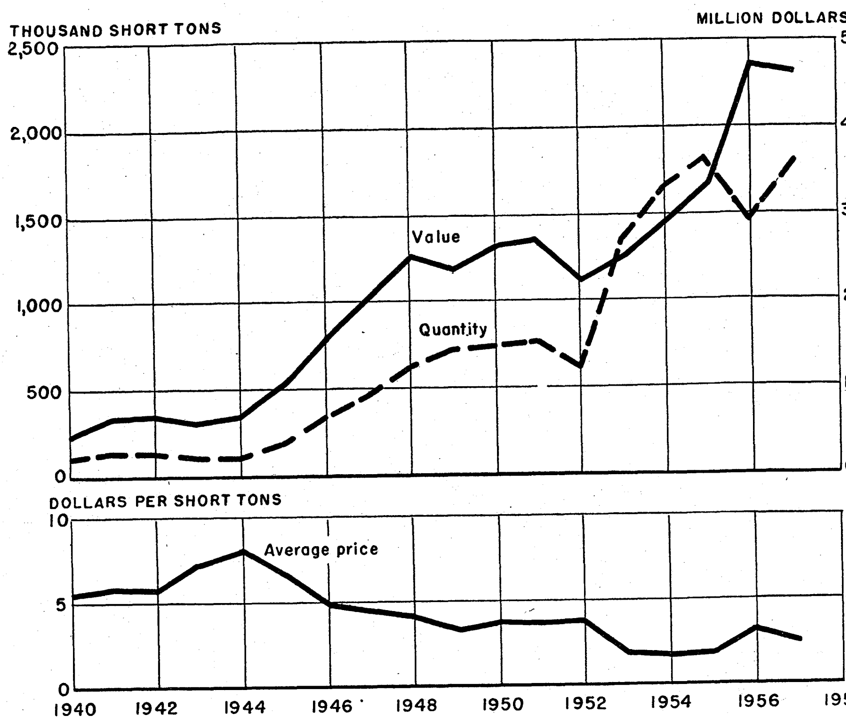

FIGURE 2.—Total value, quantity, and price per ton of pumice, 1940–57.

FOREIGN TRADE[6]

As in previous years, Greece was the major source of imported crude pumice supplying 28,571 short tons in 1957, compared with 13,025 tons in 1956. Italy supplied 6,513 tons of crude and 2,084 tons of manufactured pumice; in 1956, such imports were 6,462 and 1,312 tons, respectively.

The duty per pound on imported pumice at the beginning of 1957 was: Crude valued at $15 per ton and under, $0.0475; crude valued over $15 per ton, $0.120; wholly or partly manufactured, $0.475. On June 30, 1957, tariff rates were reduced to $0.0450 for pumice valued at $15 per ton and under; and $0.450 for wholly or partly manufactured pumice.

Imports of pumice valued at less than $15 per ton were 93 percent of the total, compared with 92 percent in 1956. Twenty-three percent came from Italy in 1957 and had an average value of $14.48 per ton. Except for insignificant quantities, the remainder, 77 percent, came

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

TABLE 5.—Pumice[1] imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	Crude or unmanufactured								Wholly or partly manufactured			
	Valued at $15 or less per ton				Valued over $15 per ton							
	1956		1957		1956		1957		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America: Canada											21	$1,671
Europe:												
Azores							26	$1,485			19	1,283
Germany, West									3	$2,023		
Greece	13,025	$44,524	28,571	$230,095								
Italy	6,040	58,394	6,227	50,859	422	$8,139	286	6,756	1,312	49,320	2,084	66,836
Portugal			46	442			26	1,645				
Total	19,065	102,918	34,844	281,396	422	8,139	338	9,886	1,315	51,343	2,103	68,119
Grand total	19,065	102,918	34,844	281,396	422	8,139	338	9,886	1,315	51,343	2,124	69,790

[1] Exclusive of "manufactures, n. s. p. f."

TABLE 6.—Pumice imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Class	1948–52 (average)		1953		1954		1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude or unmanufactured	14,865	$121,789	32,712	$166,079	20,951	$117,136	29,938	[1] $164,539	19,487	$111,057	35,182	$291,282
Wholly or partly manufactured	749	16,858	943	19,975	950	[1] 20,541	1,497	[1] 38,971	1,315	51,343	2,124	69,790
Manufactured, n. s. p. f.	(2)	2,108	(2)	5,415	(2)	[1] 6,720	(2)	[1] 4,371	(2)	[1] 7,674	(2)	13,876
Total		140,755		191,469		[1] 144,397		[1] 207,881		[1] 170,074		374,948

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.
[2] Quantity not recorded.

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from Greece and averaged $8.05 per ton in value. Virtually all of the crude imported pumice valued at more than $15 per ton came from Italy and the average value per ton was $23.62 but was less than 1 percent by weight of total crude imports.

Canada and the Azores were new, but minor, pumice exporters to the United States in 1957.

WORLD REVIEW

NORTH AMERICA

Canada.—No pumice was produced in Canada, but a quantity valued at Can$110,000 was imported from Western United States in 1956. This was 6 percent less than in 1955.[7]

A pumice deposit was reported in the Bridge River area of British Columbia near Mount Meager 35 miles northwest of Pemberton Meadows. It consists of a surface accumulation of particles from dust size to 3 inches maximum.

EUROPE

Austria.—Trass, a rock formed by the consolidation of numerous small pumice particles, is often classified as pumice. In 1956, 37,500 short tons of trass was produced, compared with 53,000 tons in 1955.

TABLE 7.—World production of pumice, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Argentina [3]				49,604	15,708	[4] 22,000
Austria: Trass	[4] 38,600	[4] 44,100	51,601	52,935	37,499	38,875
Egypt	525	761	441	181	[4] 170	[4] 170
France:						
Pumice	18,023	11,464	11,133	9,921	14,330	[4] 11,000
Pozzolan	95,776	232,903	296,207	242,508	243,611	[4] 242,500
Germany, West (marketable)	[4] 2,200,000	2,489,378	2,218,950	3,105,207	3,966,111	3,261,735
Greece:						
Pumice	15,638	47,179	34,409	33,069	27,558	[4] 28,000
Santorini earth	36,714	44,092	38,581	40,234	[4] 44,000	[4] 44,000
Iceland			12,125	[4] 14,600	[4] 19,000	[4] 19,000
Italy:						
Pumice	68,461	192,132	166,915		168,969	
Pumicite	35,289	37,148	40,400	198,614	17,196	[4] 2,800,000
Pozzolan	1,010,801	1,392,703	1,657,290	1,452,282	2,567,280	
Kenya					1,831	2,319
New Zealand	10,772	2,254	9,916	8,670	8,527	16,991
Spain (Canary Islands)	748	612	529	944		
United States (sold or used by producers)	678,166	[5] 1,348,136	[5] 1,647,397	[5] 1,804,488	[5] 1,482,214	[5] 1,826,978
World total (estimate)[1] [2]	4,300,000	5,900,000	6,200,000	7,100,000	8,700,000	8,400,000

[1] Pumice is also produced in Canada, Japan, Mexico, U. S. S. R., and a few other countries, 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 Pumice chapters. Data do not add to totals shown because of rounding where estimated figures are included in detail.

[3] Includes volcanic ash and cinders, and pozzolan.

[4] Estimate.

[5] Includes in 1953, 560,502 tons; 1954, 690,056 tons; 1955, 961,526 tons; 1956, 594,661 tons; and in 1957, 772,384 tons of volcanic cinder and scoria, used for railroad ballast or similar purposes.

[7] Canada Department of Mines and Technical Surveys, Ottawa, Lightweight Aggregates in Canada, 1956 (Prelim.): 5 pp.

Greece.—Of the 27,500 short tons of pumice produced in 1956, 12,300 tons was exported; 10,000 tons, valued at $20,900, went to the United States. This compared with exports of 20,200 tons in 1955 and 18,750 tons in 1954. The value of exports was $40,700 and $45,700 in 1955 and 1954, respectively. In early 1955, with Government approval, a Greek-owned Panamanian shipping firm loaned $418,000 to Greek pumice producers for mining, processing, and transportation facilities on the island of Yali. Expected annual production was 85,000 cubic yards.

TECHNOLOGY

A patented precoating for a rocket-type combustion chamber consists of a mixture of sodium silicate, stannic acid, sodium hydroxide, and an inorganic filler, such as pumice.[8]

Pumice was mentioned as a filler used in a patented reinforced plastic sheet.[9]

The preferred composition for making a patented, precast, building panel was crushed pumice, sawdust, and portland cement.[10]

A patented process for forming insulating walls and ceilings consisted of a stabilized mineral aggregate, such as pumice, in concrete or gypsum plaster poured between removable forms.[11]

Pumice was specified as suitable for use with a patented blasting device.[12]

The use of pumice as a suitable soil bed for receiving septic-tank effluent was patented.[13]

A unitary seed-carrying package was patented, consisting of exfoliated vermiculite and pumice mixed with plant foods and an organic, water-soluble binder. The seeds are placed in indentations in the package and covered with another layer of the mixture. When embedded in soil, the seeds germinate.[14]

Two formulas were patented for producing permeable concrete for cementing oil wells and specified pumice as suitable aggregate.[15]

A method and apparatus for the continuous, large-scale manufacture of lightweight, reinforced, insulating concrete roof and floor slabs was patented. Pumice is one of the suitable lightweight aggregates specified.[16]

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[8] Hull, E. H., and Winslow, A. F., Preliminary Coating for Combustion Chamber Wall: U. S. Patent 2,811,467, Oct. 29, 1957.

[9] Petersilie, H. H., and Zimmermann, E. O. (assigned to Frank R. Lushas, New York, N. Y.), Hardened Molded Articles: U. S. Patent 2,812,570, Nov. 12, 1957.

[10] Clary, R. L., Hollow Building Construction: U. S. Patent 2,811,850, Nov. 5, 1957.

[11] Hand, D., and Swanson, W. R. (said Swanson assigned to said Hand, Witchita, Kans.), Wall-Forming Process: U. S. Patent 2,806,277, Sept. 17, 1957.

[12] Ryan, M. A. (assigned to Phillips Petroleum Co.), Explosive Apparatus: U. S. Patent 2,797,892, July 2, 1957.

[13] Horne, F. F., and Edwards, T. J. (said Edwards assigned to said Horne), Disposal of Septic Tank Effluent and the Like: U. S. Patent 2,795,542, June 11, 1957.

[14] Clawson, C. D. (assigned to Ferro Corp., Cleveland, Ohio), Seed-Planting Package: U. S. Patent 2,785,969, Mar. 19. 1957.

[15] Mangold, G. B., Dyer, J. A., and Hart, J. T. (assigned to Petroleum Engineering Associates, Inc., Pasadena, Calif.), Permeable Concrete: U. S. Patent 2,793,957, May 28, 1957; Well Completion With Permeable Concrete: U. S. Patent 2,786,531, Mar. 26, 1957.

[16] Sterrett, R. W. (assigned to Southern Zonolite Co., Atlanta, Ga.), Manufacture of Roofing Slabs and the Like: U. S. Patent 2,778,088, Jan. 22, 1957.

Quartz Crystal (Electronic Grade)

By Waldemar F. Dietrich[1] and Gertrude E. Tucker[2]

DOMESTIC consumption of Electronic-grade quartz crystal increased 11 percent in 1957. The number of piezoelectric units was 6 percent greater. No domestic production of Electronic-grade quartz crystal was reported. Imports for consumption, principally from Brazil, decreased substantially.

GOVERNMENT PROGRAMS

Defense Minerals Exploration Administration.—DMEA, on October 22, 1957, lowered the Government's participation in quartz-crystal exploration contracts to 50 percent from 75 percent. No applications for exploration assistance for quartz crystal were received in 1957.

Defense Materials Service.—Purchases of Electronic-grade quartz crystal for the strategic stockpile by Defense Materials Service were completed in 1957.

Commodity Credit Corporation.—Some quartz crystal was obtained through barter in 1957 by the United States Department of Agriculture, Commodity Credit Corporation.

CONSUMPTION AND PRODUCTION

Raw quartz crystal consumed in the United States in 1957 for the production of piezoelectric units increased substantially for the second consecutive year—the only notable increases in consumption since 1952. Quartz-crystal cutters reported using 16,900 pounds more in 1957. Forty-one consumers reported to the Bureau of Mines in 1957 compared with 42 in 1956. Although most of the crystals consumed continued to weigh 100 to 500 grams, there was an accelerated demand for crystals weighing 700 to 2,000 grams for the production of crystal filters to be used in long-distance automatic-dialing telephone circuits.

The number of piezoelectric units produced in 1957 increased 6 percent. Production excludes finished crystal units reported produced from approximately 100,000 reworked blanks cut from quartz previously reported as consumption and a small quantity of finished crystal units marketed in the United States, which were produced from blanks imported from Canada. The yield of units per pound of raw quartz consumed decreased 4.5 percent from the alltime high reported in 1956, reflecting the unusually high production of large filter units; however, for most other applications, the trend toward increased production of smaller units continued.

[1] Chief, Branch of Ceramic and Fertilizer Materials.
[2] Statistical assistant.

TABLE 1.—Consumption of Electronic-grade quartz and production of piezoelectric units in the United States in 1957, by States

State	Consumption of Electronic-grade quartz [1]		Production of piezoelectric units [2]	
	Consumers	Pounds consumed	Producers	Units produced
California	6	5,300	8	140,900
Connecticut and Massachusetts	4	5,000	4	61,000
Illinois	4	15,000	3	1,528,800
Iowa, Kansas, Nebraska, and Wisconsin	4	24,000	5	
Missouri	2	17,500	3	754,500
New Jersey	5	34,500	6	932,100
Ohio	2	9,800	2	
New York	3		4	162,900
Pennsylvania	7	52,700	7	1,645,500
Texas	1	1,900	2	19,700
Other States	[3] 3	[3] 1,500	[4] 9	[4] 123,200
Total	41	167,200	53	5,368,600

[1] May include a small quantity of reworked scrap previously reported as consumption.
[2] For radio oscillators, telephone resonators, filters, and miscellaneous purposes.
[3] Includes Florida, Maryland, and Virginia.
[4] Includes Florida, Georgia, Louisiana, Maryland, Oklahoma, Virginia, and Washington.

Consumers of quartz crystal and producers of piezoelectric units were distributed among 17 States; there were producers of units only in 4 other States, as shown in table 1. Pennsylvania continued to lead and reported about 31 percent of both consumption of quartz and production of units. Other important consuming States were Illinois, Kansas, Missouri, and New Jersey. About 90 percent of the total was consumed in 8 States. Thirty-nine of the 41 quartz-crystal consumers also produced piezoelectric units, and 14 of the 53 producers of units did not consume quartz crystal.

Production of piezoelectric units for oscillator plates comprised 91 percent of the total crystal units and was reported from all 21 States. Piezoelectric units also were produced for filter and telephone-resonator plates, and a small quantity was produced for other uses.

Westinghouse Electric Corp. began to manufacture fused quartz in 1957.[3]

PRICES

Prices of Electronic-grade quartz crystal are negotiated between buyer and seller. The heavy demand for large crystals in 1957 resulted in increases up to about 10 percent in the prices of high-quality crystals in the 701- to 1,000- and 1,001- to 2,000-gram weight groups, which were sold at about $30 and $40 per pound, respectively. There was a softening of prices in the weight groups up to 500 grams. Class 1 crystals, weighing 201 to 300 and 301 to 500 grams, sold up to 20 percent below the 1956 prices of about $12 and $17 to $18 per pound, respectively. Importers reported some changes in export prices of quartz crystal from Brazil, but details were not available.

Synthetic quartz Z-bar crystals, 200 to 250 grams in weight and free from crystallographic and electrical twinning, were offered at $50 per pound. These crystals are said to have a usability 4 to 5 times that of natural quartz.

[3] Ceramic Age, vol. 70, No. 6, December 1957, p. 33.

Approximate prices for lasca, used to produce clear fused quartz, were $0.50 per pound for 10- to 29-gram crystals, $0.80 per pound for 30- to 99-gram crystals, and $1 per pound for crystals weighing 100 grams or more.

FOREIGN TRADE [4]

Imports of Electronic- and Optical-grade quartz crystal in 1957, valued at 35 cents or more per pound, decreased 17 percent in quantity and 43 percent in value, the lowest in quantity since 1950 and the lowest in value since 1940 (see table 2). The average declared value per pound declined from $2.19 in 1956 to $1.51 in 1957. Of the total imports, Brazil supplied 411,100 pounds (95 percent) and Japan 18,900 pounds (4 percent). The remaining 2,100 pounds was furnished by France, United Kingdom, Madagascar, and Canada. Shipments from France were believed to have originated in Madagascar. Part of the United States imports credited to Japan comprised material sent from the United States for partial processing. Most of the United States imports credited to Canada were believed to comprise material reentering the United States after shipment from the United States to Canada for partial processing. The value of imports from the United Kingdom was believed to have been balanced approximately by United States exports of crystals of different weight groups.

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, 1948–52 (average) and 1953–57

Year	Estimated imports of Electronic- and Optical-grade quartz crystal [1] [2]			Consumption of raw Electronic-grade quartz (pounds)	Piezoelectric units	
	Pounds	Value	Value per pound		Production (number)	Number per pound of raw quartz
1948–52 (average)	733,100	$2,275,800	$3.10	201,400	2,649,600	13.2
1953	1,119,200	2,240,200	2.00	399,200	7,217,700	18.1
1954	613,100	1,562,800	2.55	133,900	3,653,800	27.3
1955	704,500	1,393,500	1.98	134,200	4,089,500	30.5
1956	521,400	1,142,200	2.19	150,300	[3] 5,044,500	33.6
1957	432,100	651,900	1.51	167,200	5,368,600	32.1

[1] Figures for 1948–52 (average) derived from Bureau of the Census 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] Figures for 1953–57 are imports of Brazilian pebble, valued at 35 cents or more per pound.
[3] Revised figure.

In 1957 imports of quartz crystal valued at less than 35 cents per pound—classed as lasca—totaled 1,114,100 pounds valued at $77,300, compared with 645,100 pounds valued at $106,600 in 1956. Brazil was the principal supplier of lasca, obtained from the rejects of Electronic-grade quartz-crystal production. A small quantity of lasca was imported from Canada.

Exports of quartz crystal in 1957 were valued at $152,800, an increase of 137 percent over 1956. The value of reexports, totaling

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

$310,800, declined 49 percent in 1957. "Exports" include crystals of foreign origin that have been changed in the United States to enhance their value, and "reexports" comprise crystals of foreign origin that have been exported without being changed. The principal country of destination for United States reexports in 1957 was Japan, which received lasca and ornamental quartz, as well as some 100- to 200-gram irregular Electronic-grade crystals for partial processing and return to United States dealers.

WORLD REVIEW

Brazil.—Exports of Piezoelectric (Electronic)-grade quartz crystal from Brazil in 1956 totaled 491,500 pounds valued at US$1,099,000. Exports of lasca, principally classed as Fusing-grade quartz, totaled 1,615,500 pounds valued at $181,000.[5]

Madagascar.—The production and exports of quartz crystal in Madagascar in 1956 and for the first 9 months of 1957 are shown in table 3.

TABLE 3.—Production and exports of quartz crystal in Madagascar in 1956 and 1957 [1]

Class	Production				Exports			
	1956		1957		1956		1957	
	Pounds	Value [2]	Pounds	Value [2]	Pounds	Value [2]	Pounds	Value [2]
Piezoelectric	[3] 31,100	[3] $120,900	18,100	$70,300	[3] 38,300	[3] $397,700	33,500	$347,400
Ornamental	[3] 30,900	[3] 4,000	20,500	2,700	24,500	6,300	23,100	6,000
Fusing	[3] 8,400	[3] 600	11,000	900	15,600	2,000	24,000	3,100
Total	[3] 70,400	[3] 125,500	49,600	73,900	[3] 78,400	[3] 406,000	80,600	356,500

[1] U. S. Embassy, Johannesburg, Union of South Africa, State Department Dispatches 29, Aug. 14, 1957 (revised data, 1956); 1, July 2, 1957; 54, Sept. 19, 1957; 161, Jan. 23, 1958; 310, July 16, 1958.
[2] Converted from African Colonial Francs (CFA) at 175CFA equal US$1.
[3] Revised figure.

TECHNOLOGY

The quartz-crystal deposits of Guatemala were described, and past production was reviewed.[6]

Sawyer Research Products, Inc., Eastlake, Ohio, under contract with the United States Army Signal Corps Supply Agency, continued pilot-plant production of synthetic quartz crystal in vertical stationary autoclaves. According to C. B. Sawyer, president of Sawyer Research Products, Inc., improvements were made in the design of equipment and in operating practices that resulted in a substantial decrease in equipment and operating-cost estimates for full-scale operation.

Research on quartz-crystal synthesis at Clevite Research Center, Cleveland, Ohio, was continued under contract with the United States Army Signal Engineering Laboratories. Emphasis was placed on improving the quality of synthetic quartz. It was confirmed that the growing Z-crystallographic surface of quartz rejects impurities, causing

[5] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, p. 43.
[6] Roberts, R. J., and Irving, E. M., Mineral Deposits of Central America: Geol. Survey Bull. 1034, 1957, pp. 161-169.

darkening by X-ray irradiation. Criteria were established to control the critical variables of quartz synthesis to obtain a structurally uniform and improved product.[7]

A patent was granted on a method of growing quartz crystals.[8]

Hungarian scientists reported experiments on the growing of synthetic quartz crystal in autoclaves by using Wooster's method.[9]

Articles on various aspects of quartz-crystal synthesis in the U. S. S. R. were published.[10]

Data were published on the effect of X-ray irradiation and heat treatment on the piezoelectric properties of synthetic quartz crystal grown under different conditions and containing either aluminum or germanium as an added impurity.[11] Various kinds of silica glass and natural and synthetic crystals were irradiated with fast neutrons, and the paramagnetic resonance was correlated with lattice defects.[12] The frequency-temperature characteristics of natural quartz were compared with those of piezoelectric units prepared from doped and undoped synthetic quartz.[13] The direct-current resistivity of Z-cut plates of quartz was measured.[14]

Studies were made of the anelasticity of quartz,[15] and data were published on the anisotropic relaxation peak of quartz crystal.[16]

The structure of accessory growth on synthetic quartz crystals was described,[17] the dynamic elastic constants of quartz were redetermined,[18] the pattern of light diffracted by ultrasonic waves in quartz

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[7] Augustine, Frank, Improving the Quality of Synthetic Quartz: Proc. 11th Ann. Symposium on Frequency Control, U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., May 1957, pp. 130–141.

[8] Buehler, E. (assigned to Bell Telephone Laboratories, Inc.), Method of Growing Quartz Crystals: U. S. Patent 2,785,058, Mar. 12, 1957.

[9] Nagy, J., and Tarján, I. [Growing of Artificial Quartz Crystals]: Acta Phys. Acad. Sci. Hung., vol. 6, 1957, pp. 485–488 (in German); Chem. Abs., vol. 51, No. 16, Aug. 25, 1957, p. 11943h.

[10] Ikornikova, N. Y., and Butuzov, V. P. [The Relief of Crystal Faces in Synthetic Quartz in the Initial Period of Growth]: Trudy Inst. Krist., Akad. Nauk S. S. S. R., 1955, No. 11, pp. 223–228; Chem. Abs., vol. 51, No. 17, Sept. 10, 1957, p. 12589b.

Butuzov, V. P., and Ikornikova, N. Y. [The Formation of Quartz in Nature]: Trudy Inst. Krist., Akad. Nauk S. S. S. R., 1955, No. 11, pp. 229–232; Chem. Abs., vol. 51, No. 16, Aug. 25, 1957, p. 11943h.

Sheftal, N. N. [The Genesis of Piezoquartz Deposits Considering the Data of Growing Artificial Quartz]: Voprosy Geokhim. i Mineral., Akad. Nauk S. S. S. R., Otdel. Geol. Geograf. Nauk, 1956, pp. 142–157; Chem. Abs., vol. 51, No. 17, Sept. 10, 1957, p. 13329e.

Vitovskiĭ, B. V. [Increasing the Growth Rate of a Crystal by Exposing It to Vibrations of Sonic Frequency]: Trudy Inst. Krist., Akad. Nauk S. S. S. R., 1955, No. 11, pp. 221–222; Chem. Abs., vol. 51, No. 17, Sept. 10, 1957, p. 12589a.

[11] Stanley, J. M., and Chi, A. R., Some Properties of Doped and Undoped Synthetic Quartz: Proc. 11th Ann. Symposium on Frequency Control, U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., May 1957, pp. 90–111.

[12] Weeks, R. A., Paramagnetic Resonance of Lattice Defects in Irradiated Quartz: Jour. Appl. Phys., vol. 27, No. 11, November 1956, pp. 1376–1381.

[13] Chi, A. R., Resonator Properties of Synthetic and Doped Synthetic Quartz: Inst. Radio Eng. Nat. Convention Record, vol. 5, pt. 9, 1957, pp. 70–75.

[14] Wenden, H. E., Ionic Diffusion and the Properties of Quartz. I. The Direct Current Resistivity: Am. Mineral., vol. 42, No. 11/12, November-December 1957, pp. 859–888.

[15] Cook, R. K., and Wasilik, J. H., Anelasticity and Dielectric Loss of Quartz: Jour. Appl. Phys., vol. 27, No. 7, July 1956, pp. 836–837.

King, J. C., The Anelasticity of Natural and Synthetic Crystalline Quartz: Proc. 11th Ann. Symposium on Frequency Control, U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., May 1957, pp. 62–77.

Zubov, V. G., The Variation of the Elastic Constants of Quartz With Temperature: Soviet Phys. Doklady, vol. 1, 1956, pp. 187–188 (English translation—see footnote 10, Chap. on Quartz Crystal (Electronic Grade) in Minerals Yearbook, 1956).

[16] Wasilik, J. H., Anisotropic Relaxation Peak in the Internal Friction of Crystaline Quartz: Phy. Rev., vol. 105, No. 4, Feb. 15, 1957, pp. 1174–1180.

[17] Tsinober, L. I. [The Spiral Structure of Accessory Growth on the 0001 Surfaces of Crystals of Synthetic Quartz]: Kristallografiya, vol.1, 1956, pp. 609–610; Chem. Abs., vol. 51, No. 9, May 10, 1957, p. 6261f.

[18] Zubov, V. G., and Firsova, M. M. [Measurement and Recalculation of the Dynamic Elastic Constants of Quartz]: Kristallografiya, vol. 1, 1956, pp. 546–554; Chem. Abs., vol. 51, No. 9, May 10, 1957, p. 6262c.

was reported,[19] and various imperfections in synthetic quartz revealed by optical methods were described.[20]

The dispersion of Faraday rotation in fused quartz was measured and found to differ significantly from that of quartz crystal.[21]

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19 Zubov, V. G., and Firsova, M. M. [Peculiarities in the Diffraction of Light by Ultrasonic Waves in Quartz]: Kristallografiya, vol. 1, 1956, pp. 555–556; Chem. Abs., vol. 51, No. 9, May 10, 1957, p. 6262e.

20 Arnold, G. W., Jr., Defects in Quartz Crystals: Proc. 11th Ann. Symposium on Frequency Control, U. S. Army Signal Engineering Laboratories, Fort Monmouth, N. J., May 1957, pp. 112–117.

21 Sivaramakrishnan, V., Dispersion of Faraday Rotation in Fused Quartz: Proc. Indian Acad. Sci., vol. 44A, 1956, pp. 206–215.

Salt

By R. T. MacMillan [1] and Annie L. Mattila [2]

OUTPUT of salt in 1957 decreased slightly from the record high mark established for the United States in 1956. Small decreases in both rock salt and brine sold or used followed a general leveling off in business activity in 1957.

TABLE 1.—Salient statistics of the salt industry in the United States, 1948–52 (average) and 1953–57 [1]

	1948–52 (average)	1953	1954	1955	1956	1957
Sold or used by producers:						
Dry salt:						
Evaporated (manufactured) short tons	3,423,549	3,702,305	3,731,087	3,986,967	4,027,953	3,993,689
Rock salt do	4,089,636	4,478,655	4,824,708	5,293,282	5,622,897	5,341,586
Total do	7,513,185	8,180,960	8,555,795	9,280,249	9,650,850	9,335,275
Value	$52,473,044	$65,407,021	$73,405,616	$80,952,078	$88,512,866	$96,706,087
Average per ton	$6.97	$7.99	$8.58	$8.72	$9.17	$10.36
In brine:						
Short tons	10,158,347	12,608,043	12,113,608	13,423,894	14,564,773	14,518,744
Value	$9,249,846	$12,869,646	$32,180,276	$42,436,769	$47,726,757	$50,688,667
Total salt:						
Short tons	17,671,532	20,789,003	20,669,403	22,704,143	24,215,623	23,854,019
Value [2]	$61,722,890	$78,276,667	$105,585,892	$123,388,847	$136,239,623	$147,394,754
Imports for consumption:						
Short tons	637	137,308	160,770	185,653	368,212	654,149
Value	$50,247	$473,472	[3] $878,961	[3] $1,160,519	[3] $2,353,728	[3] $3,545,772
Exports:						
Short tons	345,368	249,521	385,259	407,131	336,320	390,707
Value	$3,603,923	$2,327,656	$3,085,652	$3,023,025	$2,463,766	$2,591,049
Apparent consumption: short tons	17,332,401	20,676,790	20,444,914	22,482,665	24,247,515	24,117,461

[1] Includes Hawaii (1952–57 only) and Puerto Rico.
[2] Values are f. o. b. mine or refinery and do not include cost of cooperage or containers.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with earlier years.

DOMESTIC PRODUCTION

As in previous years, most salt came from Michigan, where 22 percent of the total was produced. Texas ranked second, with 19 percent, and New York, third, with 15 percent. Louisiana, Ohio, and California ranked fourth, fifth, and sixth, with 15, 12, and 6 percent, respectively. Together these 6 States furnished about 89 percent of the salt sold or used in the United States in 1957.

Salt was produced at 89 facilities in the United States, Hawaii, and Puerto Rico in 1957; 4 leading companies operating 10 plants supplied 53 percent of the total output; the next 5 companies, operating 17 plants, furnished 31 percent; and the remaining 62 plants supplied 16 percent.

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

Over 1 million tons of salt was produced by each of 8 plants during the year; 6 plants reported production ranging between 500,000 and 1 million tons each, and 30 plants produced 100,000 to 500,000 tons. Of the remaining plants, 26 produced less than 10,000 tons each.

About 61 percent of the total salt sold or used was produced and used as brine.

TABLE 2.—Salt sold or used by producers in the United States, 1955–57, by States

State	1955			1956			1957		
	Quantity		Value	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total		Short tons	Percent of total	
California	1,314,535	6	$6,751,420	1,444,211	6	$7,605,764	1,330,060	6	$8,721,242
Hawaii	(1)	(1)	(1)	270	(2)	18,119	194	(2)	15,239
Kansas	910,866	4	8,432,325	1,004,042	4	9,167,364	1,018,027	4	10,353,119
Louisiana	3,562,636	16	15,406,993	3,703,500	15	17,695,270	3,460,921	15	18,943,861
Michigan	4,975,442	22	31,668,351	5,548,178	23	35,643,860	5,225,425	22	41,072,497
New Mexico	49,738	(2)	596,780	57,156	(2)	501,040	53,065	(2)	429,320
New York	3,779,547	16	25,214,191	3,872,777	16	27,544,908	3,690,981	15	28,001,832
Ohio	2,905,028	13	14,768,761	2,971,702	12	15,922,765	2,824,878	12	16,935,523
Oklahoma	(1)	(1)	(1)	9,980	(2)	89,764	6,943	(2)	62,664
Puerto Rico	10,496	(2)	112,399	9,936	(2)	101,243	9,755	(2)	104,324
Texas	3,583,242	16	12,867,094	3,962,778	17	14,369,558	4,612,093	19	17,104,385
Utah	195,726	1	1,339,085	183,701	1	1,471,080	220,942	1	2,013,131
West Virginia	638,390	3	3,476,352	680,964	3	3,453,305	648,139	3	2,641,595
Other States [3]	778,497	3	2,755,096	766,428	3	2,655,583	752,606	3	996,022
Total	22,704,143	100	123,388,847	24,215,623	100	136,239,623	23,854,019	100	147,394,754

[1] Included with "Other States" to avoid disclosing individual company confidential data.
[2] Less than 1 percent.
[3] Includes States indicated by footnote 1, and Alabama, Colorado, Nevada, and Virginia.

TABLE 3.—Salt sold or used by producers in the United States,[1] 1956–57, by methods of recovery

Method of recovery	1956		1957	
	Short tons	Value	Short tons	Value
Evaporated:				
Bulk:				
Open pans or grainers	379,746	$9,210,091	399,806	$11,005,508
Vacuum pans	2,147,078	32,610,436	2,158,627	36,664,930
Solar	1,232,161	5,685,437	1,146,024	6,582,646
Pressed blocks	268,968	4,967,529	289,232	6,063,695
Rock:				
Bulk	5,571,114	35,045,478	5,286,322	35,062,114
Pressed blocks	51,783	993,895	55,264	1,327,194
Salt in brine (sold or used as such)	14,564,773	47,726,757	14,518,744	50,688,667
Total	24,215,623	136,239,623	23,854,019	147,394,754

[1] Includes production in Hawaii and Puerto Rico.

CONSUMPTION AND USES

The apparent consumption of salt in 1957 was 24.1 million tons, a decrease of less than 1 percent compared with the preceding year. Following an increasing trend of the past 3 years, chlorine manufacture consumed more salt than any other single use. Soda-ash manufacture, formerly the chief consumer of salt, ranked second. State and local governments consumed salt largely for road stabilization and ice and snow removal. Meatpackers, feed dealers, grocery stores, and chemical and water-softener manufacturers also consumed important tonnages of salt.

In a few categories, such as the production of soda ash and chemicals, salt consumption decreased. These two uses and chlorine production consumed 71 percent of the salt produced in 1957.

TABLE 4.—Evaporated salt sold or used by producers in the United States, 1955–57, by States

State	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
California	1,105,772	$6,120,822	(1)	(1)	(1)	(1)
Hawaii	(1)	(1)	270	$18,119	194	$15,239
Kansas	361,612	5,819,536	350,208	5,963,055	371,752	7,259,628
Louisiana	110,218	1,743,445	121,900	1,995,188	128,220	2,691,921
Michigan	857,265	14,234,709	854,335	15,150,073	835,263	16,746,595
New York	568,497	9,655,884	560,693	10,116,141	(1)	(1)
Ohio	509,905	6,113,567	(1)	(1)	(1)	(1)
Oklahoma	(1)	(1)	9,980	89,764	6,943	62,664
Puerto Rico	10,496	112,399	9,936	101,243	9,755	104,324
Texas	117,237	2,016,600	112,984	2,214,480	127,105	2,930,819
Utah	(1)	(1)	176,057	1,421,395	(1)	(1)
Other States [2]	345,965	3,156,713	1,831,590	15,404,035	2,514,457	30,505,589
Total	3,986,967	48,973,675	4,027,953	52,473,493	3,993,689	60,316,779

[1] Included with "Other States" to avoid disclosing individual company confidential data.
[2] Includes States indicated by footnote 1, and Nevada, New Mexico, and West Virginia.

TABLE 5.—Rock salt sold by producers in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	4,089,036	$20,070,013	1955	5,293,282	$31,978,403
1953	4,478,655	23,777,527	1956	5,622,897	36,039,373
1954	4,824,708	28,319,630	1957	5,341,586	36,389,308

TABLE 6.—Pressed-salt blocks sold by original producers of the salt in the United States, 1948–52 (average) and 1953–57

Year	From evaporated salt		From rock salt		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	274,380	$3,493,875	62,616	$678,395	336,996	$4,172,270
1953	293,014	4,603,864	62,247	853,521	355,261	5,457,385
1954	284,276	4,929,057	59,615	1,011,607	343,891	5,940,664
1955	285,670	5,069,998	57,539	1,037,523	343,209	6,107,521
1956	268,968	4,967,529	51,783	993,895	320,751	5,961,424
1957	289,232	6,063,695	55,264	1,327,194	344,496	7,390,889

TABLE 7.—Salt sold or used by producers in the United States, 1956–57, by classes and consumers or uses, in thousand short tons

Consumer or use	1956				1957			
	Evaporated	Rock	Brine	Total	Evaporated	Rock	Brine	Total
Chlorine	716	1,402	6,190	8,308	648	1,314	6,734	8,696
Soda ash	([1])	([1])	7,797	7,805	([1])	--------	([1])	7,221
Textile and dyeing	55	137	--------	192	64	135	--------	199
Soap (including detergents)	35	([1])	([1])	43	36	6	--------	42
All other chemicals	174	470	516	1,160	171	420	452	1,043
Meatpackers, tanners, and casing manufacturers	([1])	510	([1])	934	([1])	486	([1])	884
Fishing	23	13	--------	36	25	11	--------	36
Dairy	55	19	--------	74	57	6	--------	63
Canning	173	35	--------	208	173	36	--------	209
Baking	105	3	--------	108	111	4	--------	115
Flour processors (including cereal)	55	3	--------	58	55	3	--------	58
Other food processing	84	32	--------	116	77	32	--------	109
Ice manufacturers and cold-storage companies	([1])	46	([1])	83	([1])	43	([1])	79
Feed dealers	558	319	--------	877	575	267	--------	842
Feed mixers	168	54	--------	222	171	65	--------	236
Metals	76	78	4	158	([1])	67	([1])	150
Ceramics (including glass)	4	11	--------	15	([1])	([1])	--------	18
Rubber	([1])	82	([1])	100	([1])	144	([1])	209
Oil	([1])	77	([1])	135	([1])	72	([1])	127
Paper and pulp	([1])	88	([1])	126	([1])	94	([1])	135
Water-softener manufacturers and service companies	([1])	256	([1])	370	([1])	252	([1])	383
Grocery stores	568	150	--------	718	582	151	--------	733
Railroads	20	66	--------	86	14	55	--------	69
Bus and transit companies	([1])	([1])	--------	34	([1])	([1])	--------	38
State, counties, and other political subdivisions (except Federal)	([1])	1,494	([1])	1,573	([1])	1,456	([1])	1,544
U. S. Government	26	18	--------	44	22	18	--------	40
Miscellaneous	([1])	218	([1])	633	420	156	--------	576
Undistributed [2]	1,133	42	58	--------	793	48	7,333	--------
Total	4,028	5,623	14,565	24,216	3,994	5,341	14,519	23,854

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes some exports and consumption in Territories and possessions.

TABLE 8.—Distribution (shipments) of evaporated and rock salt in the United States, 1956–57, by States of destination, in short tons

Destination	1956		1957	
	Evaporated	Rock	Evaporated	Rock
Alabama	19,684	256,065	23,187	224,214
Arizona	15,274	19,361	13,940	14,419
Arkansas	9,293	65,645	10,978	56,764
California	554,168	107,316	539,400	103,363
Colorado	73,404	24,682	76,523	21,619
Connecticut	12,758	36,637	12,497	40,952
Delaware	6,619	6,263	6,676	4,394
District of Columbia	5,454	2,862	5,225	3,761
Florida	13,558	47,842	17,244	46,568
Georgia	29,851	65,222	29,262	61,948
Idaho	24,621	2,090	26,625	2,090
Illinois	226,215	286,947	233,579	327,262
Indiana	132,097	98,850	132,112	117,014
Iowa	129,689	111,980	130,662	111,484
Kansas	45,890	194,853	50,619	196,723
Kentucky	33,489	117,700	32,240	114,950
Louisiana	20,950	157,457	23,171	167,081
Maine	9,527	128,736	8,765	115,867
Maryland	43,436	94,577	41,601	93,672
Massachusetts	43,380	143,008	41,549	140,594
Michigan	135,749	338,487	141,338	260,759
Minnesota	133,580	62,045	130,919	57,904
Mississippi	12,309	42,434	13,166	44,384
Missouri	78,788	79,430	78,197	73,398
Montana	25,207	4,729	23,541	4,349
Nebraska	56,931	65,559	57,593	54,521
Nevada	6,423	141,631	6,318	132,372
New Hampshire	4,567	135,872	4,852	116,745
New Jersey	115,017	182,747	111,463	193,613
New Mexico	14,299	32,945	19,159	40,632
New York	195,379	960,124	189,315	905,991
North Carolina	65,120	102,824	68,450	102,890
North Dakota	18,789	15,768	16,132	8,858
Ohio	236,758	344,565	235,402	325,023
Oklahoma	30,533	34,756	29,072	32,355
Oregon	134,862	359	112,180	(1)
Pennsylvania	141,898	141,766	143,062	146,989
Rhode Island	10,975	13,971	9,748	14,849
South Carolina	13,782	23,467	15,734	24,610
South Dakota	24,089	17,268	23,327	14,900
Tennessee	38,579	89,905	38,849	95,595
Texas	96,740	265,783	93,335	209,031
Utah	33,726	(1)	42,934	(1)
Vermont	5,984	53,122	5,955	45,096
Virginia	100,685	72,884	96,645	64,499
Washington	407,486	(1)	329,244	(1)
West Virginia	148,530	106,528	156,023	84,447
Wisconsin	137,038	74,856	137,616	82,784
Wyoming	14,166	1,015	15,088	1,258
Other [2]	140,607	249,964	193,177	238,995
Total	4,027,953	5,622,897	3,993,689	5,341,586

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Includes shipments to Territories and possessions of the United States, exports, and some shipments to unspecified destinations.

PRICES

Prices quoted in Oil, Paint and Drug Reporter for both rock and table salt, vacuum, common fine, increased during 1957. In January the price of rock salt in paper bags, carlots, f. o. b. New York, was $1.02½ per 100 pounds; table salt, vacuum, common fine, on the same basis was quoted at $1.27½ per 100 pounds. These prices were increased in February to $1.04 and $1.29 and again in April to $1.07 and $1.32 per 100 pounds of rock and table salt, respectively. From September to the end of the year the prices quoted per 100 pounds were $1.07½ for rock and $1.27½ for table salt.

The average value of dry salt in 1957 was $10.36 per ton, a 13-percent increase over the previous year. Salt in brine averaged $3.49 per ton of contained salt, a 6-percent increase compared with 1956.

FOREIGN TRADE [3]

Salt imported for consumption in the United States increased 78 percent in 1957, compared with the previous year. This was the second consecutive year that salt imports increased substantially. Most of the increase came from the Bahamas, Canada, and Mexico, although shipments from the Dominican Republic and Jamaica were also larger than in 1956. A small tonnage was imported from Italy.

Exports of salt from the United States increased slightly but were less than imports. Chief recipients were Japan and Canada; each received more than in 1956.

Salt exports were less than 2 percent of the United States production in 1957; imports were slightly less than 3 percent.

TABLE 9.—Salt imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	1956		1957	
	Short tons	Value	Short tons	Value
North America:				
Bahamas	19,477	$50,531	134,473	$463,112
Canada	306,166	2,146,297	405,952	2,820,938
Dominican Republic	32,757	124,297	37,559	148,145
Jamaica	3,501	7,940	11,984	26,751
Leeward and Windward Islands	6,048	21,773		
Mexico	263	2,890	53,541	60,766
Total	368,212	2,353,728	643,509	3,519,712
Europe: Italy			10,640	26,060
Grand total	368,212	2,353,728	654,149	3,545,772

TABLE 10.—Salt imported for consumption in the United States, 1948–52 (average) and 1953–57, by classes

[Bureau of the Census]

Year	In bags, sacks, barrels, or other packages (dutiable)		Bulk			
			Dutiable		Free (used in curing fish)	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	2,663	$34,326	3,420	$15,372	154	$549
1953	2,550	26,428	134,758	447,044		
1954	946	[1] 13,672	159,824	865,289		
1955	8,109	[1] 116,409	177,544	[1] 1,044,110		
1956	25,255	[1] 360,864	342,957	1,992,864		
1957	34,501	426,596	619,648	3,119,176		

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

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

TABLE 11.—Salt exported from the United States, 1956–57, by countries

[Bureau of the Census]

Country	1956		1957	
	Short tons	Value	Short tons	Value
North America:				
Bermuda	27	$1,930		
Canada	244,292	1,459,201	261,109	$1,485,668
Central America:				
Canal Zone	487	30,605	145	13,476
Costa Rica	127	3,529	102	3,150
El Salvador	155	5,889	65	2,457
Guatemala	179	5,649	130	5,910
Honduras	528	14,091	485	11,500
Nicaragua	249	7,033	650	16,140
Panama	92	10,794	280	14,473
Mexico	6,842	209,673	4,921	180,443
West Indies:				
Bahamas	29	3,990	18	2,600
Cuba	8,584	255,675	5,858	156,970
Dominican Republic	222	15,983	307	22,979
Haiti	39	3,600	49	5,000
Netherlands Antilles	597	38,017	446	37,265
Other West Indies	1	1,270	19	2,650
Total	262,450	2,066,929	274,584	1,960,681
South America	115	11,280	160	22,050
Europe	2	3,150	9	6,250
Asia:				
Japan	72,852	319,223	114,814	526,083
Korea, Republic of			144	5,214
Philippines	431	29,396	237	18,466
Saudi Arabia	183	18,453	299	19,016
Viet-Nam, Laos, and Cambodia			190	5,338
Other Asia	9	1,200	20	8,401
Total	73,475	368,272	115,704	582,518
Africa	138	3,050	10	720
Oceania	140	11,085	240	18,830
Grand total	336,320	2,463,766	390,707	2,591,049

TABLE 12.—Salt shipped to possessions and other areas administered by the United States,[1] 1955–57

[Bureau of the Census]

Territory	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
American Samoa	52	$2,171	58	$2,558	76	$3,796
Guam	99	7,772	71	6,836	59	6,059
Puerto Rico	9,784	703,222	11,448	863,175	10,672	828,800
Virgin Islands	84	7,128	72	7,126	167	16,281
Wake	(2)	412	(2)	1,464	1	1,753
Total	10,019	720,705	11,649	881,159	10,975	856,689

1 Salt is also shipped to the Territories of Alaska and Hawaii, but no record has been kept of these shipments since March 1948.
2 Less than 1 ton.

Tariff.—The duty on bulk salt imported into the United States was reduced from $0.019 to $0.018 per 100 pounds, effective July 1, 1957. A further reduction to $0.017, effective July 1, 1958, was agreed upon at the 11th meeting of the Contracting Parties of the General Agreement on Tariffs and Trade at Geneva in 1956. Duty on packaged salt was unchanged at $0.035 per 100 pounds.

WORLD REVIEW

NORTH AMERICA

Canada.—Salt production in Canada increased about 11 percent in 1957, compared with 1956. Although this gain was substantial, it was less than that in the previous year. The new rock-salt mine opened at Ojibway largely supplied the increased output in the past several years.

Further expansion of the industry was planned, as, for example, the projected development of a salt mine near Goderich.[4]

Mexico.—Shipments of salt from a new solar-evaporation installation at Guerrero Negro in Baja California were reported.

SOUTH AMERICA

Peru.—Private firms were permitted to exploit the coastal salt deposits of Peru for the first time. Formerly Estanco de la Sal, a Government agency, operated a salt monopoly.[5]

TABLE 13.—World production of salt by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	856,652	959,898	963,357	1,253,870	1,598,549	1,771,800
Costa Rica	6,794	4,289	4,519	4,960	[3] 5,500	48,039
Guatemala	13,002	16,736	12,804	17,313	15,950	17,500
Honduras	5,829	[3] 11,500	[3] 11,000	[3] 11,000	15,018	[3] 11,000
Mexico	168,738	246,763	246,917	[3] 248,000	[3] 265,000	[3] 265,000
Nicaragua	12,745	15,400	16,035	11,250	11,460	10,037
Panama	5,335	4,764	7,692	11,377	8,471	9,366
Salvador	21,760	38,304	41,104	[3] 42,000	55,001	55,002
United States:						
Rock salt	4,089,636	4,458,393	4,824,708	5,293,282	5,622,897	5,341,586
Other salt	13,581,844	16,330,610	15,844,695	17,410,861	18,592,726	18,512,433
West Indies:						
British:						
Bahamas	70,111	165,347	149,357	59,149	154,560	191,339
Leeward Islands (exports)	6,076	5,934	4,664	5,104	1,142	[3] 1,100
Turks and Caicos Islands	43,946	11,046	10,740	7,033	15,392	[4] 21,275
Cuba	60,054	57,027	60,305	70,649	70,989	75,106
Dominican Republic:						
Rock salt	2,636	4,183	47,573	19,763	36,533	50,284
Other salt	13,183	15,064	15,948	20,242	559	441
Haiti	[3] 21,250	33,510	33,510	33,510	49,383	11,500
Netherlands Antilles	2,094	[3] 3,300	[3] 3,300	[3] 3,300	1,265	347
Total [3]	18,982,000	22,382,000	22,298,000	24,523,000	26,520,000	26,393,000
South America:						
Argentina	428,764	498,775	578,713	606,271	416,496	465,726
Brazil	971,402	839,192	744,416	640,241	822,610	[3] 826,700
Chile:						
Rock salt	50,468	39,129	49,726	56,870	[3] 55,000	[3] 55,000
Other salt	8,271	1,345				
Colombia:						
Rock salt	129,123	163,305	190,117	193,052	214,395	228,223
Other salt	35,333	53,191	39,943	44,789	40,982	86,862
Ecuador	28,924	15,831	38,443	55,077	30,368	[3] 33,000
Peru	73,552	84,860	92,494	98,723	112,031	104,940
Venezuela	70,299	80,012	91,948	68,504	41,434	94,443
Total [1,3]	1,813,000	1,792,000	1,842,000	1,780,000	1,750,000	1,911,000

See footnotes at end of table.

[4] Northern Miner, Develop Salt Mine Near Goderich: Vol. 48, No. 18, July 25, 1957, p. 32.
[5] Chemical Age, vol. 77, No. 1967, Mar. 16, 1957, p. 470.

TABLE 13.—World production of salt by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]—Continued

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Europe:						
Austria:						
Rock salt	1,188	1,349	1,409	893	692	712
Other salt	354,300	365,485	394,661	438,110	[3] 481,000	491,777
Bulgaria	[3] 106,000	97,003	91,492	36,376	63,934	[3] 66,000
Czechoslovakia	113,538	200,620	149,914	146,607	[3] 168,700	[3] 168,700
France:						
Rock salt and salt from springs	2,540,816	2,670,988	2,715,835	2,374,376	2,987,701	[3] 2,980,000
Other salt	662,125	622,677	564,332	787,177	606,271	[3] 606,000
Germany:						
East	[3] 1,653,500	[3] 1,653,500	[3] 1,653,500	1,675,511	1,862,904	[3] 1,874,000
West:						
Rock salt	2,274,193	3,522,953	3,503,217	3,361,434	3,591,326	3,597,940
Brine salt	288,673	327,607	393,423	369,023	356,046	357,148
Greece	92,593	86,796	86,746	79,511	102,515	[3] 110,000
Italy:						
Rock salt and brine salt	914,482	983,621	1,133,965	1,103,000	1,082,769	1,152,634
Other salt	1,065,970	818,596	816,338	948,228	655,607	488,787
Malta	2,395	4,103	3,618	1,262	1,724	[3] 1,650
Netherlands	418,812	503,664	563,835	644,851	689,973	803,634
Poland:						
Rock salt	652,738	405,650	421,082	424,389	435,412	440,924
Other salt		908,303	870,825	939,168	963,419	964,521
Portugal:						
Rock salt	47	54	60	53	19	[3] 20
Other salt (exports)	24,395	3,325	2,513	1,383	3,948	2,937
Rumania	417,335	[3] 440,900	[3] 551,200	623,907	929,247	[3] 937,000
Spain:						
Rock salt	360,030	434,098	447,210	476,209	545,908	558,302
Other salt	801,314	1,074,363	957,580	671,075	822,643	881,848
Switzerland	121,575	121,544	128,405	134,977	131,405	144,281
U. S. S. R.[3]	5,800,000	6,800,000	7,200,000	7,200,000	7,200,000	7,200,000
United Kingdom:						
Great Britain:						
Rock salt	49,724	48,160	48,160	78,401	111,145	98,710
Other salt	4,511,817	4,495,689	4,964,970	5,195,689	5,471,453	5,479,057
Northern Ireland	13,984	[3] 11,000	12,143	13,879	10,065	8,132
Yugoslavia	129,196	136,045	152,119	149,221	[3] 159,800	[3] 159,800
Total [1] [3]	23,600,000	27,100,000	28,200,000	28,200,000	29,800,000	29,900,000
Asia:						
Aden	338,406	269,274	235,201	307,544	239,052	221,576
Afghanistan	28,976	30,016	28,550	24,471	24,912	[3] 24,250
Burma	49,012	69,909	107,456	117,297	96,428	128,248
Ceylon	57,183	65,970	57,500	40,684	120,783	94,911
China [3]	3,748,000	5,500,000	6,100,000	6,600,000	6,600,000	8,820,000
Cyprus	3,380	2,196	5,249	----------	[4] 5,025	[4] 7,097
India:						
Rock salt	5,549	6,465	4,488	5,512	4,480	4,856
Other salt	2,780,272	3,538,383	3,038,867	3,227,564	3,550,407	4,040,967
Indonesia	409,748	295,419	143,300	50,846	112,436	[3] 110,000
Iran [5]	139,993	[3] 241,400	[3] 275,600	294,317	308,647	330,693
Iraq [5]	15,576	22,408	33,936	21,455	[3] 22,000	[3] 22,000
Israel	10,401	23,141	26,511	30,865	28,660	29,762
Japan	338,663	507,944	473,552	619,328	690,487	917,169
Jordan	[3] 3,500	7,778	11,472	8,493	12,125	11,139
Korea, Republic of	163,604	212,400	198,547	390,128	216,775	406,962
Lebanon [3]	5,500	4,400	4,400	5,000	5,300	5,500
Pakistan:						
Rock salt	164,626	163,716	164,654	156,559	180,261	174,349
Other salt	202,564	189,097	280,539	289,877	210,176	220,462
Philippines	73,333	52,690	52,990	88,180	70,107	121,899
Portuguese India	21,605	17,606	14,858	[3] 16,500	6,167	[3] 6,600
Ryukyu Islands	2,266	3,545	3,771	5,650	5,215	3,769
Syria	17,884	21,479	14,330	15,386	36,094	27,558
Taiwan	304,522	178,536	406,232	464,127	336,345	426,696
Thailand [3]	231,500	275,000	330,000	330,000	330,000	220,000
Turkey:						
Rock salt	28,444	29,962	28,660	31,355	33,069	10,075
Other salt	300,313	354,020	458,561	529,109	385,809	493,681
Viet-Nam	105,857	117,947	116,899	71,030	97,332	86,729
Yemen	2,266	110,231	110,231	110,231	27,575	[3] 110,000
Total [3]	9,553,000	12,300,000	12,700,000	13,900,000	13,800,000	17,100,000

See footnotes at end of table.

TABLE 13.—World production of salt by countries,[1] 1948–52 (average) and 1953–57, in short tons[2]—Continued

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Africa:						
Algeria	94,799	66,409	108,798	113,709	117,271	[3] 110,000
Angola	53,334	63,723	60,810	63,860	89,794	57,674
Belgian Congo	786	893	928	505	562	303
Canary Islands	12,243	19,456	20,408	21,466	19,276	[3] 22,000
Cape Verde Islands	20,922	11,715	23,326	24,057	24,221	[3] 22,000
Egypt	485,185	418,878	496,552	442,797	584,715	[3] 550,000
Eritrea	143,580	212,746	201,723	202,825	147,710	220,462
Ethiopia: Rock salt	[3] 16,500	16,211	15,432	16,535	[3] 13,000	[3] 7,700
French Equatorial Africa	2,998	4,519	6,834	5,291	[3] 5,300	[3] 5,300
French Somaliland	72,223	67,202	63,389	20,082	7,356	----------
French West Africa [3]	62,200	40,000	24,000	11,000	3,300	3,300
Ghana [3]	24,000	24,000	24,000	24,000	24,000	24,000
Italian Somaliland [3]	3,000	5,000	5,500	5,500	5,500	5,500
Kenya	19,900	23,392	21,051	28,421	24,511	25,315
Libya	10,613	13,228	16,535	16,535	18,894	[3] 16,500
Mauritius	3,705	2,646	3,417	3,858	3,858	4,189
Morocco:						
Northern zone	[3] 275	[3] 275	9,389	9,649	----------	----------
Southern zone:						
Rock salt	10,701	8,317	3,648	17,961	} 30,773	57,282
Other salt	40,676	42,117	38,320	31,313	}	
Mozambique:						
Rock salt	89	121	109	153	79	[3] 110
Other salt	10,992	11,891	13,834	16,477	[3] 13,000	[3] 13,000
Nigeria [3]	440	210	240	280	330	330
South West Africa:						
Rock salt	4,941	5,176	5,404	7,004	5,010	6,959
Other salt	24,292	40,262	46,792	58,527	82,253	66,033
Sudan	48,401	60,473	61,330	57,320	[3] 77,000	[3] 77,000
Tanganyika	16,344	22,159	23,961	26,343	31,214	28,684
Tunisia	124,546	169,108	181,881	146,607	145,505	[3] 143,300
Uganda	6,576	8,419	8,052	10,091	9,915	10,686
Union of South Africa	157,123	140,610	172,186	154,318	189,249	160,743
Total [1, 3]	1,472,000	1,500,000	1,660,000	1,540,000	1,675,000	1,640,000
Oceania:						
Australia	301,729	[3] 347,200	[3] 425,500	[3] 413,400	[3] 457,500	[3] 440,900
New Zealand	[6] 784	----------	1,680	3,360	12,768	8,568
Total	302,513	[3] 347,200	[3] 427,180	[3] 416,760	[3] 470,268	[3] 449,468
World total (estimate) [1, 2]	55,700,000	65,400,000	67,100,000	70,400,000	74,000,000	77,400,000

[1] In addition to the countries listed, salt is produced in Albania, Bolivia, Hungary, and Madagascar, but figures 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 Salt chapters. Data do not add to totals shown because of rounding where estimated figures are included in detail.
[3] Estimate.
[4] Exports.
[5] Year ended March 31 of year following that stated.
[6] Average for 1 year only; 1952 was first year of commercial production.

EUROPE

Denmark.—A 7-year plan for the economic and cultural development of areas in West Jutland was advanced by the director of a large Danish chemical concern. A key feature of the plan was development of large underground deposits of salt—said to be among the largest in Europe.

ASIA

India.—With a production target of 3.6 million tons for the Second 5-Year Plan the Indian salt industry continued to develop its mines, refineries, laboratories, and model salt farms. Production improved steadily. Salt exports, chiefly to Japan, also increased.[6]

[6] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 3, March 1957, pp. 32, 33.

AFRICA

French Somaliland.—The Compagnie des Salins du Midi et des Salins de Djibouti ceased operations owing to competition from Eritrean salt in the Ethiopian market.

Tanganyika.—Output of salt by the Nyanza Salt Mines, Ltd., at Uvinza, the largest producer in Tanganyika, reached a new production record of over 18,200 short tons in 1956.[7]

TECHNOLOGY

The addition of sodium chloride to sulfuric acid pickling baths has been found to inhibit attack on steel. A concentration of 1.5 percent sodium chloride was specified for the pickling baths of certain high-yield-strength steels.[8]

Installation of belt haulage as the sole means of transport from the face to the mine shaft tripled the production capacity of a Louisiana salt mine. At the same time working force in the mine was reduced one-third. The determining factor was the practicability of using a portable crusher at the working face to reduce lumps to a size that could be handled by the belts. The problem was solved by adopting a screw-feeder crusher originally developed to crush lump sulfur. As rock salt is harder and tougher than sulfur a sturdier machine was developed. After blasting from the face, a shovel loaded the broken salt into the portable crusher, which discharged on portable conveyers. These were 35 feet long and 2½ feet wide and had a speed up to 350 feet per minute.

The portable conveyers discharged on to semiportable conveyers, which fed the main haulage belt. The total length of conveyers was 4,550 feet.[9] Construction costs for modernization of the mine's haulage system were considerably reduced by using coarse salt in place of aggregate and minus-18-mesh salt in place of sand for all concrete work. These salts, when mixed with cement and saturated brine in the same proportions as ordinary concrete, were found to develop about 75 percent of the strength of ordinary concrete. The use of "saltcrete" for footings and walls in the mine was possible only because there was no exposure to moisture.

Storage of petroleum products in cavities in salt domes has gained increasing acceptance as a solution to the problem of low-cost storing of products that have a seasonal demand. Salt domes are especially suitable because salt forms an excellent seal for many petroleum products, which do not dissolve salt and are not contaminated by it. The cavities are leached from deep inside the salt mass by injecting water and removing the brine. A cavity roughly 850 feet from bottom to top and 35 feet in diameter will hold about 150,000 barrels. The costs of providing underground storage of this type were estimated to be about one-twelfth the cost of above-ground storage of similar capacity.[10]

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[7] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 41.
[8] Iron Age, New Method Speeds Analysis for Salt in Pickling Bath: Vol. 179, No. 23, June 6, 1957, p. 105.
[9] Johnson E., Hauling Salt At Avery Island Mine: Min. Eng., vol. 9, No. 6, June 1957, p. 667.
[10] Chemical and Engineering News, Wells for L. P. G.: Vol. 35, No. 17, Apr. 29, 1957, pp. 104, 106.

The problems and techniques associated with the use of rock salt for highway snow and ice control were discussed in a technical journal. Compared with alternate methods, the use of rock salt was equally or more effective and had advantages of economy and the end effect of street cleanliness. The rate of application averaged 2,930 pounds of mixed No. 1 and CC grades of rock salt per mile of 20-foot roadway. Corrosion problems of vehicles and of the concrete roadway itself were found to be less serious than anticipated. Use of 1 percent admixture of rust inhibitor with the salt was found to reduce corrosion of steel test panels. Damage to concrete by the action of salt is relatively minor and is correctible; old concrete may be protected by a sealing agent; new concrete using air-entrained cement produces a cellular, spongelike concrete that absorbs the expansive forces of recrystallizing salt.[11]

[11] Rogus, C. A., Rock Salt for Snow and Ice Removal: Public Works Mag., vol. 88, No. 11, November 1957, p. 113-117.

Sand and Gravel

By Wallace W. Key [1] and Dorothy T. Shupp [2]

FIRST in tonnage of all minerals, sand and gravel production in 1957 increased slightly over 1956, despite declines in the cement and asphalt industries and in home building. Initiation of the construction phase of the Federal Highway Program was a major factor in maintaining the stability of the sand and gravel industry in 1957.

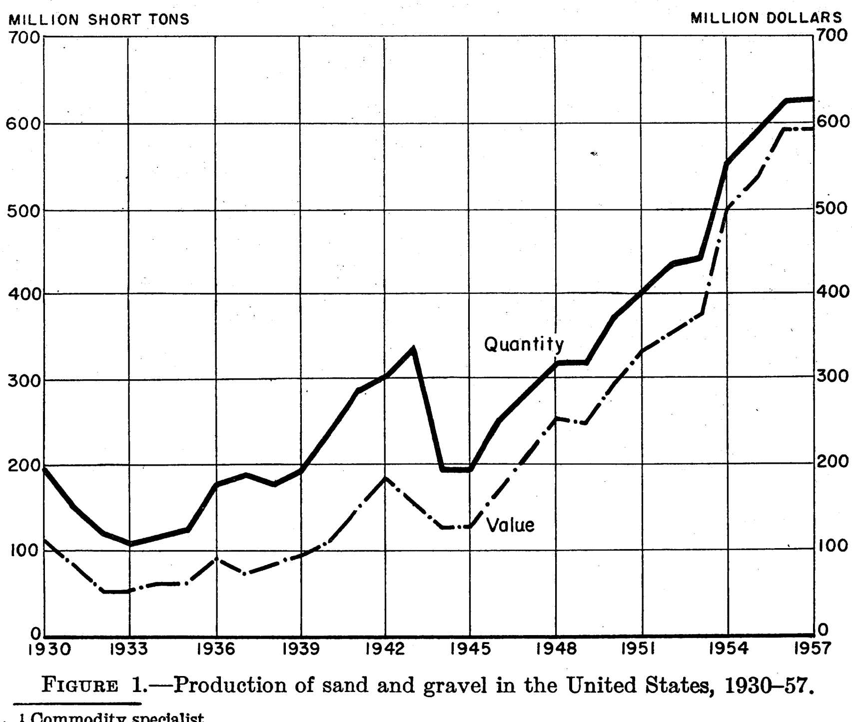

FIGURE 1.—Production of sand and gravel in the United States, 1930–57.

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

DOMESTIC PRODUCTION

An output of 627 million short tons valued at $594 million elevated sand and gravel production to a new level in 1957, despite declines in related industries. Sand and gravel was used in road construction as fill, subbase, and base materials and in several large dam and airfield construction projects. Many other large construction projects were in progress, and the construction phase of the Federal Highway Program began to gain momentum.

California maintained the lead in production, followed by Michigan, Ohio, Illinois, Wisconsin, Minnesota, Utah, New York, Texas, and Washington. These States, with an output of 336 million tons, contributed more than half of the total output.

Commercial Production.—Commercial operations produced about three-fourths of the total output of sand and gravel in 1957 valued at $1.06 per ton, a decrease of 1 cent a ton compared with 1956. The higher value of commercially produced sand and gravel is attributed to the larger proportion that is processed. Most stationary commercial plants were well equipped to meet complex specifications, but portable plants gained increased recognition for their ability to produce a marketable material from small deposits near the jobsite.

TABLE 1.—Sand and gravel sold or used by producers in the United States,[1] 1956–57, by classes of operations and uses

	1956			1957			Percent of change in—	
	Thousand short tons	Value		Thousand short tons	Value		Tonnage	Average value
		Total (thousand dollars)	Average per ton		Total (thousand dollars)	Average per ton		
COMMERCIAL OPERATIONS								
Sand: [2]								
Glass	[3] 6,758	[3] 19,325	$2.86	6,748	19,139	$2.84	--------	−1
Molding	7,962	16,639	2.09	7,538	16,552	2.20	−5	+5
Building	114,828	108,553	.95	100,450	99,469	.99	−13	+4
Paving	66,337	58,518	.88	63,932	59,163	.93	−4	+6
Grinding and polishing [4]	1,668	5,251	3.15	1,911	5,574	2.92	+15	−7
Fire or furnace	687	1,396	2.03	585	1,274	2.18	−15	+7
Engine	1,356	1,825	1.35	1,286	1,797	1.40	−5	+4
Filter	549	849	1.55	391	750	1.92	−29	+24
Railroad ballast	917	552	.60	764	404	.53	−17	−12
Other [5]	11,540	21,313	1.85	24,639	24,726	1.00	+114	−46
Total commercial sand	[3] 212,602	[3] 234,221	1.10	208,244	228,848	1.10	−2	--------
Gravel: [6]								
Building	96,744	115,081	1.19	88,497	109,449	1.24	−9	+4
Paving	130,031	128,138	.99	128,750	124,793	.97	−1	−2
Railroad ballast	8,392	5,905	.70	6,963	5,027	.72	−17	+3
Other	22,051	18,698	.85	30,371	22,728	.75	+38	−12
Total commercial gravel	257,218	267,822	1.04	254,581	261,997	1.03	−1	−1
Total commercial sand and gravel	[3] 469,820	[3] 502,043	1.07	462,825	490,845	1.06	−2	−1
GOVERNMENT-AND-CONTRACTOR OPERATIONS [7]								
Sand:								
Building	2,321	2,058	.89	2,383	2,163	.91	+3	+2
Paving	19,568	9,586	.49	24,159	12,280	.51	+23	+4
Total Government-and-contractor sand	21,889	11,644	.53	26,542	14,443	.54	+21	+2
Gravel:								
Building	5,434	3,689	.68	7,428	5,215	.70	+37	+3
Paving	[3] 127,717	[3] 77,740	.61	130,691	83,282	.64	+2	+5
Total Government-and-contractor gravel	[3] 133,151	[3] 81,429	.61	138,119	88,497	.64	+4	+5
Total Government-and-contractor sand and gravel	[3] 155,040	[3] 93,073	.60	164,661	102,940	.63	+6	+5
ALL OPERATIONS								
Sand	[3] 234,491	[3] 245,865	1.05	234,786	243,291	1.04	--------	−1
Gravel	[3] 390,369	[3] 349,251	.89	392,700	350,494	.89	+1	--------
Grand total	[3] 624,860	[3] 595,116	.95	627,486	593,785	.95	--------	--------

[21] Includes Territories, possessions and other areas administered by the United States.
n Includes sand produced by railroads for their own use—1956: 229,045 tons valued at $98,254; 1957: 177,471 to[3] s, $62,489.
[4] Revised figure.
[5] Includes blast sand as follows—1956: 776,961 tons valued at $3,611,085; 1957: 916,231 tons, $3,756,695.
[6] Includes ground sand as follows—1956: 1,422,116 tons valued at $10,208,266; 1957: 798,052 tons, $7,472,633.
8 Includes gravel produced by railroads for their own use—1956: 3,651,198 tons valued at $1,774,978; 1957: 2, 06,745 tons, $1,523,924.
[7] Approximate figures for States, counties, municipalities, and other Government agencies directly or under lease.

TABLE 2.—Sand and gravel sold or used by producers in the United States,[1] 1948–52 (average) and 1953–57

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)
1948–52 (average)	136,078	126,744	232,938	169,901	369,016	296,645
1953	160,581	160,336	279,818	214,459	440,399	374,795
1954	194,964	199,554	361,573	304,573	556,537	504,127
1955	221,119	222,241	371,034	313,995	592,153	536,236
1956	[2] 234,491	[2] 245,865	[2] 390,369	[2] 349,251	[2] 624,860	[2] 595,116
1957	234,786	243,291	392,700	350,494	627,486	593,785

[1] Includes Territories, possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 3.—Sand and gravel sold or used by producers in the United States in 1957, by States

State	Quantity (thousand short tons)	Value (thousand dollars)	State	Quantity (thousand short tons)	Value (thousand dollars)
Alabama	5,065	4,883	Nebraska	7,944	5,889
Alaska	6,096	8,799	Nevada	5,233	5,190
Arizona	10,287	9,222	New Hampshire	4,505	1,970
Arkansas	8,599	6,949	New Jersey	10,323	17,619
California	79,024	87,030	New Mexico	7,991	7,803
Colorado	16,400	13,994	New York	25,640	26,480
Connecticut	4,777	5,042	North Carolina	6,829	5,724
Delaware	974	860	North Dakota	7,048	4,967
Florida	6,753	6,148	Ohio	30,596	37,503
Georgia	2,127	2,096	Oklahoma	4,960	4,507
Guam	1	1	Oregon	12,843	13,481
Hawaii	286	538	Pennsylvania	12,406	19,570
Idaho	6,601	5,236	Puerto Rico	497	754
Illinois	30,151	32,572	Rhode Island	1,058	1,060
Indiana	16,750	14,206	South Carolina	2,647	2,571
Iowa	12,042	8,927	South Dakota	14,758	8,001
Kansas	9,345	6,175	Tennessee	5,617	6,641
Kentucky	4,482	4,556	Texas	23,685	23,427
Louisiana	8,870	10,388	Utah	26,958	15,485
Maine	8,037	3,099	Vermont	2,216	1,051
Maryland	8,679	11,594	Virginia	6,298	8,854
Massachusetts	9,900	9,692	Washington	19,924	16,775
Michigan	41,838	35,144	West Virginia	5,354	9,893
Minnesota	28,493	19,385	Wisconsin	29,394	18,693
Mississippi	5,172	4,344	Wyoming	2,425	1,905
Missouri	8,480	8,942			
Montana	11,108	8,150	Total	627,486	593,785

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1957, 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			132,433	$212,239	1,158,652	$1,079,321		
Alaska					63,852	154,846	94,989	$397,316
Arizona					730,700	754,400		
Arkansas	(1)	(1)	8,000	7,200	1,167,491	987,025		
California	409,391	$1,693,564	121,534	187,171	15,393,932	17,585,135	1,113,970	758,536
Colorado			16,200	17,000	2,751,400	2,756,100	117,000	87,500
Connecticut			(1)	(1)	1,260,560	1,295,098		
Delaware					(1)	(1)		
Florida			(1)	(1)	4,474,332	3,519,949		
Georgia	(1)	(1)	(1)	(1)	1,137,372	729,249		
Guam					688	1,450		
Hawaii					104,555	198,967		
Idaho					224,819	299,339	56,200	19,800
Illinois	1,321,550	3,216,458	834,324	2,184,013	5,874,777	4,909,122	1,989	597
Indiana			(1)	(1)	2,775,282	2,085,794	81,000	20,250
Iowa	(1)	(1)	(1)	(1)	1,778,561	1,518,573		
Kansas			(1)	(1)	2,890,213	2,071,620	6,931	1,386
Kentucky					1,908,215	1,905,750		
Louisiana			(1)	(1)	1,227,372	1,284,727	98,970	69,279
Maine					180,839	132,265		
Maryland	(1)	(1)			2,032,641	2,789,502		
Massachusetts			(1)	(1)	2,214,379	2,384,931		
Michigan	(1)	(1)	2,237,004	3,002,990	4,334,624	3,326,107	43,265	10,664
Minnesota	(1)	(1)	(1)	(1)	2,927,872	2,452,046	4,050	1,013
Mississippi			(1)	(1)	293,959	204,661		
Missouri	419,785	1,059,416	82,633	186,741	2,201,664	1,615,298		
Montana					340,690	542,212	103,556	67,239
Nebraska	1,300	1,300			1,577,400	1,321,700		
Nevada	(1)	(1)	77,042	258,402	184,201	221,979	5,540	3,040
New Hampshire					241,915	201,086		
New Jersey	920,539	2,493,399	1,625,598	4,644,932	3,277,351	3,119,484		
New Mexico					714,500	845,700	4,300	5,130
New York	89,718	356,330	199,122	569,097	6,734,935	7,729,686		
North Carolina					1,663,958	1,212,091	19,221	9,801
North Dakota					550,500	403,100		
Ohio	(1)	(1)	545,495	1,845,081	5,791,853	6,376,735		
Oklahoma	(1)	(1)	(1)	(1)	1,014,993	826,180		
Oregon			(1)	(1)	932,562	1,324,941	413	413
Pennsylvania	(1)	(1)	185,865	531,037	3,630,924	4,812,433	44,239	15,484
Puerto Rico	29,595	21,013	40,823	33,097	2,584	1,427	200,000	480,000
Rhode Island			(1)	(1)	(1)	(1)		
South Carolina	(1)	(1)			784,454	395,316		
South Dakota					327,400	342,900		
Tennessee	(1)	(1)	(1)	(1)	1,233,890	1,469,085		
Texas	(1)	(1)	32,256	60,721	4,647,826	4,262,098	4,775	10,450
Utah			(1)	(1)	653,300	566,600		
Vermont					19,033	18,986	2,700	6,000
Virginia	(1)	(1)			1,291,435	1,661,867		
Washington	15,683	93,500	(1)	(1)	1,772,442	1,961,994	375,195	194,406
West Virginia	(1)	(1)	(1)	(1)	973,526	1,228,895		
Wisconsin			240,159	468,145	2,483,539	2,101,977	3,463	866
Wyoming					77,400	104,200	1,600	3,600
Undistributed[1]	3,540,937	10,204,090	1,159,112	2,343,856	419,160	374,466		
Total	6,748,498	19,139,070	7,537,600	16,551,722	100,450,522	99,468,413	2,383,366	2,162,770

[1] Figures that may not be shown separately are combined under "Undistributed."

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1957, 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	588,606	$481,548	15,288	$7,644	(1)	(1)		
Alaska	3,812	7,904	194,200	673,637	(1)	(1)		
Arizona	290,900	313,300	646,700	539,700				
Arkansas	905,385	750,515	1,064,973	398,115				
California	6,573,041	6,666,490	5,155,841	3,058,906	200,759	$699,531	(1)	(1)
Colorado	407,000	308,400	172,700	205,300	(1)	(1)		
Connecticut	1,288,620	1,185,754	181,990	81,911	(1)	(1)		
Delaware	(1)	(1)						
Florida	601,685	478,340			(1)	(1)		
Georgia	428,052	303,820			(1)	(1)		
Guam								
Hawaii	(1)	(1)	472	1,922	1,800	13,860		
Idaho	87,452	109,550	23,521	7,056	130	1,400		
Illinois	3,910,616	3,134,818	155,928	54,805	364,338	1,574,701	16,410	$48,236
Indiana	3,158,250	2,668,831	3,652	1,461	1,000	500	159,275	159,275
Iowa	1,554,835	1,249,184	469,355	142,167	(1)	(1)		
Kansas	2,467,854	1,596,579	556,846	370,666	(1)	(1)		
Kentucky	608,744	653,473						
Louisiana	1,489,909	1,403,033			(1)	(1)	(1)	(1)
Maine	208,305	97,113	419,466	134,430				
Maryland	2,504,767	3,175,388	59	5	(1)	(1)	(1)	(1)
Massachusetts	1,491,244	1,290,255	137,977	32,676	890	2,800	1,973	1,223
Michigan	4,779,676	4,004,562	1,112,183	356,115	(1)	(1)		
Minnesota	1,215,594	1,004,980	626,257	159,819				
Mississippi	880,009	730,498	199,788	152,470				
Missouri	779,880	682,634	169,440	241,325	(1)	(1)	10,366	23,453
Montana	35,866	43,229	219,587	181,950				
Nebraska	1,626,500	1,122,400	235,000	106,400				
Nevada	75,218	90,550	29,576	17,154				
New Hampshire	184,745	155,504	391,281	97,614				
New Jersey	1,143,780	1,082,746	4,469	497	114,429	520,662	20,281	40,247
New Mexico	342,200	254,700	20,900	20,300				
New York	6,240,864	5,498,220	245,766	156,742	1,472	515		
North Carolina	361,640	255,370	2,158,369	1,067,439				
North Dakota	126,900	91,000	82,500	34,000				
Ohio	5,460,797	5,554,297	11,247	2,338	(1)	(1)	65,521	173,919
Oklahoma	1,141,063	879,643	602,641	194,690	400	210		
Oregon	279,013	264,666			200	500		
Pennsylvania	1,884,880	2,828,916			(1)	(1)	169,862	590,671
Puerto Rico	82,019	66,620						
Rhode Island	(1)	(1)	14,379	5,287			11,791	8,100
South Carolina	311,323	112,402	50,222	22,030	(1)	(1)	(1)	(1)
South Dakota	132,600	101,500	374,800	253,600				
Tennessee	460,019	657,235			(1)	(1)	967	1,160
Texas	2,962,248	3,216,959	1,190,395	270,840	162,043	587,101		
Utah	360,500	349,900	32,200	39,400			(1)	(1)
Vermont	209,346	121,027	58,086	24,772				
Virginia	710,067	751,637	57,924	33,905				
Washington	526,644	455,995	378,662	239,992	(1)	(1)		
West Virginia	909,529	1,130,924			(1)	(1)	54,295	86,607
Wisconsin	1,747,097	1,388,962	6,679,539	2,884,020	(1)	(1)		
Wyoming	56,600	52,700	14,600	7,600	3,300	6,600		
Undistributed [1]	335,942	339,008			1,060,547	2,165,796	74,039	141,443
Total	63,931,636	59,163,079	24,158,779	12,280,700	1,911,218	5,574,176	584,780	1,274,334

[1] Figures that may not be shown separately are combined under "Undistributed."
[2] Includes 916,231 tons of blast sand valued at $3,756,695.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1957, 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	86,423	$64,422	----	----	(1)	(1)	125,187	$74,890
Alaska	----	----	(1)	(1)	----	----	(1)	(1)
Arizona	(1)	(1)	(1)	(1)	(1)	(1)	166,600	184,800
Arkansas	----	----	(1)	(1)	(1)	(1)	49,496	25,664
California	101,181	208,526	61,933	$58,421	34,795	$22,074	3,658,796	3,175,887
Colorado	(1)	(1)	17,700	17,500	(1)	(1)	42,100	32,700
Connecticut	----	----	(1)	(1)	----	----	(1)	(1)
Delaware	42,307	25,384	----	----	----	----	----	----
Florida	7,000	3,500	2,465	2,960	----	----	328,368	186,231
Georgia	----	----	(1)	(1)	(1)	(1)	71,475	90,823
Guam	----	----	----	----	----	----	----	----
Hawaii	----	----	----	----	----	----	(1)	(1)
Idaho	----	----	(1)	(1)	----	----	(1)	(1)
Illinois	85,545	130,013	12,807	16,445	5,250	3,943	940,198	3,750,252
Indiana	100,582	72,897	----	----	(1)	(1)	238,475	145,917
Iowa	(1)	(1)	(1)	(1)	32,758	15,517	164,142	108,317
Kansas	33,615	25,218	16,092	17,320	(1)	(1)	451,428	206,418
Kentucky	19,532	20,281	2,000	2,000	----	----	(1)	(1)
Louisiana	2,123	849	(1)	(1)	58,803	42,413	91,254	262,094
Maine	(1)	(1)	124	43	----	----	(1)	(1)
Maryland	----	----	(1)	(1)	(1)	(1)	31,594	20,257
Massachusetts	----	----	(1)	(1)	----	----	439,091	248,947
Michigan	74,809	67,644	6,767	3,774	63,636	31,818	1,596,293	769,669
Minnesota	(1)	(1)	----	----	45,700	13,063	337,956	572,535
Mississippi	6,500	4,300	----	----	----	----	38,719	20,235
Missouri	33,289	27,245	(1)	(1)	7,375	2,950	320,212	864,788
Montana	(1)	(1)	----	----	----	----	(1)	(1)
Nebraska	46,300	32,300	----	----	22,900	14,600	149,300	65,400
Nevada	----	----	----	----	----	----	(1)	(1)
New Hampshire	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
New Jersey	20,810	33,041	38,121	101,303	----	----	658,948	1,896,026
New Mexico	(1)	(1)	----	----	----	----	(1)	(1)
New York	(1)	(1)	(1)	(1)	----	----	855,702	454,438
North Carolina	----	----	(1)	(1)	(1)	(1)	(1)	(1)
North Dakota	----	----	100	100	----	----	5,200	3,300
Ohio	(1)	(1)	78,503	115,140	(1)	(1)	597,672	1,193,544
Oklahoma	(1)	(1)	----	----	----	----	(1)	(1)
Oregon	(1)	(1)	(1)	(1)	445	171	42,242	30,109
Pennsylvania	91,955	215,032	----	----	----	----	287,326	970,808
Puerto Rico	----	----	----	----	----	----	5,850	2,700
Rhode Island	----	----	----	----	----	----	(1)	(1)
South Carolina	35,344	32,087	4,312	15,585	(1)	(1)	35,224	48,865
South Dakota	----	----	(1)	(1)	(1)	(1)	24,200	13,400
Tennessee	1,300	1,625	572	715	1,352	1,690	(1)	(1)
Texas	22,850	15,336	(1)	(1)	(1)	(1)	834,066	645,862
Utah	(1)	(1)	----	----	----	----	(1)	(1)
Vermont	368	537	----	----	----	----	69,324	39,047
Virginia	80,879	93,251	(1)	(1)	35,258	34,100	325,322	167,257
Washington	----	----	(1)	(1)	(1)	(1)	137,457	51,935
West Virginia	172,449	386,475	----	----	----	----	(1)	(1)
Wisconsin	(1)	(1)	(1)	(1)	(1)	(1)	1,122,460	574,209
Wyoming	----	----	----	----	----	----	26,000	28,600
Undistributed [1]	221,008	336,723	149,848	398,960	455,807	221,944	10,371,049	7,800,153
Total	1,286,169	1,796,686	391,344	750,266	764,079	404,283	24,638,726	24,726,077

[1] Figures that may not be shown separately are combined under "Undistributed."
[3] Includes 1,753 tons of engine sand valued at $1,277, produced by railroads for their own use.
[4] Includes 69,261 tons of ballast sand valued at $36,390, produced by railroads for their own use.
[5] Includes 106,457 tons of sand valued at $24,822, used by railroads for fills and similar purposes. Also includes 798,052 tons of ground sand valued at $7,472,633. See table 11 for ground sand.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1957, by States, uses, and class of operations—Continued

State	Gravel							
	Building				Paving			
	Commercial [6]		Government-and-contractor		Commercial [7]		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	1,322,912	$1,390,587			664,515	$751,394	151,413	$127,765
Alaska	113,607	225,777	216,821	$494,309	28,957	47,601	5,078,624	6,541,054
Arizona	1,162,200	1,343,800	800	1,300	594,000	647,400	6,232,200	5,035,000
Arkansas	1,198,077	1,247,092			1,678,191	1,582,169	2,040,539	1,206,719
California	16,061,984	20,607,123	1,963,823	1,809,161	14,235,511	16,955,746	9,855,192	9,119,397
Colorado	2,072,400	2,740,100	292,800	196,000	3,054,900	2,721,300	7,257,100	4,682,400
Connecticut	986,216	1,349,605			648,897	746,273	57,890	20,435
Delaware	(1)	(1)			(1)	(1)		
Florida	(1)	(1)			(1)	(1)		
Georgia	135,990	145,990			(1)	(1)		
Guam								
Hawaii	925	3,400	56	207	81,424	58,744	898	2,882
Idaho	369,831	480,219	1,331,650	406,495	1,607,022	1,235,102	2,848,051	2,640,504
Illinois	5,628,097	5,116,771	35,804	13,981	7,764,732	6,376,159	1,439,221	670,329
Indiana	2,532,254	2,417,558	130,424	37,923	5,560,760	5,121,292	382,141	149,013
Iowa	1,103,306	1,587,562	66,180	19,854	3,909,287	2,626,163	2,680,578	1,135,574
Kansas	280,077	230,030	20,250	4,050	1,458,976	1,148,678	1,081,326	373,952
Kentucky	1,164,546	1,226,100			338,789	392,154	250,828	197,437
Louisiana	1,880,301	2,574,480			3,777,087	4,522,004	2,700	800
Maine	250,052	277,151	4,500	450	557,526	426,738	6,088,244	1,868,337
Maryland	1,739,119	2,956,809			1,585,470	2,110,932	311,003	27,183
Massachusetts	1,962,566	2,664,927			2,134,886	1,699,801	611,188	539,346
Michigan	3,770,659	4,409,145	103,641	40,553	15,779,056	13,807,840	6,574,493	3,563,500
Minnesota	2,376,614	3,552,497			7,484,389	5,065,797	12,011,067	5,590,913
Mississippi	430,652	404,382			2,021,443	2,111,342	487,986	271,513
Missouri	1,848,071	1,874,540			1,180,122	1,035,187	1,113,315	700,515
Montana	1,052,350	884,211	27,960	72,654	932,453	1,189,522	8,032,518	4,880,274
Nebraska	564,800	423,900	47,200	44,500	2,979,500	2,218,600	602,200	474,500
Nevada	164,424	216,785	13,560	13,932	685,500	596,040	3,492,764	2,945,250
New Hampshire	190,161	286,594			672,068	831,602	2,692,305	341,245
New Jersey	1,510,397	2,673,760			866,012	887,099	22,107	4,094
New Mexico	948,700	1,168,000	27,700	53,400	2,278,700	2,085,400	3,390,000	3,158,580
New York	3,690,137	5,323,616			4,033,823	4,370,369	1,737,194	641,706
North Carolina	838,727	1,267,372			1,086,944	1,304,631	351,479	258,131
North Dakota	229,100	387,400	41,200	35,000	1,881,400	1,303,200	3,727,300	2,446,400
Ohio	5,434,932	6,429,913			9,798,593	11,505,049	33,822	21,040
Oklahoma	234,159	260,633	13,986	22,274	288,338	259,311	1,046,603	682,205
Oregon	2,109,366	2,774,281	174,381	56,626	3,903,920	4,123,510	4,546,207	4,187,735
Pennsylvania	3,456,047	4,760,230	112,367	39,328	1,527,864	2,204,341		
Puerto Rico	18,996	28,759			117,111	120,335		
Rhode Island	185,091	211,715			300,371	304,601	8,330	4,877
South Carolina	(1)	(1)			(1)	(1)		
South Dakota	77,600	97,000	10,000	5,000	1,363,300	836,400	12,355,500	6,297,100
Tennessee	1,246,081	1,480,735			1,455,389	1,362,588	692,256	543,961
Texas	5,852,411	7,203,410	63,542	47,869	3,709,971	4,645,522	3,271,455	1,119,293
Utah	814,400	712,700	753,200	635,600	1,906,100	1,579,500	2,240,700	1,408,600
Vermont	88,564	60,339			656,081	462,317	1,049,691	249,974
Virginia	(1)	(1)			(1)	(1)	151,468	94,492
Washington	3,050,888	3,306,541	1,954,482	1,154,172	3,149,776	3,279,736	7,116,706	4,728,205
West Virginia	1,392,791	1,445,064			424,061	729,378		
Wisconsin	2,862,228	2,456,075	10,679	3,204	5,197,402	3,885,619	6,540,137	3,532,125
Wyoming	167,600	213,200	10,500	7,100	916,800	625,900	1,034,500	797,400
Undistributed [1]	3,926,894	6,550,652			2,472,383	2,892,928		
Total	88,497,300	109,448,530	7,427,506	5,214,942	128,749,800	124,793,314	130,691,239	83,281,755

[1] Figures that may not be shown separately are combined under "Undistributed."
[6] Includes 44,759 tons of building gravel valued at $22,963, produced by railroads for their own use.
[7] Includes 91,391 tons of paving gravel valued at $23,739, produced by railroads for their own use.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1957, by States, uses, and class of operations—Continued

State	Gravel—Continued				Sand and gravel			
	Railroad ballast [8]		Other [9]		Total commercial		Total Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	135, 863	$103, 148	618, 513	$546, 149	4, 898, 144	$4, 748, 027	166, 701	$135, 409
Alaska	276, 972	240, 955	(1)	(1)	511, 253	692, 315	5, 584, 634	8, 106, 316
Arizona	20, 400	23, 200	440, 900	377, 000	3, 407, 700	3, 646, 400	6, 879, 700	5, 576, 000
Arkansas	(1)	(1)	202, 668	121, 831	5, 494, 006	5, 344, 477	3, 105, 512	1, 604, 834
California	(1)	(1)	3, 876, 843	4, 216, 455	60, 935, 611	72, 284, 129	18, 088, 826	14, 746, 000
Colorado			163, 100	160, 700	8, 560, 700	8, 822, 400	7, 839, 600	5, 171, 200
Connecticut	(1)	(1)	(1)	(1)	4, 537, 097	4, 939, 153	239, 880	102, 346
Delaware			(1)	(1)	974, 014	859, 949		
Florida					6, 753, 279	6, 147, 874		
Georgia					2, 126, 718	2, 096, 446		
Guam					688	1, 450		
Hawaii					285, 067	533, 421	1, 426	5, 011
Idaho	15, 808	12, 177	11, 301	8, 448	2, 341, 613	2, 161, 826	4, 259, 422	3, 073, 855
Illinois	659, 019	432, 291	1, 100, 659	939, 109	28, 518, 322	31, 832, 331	1, 632, 942	739, 712
Indiana	502, 575	393, 647	600, 503	333, 626	16, 153, 295	13, 997, 757	597, 217	208, 647
Iowa	41, 935	22, 263	61, 148	89, 083	8, 825, 929	7, 628, 949	3, 216, 113	1, 297, 595
Kansas			66, 167	113, 476	7, 679, 555	5, 424, 703	1, 665, 353	750, 054
Kentucky	73, 749	44, 823	(1)	(1)	4, 231, 659	4, 358, 675	250, 828	197, 437
Louisiana	117, 378	94, 412	103, 327	56, 064	8, 768, 402	10, 317, 643	101, 670	70, 079
Maine	(1)	(1)	(1)	(1)	1, 524, 546	1, 095, 750	6, 512, 210	2, 003, 217
Maryland			370, 336	220, 850	8, 368, 327	11, 566, 728	311, 062	27, 188
Massachusetts	39, 253	14, 334	749, 545	509, 551	9, 150, 461	9, 119, 566	749, 165	572, 022
Michigan	324, 256	255, 795	452, 157	320, 126	34, 004, 312	31, 173, 520	7, 833, 582	3, 970, 832
Minnesota	1, 025, 477	532, 546	282, 826	147, 451	15, 852, 043	13, 633, 741	12, 641, 374	5, 751, 745
Mississippi	(1)	(1)	697, 948	383, 701	4, 483, 763	3, 919, 999	687, 774	423, 983
Missouri	(1)	(1)	19, 783	16, 581	7, 197, 572	8, 000, 436	1, 282, 755	941, 840
Montana	243, 762	201, 158	91, 247	78, 519	2, 723, 923	2, 948, 320	8, 383, 621	5, 202, 117
Nebraska			91, 900	63, 400	7, 059, 900	5, 263, 600	884, 400	625, 400
Nevada			328, 328	353, 604	1, 691, 525	2, 210, 626	3, 541, 440	2, 979, 376
New Hampshire	4, 644	728	47, 264	16, 460	1, 421, 111	1, 531, 054	3, 083, 586	438, 859
New Jersey			99, 900	122, 144	10, 296, 166	17, 614, 843	26, 576	4, 591
New Mexico	12, 300	8, 500	249, 000	200, 200	4, 548, 100	4, 565, 400	3, 442, 900	3, 237, 410
New York	67, 747	67, 667	1, 668, 884	1, 219, 221	23, 656, 695	25, 681, 739	1, 982, 960	798, 448
North Carolina	(1)	(1)	(1)	(1)	4, 300, 282	4, 388, 832	2, 529, 069	1, 335, 371
North Dakota	232, 200	177, 300	171, 400	85, 900	3, 196, 800	2, 451, 300	3, 851, 000	2, 515, 400
Ohio	345, 099	340, 153	2, 106, 349	2, 723, 689	30, 550, 808	37, 479, 919	45, 069	23, 378
Oklahoma			3, 225	2, 250	3, 296, 510	3, 607, 646	1, 663, 230	899, 169
Oregon	234, 520	358, 584	593, 207	341, 138	8, 121, 940	9, 236, 489	4, 721, 001	4, 244, 774
Pennsylvania	(1)	(1)	(1)	(1)	12, 249, 048	19, 514, 702	156, 606	54, 812
Puerto Rico					296, 978	273, 951	200, 000	480, 000
Rhode Island			74, 615	38, 402	1, 035, 308	1, 049, 598	22, 709	10, 164
South Carolina	(1)	(1)			2, 597, 158	2, 549, 130	50, 222	22, 030
South Dakota	(1)	(1)	32, 500	17, 700	2, 017, 500	1, 445, 700	12, 740, 300	6, 555, 700
Tennessee	118, 998	117, 687	(1)	(1)	4, 925, 174	6, 096, 514	692, 256	543, 961
Texas	112, 646	92, 601	574, 953	645, 278	19, 155, 033	21, 978, 743	4, 530, 167	1, 448, 452
Utah	(1)	(1)	(1)	(1)	23, 928, 800	13, 395, 100	3, 028, 800	2, 089, 600
Vermont	(1)	(1)	(1)	(1)	1, 107, 776	776, 006	1, 107, 777	274, 746
Virginia					6, 088, 877	8, 725, 112	209, 392	128, 397
Washington	389, 049	231, 225	1, 050, 384	1, 054, 294	10, 098, 576	10, 457, 746	9, 825, 045	6, 316, 775
West Virginia	14, 899	17, 134	109, 752	209, 271	5, 353, 527	9, 892, 723		
Wisconsin	947, 702	507, 536	1, 376, 040	674, 828	16, 159, 707	12, 273, 239	13, 233, 818	6, 420, 215
Wyoming	116, 600	58, 300			1, 364, 300	1, 089, 500	1, 061, 200	815, 700
Undistributed [1]	889, 870	679, 128	11, 884, 533	6, 321, 456				
Total	6, 962, 721	5, 027, 292	30, 371, 205	22, 727, 955	462,825,598	490,845,197	164,660,890	102,940,167

[1] Figures that may not be shown separately are combined under "Undistributed."
[8] Includes 2,335,085 tons of ballast gravel valued at $1,271,644, produced by railroads for their own use.
[9] Includes 335,510 tons of gravel valued at $205,578, used by railroads for fills and similar purposes.

Government-and-Contractor Production.—As shown in figure 2, Government-and-contractor production in 1957 continued to gain in percentage of total output. This gain can be attributed mainly to the tendency of the contractor to maintain portable plants. The quantity of aggregates purchased and produced by contractors in 1957 for use under the new highway program fell short of estimates by the Bureau of Public Roads owing to greater emphasis on land acquisition than on construction. The Bureau of Public Roads also estimated that about 58 percent of the aggregates used for the program would be produced by the contractor himself.[3]

States reported 59 percent of the Government-and-contractor production in 1957, counties 27 percent, Federal Agencies 12 percent, and municipalities 2 percent. Contractors continued to lead the Government construction and maintenance crews in quantity produced by a wide margin.

A contracting company in New York that had difficulty in acquiring an adequate supply of aggregates of the desired quality and gradation became self-sufficient by setting up a separate company to supply aggregates.[4]

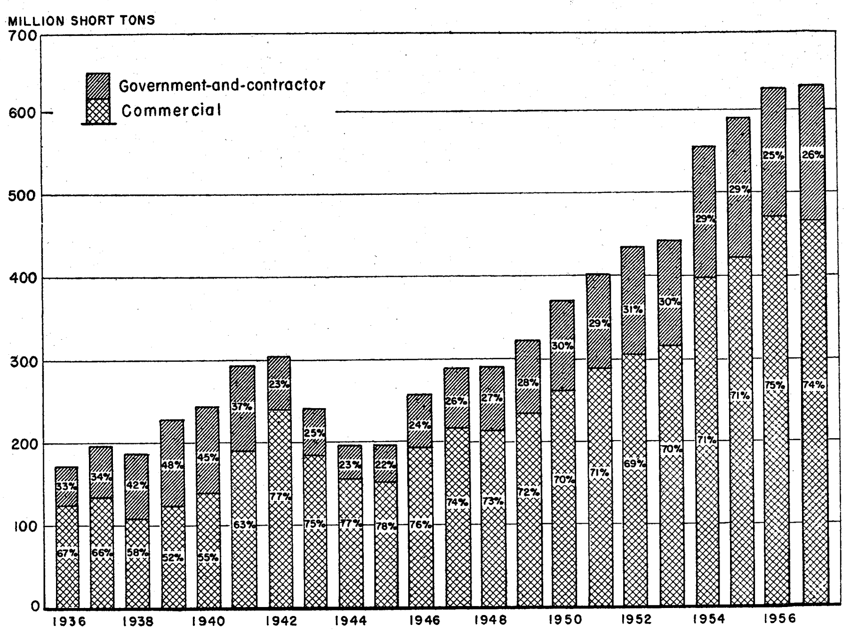

FIGURE 2.—Sand and gravel sold or used in the United States by producers, 1936–57.

[3] U. S. Department of Commerce, Bureau of Public Roads Release, Comm. D. C. 10077, July 25, 1956.
[4] Trauffer, Walter E., New York Plant Built to Supply Ready-Mix Aggregates: Pit and Quarry, vol. 49, No. 8, February 1957, pp. 114–116.

TABLE 5.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1948–52 (average) and 1953–57, 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)
1948–52 (average)	1,789	1,317	10,777	4,313	5,013	3,983	89,453	39,144	107,032	48,757
1953	1,078	1,197	13,925	5,926	9,044	5,937	107,456	49,575	131,503	62,635
1954	1,202	1,299	16,447	8,826	10,966	6,418	130,989	71,225	159,604	87,768
1955	1,758	1,975	22,833	11,099	15,045	7,994	132,441	77,616	172,077	98,684
1956	2,321	2,058	19,568	9,586	5,434	3,689	[2] 127,717	[2] 77,740	[2] 155,040	[2] 93,073
1957	2,383	2,163	24,159	12,280	7,428	5,215	130,691	83,282	164,661	102,940

[1] Includes Territories, possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 6.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1948–52 (average) and 1953–57, by types of producer

Type of producer	1948–52 (average)		1953		1954	
	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton
Construction and maintenance crews	44,679	$0.34	46,250	$0.38	49,232	$0.37
Contractors	62,353	.55	85,253	.53	110,372	.63
Total	107,032	.46	131,503	.48	159,604	.55
States	56,127	.47	71,199	.49	95,420	.57
Counties	35,456	.33	39,954	.38	43,378	.42
Municipalities	2,069	.47	2,720	.46	3,920	.42
Federal agencies	13,380	.77	17,630	.64	16,886	.81
Total	107,032	.46	131,503	.48	159,604	.55

Type of producer	1955		1956		1957	
	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton
Construction and maintenance crews	46,483	$0.40	[2] 47,592	$0.48	49,646	$0.48
Contractors	125,594	.64	107,448	.65	115,015	.69
Total	172,077	.57	[2] 155,040	.60	164,661	.63
States	101,842	.57	[2] 94,767	[2] .60	97,813	.61
Counties	41,444	.45	40,608	.52	44,303	.52
Municipalities	2,761	.50	4,149	.58	3,092	.82
Federal agencies	26,030	.79	15,516	.83	19,453	.88
Total	172,077	.57	[2] 155,040	.60	164,661	.63

[1] Includes United States Territories and possessions, and other areas administered by the United States.
[2] Revised figure.

Degree of Preparation.—Many plants producing for construction were called upon to furnish as many as 15 sizes of gravel to satisfy requirements set by various purchasers. At one extreme, the sand and gravel industry in 1957 included large operations with flow-sheet complexities comparable to high-value ore-processing plants; at the other extreme were one-man "bank run" operations with little or no processing.

Owing to specific requirements and refinements in technology, the quantity of prepared sand and gravel continued to increase. In 1957 washed, screened, and otherwise prepared material accounted for 82 percent of the total commercial production and averaged $1.15 per ton compared with $0.63 a ton for the unprepared commercial production. The fact that commercial producers furnished most of the prepared material accounted for the higher value of their output. Only 54 percent of Government-and-contractor production was prepared; its average value was $0.78 per ton. Bank-run material was preferred for many uses because of its binding quality and lower unit value.

Size of Plants.—As in 1956 the average sand and gravel plant was comparatively small. Plants producing more than 1 million tons annually furnished only 17 percent of the output. Portable plants, where higher cost of production was offset by lower cost of transporting the product, reportedly increased in number. On the other hand, the number of plants producing more than 500,000 tons decreased.

The widespread occurrence of sand and gravel deposits is the principal difference between sand and gravel and most other mineral operations; consequently, sand and gravel producers are less restricted by the location of raw materials. As a result, hundreds of small operations produced for brief periods or were in transit between locations in 1957.

Methods of Transportation.—As demand for sand and gravel continued to grow and sources became more distant, many problems of transportation were critical. For example, in Los Angeles, where about 32 million tons is used annually, an average delay of 1 minute for each truck coming into the city would cost an estimated $250,000 a year.[5] Trucks were again by far the most widely used method of transport. Railroads were still used exclusively by some operators, and waterways were used locally.

Increases in freight rates were widespread throughout the transportation industry. Barge lines associated with the Waterways Freight Bureau increased their rates 4 percent. The 16 member companies handled about 95 percent of barge-line, common-carrier freight in the Nation. The Middle Atlantic Rate Conference, representing 1,500 trucking firms, indicated that truck rates would increase about 7 percent to rail level.[6]

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[5] Rock Products, Sand and Gravel Producers Find That an Expanding Market Poses Some Rough Transportation Problems: Vol. 60, No. 7, July 1957, pp. 80–81.

[6] Rock Products vol. 60, No. 11, November 1957, p. 11.

TABLE 7.—Sand and gravel sold or used by producers in the United States,[1] 1956–57, by classes of operation and degrees of preparation

	1956			1957		
	Quantity		Average value per ton	Quantity		Average value per ton
	Thousand short tons	Percent		Thousand short tons	Percent	
Commercial operations:						
Prepared	[2] 410,425	87	$1.13	381,344	82	$1.15
Unprepared	59,395	13	.61	81,481	18	.63
Total	[2] 469,820	100	1.07	462,825	100	1.06
Government-and-contractor operations:						
Prepared	80,104	52	.76	89,665	54	.78
Unprepared	[2] 74,936	48	.43	74,996	46	.44
Total	[2] 155,040	100	.60	164,661	100	.63
Grand total	[2] 624,860	--------	.95	627,486	--------	.95

[1] Includes Territories, possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 8.—Comparison of number and production of commercial sand and gravel plants in the United States, 1956–57, by size groups[1]

Annual production, short tons	1956				1957			
	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	[3] 1,680	39.3	[3] 15,352	3.3	1,759	40.9	16,257	3.5
25,000 to less than 50,000	730	17.1	26,253	5.6	658	15.3	23,681	5.2
50,000 to less than 100,000	[3] 681	15.9	[3] 48,835	10.5	699	16.2	50,161	11.0
100,000 to less than 200,000	589	13.8	83,703	18.0	577	13.4	81,995	17.8
200,000 to less than 300,000	237	5.5	57,238	12.3	264	6.1	63,949	13.9
300,000 to less than 400,000	117	2.7	40,562	8.7	134	3.1	46,099	10.0
400,000 to less than 500,000	76	1.8	34,130	7.3	70	1.6	31,372	6.8
500,000 to less than 600,000	46	1.1	24,919	5.3	45	1.0	24,412	5.3
600,000 to less than 700,000	32	.7	20,454	4.4	24	.6	15,391	3.3
700,000 to less than 800,000	16	.4	12,076	2.6	16	.4	11,783	2.6
800,000 to less than 900,000	14	.3	11,508	2.5	17	.4	14,339	3.1
900,000 to less than 1,000,000	15	.4	14,138	3.0	1	(4)	987	.2
1,000,000 and over	43	1.0	76,772	16.5	42	1.0	79,415	17.3
Total	4,276	100.0	[3] 465,940	100.0	4,306	100.0	459,841	100.0

[1] Excludes operations by or for States, counties, municipalities, and Federal Government agencies as follows—1956: 1,683 operations with an output of 155,039,837 tons (revised figure) of sand and gravel; 1957: 1,639 operations, 164,660,890 tons. Excludes operations by or for railroads as follows—1956: 94 operations with an output of 3,880,243 tons of sand and gravel; 1957: 71 operations, 2,984,216 tons. Includes territories, possessions, and other areas administered by the United States.
[2] Includes a few companies operating more than 1 plant but not submitting separate returns for individual plants.
[3] Revised figure.
[4] Less than 0.05 percent.

TABLE 9.—Sand and gravel sold or used in the United States,[1] 1955–57, by method of transportation

	1955		1956		1957	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Commercial:						
Truck	284,825	48	341,029	55	340,432	55
Rail	85,001	14	[2] 83,737	13	87,845	14
Waterway	23,679	4	26,991	4	21,387	3
Unspecified	26,571	5	18,063	3	13,161	2
Total commercial	420,076	71	[2] 469,820	75	462,825	74
Government-and-contractor: Truck [3]	172,077	29	[2] 155,040	25	164,661	26
Grand total	592,153	100	[2] 624,860	100	627,486	100

[1] Includes Territories, possessions, and other areas administered by the United States.
[2] Revised figure.
[3] Entire output of Government-and-contractor operations assumed to be moved by truck.

Expanding markets forced the sand and gravel industry throughout the country to develop new facilities. Recognition of the value of portable plants continued to increase. Manufacturers advertised off-the-road, bottom-dump trucks having capacities up to 40 tons. Moreover, weight limitations of trucks on highways were more rigidly controlled.

In addition to freight-rate increases, another factor causing the shift from rail to truck has been the exhaustion of many deposits near railroads. Also, according to the National Sand and Gravel Association, at least one railroad considers the commodity freight rate so low that it would prefer not to haul sand and gravel.[7]

The first large-scale belt-conveyor transportation of sand and gravel was under way at the Great Salt Lake Fill Project, where 19 million cubic yards will be transported over a 9,900-foot belt-conveyor system.[8]

Employment and Productivity.—Plant automation and technology continued to increase the number of tons produced per man in 1957. The industry employed 32,000 men in 1957 compared with 33,000 in 1956. The average number of days decreased, also the average number of hours per man per day decreased slightly compared with 1956. The highest average production per hour was reported from the Michigan-Wisconsin area; the California and Nevada area employed the most men. Additional requirements for manpower are anticipated when the National Highway Program fully reaches the construction phase. The Bureau of Public Roads estimated that 9,710 million tons of aggregate would be needed for the new highway program alone. A large part of this tonnage will be sand and gravel. Public Roads also estimated that the highway program would require 442,000 men directly on construction jobs.[9]

[7] Pit and Quarry, NISA Convention Features Important Committee Meetings and Reports: Vol. 50, No. 6, December 1957, pp. 98–100.
[8] Utley, Harry F., 19,000,000 Cu. Yds. of Gravel For Great Salt Lake Fill: Pit and Quarry, vol. 49, No. 9, March 1957, pp. 132–134.
[9] U. S. Department of Commerce, Bureau of Public Roads Release, Comm. D. C. 10077, July 25, 1956.

TABLE 10.—Employment in the commercial sand and gravel industry and average output per man in the United States, 1948–52 (average) and 1953–57, by regions [1]

	Employment					Production (short tons)	Average output per man		Percent of commercial industry represented
	Average number of men	Time employed							
		Average number of days	Total man shifts	Man-hours			Per shift	Per hour	
				Average men per day	Total				
1948–52 (average)	23,853	239	5,705,129	8.7	49,530,774	235,125,095	41.2	4.7	89.8
1953	24,663	240	5,907,199	8.6	51,004,252	278,744,705	47.2	5.5	90.3
1954	31,891	251	8,003,743	8.6	69,047,194	364,647,149	45.6	5.3	91.9
1955	30,913	231	7,143,735	8.8	63,102,620	362,779,573	50.8	5.7	86.4
1956									
Maine, N. H., Vt., R. I., Mass., and Conn	1,642	212	348,183	8.8	3,066,396	17,294,626	49.7	5.6	92.2
N. Y	1,450	234	339,435	8.2	2,769,417	21,305,409	62.8	7.7	83.7
Pa., N. J., and Del	2,461	262	644,364	8.4	5,443,441	25,462,315	39.5	4.7	96.9
W. Va., Va., and Md	1,782	252	449,702	8.7	3,906,463	18,591,262	41.3	4.8	83.0
S. C., Ga., Ala., Fla., and Miss	1,726	263	454,603	10.4	4,735,877	20,853,272	45.9	4.4	99.9
N. C., Ky., and Tenn	1,386	240	332,411	9.2	3,046,548	14,793,591	44.5	4.9	95.7
Ark., La., and Tex	3,614	270	973,990	9.0	8,805,745	39,310,238	40.4	4.5	98.0
Ohio	2,256	251	566,657	8.6	4,898,286	28,690,505	50.6	5.9	95.7
Ill. and Ind	2,239	261	584,799	8.6	5,011,262	36,118,656	61.8	7.2	78.7
Mich. and Wis	2,673	180	480,127	8.7	4,182,488	39,561,374	82.4	9.5	77.2
N. Dak., S. Dak., and Minn	933	168	156,517	8.9	1,399,193	9,756,709	62.3	7.0	56.0
Nebr. and Iowa	1,098	215	235,732	9.3	2,195,970	14,035,467	59.5	6.4	72.2
Kans., Mo., and Okla	1,736	255	442,784	8.6	3,787,958	22,012,132	49.7	5.8	99.0
Wyo., Colo., N. Mex., Utah, and Ariz	1,210	225	271,977	8.3	2,248,904	13,512,000	49.7	6.0	90.4
Calif. and Nev	[2]4,200	229	[2]960,428	8.4	[2]8,070,753	[2]69,401,077	72.2	8.6	91.8
Mont., Wash., Oreg., and Idaho	2,228	153	340,424	8.1	2,762,745	19,476,856	57.2	7.0	86.5
Alaska, Hawaii, Panama Canal Zone, and Puerto Rico	125	170	21,191	8.2	173,603	598,139	28.2	3.4	49.7
Total	[2]32,759	232	[2]7,603,324	8.7	[2]66,505,049	[2]410,773,628	54.0	6.2	87.4
1957									
Maine, N. H., Vt., R. I., Mass., and Conn	1,442	218	314,477	8.5	2,678,598	15,750,451	50.1	5.9	83.9
N. Y	1,261	226	284,595	8.3	2,369,597	16,812,784	59.1	7.1	71.1
Pa., N. J., and Del	2,445	246	602,506	8.3	5,015,850	22,984,977	38.1	4.6	97.7
W. Va., Va., and Md	1,636	219	358,747	8.5	3,054,103	16,344,709	45.6	5.4	82.5
S. C., Ga., Ala., Fla., and Miss	1,634	254	414,404	8.6	3,555,994	19,375,782	46.8	5.4	99.7
N. C., Ky., and Tenn	1,199	234	280,256	8.4	2,358,892	13,457,115	48.0	5.7	100.0
Ark., La., and Tex	3,173	264	838,022	8.9	7,464,546	32,493,143	38.8	4.4	97.2
Ohio	2,488	237	588,939	8.9	5,227,930	29,524,740	50.1	5.6	96.6
Ill. and Ind	2,043	236	481,883	8.3	4,001,565	28,906,395	60.0	7.2	64.7
Mich. and Wis	2,228	195	433,966	8.8	3,812,875	37,136,399	85.6	9.7	74.0
N. Dak., S. Dak., and Minn	1,435	151	215,978	9.4	2,024,502	14,344,656	66.4	7.1	68.1
Nebr. and Iowa	1,372	156	214,046	9.6	2,053,295	12,094,313	56.5	5.9	76.1
Kans., Mo., and Okla	1,530	247	378,490	8.5	3,227,739	17,690,304	46.7	5.5	97.3
Wyo., Colo., N. Mex., Utah, and Ariz	1,532	231	353,829	8.5	2,993,355	17,626,000	49.8	5.9	42.2
Calif. and Nev	3,876	224	868,425	8.3	7,181,771	57,170,386	65.8	8.0	91.3
Mont., Wash., Oreg., and Idaho	2,054	144	295,044	8.3	2,440,001	20,991,615	71.1	8.6	90.1
Alaska, Hawaii, and Puerto Rico	183	166	30,400	10.0	303,279	726,337	23.9	2.4	66.4
Total	31,531	221	6,954,007	8.6	59,763,892	373,430,106	53.7	6.2	80.7

[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.
[2] Revised figure.

CONSUMPTION AND USES

Construction Uses, Including Ballast.—Although private residential construction declined in 1957, total new construction increased 3 percent over 1956. Impact of the construction phase of the Federal Highway Program began to be felt in some areas. New highways completed increased 8 percent in 1957 over 1956.[10] Paving uses accounted for 55 percent of the total production, a slight increase over 1956. Large quantities of sand and gravel also were used for industrial-building and water-control projects. Construction was begun on several new dams in 1957, and plans were made for additional ones. For example, 2 million cubic yards of sand and gravel will be used in Priest Rapids Dam on the Columbia River in Washington. The project is one of the largest in construction history and is scheduled for completion in 1961.[11]

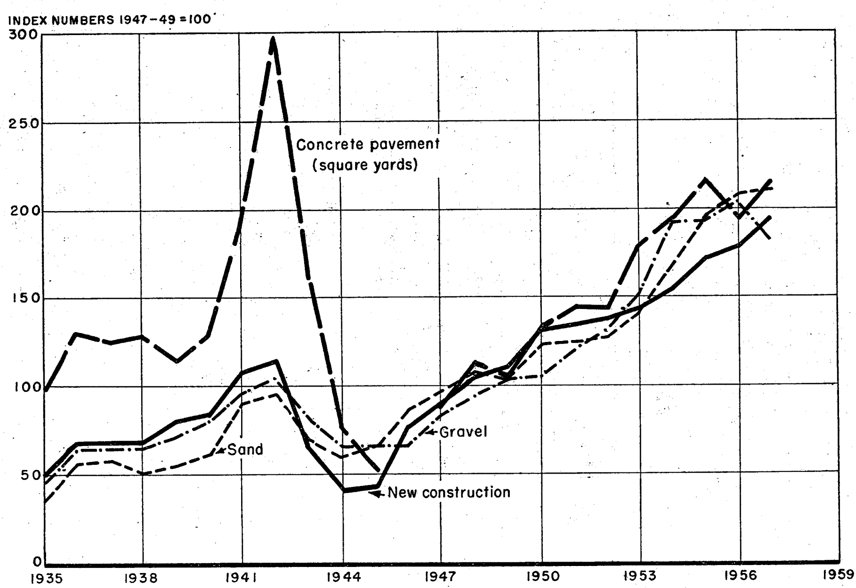

FIGURE 3.—Quantity of sand and gravel produced compared with value of total new construction, adjusted to 1947–49 prices, and total square yards of concrete pavements contracted for in the United States, 1935–57. Data on construction from Construction Review and on pavements from Survey of Current Business.

[10] U. S. Department of Commerce, Construction Review: Vol. 4, No. 2, February 1958, p. 17.
[11] Lenhart, Walter B., New Dam Gobbles Up Sand, Gravel at Furious Pace: Rock Products, vol. 60, No. 10, October 1957, pp. 144, 146, 195.

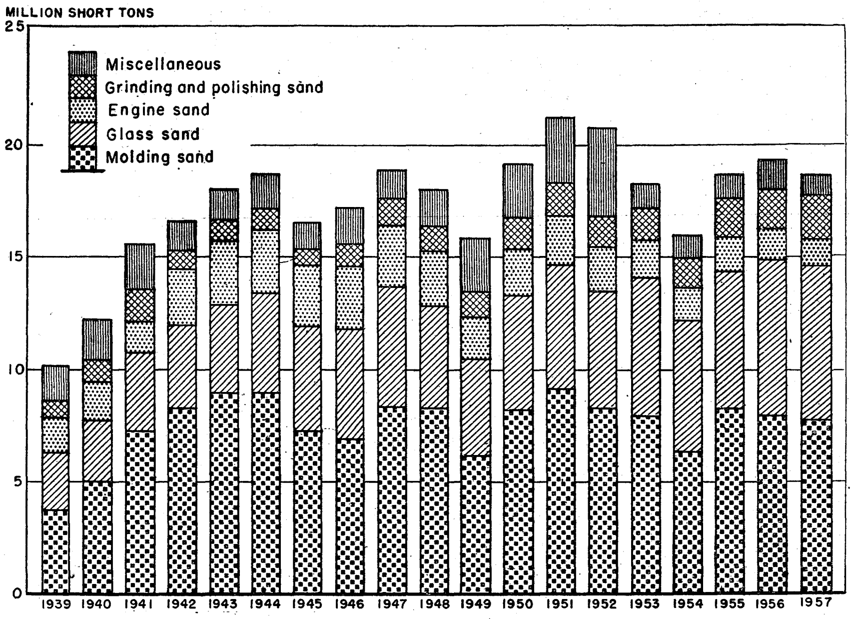

FIGURE 4.—Production of industrial sands in the United States, 1939–57.

TABLE 11.—Ground sand sold or used by producers in the United States, 1956–57, by uses

Use	1956			1957		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Abrasives	257,656	$1,939,524	$7.53	191,978	$1,716,196	$8.94
Enamel	38,261	365,748	9.56	25,876	263,900	10.20
Ferrosilicon	(1)	(1)	(1)			
Filler	153,347	1,186,976	7.74	134,163	1,196,842	8.92
Filter purposes	(1)	(1)	(1)	(1)	(1)	(1)
Foundry uses	314,063	2,009,693	6.40	133,249	1,314,558	9.87
Glass	(1)	(1)	(1)	(1)	(1)	(1)
Pottery, porcelain, and tile	214,953	2,042,704	9.50	196,354	1,847,249	9.41
Unspecified	136,925	1,090,906	7.97	100,557	993,463	9.88
Undistributed [1]	306,911	1,572,715	5.12	15,875	140,425	8.85
Total	1,422,116	10,208,266	7.18	798,052	7,472,633	9.36

[1] Figures that may not be shown separately are combined under "Undistributed."

A new plant was built on the San Juan River in New Mexico to help supply aggregates for the Bureau of Reclamation's Glen Canyon Dam. More materials will be required here than at the Hoover Dam.[12]

[12] Utley, Harry F., Booming New Mexico Construction Calls for New Gravel Operation: Pit and Quarry, vol. 49, No. 12, June 1957, pp. 120–121, 138.

Many other dams were reported to be in various stages of completion throughout many sections of the country.[13] The St. Lawrence seaway still exerted a large influence on the local aggregates supply in 1957, and sand was so scarce locally that some plants began to produce manufactured sand.

Plans were completed to begin testing asphalt-paved airstrips at Columbus, Miss., to see how they compare with concrete for big military aircraft.[14]

Wasteland became a commercial asset in the California desert, where a large dune was the source of more than half a million tons of road material. The operation used three portable plants operating simultaneously to produce sized aggregate for a hot-mix asphalt plant.[15]

Bonds totaling $614 million were approved for public-works construction.[16]

The economic aspects of the 41,000-mile interstate highway system [17] and the quantity of materials required for its construction, by years,[18] were outlined.

The quantity of aggregates needed for the base material alone was reported to be equivalent to 500 conical piles, 4 city blocks square, rising to the height of a 40-story building.[19]

Industrial Sands.—Consumption of industrial sands, including ground sand, totaled 19 million short tons in 1957, a decrease of about 1 million tons compared with 1956. Consumption of molding sand was affected by the lower output of iron and steel.

With declines in automobile sales and housing construction, use of glass sand decreased slightly in 1957. The United States automobile industry reportedly spends $350 million annually for glass.[20] New developments reported in the glass industry included the use of nearly 500 tons of glass beads on Pennsylvania roads to mark traffic lanes for improved visibility.[21]

Demand increased for coarse-grained, rounded silica sand for use in recovering oil and gas by pumping the material between the strata to increase flow. Several companies reported as licenses for the process.

STOCKS

Stocks of sand and gravel are relatively small compared with output and are approximately constant from year to year; therefore, production and sales are virtually equivalent, and the terms are used interchangeably in this chapter.

[13] Engineering News Record, Annual Forecast, Major River Use and Control Projects: Vol. 160, No. 7, February 1958, pp. 217-236.
[14] Poe, Edgar, Washington Letter: Rock Products, vol. 60, No. 10, October 1957, p. 19.
[15] Rock Products, In Southern California They're Turning a Gravel Dune Into a Long, Smooth Highway: Vol. 60, No. 2, February 1957, pp. 129-130, 132.
[16] Gillson, J. L., Industrial Minerals: Min. Cong. Jour., vol. 44, No. 2, February 1958, p. 94.
[17] Atkinson, L. J., and Kanwit, E. L., Economic Aspects of the New Highway Program: U. S. Dept. of Commerce, Construction Rev., vol. 3, No. 3, March 1957, pp. 7-15.
[18] Stern, Edwin L., Material Requirements for the Expanded Highway Program, 1957-59: U. S. Dept. of Commerce, Construction Rev., vol. 2, No. 9, September 1956, pp. 5-7.
[19] Pit and Quarry, The Highway Construction Picture: Vol. 49, No. 7, January 1957, pp. 134-137.
[20] Gillson, J. L., Industrial Minerals: Min. Cong. Jour., vol. 44, No. 2, February 1958, p. 98.
[21] Rock Products, vol. 60, No. 10, October 1957, p. 11.

PRICES

The average value of all sand and gravel shipped in 1957, both from commercial plants and from Government-and-contractor operations remained the same as in 1956. Unit value per ton for commercial operations was $1.06 per ton compared with $0.63 for Government-and-contractor operations. The percentage change in average value of each class at the source are shown in table 1.

Prices are held in line by the ability of the larger contractors to produce their own aggregates if the established producer allows his price to become too high.[22]

Total sales and profits of several large sand and gravel producers were reported.[23]

The wholesale price for sand, f. o. b. plant, was reported by the Department of Labor to be $1.302 in November 1957, compared with $1.232 in November 1956. Gravel was sold for $1.591 in November 1957 and $1.517 in November 1956.[24] These prices are compiled from selected commercial producers and do not include prices of unprocessed materials.

FOREIGN TRADE [25]

Sand and gravel remained a small factor in foreign trade in 1957. Shipments of ordinary sand and gravel were limited to border operations, but some sand was imported from Europe for glassmaking.

TABLE 12.—Sand and gravel imported for consumption in the United States, 1948–52 (average) and 1953–57, by classes

[Bureau of the Census]

Year	Sand				Gravel		Total	
	Glass sand [1] [2]		Sand, n. s. p. f., crude or manufactured					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	9,574	$37,038	306,828	$301,525	124,916	$24,715	441,318	$363,278
1953	5,690	114,000	313,176	329,612	87,028	9,699	405,894	453,311
1954	10,329	93,441	271,364	[3] 298,427	2,387	[3] 1,685	284,080	[3] 393,553
1955	170	171,973	317,947	[3] 384,637	1,680	[3] 100	319,797	[3] 556,710
1956	478	393,476	332,031	[3] 454,477	179	[3] 405	332,688	[3] 848,358
1957	683	621,065	290,280	437,114	14,877	21,951	305,840	1,080,130

[1] Classification reads: "Sand containing 95 percent or more silica and not more than 0.6 percent oxide of iron and suitable for manufacturing glass."
[2] Consists mainly of synthetically prepared silica from West Germany for specialized uses and is not comparable in value to ordinary glass sand.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable with years before 1954.

[22] Bell, Joseph N., Rock Products Forecast: Rock Products, vol. 60, No. 1, January 1957, pp. 68–79.
[23] Mead, Edgar T., Jr., From a Grain of Sand: The Magazine of Wall Street and Business Analyst, vol. 100, No. 10, Aug. 3, 1957, pp. 576–579, 622–624.
[24] Construction Review, vol. 4, No. 2, February 1958, p. 39.
[25] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the Bureau of the Census, U. S. Department of Commerce.

WORLD REVIEW

NORTH AMERICA

Canada.—Production of sand and gravel in Canada in 1956 was estimated at 151 million tons valued at $102 million. Sand and gravel was the third largest mineral industry of Canada. Development of the St. Lawrence seaway continued to exert a predominating influence on aggregate production in eastern Ontario and Quebec. Owing to the depletion of suitable sand and gravel within easy reach of some markets, it became necessary to manufacture sand from stone.[26] Although sand and gravel deposits are widespread in Canada, suitable material is scarce in Saskatchewan and nearby parts of Alberta and Manitoba. In 1955 there were 430 principal producers in Canada, not including railway companies or Government agencies.

TECHNOLOGY

The modern sand and gravel plant requires a high degree of flexibility in productive capacity, as well as provision for future expansion. A Wisconsin operation was so planned that production could be increased from 200 to 425 cubic yards per hour with little additional equipment.[27]

Because of more rigid specifications and a highly competitive market, emphasis on automation became more apparent at processing plants in 1957. A plant and dredge near Denver, Colo., included many labor-saving devices.[28] The nature of sand and gravel deposits in the Denver area presented production problems that resulted in unusual plants. Another new plant in the area began operating a dredge in a dragline-developed pond, from which the material was transported through pipeline to the complex processing plant.[29]

A new glass-sand operation in California used attrition mills and flotation cells as part of the complicated processing techniques required to produce a high-quality product.[30] Another California producer profited by frequent floods that brought more gravel to worked-out areas in 1957. The firm used its natural advantages in an unusual and reportedly efficient manner. A high-capacity dragline and a fleet of bottom-dump trucks fed a double-duty belt. The belt delivered gravel to a splitter box at the top of the plant, which sent one fraction to the wet side of the plant and the other to the dry. Plus-1½-inch screen-sized rock from either side passed to a reduction crusher. The crushed material was then refed to the same belt that conveyed the pit-run gravel and carried again to the splitter box, where it was delivered to the dry side.[31]

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[26] Department of Mines and Technical Surveys, Sand, Gravel, and Crushed Stone in Canada, 1956 (Preliminary): Ottawa, No. 52, 4 pp.

[27] Herod, Buren C., Design Flexibility With An Eye to the Future: Pit and Quarry, vol. 50, No. 5, November 1957, pp. 84–87, 89, 90.

[28] Hack, A., and Tomlin W., Push-Button Control Produces Sand and Gravel: Rock Products, vol. 60, No. 7, July 1957, pp. 76–79, 120–122.

[29] Trauffer, Walter E., Inland's New Gravel Plant: Pit and Quarry, vol. 50, No. 3, September 1957, pp. 82–84, 86, 87.

[30] Utley, Harry F., High-Solids Conditioning and Flotation in Processing: Pit and Quarry, vol. 50, No. 4, October 1957, pp. 72–74, 100.

[31] Lenhart, Walter B., Rampaging River Aids Gravel Plant: Rock Products, vol. 60, No. 11, November 1957, pp. 94–95, 122, 123.

In heavily populated and arid sections of California, three ready-mix firms found a solution for the common problem of scarce and expensive water and land. Water was reused, and space wasted on tailing ponds was saved by using liquid cyclones.[32] A highly advanced aggregate plant began operation in southern California. All finished materials were reclaimed, blended, transported, and weighed into trucks electronically.[33]

The first sink-float beneficiation plant in southern California began operation in 1957 after years of attempting to eliminate shale and chert by other methods.[34]

Although the sand and gravel particles were clay coated and required several scrubbing and washing processes, a Nevada operation produced 140 tons per hour of high-grade aggregate.[35]

A new process for upgrading gravel was used in two commercial plants in Michigan. The process makes use of the difference between the elastic properties of soft, deleterious materials and hard, sound particles. The gravel is dropped in a specified pattern on an inclined plate. The rebound of the stone is classified by allowing it to fall into 1 of 3 compartments.[36] In the latter part of the year two plants had incorporated this method.[37]

The 10th in a series of plant operations designed by 1 producer incorporated the best features of the other 9 to meet the market demand for various aggregates.[38]

Hydraulic Fracturing—a relatively new oil-well-completion technique, requiring sand to be pumped between the strata, is credited with increasing crude-petroleum output in a north Texas area by more than 1 million barrels during a recent 2-year period, according to a Bureau of Mines publication.[39] The report presents information obtained from a lengthy study of 184 wells. The principal purpose of the Bureau's work was to determine whether hydraulic fracturing would increase the quantity of oil that could untimately be recovered by primary-production methods.

In tunnel construction under the Thames River a new technique was used to stabilize and solidify the riverbed gravels. Reportedly, this pretreatment maintained the pressure of compressed air and prevented the collapse of the riverbed gravel. A special mixture of cement and chemicals was injected into the gravel on each side of the tunnel. This procedure developed dikes of impermeable gravel to contain the compressed air and formed a "box" through which the tunnel was driven.[40] The method might be useful for stabilizing sandfill.

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[32] Rock Products, Neighboring Sand Processors Decide Water Scarcity Can't Halt Production: Vol. 60, No. 11, November 1957, pp. 116, 118.

[33] Utley, Harry F., Star Rock Concentrates on Processing Sand and Gravel: Pit and Quarry, vol. 49, No. 8, February 1957, pp. 73–74, 76–77.

[34] Utley, Harry F., Sink-Float Beneficiation of Gravel Is Begun in Los Angeles Area: Pit and Quarry, vol. 50, No. 6, December 1957, pp. 132–134, 136.

[35] Utley, Harry F., Clay Coating Removed From Sand by Attrition at Nevada Plant: Pit and Quarry, vol. 50, No. 3, September 1957, pp. 144, 145.

[36] Engineering News-Record, Low-Grade Gravel is Given the Bounce: Vol. 159, No. 11, Sept. 12, 1957, pp. 87, 88.

[37] Herod, Buren C., Beneficiation By Bounce: Pit and Quarry, vol. 50, No. 4, October 1957, pp. 88–91, 122, 126, 140.

[38] Herod, Buren C., New Standard Materials Plant: Pit and Quarry, vol. 50, No. 3, September 1957, pp. 123–125, 130.

[39] Garland, T. M., Elliott, W. C., Dolan, Pat, and Dobyns, R. P., Effects of Hydraulic Fracturing Upon Oil Recovery From the Strawn and Cisco Formations in North Texas: Bureau of Mines Rept. of Investigations 5371, November 1957, 33 pp.

[40] Rock Products, vol. 60, No. 11, November 1957, p. 12.

An apparatus was patented for removing mud and clay balls from gravel. The wet, raw material is fed continuously to an inclined belt studded with spikes on its outer surface. The mud and clay balls are impaled, whereas the gravel drops into a bin. The spikes are cleaned by raking or washing at some stage of the belt's travel.[41]

A method was patented for controlling and consolidating loose sand when drilling through an unconsolidated formation. The formation is impregnated by pumping into it a mixture of Ottawa sand and oil, followed by Ottawa sand that has been coated with a resin and curing agent.[42]

A rotary apparatus for drying mineral aggregates was patented. It is said to have a large capacity and to be relatively simple and inexpensive.[43]

A patent was issued on an apparatus for washing gravel that reportedly costs little, is efficient, and has a large capacity.[44] Another patent was granted on an apparatus that automatically measures the fineness modulus of sand.[45]

A centrifuge was patented for recovering clean sand from gravel-plant tailings,[46] and a device was invented to prevent "bridging" of particles when fed to conveyors.[47]

A centrifugal dewatering device was patented that is said to produce sand suitable for direct use in foundry molds.[48]

A reportedly improved method has been patented for heating screens so that damp particles will pass instead of clogging the interstices of the screen.[49]

A method of beneficiating glass sand was patented. It is said to produce higher grade material and to require less reagent during flotation.[50]

Two methods were patented for the manufacturing of silica brick.[51]

The Federal Geological Survey published a comprehensive bibliography on high-grade silica of the United States and Canada.[52]

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41 Spence, P. Gravel Processing Means: U. S. Patent 2,788,895, Apr. 16, 1957.

42 Hower, W. F., and Knox, J. A. (assigned to Halliburton Oil Well Cementing Co., Duncan, Okla.), Method of Controlling Loose Sand: U. S. Patent 2,815,815, Dec. 10, 1957.

43 Madsen, W. M., Aggregate Dryer: U. S. Patent 2,815,940, Dec. 10, 1957.

44 Gorman, H. C., Material Washing Machine: U. S. Patent 2,812,622, Nov. 12, 1957.

45 Saxe, W. E. (assigned to the Conveyor Co., Inc., Los Angeles, Calif.), Apparatus for Measuring Fineness Modulus: U. S. Patent 2,782,926, Feb. 26, 1957.

46 Harris, B. G., Apparatus for Recovering and Cleaning the Residual Sand Content From the Tailings of Gravel Washing Plants: U. S. Patent 2,779, 469, Jan. 29, 1957.

47 Borrowdale, O. J., Freely Swinging, Rotating, Antibridging Device for Bulk Material: U. S. Patent 2,803,445, Aug. 20, 1957.

48 Peck, N. O. (three-fourths assigned to William H. Peck, Tulsa, Okla.), Centrifugal Separators: U. S. Patent 2,796,990, June 25, 1957.

49 Kaufman, J. S., and Lepley, C. F. (assigned to the Marble Cliff Quarries Co., Columbus, Ohio), Terminal Construction for Electrically Heated Screens of Material Separators: U. S. Patent 2,808,152, Oct. 1, 1957.

50 Brown, O. R. (assigned to American Cyanamid Co., New York, N. Y.), Froth Flotation Process: U. S. Patent 2,806,598, Sept. 17, 1957.

51 West, H. F., and Veale, J. H. (assigned to the Illinois Clay Products Co., Joliet, Ill.), Chemically Bonded Silica Brick and Method of Making Phosphate Bonded Silica Refractory Body: U. S. Patents 2,802,749 and 2,802,750, Aug. 13, 1957.

52 Jaster, M. C., Selected Annotated Bibliography on High-Grade Silica of the United States and Canada Through December 1954: U. S. Geol. Survey Bull. 1019H, 1957, pp. 609–673.

Secondary Metals—Nonferrous

By Archie J. McDermid[1][2]

THE CONTINUING decline in business activity, foreign competition, and overproduction of primary copper were major factors in the decrease in recovering secondary metal, compared with 1956. The decrease was greatest in secondary copper; recovery was 11 percent lower than in 1956. The decrease in copper recovery from scrap affected that of zinc, the alloying constituent most used in copper-base alloys.

Imports of copper and brass sheet and tubing continued to depress the brass-mill industry, and sharp decreases in the price of refined copper, caused by overproduction, increased the competitive difficulties of the brass-ingot makers whose raw material is chiefly copper scrap. There was also an oversupply of primary aluminum, but recovery of secondary aluminum increased 6 percent in 1957.

Monthly consumption of copper, lead, and zinc scrap was greater in the first half of 1957 than in the second half. After the low con-

TABLE 1.—Salient statistics of nonferrous secondary metals recovered from scrap processed in continental United States, 1956–57

Metal	From new scrap		From old scrap		Total	
	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)	Short tons	Value (thousand dollars)
1956						
Aluminum	268,095	128,686	71,673	34,403	339,768	163,089
Antimony	3,119	2,181	20,987	14,678	24,106	16,859
Copper	462,175	392,849	468,489	398,216	930,664	791,065
Lead	61,239	19,229	445,516	139,892	506,755	159,121
Magnesium	5,170	3,505	5,359	3,634	10,529	7,139
Nickel	6,344	8,595	8,516	11,537	14,860	20,132
Tin	13,226	26,785	19,747	39,992	32,973	66,777
Zinc	207,609	56,885	73,746	20,206	281,355	77,091
Total		638,715		662,558		1,301,273
1957						
Aluminum	289,360	146,995	72,459	36,809	361,819	183,804
Antimony	2,581	1,805	19,984	13,977	22,565	15,782
Copper	397,395	239,232	444,492	267,584	841,887	506,816
Lead	57,346	16,401	431,883	123,519	489,229	139,920
Magnesium	5,597	3,946	5,061	3,568	10,658	7,514
Nickel	5,298	8,316	6,719	10,546	12,017	18,862
Tin	10,670	20,523	16,504	31,744	27,174	52,267
Zinc	187,315	44,206	76,789	18,122	264,104	62,328
Total		481,424		505,869		987,293

[1] Commodity specialist.
[2] The assistance of Ivy C. Roberts, statistical, is acknowledged.

sumption in July caused by employee vacations and shutdowns for equipment repairs, activity failed to rise to the level of the first half of the year. Aluminum scrap monthly consumption varied little in 1957.

TABLE 2.—Secondary metals recovered as unalloyed metal, in alloys, and in chemical compounds in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Aluminum	261, 667	368, 566	292, 041	335, 994	339, 768	361, 819
Antimony	21, 709	22, 360	22, 358	23, 702	24, 106	22, 565
Copper	899, 730	958, 464	839, 907	989, 004	930, 664	841, 887
Lead	476, 787	486, 737	480, 925	502, 051	506, 755	489, 229
Magnesium	9, 199	11, 930	8, 250	10, 246	10, 529	10, 658
Nickel	7, 881	8, 352	8, 605	11, 540	14, 860	12, 017
Tin	31, 440	30, 914	29, 334	31, 743	32, 973	27, 174
Zinc	302, 656	294, 678	271, 774	304, 775	281, 355	264, 104

Additional information on nonferrous secondary metals, listed in the foregoing tables, appears in the commodity chapters of this volume.

Nonferrous-scrap consumption declined in 1957, but the supply was not plentiful. Owing to low prices for both steel and nonferrous scrap, recovery of market scrap from junked automobiles was not profitable. Old automobiles are a source of iron and steel scrap and considerable zinc and aluminum die-cast scrap, as well as copper and lead scrap. One of the items least affected, however, was battery-plate scrap. Consumption of this item, by far the largest nonferrous-scrap type, declined 2 percent, whereas total lead-scrap consumption decreased 7 percent.

One reason for the relatively high consumption of battery-plate scrap was the wide distribution of the scrap and of the smelters for treating it. Two hundred and fifty-nine smelters, more than all other secondary smelters combined, reported consumption of lead and tin scrap in lead and tin products in 1957.

Figure 1 shows the aluminum, copper, lead, and zinc content of total nonferrous scrap consumed over a 10-year period, and figure 2, the relation of scrap consumption (metal content) to total consumption of primary metal and scrap.

The graphs in figure 1 show total consumption of scrap, including new and old but not home scrap.

In preparing data for figure 2 total consumption was calculated as apparent primary metal consumption from foreign and domestic ores plus metal content of scrap consumed, as shown in figure 1. Total consumption of aluminum includes aluminum added to the National Stockpile. The approximate total consumption may be calculated from the figures by dividing the scrap consumption of a metal, as shown in figure 1, by the percentage of total consumption for that year, as shown in figure 2. The apparent primary consumption may be obtained by then subtracting the scrap consumption from the total consumption.

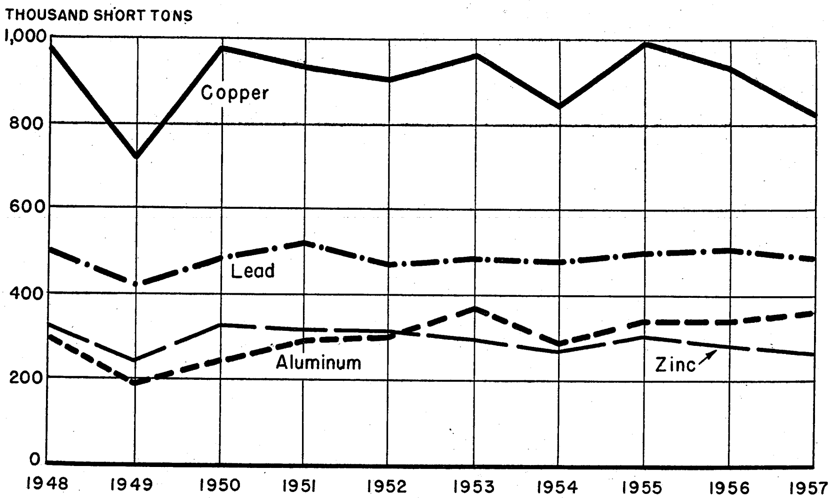

FIGURE 1.—Aluminum, copper, lead, and zinc content of total nonferrous scrap consumed in 1948–57.

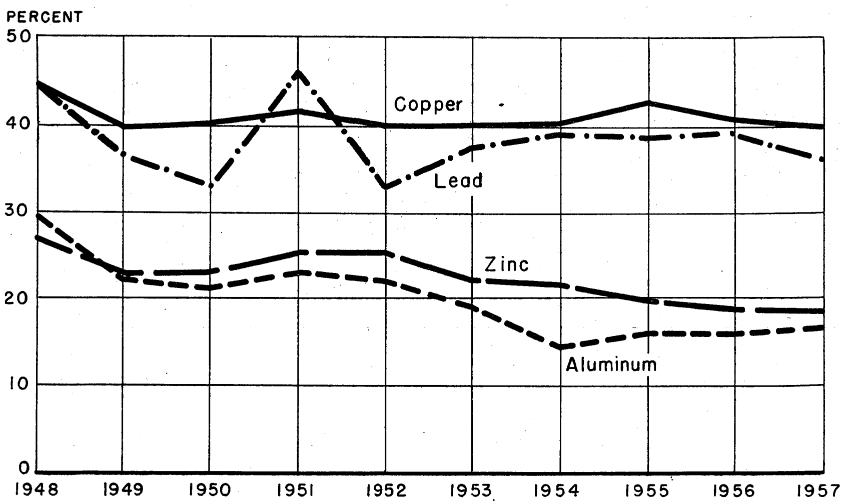

FIGURE 2.—Percentage of total consumption of aluminum, copper, lead, and zinc supplied by secondary metal in 1948–57.

The definitions for secondary metal products, as given in Minerals Yearbook, volume I, 1954, Secondary Metals—Nonferrous chapter, have been revised as follows:

Secondary metals.—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.

Secondary metal production and secondary metal recovery.—Synonymous terms meaning the total quantity of metals recovered from a

TABLE 3.—Number and classification of plants in the United States reporting consumption of nonferrous scrap metals, refined copper, and copper-alloy ingots in 1957 [1]

Kind of plant	Type of materials used			
	Aluminum scrap	Copper	Lead and tin scrap	Zinc scrap
Primary plants	35	12	5	
Secondary smelters	119	71	259	44
Secondary distillers				14
Primary distillers				11
Chemical plants	12	42		15
Brass mills		62		
Wire mills		18		
Foundries and miscellaneous manufacturers	130	1,748	58	35

[1] Plants listed in each column used material of the metal heading the column in products of that metal; for example, 71 secondary smelters used copper materials in copper-base products.

scrap charge. Secondary production is usually not a separate physical item but is combined with alloying ingredients.

Total production.—Secondary metal recovery plus added alloying ingredients. Total production has a secondary metal content and a content from other than scrap.

Secondary metal recoverable.—The recoverable metal content of scrap. This is obtained by first multiplying the gross weight of scrap consumed by the metallic-recovery percentage for the class of scrap consumed. The result is the metal recovered after allowing for melting loss. This metallic-recovery figure is then multiplied by composition percentages to obtain the quantities of the different metals recovered.

The definition for purchased scrap has been revised as follows:

Purchased scrap.—Scrap other than home scrap that has been purchased or transported from one plant to another. It includes new scrap, old scrap, toll scrap, and scrap generated at one plant and transferred to another plant of the same company for processing. Purchased scrap also includes wornout equipment such as is reclaimed in shipyard repair work and from line operations at railroad foundries although no definite financial transaction may have resulted.

TECHNOLOGY

The Federal Bureau of Mines completed an investigation on the recovery of tin from hardhead, a material generated in tin refining and composed primarily of tin-iron compounds. Tin was extracted from hardhead in a series of pressing and filtration operations based on the equilibrium diagram for the tin-iron system. The recovered impure tin was refined by a final filtration after ingredients were added to form solid compounds with impurities in the molten tin. Residues from the final filtration and the high-temperature pressings were returned to the process with new charges of hardhead. Information on recovery of zinc from brass-ingot makers' baghouse dust was also obtained in 1957.

Fundamental research by the Bureau in 1957 and in 1958 included studies to accelerate process-control analyses by combining spectrophotometric, polarographic, and controlled-potential electrolytic methods of analysis. Other basic research included measurement of activities and vapor pressures of nonferrous metals and alloys to supplement vacuum-distillation investigations. Rates of oxidation of nonferrous metals were being determined as part of the investigation of selective oxidation refining.

Experiments were continued in developing new or improved processes for recovering zinc from galvanizers' dross, zinc-base die-cast scrap, and other zinc scrap by distillation, mechanical separation, and electrolysis and for recovering tin from tin-base scrap by selective oxidation and amalgam electrolysis. Research was also under way in separating constituents from brass by chemical and electrolytic methods.

The Federal Bureau of Mines also continued laboratory-scale research on separating the constituents in scrapped S–816 high-temperature alloy. This alloy contains 43 percent cobalt, 20 percent chromium, 20 percent nickel, and smaller percentages of molybdenum, tungsten, columbium, iron, carbon, manganese, and silicon. Two effective methods were developed for solubilizing the cobalt, nickel, chromium, iron, and manganese in the alloy while obtaining the tungsten, molybdenum, columbium, carbon, and silicon in a sludge. Separation of the individual elements or their salts from the soluble and insoluble fractions is now the principal remaining problem. Separations obtained were not sharp enough to produce specification-grade products, but improvements were gained.

Increasing use of a shortcut to producing sheet metal from refined metal, ore, and scrap was indicated in 1957 by developing equipment for large-scale conversion of metal powders to strip. Two companies built machines of commercial capacity in which copper, brass, and nickel strip were successfully sinter-rolled from metal powders.[3] Such alloys as nickel-cobalt, stainless steel, and tin bronzes were successfully rolled in laboratory-size equipment.[4] The process eliminates melting and slabbing operations.

The E. W. Bliss Co., of Salem, Ohio, introduced a production line in which the powder was first passed through horizontal compacting rolls, then successively through a sintering furnace, a 2-high hot-roll mill, a second sintering furnace, a second 2-high hot-roll mill, and an atmosphere-cooling chamber, after which the strip was coiled on a tension reel. All hot rolling and sintering were done in a protective atmosphere. The sizes made were 0.025 to 0.060 inch thick and up to 16 inches wide. The cost of the mechanical equipment, exclusive of electrical equipment, for a production line, with a capacity of 50 tons per 24 hours, was estimated at $750,000.

Stanat Manufacturing Co., of Westbury, Long Island, developed a powder-rolling mill in which the compacting rolls were convertible to a 2-high or 4-high combination for hot- or cold-rolling the strip after sintering. It was proposed as especially suitable for research, development, and pilot-plant operation. The roll bearings had a maximum roll-separating strength of 350,000 pounds and could produce strip at about 25 feet per minute. Maximum sheet width was 11 inches and maximum thickness, over one-eighth of an inch. The machine weighed about 25,000 pounds and cost about $35,000.

[3] American Metal Market, Metal Powder Progress Signaled in Construction of Bigger Mills: Vol. 65, No. 17, Jan. 24, 1958, pp. 5, 8.
[4] Iron Age, Strip From Powder Makes Gains: Vol. 181, No. 3, Jan. 16, 1958, p. 42.

Hydrometals, Inc., formerly Illinois Zinc Co., was reported planning construction of 5 plants, at an estimated cost of $9.5 million each, to chemically reduce copper ore and copper-base scrap to copper powder and then to sinter-roll the powder to continuous copper strip. Chemetals Corp. was the exclusive licensing company in the United States for both the powder-producing and powder-rolling processes. Metal powders rolled to strip in 1957 were principally iron and copper base, but interest in applying the process to other metals was increasing.

In a process development completed in 1957 titanium and zirconium scrap were converted to platelets 1/16 to 1/8 inch square for use as scavengers in producing steel.[5] The platelets were also reduced to powder which, when mixed with 30 percent virgin metal powder, was compacted, then sintered, and hot-compacted to billets from which bars and flats were rolled.

A development related to part of the Hawkridge process was the completion in 1957 by the Federal Bureau of Mines of research on electrorefining titanium metal. The electrolyte used was a fused salt, the anode was a combination of offgrade sponge and scrap, and the purified metal was collected at the cathode.[6]

Manufacture and distribution of oxygen on a liquid tonnage basis was increasing in 1957.[7] Its substitution for oxygen in gaseous form was expected to expedite separation of attached iron from nonferrous scrap at dealers' yards.

A blast furnace equipped with inverted boshes in use at the Franklin Smelting Co., a secondary copper smelter at Philadelphia, was described.[8] The plant specialized in treating low-grade copper scrap and residues, from which it produced black copper for sale to primary producers for further processing. Use of the inverted bosh at this plant was said to eliminate crusts and arches, to reduce coke consumption, and to lower temperatures of exhaust gases in operation of the furnace. The only other inverted bosh in use was at the El Segundo, Calif., plant of H. Kramer & Co.

It was reported that Handy & Harman, producers of precious-metal alloys, had recovered 1,477 troy ounces of silver from obsolete X-ray films, accumulated over a period of 7 months from use in inspecting aircraft parts by United Aircraft Corporation.[9] As a result, investigation of the salvage of silver from the fixing solution used was conducted. Handy & Harman was extending the program to include similar material in other plants.

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[5] American Metal Market, Hawkridge Has Salvage Process for Titanium and Zirconium: Vol. 65, No. 20' Jan. 29, 1958, p. 7.

[6] Nettle, J. R., Baker, D. H., Jr., and Wartman, F. S., Electrorefining Titanium Metal: Bureau of Mines Rept. of Investigations 5315, 43 pp.

[7] Loveman, S. Michael, New Types of Distribution for Liquid Oxygen: Waste Trade Jour., vol. 102, No. 16, Jan. 5, 1957, p. 38.

[8] Engineering and Mining Journal, How the Inverted-Bosh Blast Furnace Increases Smelting Capacity: Vol. 158, No. 8, August 1957, pp. 100, 101.

[9] Iron Age, X-Ray Silver Mine: Vol. 181, No. 7, Feb. 13, 1958, p. 79.

Silver

By J. P. Ryan[1] and Kathleen M. McBreen

BOTH DOMESTIC mine production and consumption of silver declined in 1957, but imports continued to rise sharply owing to lend-leaser eturns. Silver prices remained virtually unchanged. Mine output was 38.2 million ounces, 2 percent below the 1956 output, and consumption in the arts and industries was about 95.4 million ounces, 5 percent below the 1956 level.

Lower mine output of silver reflected the curtailment in production of base-metal ores yielding byproduct silver; lower demand for industrial silver resulted from the general decline in business activity in the latter part of the year. Free stocks of silver in the United States Treasury rose about 40 million ounces in 1957, and total Treasury stocks were 2,014 million ounces at the end of the year.

TABLE 1.—Salient statistics of silver in the United States,[1] 1948–52 (average) and 1953–57

	1948-52 (average)	1953	1954	1955	1956	1957
United States:						
Mine production...thousand ounces..	38,889	37,571	36,941	37,198	38,948	38,165
Value.............thousand dollars..	35,197	34,004	33,434	33,666	35,250	34,541
Ore (dry and siliceous) produced (thousand short tons):						
Gold ore..................	3,033	2,199	2,249	2,234	2,255	2,359
Gold-silver ore..................	404	82	46	120	245	116
Silver ore..................	494	555	680	570	687	712
Percentage derived from—						
Dry and siliceous ores..............	29	29	40	30	29	32
Base-metal ores..................	71	71	60	70	71	68
Net consumption in industry and the arts..............thousand ounces..	100,958	106,000	86,000	101,400	100,000	95,400
Imports[2]..................do....	89,069	81,510	90,897	84,519	162,832	206,119
Exports[2]..................do....	3,458	1,023	1,703	4,893	5,501	10,299
Monetary stocks (end of year)[3] million ounces..	....	1,926	1,935	1,930	1,981	2,014
Price, average, per fine troy ounce[4]...	\$0.905+	\$0.905+	\$0.905+	\$0.905+	\$0.905+	\$0.905+
World: Production (estimated) thousand ounces..	194,900	[5] 221,800	[5] 214,300	[5] 223,700	[5] 224,200	228,700

[1] Includes Alaska.
[2] Excludes coinage.
[3] Owned by Treasury Department; privately held coinage not included.
[4] Treasury buying price for newly mined silver.
[5] Revised figure.

World production of silver rose 2 percent in 1957 to 229 million ounces, but world consumption in the arts and industries decreased slightly to 210 million ounces.[3] North American countries con-

[1] Commodity specialist.
[2] Statistical assistant.
[3] Handy & Harman, The Silver Market in 1957: 42d Ann. Review, p. 25.

tributed more than half the world output of silver, Mexico being the leading producer. The United States was by far the leading consumer of silver, accounting for about half of the world consumption (including coinage) in 1957. Silver used for world coinage in 1957 was estimated at 79.2 million ounces—about 18.1 million ounces more than in 1956.

LEGISLATION AND GOVERNMENT PROGRAMS

Legislation to repeal existing silver purchase laws, similar to that introduced in 1956, was again introduced in the 84th Congress in 1957 (H. R. 448, H. R. 4562, S. 1201). These bills were referred to the Committee on Banking and Currency and the Ways and Means Committee of the House, and to the Committee on Banking and Currency of the Senate, respectively, but no further action was taken. The bills also provided for repeal of the 50-percent transfer tax on profits made in trading in silver.

DOMESTIC PRODUCTION

United States mine production of recoverable silver declined 2 percent in 1957, owing principally to lower output of base-metal ores yielding silver as a byproduct.

Idaho continued to rank as the leading silver-producing State by a wide margin, followed by Utah, which regained second place (having displaced Montana). Montana was third, and Arizona was again fourth. These 4 States continued to supply about 84 percent of the domestic output of silver in 1957. About one-fourth of the domestic production was recovered from dry ores in Idaho in which silver was the principal product. Most of the remaining domestic output was recovered as a byproduct of ores mined principally for base metals or gold. In 1957, as in 1956, about 99 percent of domestic silver production was recovered by smelting ores and concentrates.

TABLE 2.—Silver produced in the United States,[1] 1948–52 (average) and 1953–57, according to mine and mint returns, in fine ounces of recoverable metal

	1948–52 (average)	1953	1954	1955	1956	1957
Mine	38, 889, 452	37, 570, 838	36, 941, 383	37, 197, 742	38, 948, 121	38, 164, 915
Mint	39, 245, 864	37, 735, 500	35, 584, 800	36, 469, 610	38, 739, 400	35, 043, 736

[1] Includes Alaska.

TABLE 3.—Mine production of silver in the United States[1] in 1957, by months

Month	Fine ounces	Month	Fine ounces
January	3, 303, 457	August	3, 105, 614
February	3, 155, 027	September	3, 106, 612
March	3, 474, 950	October	3, 084, 570
April	3, 502, 555	November	2, 744, 572
May	3, 427, 192	December	2, 792, 716
June	3, 242, 780		
July	3, 224, 870	Total	38, 164, 915

[1] Includes Alaska.

A detailed description of the units of measurement, methods of calculating production, ore classification, and methods of recovery is given in the Gold chapter of the 1954 Minerals Yearbook.

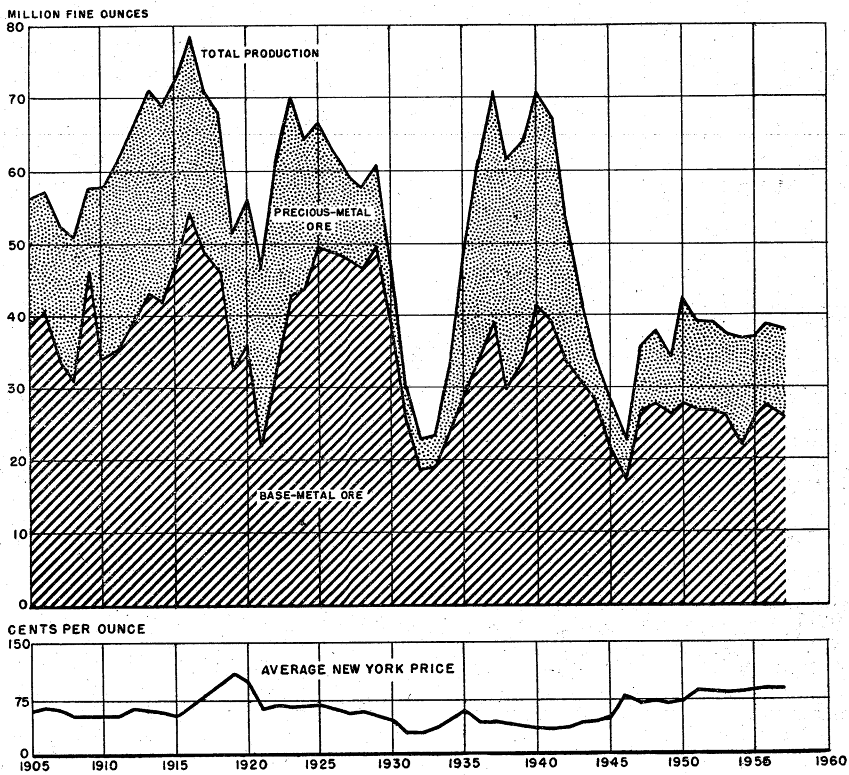

FIGURE 1.—Silver production in the United States and average price per ounce, 1905–57.

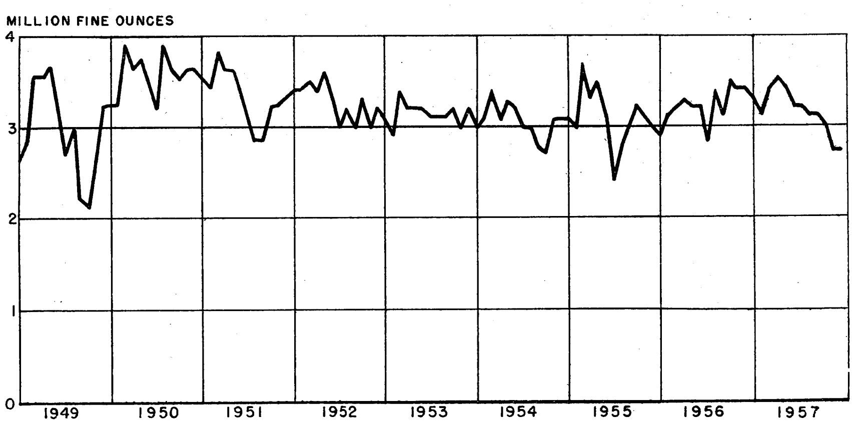

FIGURE 2.—Mine production of silver in the United States, 1949–57, by months, in terms of recoverable silver.

The leading silver-producing areas, in order of output, were: Coeur d'Alene region in Idaho, Summit Valley (Butte) district in Montana, and West Mountain (Bingham) district in Utah—an order unchanged since 1932. Nearly 63 percent of the domestic mine output of silver in 1957 came from these 3 districts.

Of the 25 leading domestic silver-producing mines in 1957, only 4 depended chiefly on the value of silver in the ore. Ores mined chiefly for copper, lead, and zinc again supplied most of the silver output. The 10 leading mines—each producing over 1 million ounces of silver in 1956—supplied 56 percent of the United States production; the 25 leading mines together contributed 79 percent.

TABLE 4.—Mine production of recoverable silver in the United States, 1948–52 (average) and 1953–57, by districts and regions that produced 300,000 fine ounces or more during any year (1953–57), in thousand fine ounces

District or region	State	1948-52 (average)	1953	1954	1955	1956	1957
Coeur d'Alene region	Idaho	9,728	13,637	14,899	12,984	12,663	14,398
Summit Valley (Butte)	Montana	5,864	6,289	4,663	5,578	6,772	5,069
West Mountain (Bingham)	Utah	4,817	5,027	4,109	4,409	4,541	4,443
Warren	Arizona	1,243	1,266	1,379	1,209	1,267	1,185
Park City region	Utah	1,142	802	826	989	1,198	1,164
Red Cliff (Battle Mountain)	Colorado	413	581	2,112	1,613	581	932
Big Bug	Arizona	585	591	579	696	800	(1)
Upper San Miguel	Colorado	644	718	577	454	(1)	(1)
Copper Mountain	Arizona	596	369	403	634	800	739
Pioneer	do	485	628	634	486	492	550
Ajo	do	457	436	390	488	508	467
Ferry County	Washington	(1)	[2] 251	[2] 273	[2] 363	[2] 383	(1)
Upper Peninsula	Michigan	------	------	------	478	380	430
California (Leadville)	Colorado	(1)	196	138	98	157	374
Pima	Arizona	174	27	75	146	226	367
Flint Creek	Montana	77	[3] 225	332	387	413	344
Darwin (Coso)	California	(1)	(1)	(1)	(1)	(1)	(1)
Warm Springs	Idaho	475	562	554	427	345	246
Elk Mountain	Colorado	6	------	------	(1)	(1)	(1)
Mineral Creek	Arizona	117	266	208	351	261	220
Tintic	Utah	915	563	933	612	497	218
Southeastern	Missouri	235	360	353	269	295	183
Robinson	Nevada	159	185	107	113	365	(1)
Pioche	do	568	318	79	48	180	(1)
Silver Peak	do	(1)	(1)	(1)	353	87	(1)

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Chelan and Ferry Counties combined.
[3] Combined with First Chance and Henderson districts in 1953.

TABLE 5.—Twenty-five leading silver-producing mines in the United States in 1957, in order of output

Rank	Mine	District or region	State	Operator	Source of silver
1	Sunshine	Coeur d'Alene	Idaho	Sunshine Mining Co	Silver ore.
2	Galena	do	do	American Smelting & Refining Co	Do.
3	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
4	Butte Hill Lead-Zinc Mines	Summit Valley (Butte)	Montana	The Anaconda Co	Zinc ore.
5	Bunker Hill	Coeur d'Alene	Idaho	The Bunker Hill Co	Lead-zinc ore.
6	United States & Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Silver, lead, lead-zinc ores.
7	Kelley	Summit Valley (Butte)	Montana	The Anaconda Co	Copper ore.
8	Copper Queen-Lavender Pit	Warren	Arizona	Phelps Dodge Corp	Do.
9	Silver Summit	Coeur d'Alene	Idaho	Polaris Mining Co	Silver ore.
10	Eagle	Red Cliff (Battle Mountain)	Colorado	The New Jersey Zinc Co	Copper, lead-zinc ores.
11	Butte Hill Copper Mines	Summit Valley (Butte)	Montana	The Anaconda Co	Copper ore.
12	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp	Lead-zinc ore.
13	Treasury Tunnel-Black-Bear-Smuggler Union.	Upper San Miguel	Colorado	Idarado Mining Co	Copper, lead-zinc ore.
14	Morenci	Copper Mountain	Arizona	Phelps Dodge Corp	Gold-silver, copper ores.
15	Lucky Friday	Coeur d'Alene	Idaho	Lucky Friday Silver-Lead Mines, Inc	Lead-zinc ore.
16	United Park City Mines	Uintah	Utah	United Park City Mines Co	Silver, lead-zinc ores.
17	Magma	Pioneer	Arizona	Magma Copper Corp	Copper ore.
18	New Cornelia	Ajo	do	Phelps Dodge Corp	Gold-silver, copper ores.
19	White Pine	Upper Peninsula	Michigan	White Pine Copper Co	Copper ore.
20	Page	Coeur d'Alene	Idaho	American Smelting & Refining Co	Lead-zinc ore.
21	Berkeley Pit	Summit Valley (Butte)	Montana	The Anaconda Co	Copper ore.
22	Knob Hill	Republic (Eureka)	Washington	Knob Hill Mines, Inc	Gold ore.
23	Alice Silicious	Summit Valley (Butte)	Montana	The Anaconda Co	Silver ore.
24	Algonquin	Flint Creek	do	American Machine & Metals, Inc	Lead-zinc ore.
25	Emperius	Creede	Colorado	Emperius Mining Co	Gold-silver, lead-zinc ores.

TABLE 6.—Mine production of recoverable silver in the United States, 1948–52 (average) and 1953–57, by States, in fine ounces

State	1948–52 (average)	1953	1954	1955	1956	1957
Alaska	44,009	35,387	33,697	33,693	28,360	28,862
Arizona	4,991,246	4,351,429	4,298,811	4,634,179	5,179,185	5,279,323
California	965,089	1,036,372	309,575	954,181	938,139	522,288
Colorado	2,999,940	2,200,317	3,417,072	2,772,073	2,284,701	2,787,892
Idaho	13,453,868	14,639,740	15,867,414	13,831,458	13,471,916	15,067,420
Illinois	3,284	2,338	1,160	3,075	1,580	----
Kentucky	----	----	----	----	31	56
Michigan	----	----	----	478,000	379,990	430,000
Missouri	235,146	359,781	352,971	268,620	295,111	183,427
Montana	6,476,088	6,689,556	5,177,942	6,080,390	7,385,908	5,558,228
Nevada	1,410,062	697,086	560,182	845,397	1,220,473	958,477
New Mexico	435,939	205,309	109,132	251,072	392,967	309,385
New York	31,251	35,398	34,576	66,162	84,158	63,880
North Carolina	----	----	438	181	753	12,347
Oregon	9,922	12,259	14,335	8,815	13,542	15,924
Pennsylvania	11,589	6,972	8,415	10,379	(1)	(2)
South Dakota	123,567	138,642	151,407	154,092	136,118	134,737
Tennessee	40,803	68,935	60,759	66,619	64,878	54,407
Texas	2,852	----	100	126	----	----
Utah	7,271,758	6,725,807	6,179,243	6,250,565	6,572,041	6,198,464
Vermont	33,444	43,128	48,572	50,447	[3] 47,800	36,794
Virginia	----	1,169	1,773	1,850	1,874	1,745
Washington	349,587	321,202	313,735	436,348	448,442	[4] 521,133
Wyoming	7	11	74	20	154	126
Total	[5] 38,889,452	37,570,838	36,941,383	37,197,742	38,948,121	38,164,915

1 Included with Vermont.
2 Included with Washington.
3 Includes silver recovered from magnetite-pyrite-chalcopyrite ores in Pennsylvania.
4 Includes production from Pennsylvania.
5 Includes 1 ounce from Georgia.

TABLE 7.—Ore, old tailings, etc., yielding silver, produced in the United States and average recoverable content, in fine ounces, of silver per ton in 1957 [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
Alaska	11,571	0.006	----	----	----	----
Arizona	5,059	1.061	74,870	0.176	33,919	0.408
California	126,114	.433	43	1.814	37	35.757
Colorado	121,398	.072	4,966	1.776	2,208	5.018
Idaho	2,938	2.318	9	127.889	403,584	25.579
Montana	7,980	1.606	13,791	6.117	92,023	4.023
Nevada	161,902	.039	1,278	21.630	4,243	10.439
New Mexico	23	.826	211	5.649	13,434	.367
Oregon	2,427	----	----	----	----	----
South Dakota	1,778,583	.076	----	----	----	----
Utah	236	1.042	20,852	2.918	162,011	3.805
Washington [7]	----	----	----	----	----	----
Wyoming	2,000	.046	----	----	----	----
Undistributed [8]	138,839	3.027	----	----	84	----
Total	2,359,070	.282	116,020	1.700	711,543	16.001

See footnotes at end of table.

TABLE 7.—Ore, old tailings, etc., yielding silver, produced in the United States and average recoverable content, in fine ounces, of silver per ton in 1957 [1]—Con.

State	Copper ore		Lead ore		Zinc 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
Alaska	--------	--------	55	32.018	--------	--------
Arizona	59,621,032	[2] 0.069	9,920	4.102	7,072	0.199
California	8,242	[2] 16.759	1,609	18.823	--------	--------
Colorado	32,138	18.660	27,225	[3] 4.580	785	2.850
Idaho	282,855	.064	55,903	4.246	[4] 88,427	.668
Montana	9,576,968	.259	7,003	4.156	[5] 1,059,177	2.119
Nevada	11,514,197	.035	26,740	12.329	1,003	1.494
New Mexico	7,618,015	.007	35,799	.157	327,591	.292
Oregon	167	--------	--------	--------	--------	--------
South Dakota	--------	--------	--------	--------	--------	--------
Utah	30,940,383	.093	35,848	6.321	[6] 25,240	.166
Washington [7]	--------	--------	--------	--------	--------	--------
Wyoming	69	.493	--------	--------	--------	--------
Undistributed [8]	8,801,315	.059	110	.436	1,961,934	--------
Total	128,395,381	.087	200,212	5.124	3,471,229	.694

State	Zinc-lead, zinc-copper, lead-copper, and zinc-lead-copper ores		Total ore	
	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton
Alaska	--------	--------	11,626	0.158
Arizona	462,471	2.406	60,214,343	[2] .088
California	68,206	4.260	204,251	[3] 2.522
Colorado	922,172	2.204	1,110,892	[3] 2.509
Idaho	1,296,785	[2] 3.409	2,130,501	[2] 7.072
Montana	33,067	10.188	[5] 10,790,009	.515
Nevada	60,471	2.323	11,769,834	.081
New Mexico	82,582	1.820	8,077,655	.038
Oregon	--------	--------	2,594	--------
South Dakota	--------	--------	1,778,583	.076
Utah	543,621	4.450	[6] 31,728,191	.195
Washington [7]	--------	--------	--------	--------
Wyoming	--------	--------	2,069	.061
Undistributed [8]	3,883,102	.044	[9] 14,785,384	[9] .075
Total	7,352,477	1.506	142,605,932	.266

[1] Missouri excluded.
[2] Includes gold recovered from tungsten ore.
[3] Includes gold recovered from fluorspar ore.
[4] Zinc slag.
[5] Includes 51,888 tons of zinc slag.
[6] Includes 25,200 tons of zinc slag.
[7] Included in "Undistributed."
[8] Includes Kentucky, Michigan, New York, North Carolina, Tennessee, Vermont, Virginia, and Washington.
[9] Excludes magnetite-pyrite-chalcopyrite ore and silver therefrom in Pennsylvania.

TABLE 8.—Mine production of silver in the United States,[1] 1948–52 (average) and 1953–57, 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
1948–52 (average)	0.2	29.4	20.4	5.4	1.5	43.1	38,889,452
1953	.1	29.2	24.5	5.2	.9	40.1	37,570,838
1954	.1	39.5	22.0	3.4	1.1	33.9	36,941,383
1955	.1	30.4	30.8	2.7	1.2	34.8	37,197,742
1956	.1	29.2	29.6	3.0	.6	37.5	38,948,121
1957	.1	32.1	29.3	3.2	6.3	29.0	38,164,915

[1] Includes Alaska.

TABLE 9.—Mine and refinery production of silver in the United States in 1957, by States and sources, in fine ounces of recoverable metal

State	Mine production							Refinery production [1]
	Placers	Dry ore	Copper ore	Lead ore	Zinc ore	Zinc-lead, zinc-copper, lead-copper, and zinc-lead-copper ores	Total	
Alaska	27,026	75		1,761			28,862	27,180
Arizona	4	32,362	[2] 4,091,973	40,695	1,405	1,112.884	[2] 5,279,323	5,250,000
California	7,235	56.059	[2] 138,128	30,287		290,579	[2] 522,288	525,530
Colorado	236	28,696	599,688	[3] 124,691	2,237	2,032,344	[3] 2,787,892	2,800,000
Idaho	485	10,331,123	18,228	237,345	59,064	[2] 4,421,175	[2] 15,067,420	15,000,000
Illinois								1,360
Kentucky						56	56	
Michigan			430,000				430,000	410,000
Missouri				[4] 183,427		([4])	183,427	230,000
Montana	77	467,406	2,480,760	29,107	2,243,989	336,889	5,558,228	5.860,000
Nevada	115	78.276	408,441	329.683	1,498	140,464	958,477	1,011,000
New Mexico		6,145	51,537	5,624	95,780	150,299	309.385	324,000
New York						[5] 65,625	[5] 65,625	64,000
North Carolina		586	11,761				12,347	11,800
Oregon	27	15,740	157				15,924	10,500
Pennsylvania [6]								12,500
South Dakota		134,737					134,737	132,610
Tennessee						54,407	54,407	53,700
Utah	1	677,517	2,871,126	226,583	4,195	2,419,042	6,198,464	6,556,250
Vermont			36,794				36,794	37,900
Virginia						([5])	([5])	1,740
Washington [7]	1	419,941	[8] 52,285	48		48,858	[8] 521,133	400,000
Wyoming		92	34				126	130
Total	35,207	12,248,755	11,190,912	1,209,251	2,408,168	11,072,622	38,164,915	38,720,200

[1] U. S. Bureau of the Mint.
[2] Includes gold recovered from tungsten ore.
[3] Includes gold recovered from fluorspar ore.
[4] A little silver recovered from lead-copper ore from 1 mine included with that from lead ore.
[5] Production in New York and Virginia combined.
[6] Included with Washington.
[7] Includes production from Pennsylvania.
[8] Includes silver recovered from magnetite-pyrite-chalcopyrite ores in Pennsylvania.

TABLE 10.—Silver produced in the United States from ore and old tailings in 1957, by States and methods of recovery, in terms of recoverable metal [1]

State	Total ore, old tailings, etc., treated (short tons)	Ore and old tailings to mills					Crude ore to smelters	
		Short tons	Recoverable in bullion		Concentrates smelted and recoverable metal			
			Amalgamation (fine ounces)	Cyanidation (fine ounces)	Concentrates (short tons)	Fine ounces	Short tons	Fine ounces
Alaska	11,626	11,571	58		4	17	55	1,761
Arizona	60,214,343	59,423,329	17	41,960	1,906,661	4,183,432	791,014	1,053,910
California	204,251	194,219	4,146	45,299	13,479	368,270	10,032	97,338
Colorado	1,110,892	1,069,343	2,920	6,558	151,499	2,125,637	41,549	652,541
Idaho	2,130,501	2,005,330	518		217,882	14,872,446	125,171	193,971
Montana	[2] 10,790,009	10,623,288	10	4,825	585,371	5,056,174	[2] 166,721	497,142
Nevada	11,769,834	11,647,126	138	5,403	283,008	300,701	122,708	652,120
New Mexico	8,077,655	7,974,647	2,294		286,288	297,702	103,008	9,389
Oregon	2,594	2,371	34		195	15,526	223	337
South Dakota	1,778,583	1,778,583	85,516	49,221				
Utah	[3] 31,728,191	31,515,590	47		926,537	5,511,807	212,601	686,609
Washington [4]								
Wyoming	2,069	2,000	36		25	56	69	34
Undistributed [5]	[6] 14,785,384	[6] 14,716,001	75	96,966	585,049	993,650	69,383	29,670
Total	142,605,932	140,963,398	95,809	250,232	4,955,998	33,725,418	1,642,534	3,874,822

[1] Missouri excluded.
[2] Includes 51,888 tons of zinc slag.
[3] Includes 25,220 tons of zinc slag.
[4] Included in "Undistributed."
[5] Includes Kentucky, Michigan, New York, North Carolina, Pennsylvania, Tennessee, Vermont, Virginia, and Washington.
[6] Excludes magnetite-pyrite-chalcopyrite ore from Pennsylvania.

TABLE 11.—Silver produced at amalgamation and cyanidation mills in the United States and percentage of silver recoverable from all sources, 1948–52 (average) and 1953–57 [1]

Year	Bullion and precipitates recoverable (fine ounces)		Silver from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1948–52 (average)	111,879	380,576	0.3	1.0	98.5	0.2
1953	98,399	129,538	.3	.3	99.3	.1
1954	95,941	208,581	.3	.6	99.0	.1
1955	90,647	643,983	.3	1.7	97.9	.1
1956	87,879	309,158	.2	.8	98.9	.1
1957	95,809	250,232	.2	.7	99.0	.1

[1] Includes Alaska.
[2] Both crude ores and concentrates.

TABLE 12.—Net industrial[1] consumption of silver in the United States, 1948–52 (average) and 1953–57, in thousand fine ounces

[U. S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1948–52 (average)	133, 659	32, 701	100, 958
1953	125, 389	19, 389	106, 000
1954	104, 629	18, 629	86, 000
1955	123, 535	22, 135	101, 400
1956	130, 000	30, 000	100, 000
1957	133, 742	38, 342	95, 400

[1] Including the arts.

CONSUMPTION AND USES

Industry and the Arts.—The United States consumed nearly half the world supply of industrial silver. According to data compiled by the United States Bureau of the Mint, domestic consumption of silver in the arts and industries declined 5 percent in 1957 to 95.4 million ounces. Domestic consumption is measured by the net amount of material issued by Government Mints and assay offices and private refiners and dealers for industrial, professional, and artistic use after deduction of secondary materials returned to monetary use and old jewelry, plate, film, and other scrap. United States consumption of silver continued to exceed its production by a wide margin.

The quantity of silver used for plated ware and for industrial applications declined owing to the business recession and lower production of consumer durable goods. Leading consumers continued to be the silverware, photographic, and electroplating industries. Use of silver in the electrical, electronic, chemical, and metal-joining fields continued to expand. Manufactured materials included contacts, wire, brazing and soldering alloys, and silver-clad equipment. Substantial quantities of silver were used in such regulating equipment as telephone relays and fluorescent-lamp controls, in electromagnetic counters, and in protective devices for motors and refrigerator thermostats. Medical and dental supplies and equipment continued to absorb considerable silver. New uses for silver in advanced weapons and other defense applications increased. World consumption of silver in the arts and industries was estimated at 209.3 million ounces,[4] about 13 million ounces less than world production.

Uses of silver in jewelry and the composition and mechanical properties of silver-jewelry alloys were described and tabulated in a trade journal.[5]

General Electric Co. developed a new subminiature, solid-electrolyte, 95-volt battery with a silver bromide electrolyte and a silver anode for high voltage-to-volume requirements and long storage or standby service. The company reports that the battery, when properly mounted, will withstand a wide range of temperatures and extreme shock and vibration. The battery was expected to be used widely in electronic devices.

[4] Work cited in footnote 3.
[5] Atkinson, Ralph H., Alloys for Precious Metal Jewelry: Metal Progress, vol. 72, No. 5, November 1957, pp. 107–111.

Silver-plated aluminum bus bars were made available commercially in 1957 by a process developed by Reynolds Metals Co. These bars provide substantial savings over equivalent copper bus bars and make connections practical by relatively simple soldering and brazing techniques, thus eliminating special contact surfaces ordinarily required for bolted connections.

Monetary.—A sharp rise of over 20 million ounces in silver used in United States coinage more than offset lower coinage requirements of Mexico and other countries except Canada. This rise accounted for virtually the entire increase in world coinage use, which in 1957 was estimated at 79.2 million ounces [6]—an increase of 18.1 million ounces over 1956.

TABLE 13.—United States monetary silver, in million ounces [1]

	1953	1954	1955	1956	1957
In Treasury:					
Securing silver certificates:					
Silver bullion	1,655.7	1,679.2	1,697.2	1,708.4	1,711.5
Silver dollars	215.2	207.0	196.1	182.8	169.4
Subsidiary coin	4.6	34.5	11.3	2.0	6.0
Free silver bullion	49.6	13.6	24.9	87.4	127.4
Total	1,925.1	1,934.3	1,929.5	1,980.6	2,014.3
Coinage in circulation:					
Silver dollars	164.9	172.5	182.0	195.1	208.3
Subsidiary coin	877.5	898.9	928.2	968.0	1,014.5
Total	1,042.4	1,071.4	1,110.2	1,163.1	1,222.8

[1] Compiled from circulation statements issued by the Treasury Department.

STOCKS

United States Treasury stocks comprising bullion and coin increased for the third successive year. The gain in 1957 was about 33.7 million ounces, as increases in silver bullion, subsidiary coin, and free-silver bullion more than offset decreases in silver dollars. Again, as in the 2 preceding years, free-silver stocks rose sharply in 1957 owing to the return of lend-lease silver from foreign countries. Silver coinage outside the Treasury, comprising silver dollars and subsidiary coin, increased 59.7 million ounces to 1,222.8 million ounces.

The historical and traditional role that silver has played in the monetary systems of the world, its strategic importance, and the need for a realistic program for its future use were discussed at the National Western Mining Conference.[7]

PRICES

United States Treasury policy, under existing silver laws, continued to be the major stabilizing force in the world silver market. The Treasury buying price for domestically mined silver, fixed by act of Congress July 31, 1946, at 90.5+ cents per fine troy ounce, remained unchanged throughout 1957. The selling price to domestic consumers, established under the act at 91 cents an ounce for delivery at United States mints or assay offices, also remained unchanged. This price at the San Francisco Mint was equivalent to 91⅜ cents at New York.

[6] Work cited in footnote 3.
[7] Groseclose, Elgin, A Look Ahead at Gold and Silver: Mines Mag., vol. 48, No. 8, August 1957, pp. 13–17.

The average New York open-market price was virtually the same in 1957 as in 1956. Prices fluctuated between a high of 91⅜ cents and a low of 89⅝ cents a troy ounce, 0.999 fine, almost the same spread as in 1956. The New York price quotations represent the prices paid by Handy & Harman in settlement for silver in unrefined silver-bearing materials and are one-fourth cent below the market price of refined bullion. When the open-market price is higher than the Treasury buying price, producers sell on the open market; when it is lower, they sell to the Treasury. Similarly, domestic consumers buy on the open market when the price is lower than the Treasury selling price and buy from the Treasury when the open-market price is higher. In 1957 about 7.2 million ounces, or nearly one-fifth of the domestic mine production of silver, was sold to the Treasury; the remainder was sold on the open market. Treasury sales of silver to domestic industry during the year were about 3.8 million ounces.

The London market price of silver per troy ounce, 0.999 fine, ranged from a high of 80½d. in January to a low of 77⅛d. in December, equivalent to about 93.69 and 90.14 cents, respectively, in United States currency and a slightly wider spread than the corresponding New York prices. The higher London prices reflected the premium obtained for silver exported from New York during periods of short supply as well as shipping charges.

FOREIGN TRADE [8]

Domestic imports of both refined and unrefined silver increased sharply for the second successive year, owing to lend-lease returns, which comprised about three-fourths of all imports. The return of lend-lease silver brought total imports, excluding United States and foreign coins, to 206.1 million ounces valued at $157.7 million. Lend-lease deliveries of approximately 152 million ounces left about 54 million ounces for market consumption—20 percent less than in 1956. Imports from Western Hemisphere countries, chiefly Canada, Mexico, Peru, and Bolivia, comprised over 90 percent of total imports outside of lend-lease returns. The value of net imports was 20 percent greater in 1957 than in 1956.

Exports of silver in 1957 increased 87 percent to 10.3 million ounces valued at $9.5 million. Nearly two-thirds of all exports went to the United Kingdom and West Germany. In addition, foreign and United States coins valued at $1.7 million were exported, chiefly to Canada.

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

TABLE 14.—Value of silver imported into and exported from the United States, 1948–52 (average) and 1953–57, in thousand dollars

[Bureau of the Census]

Year	Imports	Exports	Excess of imports over exports
1948–52 (average)	$85,044	$11,135	$73,909
1953	95,104	8,680	86,424
1954	79,699	4,523	75,176
1955	72,932	8,331	64,601
1956	129,068	7,049	122,019
1957	158,354	11,162	147,192

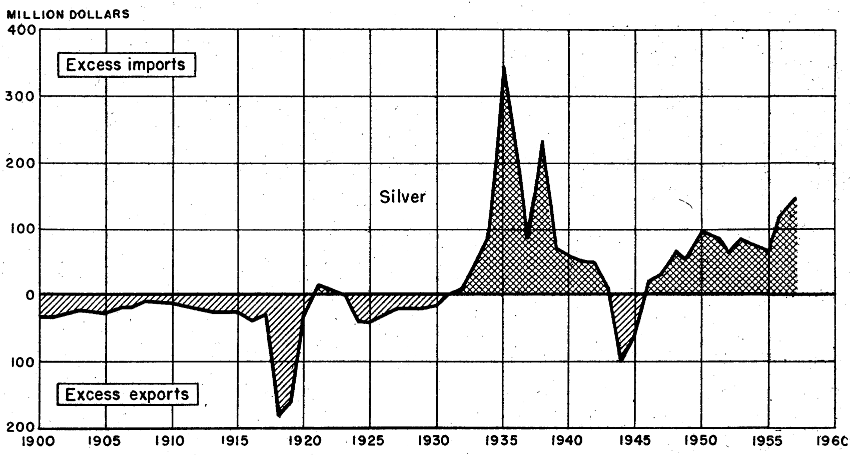

FIGURE 3.—Net imports or exports of silver, 1900–57.

TABLE 15.—Silver imported into the United States in 1957, by countries of origin

[Bureau of the Census]

Country of origin	Ore and base bullion		Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value		
North America:						
Bahamas					$11,071	
Bermuda					12,000	
Canada	7,483,875	$6,700,716	10,518,385	$9,528,207	343,119	$835
Cuba	252,728	219,180			301,400	
Dominican Republic					17,710	
El Salvador	156,580	134,229				
Guatemala	251,294	201,252				
Honduras	2,187,031	1,979,475				
Mexico	7,157,513	6,341,475	9,336,515	8,476,101		
Netherlands Antilles	5,800	5,500				
Nicaragua	224,759	190,179				
Panama	2,113	1,902				
Total	17,721,693	15,773,908	19,854,900	18,004,308	685,300	835
South America:						
Argentina	533,048	498,253				
Bolivia	3,510,746	3,129,315				
Brazil	787	746				
Chile	1,346,357	1,174,672				
Colombia	84,763	75,940				
Ecuador	53,138	47,552				
Peru	13,064,676	11,719,006				
Total	18,593,515	16,645,484				
Europe:						
Malta, Gozo, and Cyprus	25,881	22,775				
Netherlands	4,677,225	3,326,027				
Portugal	60,534	53,145				
United Kingdom	38,135	34,860	22,283,193	15,845,820	7,505	
Total	4,801,775	3,436,807	22,283,193	15,845,820	7,505	
Asia:						
India	40,227,780	28,606,132	49,276,901	35,041,205		
Korea, Republic of	22,559	20,330				
Pakistan	15,519,360	11,035,817	14,778,000	10,508,636		
Philippines	285,496	252,290				
Turkey	35,333	31,801				
Total	56,090,528	39,946,370	64,054,901	45,549,841		
Africa:						
Rhodesia and Nyasaland, Federation of	213,873	193,344				
Union of South Africa	847,908	769,208				
Total	1,061,781	962,552				
Oceania: Australia	1,656,613	1,495,019				
Grand total	99,925,905	78,260,140	106,192,994	79,399,969	692,805	835

TABLE 16.—Silver exported from the United States in 1957, by countries of destination

[Bureau of the Census]

Country of destination	Ore and base bullion		Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value		
North America:						
Bahamas					$75,300	
Canada			1,406,541	$1,285,725	6,450	$1,401,628
Cuba			29,910	29,067		5,985
Guatemala					100	
Haiti					36,000	
Mexico	1,280,849	$1,162,873	568	587		
Panama						1,772
Total	1,280,849	1,162,873	1,437,019	1,315,379	117,850	1,409,385
South America:						
Brazil			97,999	91,934		
Chile			2,245	2,023		
Colombia			320,199	294,974		
Venezuela			38,453	36,481		
Total			458,896	425,412		
Europe:						
France			109,083	99,763		
Germany, West			2,802,126	2,634,000		
Ireland					25,000	
United Kingdom	91,833	83,140	3,822,095	3,492,275		
Total	91,833	83,140	6,733,304	6,226,038	25,000	
Asia:						
Japan			16,067	14,568		
Thailand			253,188	231,352		
Turkey			28,200	25,525		
Total			297,455	271,445		
Africa: Liberia					126,000	
Grand total	1,372,682	1,246,013	8,926,674	8,238,274	268,850	1,409,385

LEND-LEASE SILVER

Lend-lease agreements executed during World War II provided for the return of silver supplied to foreign countries within 5 years after the cessation of hostilities, the date of which was marked by the signing of the Japanese Peace Treaty on April 28, 1952. Accordingly, April 28, 1957, became the repayment date. Except for Saudi Arabia and Ethiopia, which obtained 2-year extensions, most countries completed repayments on schedule.

Of an original obligation of 410.8 million ounces, about 258.4 million ounces was repaid in 1957, bringing the total amount repaid to 383.1 million ounces. Parts of the obligations of India and Pakistan that were not delivered were made available to the United States Government in the form of demonetized silver coin of these two countries. The following table shows, in million ounces, the original amounts, returns, and balances of the countries that received lend-lease silver.

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Country	Amount		
	Original	Returned as of Dec. 31, 1957	Due on Dec. 31, 1957
India and Pakistan	226.0	226.0	
United Kingdom	[1] 88.3	88.3	
Netherlands	56.7	56.7	
Saudi Arabia	22.3		22.3
Australia	11.8	11.8	
Ethiopia	5.4		5.4
Belgium	.3	.3	
Total	410.8	383.1	27.7

[1] Includes 0.2 million ounces to Fiji.

WORLD REVIEW

World output of silver increased 2 percent in 1957 to 229 million ounces, the highest level of output since 1942. Production gains in Mexico, Peru, and Australia more than offset lower output in the United States, Canada, and Bolivia. Western Hemisphere countries furnished about two-thirds of the world output.

World consumption of silver in the arts and industry and for coinage continued to exceed production by a substantial margin in 1957, reaching a total of about 289 million ounces,[9] a gain of 6 percent over 1956. For the third successive year increases in industrial consumption by West Germany and coinage requirements of the United States accounted for nearly all of the gain. In recent years demonetized coinage has furnished a substantial part of the world's supply of silver.

TABLE 17.—World production of silver, 1948–52 (average) and 1953–57, by countries,[1] in fine ounces [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	21,064,192	28,299,335	31,117,949	27,984,204	28,431,847	28,361,873
Central America and West Indies:						
Costa Rica [3]	909				80	
Cuba	[3] 179,987	[3] 167,895	164,235	259,440	284,202	[3] 252,728
Guatemala	220,480	458,481	283,811	343,111	533,179	528,436
Honduras	3,400,654	5,640,251	3,432,023	1,797,394	2,030,008	[3] 2,187,031
Nicaragua	197,287	252,697	218,148	268,316	258,521	230,081
Panama [3]	1,728	671		315	963	2,113
Salvador	336,035	348,328	256,772	230,054	161,476	172,305
Mexico	50,053,465	47,873,677	39,896,467	47,957,654	43,078,040	47,165,138
United States	39,245,864	37,735,500	35,584,800	36,469,610	38,739,400	38,720,200
Total	114,700,600	120,776,800	110,954,200	115,310,000	113,517,700	117,619,900
South America:						
Argentina	1,183,514	895,474	1,639,688	1,414,633	1,671,838	1,350,331
Bolivia (exports)	6,996,001	6,113,013	5,047,666	5,851,107	7,547,304	5,375,089
Brazil	20,580	211,938	126,449	140,113	171,524	[4] 200,000
Chile	1,042,893	1,644,575	1,489,029	1,714,535	1,821,918	1,555,867
Colombia	116,885	117,385	112,534	112,037	110,728	106,494
Ecuador	171,959	86,750	35,126	47,732	29,479	28,694
Peru	13,322,264	19,650,694	20,405,883	22,947,624	22,972,766	25,310,479
Total	22,854,100	28,719,800	28,856,400	32,227,800	34,325,600	33,927,000

See footnotes at end of table.

[9] Work cited in footnote 3.

TABLE 17.—World production of silver, 1948–52 (average) and 1953–57, by countries,[1] in fine ounces [2]—Continued

Country	1948–52 (average)	1953	1954	1955	1956	1957
Europe:						
Austria	4,958	5,144	5,787	3,537	1,286	1,350
Czechoslovakia [4]	1,606,400	1,608,000	1,608,000	1,608,000	1,608,000	1,608,000
Finland	152,412	235,794	239,459	224,573	318,453	373,592
France	642,590	675,519	555,951	628,065	234,695	307,997
Germany:						
East [4]	3,311,320	4,501,100	4,500,000	4,500,000	4,500,000	4,500,000
West	1,580,311	2,319,387	2,346,843	2,226,375	2,197,375	2,133,973
Greece	33,921	73,272	85,360	77,869	83,592	80,000
Hungary [4]	44,980	64,300	64,300	64,300	64,300	64,300
Italy	777,456	837,784	887,425	859,904	1,034,129	956,420
Norway	172,971	115,743	131,818	71,375	64,301	38,580
Poland [4]	88,180	96,500	96,500	96,500	96,500	96,500
Portugal	55,762	59,447	55,299	58,900	57,550	[4] 60,000
Rumania [4]	569,400	643,000	643,000	643,000	643,000	643,000
Spain	612,819	1,209,125	1,302,491	1,473,404	1,402,801	1,345,734
Sweden	1,379,312	1,571,464	2,215,604	2,397,738	2,562,382	2,511,847
U. S. S. R.[4]	20,800,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000
United Kingdom	21,120	28,914	26,497	29,706	27,878	[4] 30,000
Yugoslavia	2,283,584	3,048,019	2,829,394	2,983,589	2,760,013	2,589,742
Total [4]	34,140,000	42,100,000	42,600,000	42,900,000	42,700,000	42,300,000
Asia:						
Burma	185,430	672,403	1,278,289	1,537,895	1,365,154	1,526,810
China [4]	240,400	320,000	320,000	320,000	320,000	320,000
India	14,407	14,624	161,185	153,935	104,604	125,838
Japan	3,765,083	6,028,489	6,162,815	5,948,627	6,166,962	6,526,183
Korea, Republic of	17,173	52,213	50,252	79,605	196,409	277,346
Philippines	310,713	572,046	527,160	502,069	541,168	479,216
Saudi Arabia	99,052	150,626	63,681			
Taiwan	18,305	40,639	39,160	63,948	53,894	82,965
Total [4]	4,705,000	7,900,000	8,700,000	8,700,000	8,800,000	9,400,000
Africa:						
Algeria	22,261	48,200	57,900	61,100	[4] 60,000	[4] 60,000
Bechuanaland	130	463	292	189	215	35
Belgian Congo	4,267,503	4,961,631	4,550,166	4,076,457	3,791,891	3,044,868
Ghana (exports)	45,178	44,949	48,214	39,284	28,592	25,390
Kenya	5,503	21,758	1,325	1,770	54,689	23,051
Morocco: Southern Zone	1,107,569	2,054,175	1,906,057	2,324,000	2,250,000	2,411,250
Mozambique	223	209	44			
Nigeria	1,110	172	182	172	111	200
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [5]	180,749	492,813	403,661	412,191	601,985	569,949
Southern Rhodesia	82,507	84,566	81,657	76,837	76,870	74,179
South-West Africa	780,857	795,702	779,879	1,279,213	1,605,460	1,789,323
Swaziland	64				14	
Tanganyika (exports)	31,050	41,234	42,156	43,292	35,020	20,520
Tunisia	57,498	39,095	106,097	91,726	86,805	[4] 85,000
Uganda (exports)	32	55	85	70	52	
Union of South Africa	1,157,696	1,193,152	1,235,418	1,461,336	1,598,278	1,767,472
Total	7,739,900	9,780,000	9,213,000	9,868,000	10,190,000	9,871,000
Oceania:						
Australia	10,560,418	12,402,963	13,827,038	14,555,412	14,586,197	15,561,098
New Guinea	41,373	58,693	48,977	44,459	42,457	38,014
Fiji	29,477	19,328	17,794	20,421	24,302	24,946
New Zealand	169,834	75,888	33,049	27,930	950	1,279
Total	10,801,100	12,557,000	13,927,000	14,648,000	14,654,000	15,625,000
World total (estimate)	194,900,000	221,800,000	214,300,000	223,700,000	224,200,000	228,700,000

[1] Silver is also produced in Bulgaria, Cyprus, Hong Kong, Indonesia, Malaya, North Korea, Sarawak, and Sierra Leone, but production data are not available; estimates are included in total.
[2] This table incorporates a number of revisions of data published in previous Silver chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Imports into the United States.
[4] Estimate.
[5] Recovery from an accumulation of refinery slimes.

Australia.—Silver output in Australia increased for the eighth consecutive year in 1957, gaining about 7 percent over 1956. Part of the gain was attributed to increased output of ore at Mount Isa Mines in Queensland and resulted from expansion of production facilities. The ore reserve at this property increased to 20.7 million tons of silver-lead-zinc ore averaging 6 ounces of silver per ton.

Bolivia.—Silver exports from Bolivia, most of which went to the United States, declined nearly 29 percent in 1957 (to 5.4 million ounces) as a result of lower output of silver-bearing, base-metal ores.

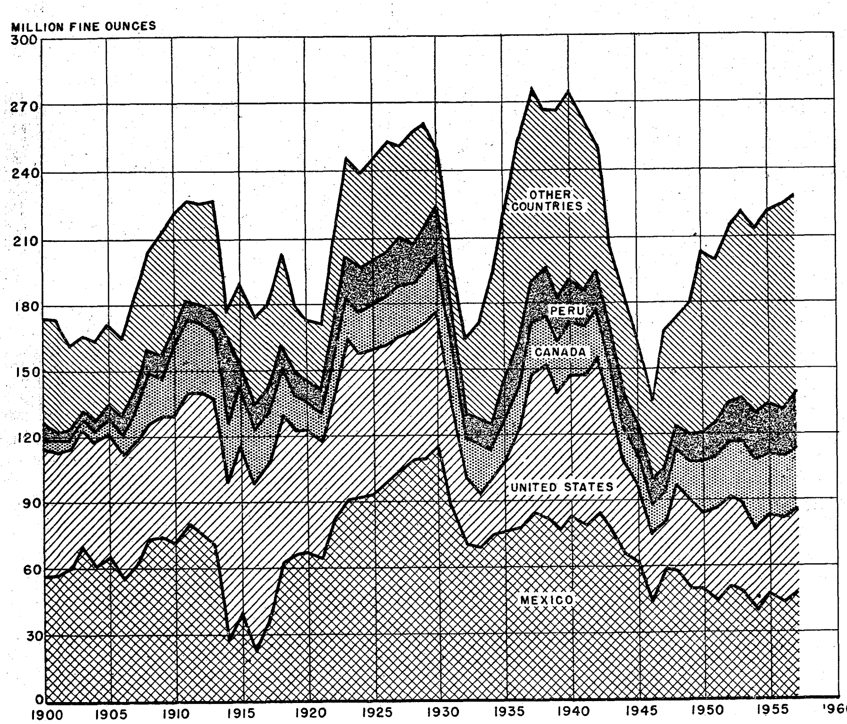

FIGURE 4.—World production of silver, 1900–57.

Canada.—Silver output in Canada, the third ranking producer, declined slightly in 1957 to 28.4 million ounces. Approximately 63 percent was exported to the United States during the year. About four-fifths percent of Canada's silver was recovered as a byproduct from smelting base-metal ores; silver and gold ores supplied the remainder.

British Columbia, Ontario, and the Yukon, the leading producers, supply more than three-fourths of the total output, respectively. The leading silver-producing mines were: United Keno Hill Mines in the Yukon and the Sullivan and Torbit mines in British Columbia. Consumption of silver in the arts and industry and for coinage was estimated at 11.4 million ounces in 1957 compared with 7.7 million ounces in 1956.[10] The gain was due chiefly to increased use in coinage.

[10] Fraser, D. B., Silver in Canada—1957: Canadian Min. Jour., vol. 79, No. 2, February 1958, p. 143.

Mexico.—Silver production in Mexico increased nearly 10 percent in 1957 to 47.1 million ounces, and this country continued to maintain its rank as the world's leading silver producer by a substantial margin. Of 37 million ounces of silver exported, 49 percent went to the United States and 39 percent to West Germany.

The Namiquipa silver-lead-zinc mines in Chihuahua have been worked intermittently since their discovery during the time of the Spaniards, but not until systematic diamond drilling was undertaken were large new ore bodies discovered and extensions of known ore bodies proved. Geology of the mineral deposits, ore development, and mining and milling methods were described and detailed engineering and cost data given in a recent technical journal.[11]

Peru.—Silver output in Peru, the leading silver-producing country in South America, increased for the ninth successive year in 1957 to an alltime high of 25.3 million ounces—a gain of 10 percent over 1956. Peru's silver was recovered chiefly as a coproduct or byproduct of base-metal ores. In 1957, 13.1 million ounces valued at $11.7 million was exported to the United States.

The Condoroma silver mine in southern Peru enlarged its milling capacity from 100 to 200 tons per day in June, 1957, thereby increasing the daily output of silver in Peru by about 2,000 ounces. San Juan de Lucanas, Cia. Minera Cailloma and Castrovirreyna Metal Mines Company continued to produce large quantities of silver. Cerro de Pasco was again the leading silver producing mine recovering about 50 percent of the country's total output of silver.

TECHNOLOGY

Excellent electrical and thermal properties, high resistance to corrosion, and ease of fabrication make silver very valuable for many uses. One author describes commercial grades, properties, and methods of fabricating fine silver.[12] A method of producing tough-adherent coatings of silver on light metals, such as aluminum and magnesium and their alloys, was developed by National Research Development Corp. of Great Britain. The process, which is especially suitable for coating the internal surfaces of tubes and complex cavities, was described in a trade journal.[13]

The use of noble metals as construction materials in chemical engineering has been restricted by their high initial cost. Where the high rate of corrosion or contamination of base metals adversely affects the purity of a product, use of noble metals often is economically justified. A recent article [14] discusses the use of silver in construction materials and cites several examples of its use in chemical equipment.

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11 Shefelbine, G. H., Silver-Lead-Zinc Mines at Namiquipa, Chihuahua, Mexico: Min. Eng., vol. 9, No. 10, October 1957, pp. 1090–1097.
12 Tietz, Edward E., Fine Silver: Materials and Methods, vol. 45, No. 1, January 1957, pp. 110–111.
13 Metals Industry (London), vol. 91, No. 22, Nov. 29, 1957, p. 462.
14 Warwick, I. J., Noble Metals in Chemical Engineering: Chem. Age (London), vol. 78, No. 1994, September 1957, pp. 501–502.

A patent was issued for a method of producing a silver catalyst [15] by applying ammoniacal silver nitrate solution to an inert carrier; the resulting catalyst contains 1.7 to 5.5 percent silver. A method of producing a silver catalyst by hot-spraying molten silver on copper fabric also was patented.[16]

A process for recovering silver from silver-bearing copper sulfide concentrate by treating the concentrate with ammonium carbonate and an oxygen-containing gas to separate a silver-rich fraction was patented.[17] Other significant articles pertaining to the technology of silver were published during the year.[18]

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15 Metzger, Floyd J., Silver Catalysts: U. S. Patent 2,805,207, Sept. 3, 1957.

16 Crum, John Patterson (assigned to D. Napier & Sons, Ltd., London, England), Method of Producing a Silver Catalyst: U. S. Patent 2,809,940, Oct. 15, 1957.

17 Abramson, Helmer A. (assigned to Calumet and Hecla, Inc.), Silver Recovery Method: U. S. Patent 2,807,533, Sept. 24, 1957.

18 Mead, H. W., and Bischenall, C. E., Diffusion of Gold and Au-Ag Alloys: Jour. Metals, vol. 9, No. 7, July 1957, pp. 874–877.

Visnes, Norman, Sand Filling at the Galena Mine: Min. Eng., vol. 9, No. 1, January 1957, p. 49–52.

Slag—Iron-Blast-Furnace

By Wallace W. Key[1]

CONTINUED demand by the construction industry resulted in another prosperous year for the iron-blast-furnace-slag industry in 1957. Increased activity in highway construction was reflected in the quantity of slag sold or used by processors. Development of the construction stage of the Federal Highway Program began to influence sales and offset to some extent the decline in home building.

The annual output of processed slag about equaled the total quantity of blast-furnace slag produced by the steel industry. Hence, the processing industry has reached the point where its output is limited by conditions in the steel industry. Concern was exhibited in the industry over the reduced quantity of slag produced per ton of iron, owing largely to use of higher grade blast-furnace feed. Increased importation of high-grade iron ore from South America and Labrador and expanding taconite-pellet production were contributing factors.

TABLE 1.—Iron-blast-furnace slag processed in the United States, 1948–52 (average) and 1953–57, 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
1948–52 (average)	19,961,382	$24,364,690	$1.22	1,086,913	$620,315	$0.57	2,065,636	$635,895	1,659,114	$3,699,394	$2.23
1953	24,021,624	32,677,948	1.36	845,311	581,083	.69	3,358,910	1,250,450	2,285,758	5,557,813	2.43
1954	22,372,477	31,228.295	1.40	808,548	537,207	.66	3,455,005	1,512,084	2,599,112	6,198,822	2.38
1955	24,900,883	36,131,615	1.45	809,461	596,540	.74	3,835,829	1,618,277	2,891,844	7,961,466	2.75
1956	25,572,388	38,476,208	1.50	2,096,479	1,280,037	.61	4,634,703	1,642,109	2,990,177	8,495,818	2.84
1957	25,414,327	40,202,524	1.58	2,166,678	1,408,412	.65	4,318,485	1,614,960	2,941,650	8,434,807	2.87

[1] Excludes value of slag used for hydraulic cement manufacture.

DOMESTIC PRODUCTION

Slag production in 1957 from iron blast furnaces remained at 39 million short tons, as in 1956. Processed slag for commercial use, as reported to the National Slag Association, also remained at 35 million short tons, about 90 percent of the total output in 1957.

[1] Commodity specialist.

Iron-blast-furnace slag was produced in 15 States; the bulk of it was processed in the steel centers of Pennsylvania, Ohio, and Alabama. Ohio continued to lead the other States in sales values, but Pennsylvania led in tonnage in 1957. California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia continued to gain in total output.

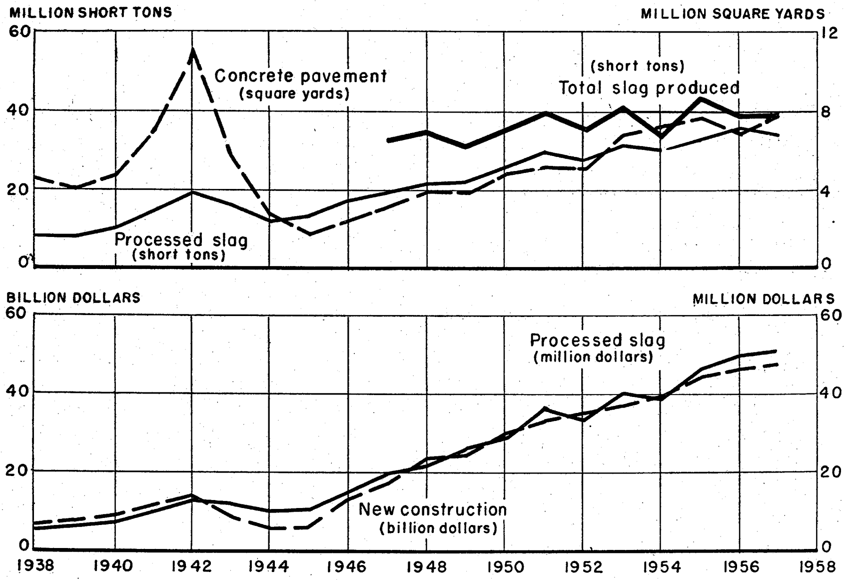

FIGURE 1.—Production of iron-blast-furnace slag compared with yards of concrete pavement (contract awards), monthly average, and value of new construction compared with value of processed slag, 1938–57.

TABLE 2.—Iron-blast-furnace slag processed in the United States, 1956–57, by States

[National Slag Association]

	Screened, air-cooled			All types		
	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total	
1956						
Alabama	4,884,371	19	$6,535,053	5,772,135	16	$8,099,533
Ohio	6,276,941	25	10,338,396	8,059,041	23	13,957,713
Pennsylvania	5,667,320	22	8,965,090	8,010,187	23	11,022,324
Other States [1]	8,743,756	34	12,637,669	13,452,384	38	16,814,602
Total	25,572,388	100	38,476,208	35,293,747	100	49,894,172
1957						
Alabama	4,067,930	16	6,025,080	4,849,231	14	7,397,871
Ohio	6,182,155	24	10,715,137	8,122,741	23	14,201,925
Pennsylvania	6,015,458	24	9,875,976	8,232,635	24	11,799,593
Other States [1]	9,148,784	36	13,586,331	13,636,533	39	18,261,313
Total	25,414,327	100	40,202,524	34,841,140	100	51,660,702

[1] California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia.

The national average showed that slightly less than 1 ton of slag was produced for every 2 tons of iron. Forty-three companies operated 63 air-cooled plants, 19 granulating plants, and 21 expanded-slag plants in the United States in 1957. Two air-cooled-slag plants closed in 1957.

Recovery of Iron.—Recovery of iron by magnetic and handpicking methods for reuse in blast furnaces continued to be an important function of the slag industry. In 1957, 387,381 tons of iron slag (about 60 percent iron), representing more than 1 percent of the slag processed, was returned to the furnaces, a 6-percent decrease from 1956.

Employment.—In all, 2,068 plant and yard employees were reported by the slag industry in 1957 compared with 2,072 in 1956. The man-hours worked in 1957 totaled 4,765,017, representing a slight decrease under the number reported in 1956.

Methods of Transportation.—As in past years, virtually the entire tonnage of processed slag in 1957 was shipped by truck and rail. Waterways played a minor but locally important role. Truck shipments increased from 64 percent of the national total in 1956 to 66 percent in 1957.

TABLE 3.—Shipments of iron-blast-furnace slag in the United States, 1956–57, by method of transportation

[National Slag Association]

Method of transportation	1956		1957	
	Short tons	Percent of total	Short tons	Percent of total
Rail	11,930,598	34	10,528,566	32
Truck	22,494,740	64	21,682,121	66
Waterway	868,409	2	751,791	2
Total shipments	35,293,747	100	32,962,478	100
Interplant handling [1]			1,878,662	
Total processed	35,293,747		34,841,140	

[1] Confined mainly to granulated slag used in manufacturing cement.

CONSUMPTION AND USES

Blast-furnace slag, when processed by crushing and selective screening, is a mineral aggregate that makes an important contribution to the special demands of the construction industry. Screened, air-cooled slag—the major type produced by the industry—constituted 73 percent of the total output of processed slag in 1957. The remainder was divided among the other types as follows: Unscreened, air-cooled, 6 percent; granulated, 12 percent; and expanded, 9 percent.

A new plant was scheduled to begin processing slag for roofing and highway purposes in Virginia.

Screened, Air-Cooled Slag.—This product results when molten slag is deposited in pits or banks for solidification under atmospheric conditions. Screened, air-cooled slag consumed in 1957 decreased about 1 percent; it was used mainly as aggregate in portland and bituminous concrete, for highway and airport construction, and as railroad ballast. These uses consumed about 92 percent of the total tonnage. Its use as railroad ballast, sewage trickling filter medium,

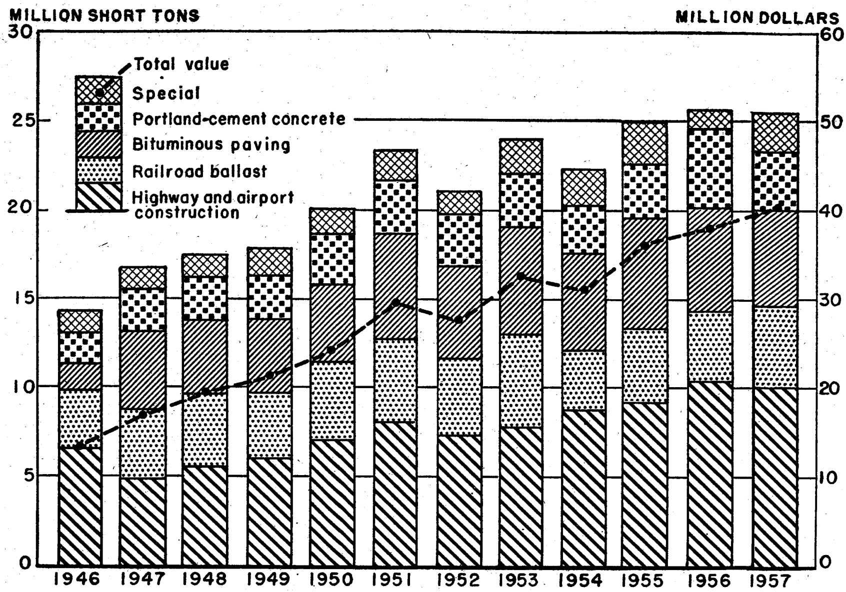

FIGURE 2.—Consumption and value of air-cooled, iron-blast-furnace slag sold or used in the United States, 1946–57.

and roofing granules substantially increased in 1957. Consumption decreased principally for use in manufacturing cement and as an aggregate in bituminous-concrete block. Other important uses for this material were in manufacturing mineral wool and glass and as road fill (parking lots and driveways).

Unscreened, Air-Cooled Slag.—In 1957 the quantity of unscreened, air-cooled slag processed totaled 2.2 million short tons valued at $1 million, increases of 3 and 10 percent, respectively compared with 1956. About 61 percent of this material was used as aggregate in highway and airport construction.

Granulated Slag.—The consumption of granulated slag in 1957 totaled 4 million short tons—a decrease of 7 percent under 1956. Of this quantity, 45 percent was used in base and insulating courses for highways and as fill; 43 percent was used in manufacturing hydraulic cement; and the remainder included slag for concrete-block manufacture, agricultural slag, and other purposes. Utilization of granulated slag decreased for all purposes except as base and subgrade aggregate in highway construction and miscellaneous uses.

Expanded Slag.—This cellular product results from applying a limited quantity of water to molten slag—less than that required for granulation. Several commercially successful methods of expanding slag are employed. Consumption of expanded slag totaled 3 million short tons valued at $8 million, slight decreases in both tonnage and value compared with the 1956 figures. The bulk of this material was used for lightweight concrete block and aggregate in lightweight concrete.

TABLE 4.—Air-cooled, iron-blast-furnace slag sold or used by processors in the United States, 1956–57, by uses

[National Slag Association]

Use	Screened		Unscreened	
	Short tons	Value	Short tons	Value
1956				
Aggregate in—				
Portland-cement concrete construction	3, 445, 351	$5, 572, 435		
Bituminous construction (all types)	5, 922, 811	9, 451, 914		
Highway and airport construction [1]	10, 283, 258	15, 557, 619	1, 261, 151	$1, 013, 755
Manufacture of concrete block	703, 744	1, 033, 091		
Railroad ballast	3, 871, 258	4, 484, 346		
Mineral wool	523, 822	795, 431		
Roofing (cover material and granules)	393, 722	891, 333		
Sewage trickling filter medium	39, 383	79, 176		
Agricultural slag, liming	6, 359	10, 429		
Other uses	382, 680	600, 434	835, 328	266, 282
Total	25, 572, 388	38, 476, 208	2, 096, 479	1, 280, 037
1957				
Aggregate in—				
Portland-cement concrete construction	3, 266, 947	5, 712, 873		
Bituminous construction (all types)	5, 465, 121	9, 161, 592		
Highway and airport construction [1]	10, 153, 593	16, 464, 868	1, 332, 262	1, 174, 991
Manufacture of concrete block	632, 615	970, 561		
Railroad ballast	4, 566, 405	5, 243, 617		
Mineral wool	476, 019	765, 448		
Roofing (cover material and granules)	421, 645	1, 136, 181		
Sewage trickling filter medium	72, 884	130, 912		
Agricultural slag, liming	6, 651	11, 321		
Other uses	352, 447	605, 151	834, 416	233, 421
Total	25, 414, 327	40, 202, 524	2, 166, 678	1, 408, 412

[1] Other than in portland-cement concrete and bituminous construction.

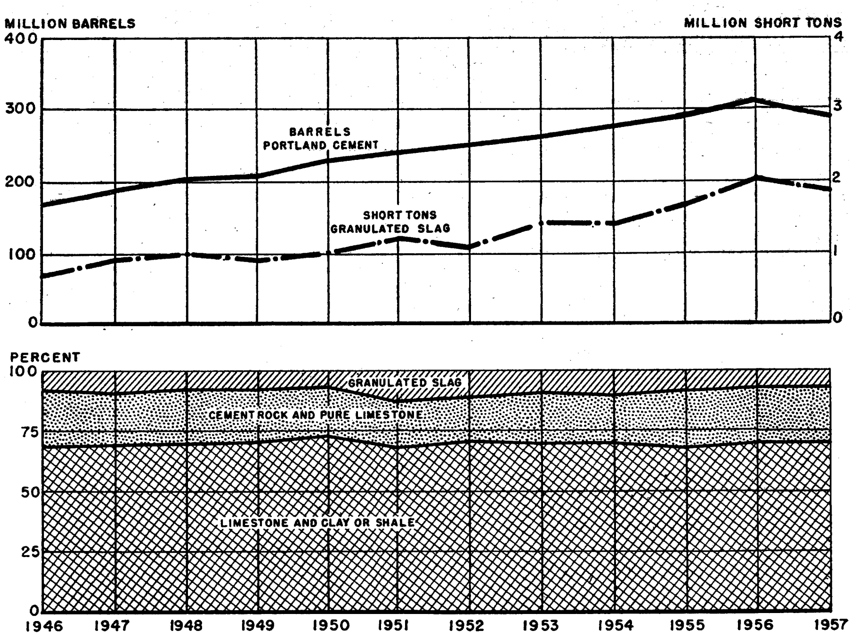

FIGURE 3.—Granulated slag used in manufacturing cement compared with barrels of portland-cement shipments and percentages of raw materials used in manufacturing portland cement, 1946–57.

TABLE 5.—Granulated and expanded iron-blast-furnace slag sold or used by processors in the United States, 1956–57, by uses

[National Slag Association]

Use	Granulated		Expanded	
	Short tons	Value	Short tons	Value
1956				
Highway construction (base and subgrade)	1,004,793	$763,090		
Fill (road, etc.)	886,197	313,207		
Agricultural slag, liming	70,684	102,313		
Manufacture of hydraulic cement	2,030,607	(1)		
Aggregate for concrete-block manufacture	372,102	287,532	2,672,189	$7,601,940
Aggregate in lightweight concrete	63,460	107,882	95,997	280,759
Other uses	206,860	68,085	221,991	613,119
Total	4,634,703	[2] 1,642,109	2,990,177	8,495,818
1957				
Highway construction (base and subgrade)	1,306,800	930,649		
Fill (road, etc.)	641,022	206,384		
Agricultural slag, liming	61,992	95,827		
Manufacture of hydraulic cement	1,877,290	(1)		
Aggregate for concrete-block manufacture	169,216	196,419	2,825,331	8,048,276
Aggregate in lightweight concrete			83,538	242,859
Other uses	262,165	185,681	32,781	143,672
Total	4,318,485	[2] 1,614,960	2,941,650	8,434,807

[1] Data not available. [2] Excludes value of slag used for hydraulic-cement manufacture.

PRICES

The average unit values of slag in 1957 varied from $0.28 to $4.38 per ton. Values for screened, air-cooled slag ranged from $1.15 per

TABLE 6.—Average value per short ton of iron-blast-furnace slag sold or used by processors in the United States, 1956–57, by uses

[National Slag Association]

Use	Air-cooled		Granulated	Expanded
	Screened	Unscreened		
1956				
Aggregate in—				
Portland-cement concrete construction	$1.62		[1] $1.70	[1] $2.92
Bituminous construction (all types)	1.60			
Highway and airport construction [2]	1.51	$0.80	[3] .76	
Manufacture of concrete block	1.47		.77	2.84
Railroad ballast	1.16			
Mineral wool	1.52			
Roofing (cover material and granules)	2.26			
Sewage trickling filter medium	2.01			
Agricultural slag, liming	1.64		1.45	
Road fill, etc.			.35	
Other uses	1.57	.32	.33	2.76
1957				
Aggregate in—				
Portland-cement concrete construction	1.75			[1] 2.91
Bituminous construction (all types)	1.68			
Highway and airport construction [2]	1.62	.88	[3] .71	
Manufacture of concrete block	1.53		1.16	2.85
Railroad ballast	1.15			
Mineral wool	1.61			
Roofing (cover material and granules)	2.69			
Sewage trickling filter medium	1.80			
Agricultural slag, liming	1.70		1.55	
Fill (road, etc.)			.32	
Other uses	1.72	.28	.71	4.38

[1] Lightweight concrete. [2] Other than in portland-cement and bituminous construction.
[3] Highway construction for base and subgrade material.

short ton for railroad ballast to $2.69 for slag used in the roofing industry; for most products the average values were slightly higher than in 1956. The average value of unscreened, air-cooled slag used in highway and airport construction was $0.88 per short ton. Among the use classifications of granulated slag, the average value of slag used in concrete block increased from $0.77 to $1.16 per short ton; average values for other uses were irregularly a few cents higher or lower than in 1956.

Producers indicated that increases in price resulted from increases in wages, costs of equipment, supplies, and from market conditions.

TECHNOLOGY

In about half a century, through technology, iron-blast-furnace slag grew from a liability to a half-million-dollar yearly asset. In 1957 technical and processing methods continued to develop.

Production Methods and Equipment.—A German article reviewed the various methods of slag production in Europe and the United States and the attributes and uses of the different products.[2]

The effect of crusher design on the quality of the crushed slag was discussed, and the interrelation of particle shape, density, and ability to withstand pressure was mentioned in an article.[3]

Cements.—Results of experimentation on concrete made from blast-furnace slag and fly ash mixed in variable proportions were reported in a French publication.[4] In France the influences of decreasing temperature on setting time of slag cements were studied.[5]

Steam-hardened concrete made from blast-furnace slag and fly ash ground together was the subject of a patent.[6]

A Soviet publication reported producing ash-slag cements by wet-grinding a mixture of blast-furnace slags, boiler ash, and lime.[7]

A method of producing an improved flue-dust sinter by adding granulated slag was patented.[8]

A series of three articles indicates how the addition of activators, such as portland-cement clinker, to cement made from granulated blast-furnace slag affects the hardness of the final product.[9]

The U. S. S. R. has developed a process for enriching portland-cement clinker from blast-furnace slag by adding limestone to the molten slag. To insure thorough disintegration of the limestone particles and its mixing with the melt, the mixture is treated with ultrasonic waves.[10]

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2 Ruopp, Walter, [Production and Utilization of Expanded Slag]: Stahl u. Eisen (trans. from German publication by the Nat. Slag Assoc.), vol. 77, No. 1, 1957, p. 17.

3 Kahlhofer, H., Send, A., and Kaiser, H., [Classification of Particle Shape in Washed and Crushed Blast-Furnace Slag]: Stahl u. Eisen, vol. 76, 1956, pp. 957–964; Ceram. Soc. Abs., vol. 40, No. 10, October 1957, p. 242.

4 Nicol, A. (Nat. School Mines, Paris), [The Mixture of Slag and Fly Ash High in Calcium Sulfate and Low in Lime]: Rev. mat. construc. et trav. pub., No. 501, 1957, pp. 157–164; Chem. Abs., vol. 51, No. 22, Nov. 25, 1957, p. 18536.

5 Blondiau, Leon, [Influence of Decreasing Temperature on the Setting Time of Cements, Especially on Slag-Base Cements]: Rev. mat. construc. et trav. pub., C, No. 500, 1957, pp. 141–146; Chem. Abs., vol. 51, No. 22, Nov. 25, 1957, p. 18538.

6 Carlsson, B. O., and Eisner, F. F. (assigned to Skovde Gasbetong Aktiebolag, Skovde, Sweden), Manufacture of Building Materials of the Concrete Type: U. S. Patent 2,803,556, Aug. 20, 1957.

7 Kristi, S., [Production of Ash-Slag Cements]: Prom. Kooperatsiya, No. 2, 1955, pp. 19–22; Chem. Abs., vol. 51, No. 22, Nov. 25, 1957, p. 18536.

8 Carney, D. J. (assigned to United States Steel Corp., a corporation of New Jersey), Flue-Dust Sinter and Method of Manufacture: U. S. Patent 2,780,536, Feb. 5, 1957.

9 Tanaka, Taro, From Blast-Furnace Slag to Cement: Rock Products, vol. 60, No. 3, March 1957, p 100, 102, 104, 106; No. 4, April 1957, pp. 107, 111, 114, 117; No. 10, October 1957, pp. 163–164, 166, 196.

10 Orinskii, N. V., and others, [Portland-Cement Clinker From Enriched Molten Blast-Furnace Slag] U. S. S. R., July 25, 1957, pp. 106, 149; Chem. Abs., vol. 51, No. 22, Nov. 25, 1957, p. 18542.

Controversy about the harmfulness of magnesia in slags used in cement blends continued. The maximum proportion of magnesia permitted in most instances has been 5 percent, but tests indicated that higher percentages may be used.[11]

Poland experimented with the use of sodium chloride and blast-furnace slags in cements; salt is considered advisable when cement must be set at low temperatures.[12]

Portland blast-furnace-slag cements, blast-furnace slags and the portland-cement clinkers used in their manufacture, from each cement mill using slag in the United States were analyzed by the United States Army Corps of Engineers. Results indicated that the then current Federal ASTM specifications provided adequate assurance of performance at least equal to type I portland cements by applicable specifications. Mortar-bar tests suggested that slag in the cement acted to keep expansion resulting from alkali-aggregate reaction from becoming excessive, even when a highly reactive aggregate is used.[13]

Metal Recovery.—An article described a magnetic separator and heavy-duty cleaning equipment that reportedly can handle 450 tons per hour and recover more iron than is possible with other types of separators.[14]

Miscellaneous.—British scientists have developed a process of determining the quantity of red-hot molten slag by using radioactive isotopes of barium and lanthanum. The isotopes were added to the slag mass in known quantity and spread throughout the melt. When a small sample was drawn off, the total mass was computed by measurable dilution of the radioisotope by the slag. To check their process, the researchers had a special run of about 30 tons of slag cooled, crushed, and weighed by machine. The isotope process showed an accuracy of plus or minus 1 percent.[15]

It has been reported that, when slag is used as the main constituent in cement, the heat required for clinkering is reduced considerably.[16]

Blast-furnace slag was mentioned in two separate patents by the same inventors as suitable material for producing permeable concrete for cementing oil wells.[17]

A patent was issued on a method for producing hydraulic cement. Granulated blast-furnace slag is wet-ground and quickly dried with hot carbon dioxide. Particles collected are ready for use with a mixture of portland cement. The powder may be stored for long periods without appreciable deterioration.[18]

The Seailles process for recovering alumina from blast-furnace slag was described.[19]

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[11] Rock Products, vol. 60, No. 10, October 1957, pp. 77, 80.

[12] Roszak, Wojciech, [Plastic Slag Cement]: Zement Wapno-Gips, vol. 13 (22), 1957, pp. 141–148; Chem. Abs., vol. 51, No. 21, Nov. 10, 1957, pp. 17, 133.

[13] Mather, Bryant, Laboratory Tests of Portland Blast-Furnace-Slag Cements: Am. Concrete Inst. Jour., vol. 29, No. 3, September 1957, pp. 205–232.

[14] Fritz, Lawrence J., Methods for Reclaiming and Processing Scrap From Steel-Plant Slags and Refuse: Iron and Steel Eng., vol. 34, No. 4, April 1957, pp. 95–97.

[15] Rock Products, vol. 60, No. 11, November 1957, p. 11.

[16] Eigne, Hans, [Use of Blast-Furnace Slag in Cement Manufacture]: Tonind.-Ztg. u. Keram. Rundschau, vol. 81 (3/4), 1957, pp. 39–40; Ceram. Soc. abs., vol. 40, No. 9, September 1957, p. 198.

[17] Mangold, G. B., Dyer, J. A., and Hart, J. T. (assigned to Petroleum Engineering Associates, Inc., Pasadena, Calif.), Well Completion With Permeable Concrete: U. S. Patent 2,786,531, Mar. 26, 1957; U. S. Patent 2,793,957, May 28, 1957.

[18] Trief, V. (by C. O. E. Trief, as administratrix), Method for Producing a Hydraulic Binder in Powder Form: U. S. Patent 2,819,172, Jan. 7, 1958.

[19] Vorwerk, O., Huttemann, O., Mintrop, R., and Roederer, G., [Recovery of Alumina From Blast-Furnace Slag for the Aluminum Industry]: Stahl u. Eisen, vol. 76, 1956, pp. 1628–1634; Ceram. Soc. Abs., vol. 40, No. 10, October 1957, p. 237.

An improved apparatus for recovering sulfur from blast-furnace slag was patented. Provision is made for a long contact time between air and slag.[20]

Processing.—A method of regulating slag flow to an apparatus used to produce foamed blast-furnace slag was patented. The invention is reportedly an improvement on the slag-feed control described in the patentee's United States Patent 2,702,407. This process retains iron from the slag in a settling chamber.[21]

Aggregates.—A patent was issued for a method said to produce a "plaster aggregate" from blast-furnace slag that would be competitive with vermiculite and perlite.[22]

A rapid method for determining frost resistance of slag and other aggregates was reported in a German article. Air is removed from the sample by immersion in ice water. The sample then is placed in brine at minus 6° F., and examined 2 hours later. It remains another 2 days in the wet frost if no damage becomes visible to the shape, surface, and structure.[23]

A Soviet publication reported test results of granulated blast-furnace slag used as an addition to natural fine-grained sand in concrete.[24]

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[20] Sconberger, F. P., Apparatus for Recovering Sulfur From Blast-Furnace Slag: U. S. Patent 2,794,712, June 4, 1957.

[21] Kinney, S. P., and Osborne, F., Iron Retention and Slag Regulating Pit: U. S. Patent 2,809,028, Oct. 8, 1957.

[22] Gallai-Hatchard, Marcel, Production of Foamed Slag and Like Material of Light Weight: U. S. Patent 2,778,160, Jan. 22, 1957.

[23] Pfeifer, Heinrich, [Rapid Method for Determining Frost Resistance of Road Materials]: Strasse u. Autobahn, vol. 7, No. 6, June 1956, pp. 203–216.

[24] Leshchinskii, M. Yu, [Evaluation of Granulated Slag as an Enriching Addition to Natural Sands in Cement-Concrete]: Zavodskaya Laboratoriya (in Russian), vol. 22 (6), 1956, pp. 698–700; Jour. Iron and Steel Ind. (abs.), vol. 187, No. 1, September 1957, p. 61.

Slate

By D. O. Kennedy [1] and Nan C. Jensen [2]

SLATE PRODUCTION in the United States in 1957 decreased for the third consecutive year. Sales of slate millstock and flagstones increased 10 percent in value, but those of all other product groupings declined.

Crushed products (granules and flour) constituted 81 percent of the total slate sold in 1957, but the value of crushed products was only 40 percent of the total value of sales.

TABLE 1.—Salient statistics of the slate industry in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Dimension slate:						
Thousand short tons	152	153	152	141	119	120
Value (thousand dollars)	7,087	6,685	6,349	6,582	6,802	6,620
Crushed slate:						
Thousand short tons	654	546	609	619	526	512
Value (thousand dollars)	6,380	5,953	6,612	6,332	4,864	4,409
Total slate:						
Thousand short tons	806	699	761	760	645	632
Value (thousand dollars)	13,467	12,638	12,961	12,914	11,666	11,029
Imported for consumption:						
Value (thousand dollars)	124	224	145	149	248	288
Exported:						
Value (thousand dollars)	526	364	421	392	331	282

DOMESTIC PRODUCTION

Slate was produced in nine States during 1957. The production from 4 States—Pennsylvania, Vermont, Virginia, and New York—amounted to over 60 percent of the total quantity and 85 percent of the total value of slate produced in the United States.

The one operator in Maine produced electrical slate and flagging. Production in that State for 1957 decreased 23 percent in value compared with 1956.

New York production consisted almost entirely of flagging, granules, and flour. Decreased production of granules and flour resulted in an overall decline of 9 percent in quantity for the State in 1957 compared with 1956, but value increased 2 percent. The number of operators increased from 10 to 14.

Production was reported in Pennsylvania from 15 operators in 1957 compared with 16 in 1956. Production declined 9 percent in quantity and 4 percent in value. Production consisted of roofing, flagging, and the full range of millstock; one operator shipped granules and flour

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[2] Statistical assistant.

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and another flour only. Production of roofing slate declined 18 percent, blackboards and bulletin boards 12, and billiard-table tops 19, but electrical, structural, and sanitary products increased 8 percent.

Production in Vermont in 1957 declined 12 percent in value compared with 1956. Sales of millstock and flagging increased, but the

TABLE 2.—The slate industry in the United States, 1956–57

Domestic production (sales by producers)	1956			1957				
	Quantity		Value	Quantity		Value	Percent of change in—	
	Unit of measurement	Approximate short tons		Unit of measurement	Approximate short tons		Quantity (unit as reported)	Value
Roofing slate	*Squares* 107,054	40,337	$2,588,971	*Squares* 85,086	32,705	$2,002,857	−21	−23
Millstock:								
Electrical, structural, and sanitary slate [1]	*Sq. ft.* 2,024,759	15,916	2,058,604	*Sq. ft.* 2,309,531	18,871	2,147,969	+14	+4
Blackboards and bulletin boards [2]	1,393,240	3,493	985,602	1,222,939	3,209	1,013,595	−12	+3
Billiard-table tops	98,511	742	69,949	81,050	619	65,397	−18	−7
Total millstock	3,516,510	20,151	3,114,155	3,613,520	22,699	3,226,961	+3	+4
Flagstones, etc.[3]	10,013,736	58,542	1,098,910	11,432,395	64,962	1,389,710	+14	+26
Total slate as dimension stone	----------	119,030	6,802,036	----------	120,366	6,619,528	+1	−3
Granules, flour, and other [4]	----------	526,449	4,863,488	----------	511,420	4,409,516	−3	−9
Grand total	----------	645,479	11,665,524	----------	631,786	11,029,044	−2	−5

[1] Includes a small quantity of slate used for grave vaults and covers.
[2] Includes a small quantity of school slates.
[3] Includes slate used for walkways, stepping stones, and miscellaneous uses.
[4] Includes crushed slate used for lightweight aggregate.

TABLE 3.—Slate sold by producers in the United States, 1948–52 (average) and 1953–57, by States and uses

	Operators	Roofing		Millstock		Other uses (value) [1]	Total value
		Squares (100 square feet)	Value	Square feet	Value		
1948–52 (average)	81	189,694	$3,969,877	2,871,418	$1,927,076	$7,569,779	$13,466,732
1953	68	142,292	3,005,649	2,940,527	2,220,504	7,412,312	12,638,465
1954	57	117,729	2,401,087	3,195,737	2,378,323	8,181,204	12,960,614
1955	55	121,480	2,568,213	3,376,286	2,747,215	7,598,349	12,913,777
1956	55	107,054	2,588,971	3,516,510	3,114,155	5,962,398	11,665,524
1957							
New York	14	32	2,554	----------	----------	958,023	960,577
Pennsylvania	15	46,429	973,767	2,402,168	2,042,798	988,809	4,005,374
Vermont	17	(2)	(2)	(2)	(2)	(2)	3,269,370
Virginia	5	(2)	(2)	----------	----------	(2)	1,002,470
Other States [3]	9	38,625	1,026,536	1,211,352	1,184,163	3,852,394	1,791,253
Total	60	85,086	2,002,857	3,613,520	3,226,961	5,799,226	11,029,044

[1] Flagging and similar products, granules, flour, and aggregates.
[2] Included with "Other States" for this use.
[3] Includes the following States to avoid disclosing individual company confidential data: Maine and North Carolina, 1 operator each; Arkansas and Georgia, 2 operators each; and California, 3 operators.

TABLE 4.—Slate sold by producers in Pennsylvania, 1948–52 (average) and 1953–57, by uses

Year	Operators	Roofing slate		Millstock	
		Squares (100 square feet)	Value	Electrical, structural, and sanitary [1] Square feet	Electrical, structural, and sanitary [1] Value
1948–52 (average)	24	122,278	$2,371,924	1,304,549	$546,215
1953	18	86,116	1,688,167	1,211,381	709,906
1954	17	77,819	1,487,870	1,093,590	735,172
1955	17	72,638	1,458,594	1,423,812	1,055,195
1956	16	56,924	1,217,404	1,019,678	950,456
1957	15	46,429	973,767	1,102,714	967,747

Year	Millstock—Continued				Other uses (value)	Total value
	Blackboards and bulletin boards [2] Square feet	Blackboards and bulletin boards [2] Value	Billiard-table tops Square feet	Billiard-table tops Value		
1948–52 (average)	1,367,492	$656,490	169,366	$103,721	$1,452,116	$5,130,466
1953	1,080,034	699,098	71,851	43,316	1,279,125	4,419,612
1954	1,295,911	808,872	116,338	72,937	1,314,588	4,419,439
1955	970,716	603,288	100,939	64,406	1,239,815	4,421,298
1956	1,393,240	985,602	94,101	64,805	975,292	4,193,559
1957	1,222,939	1,013,595	76,515	61,456	988,809	4,005,374

[1] Includes a small quantity of slate for vaults and covers.
[2] Includes a small quantity of school slates.

quantity of roofing slate, granules, and flour sold was 23 percent lower than in 1956. The number of operators remained 17.

As in previous years, the principal output of the Virginia quarries was roofing slate and granules. Total slate sales declined 3 percent in value compared with 1956.

Production in California consisted of flagging, granules, and flour, but granules, flour, and crushed slate for asphalt filler and lightweight aggregates were produced in Arkansas and Georgia. The total production of these 3 States increased 8 percent in quantity but decreased 2 percent in value.

Because of the establishment of a slate-quarrying industry at Mount Gilead, Davidson County, North Carolina joined the ranks of slate-producing States. A dark, blue-gray, fine-grained slate was produced for walks, floors, stair treads, window sills, and other structural trim. In a mill equipped with a diamond saw the stone was cut to stock sizes or to special dimensions specified by the trade. Most of it had a split-face finish, but a sand-rubbed or hone finish was furnished if required.

CONSUMPTION AND USES

Consumption of roofing slate, slate billiard-table tops, granules, and flour declined in 1957. As indicated in figure 1, the decline in sales of roofing slate that has been in progress during recent years was accelerated by the continued recession in new residential building in 1957. Roofing slate had strong competition from alternate roofing products. The consumption of total millstock slate increased moderately since nonresidential building, the field in which millstock slate is most widely used, increased. This condition is also shown graphically in figure 1.

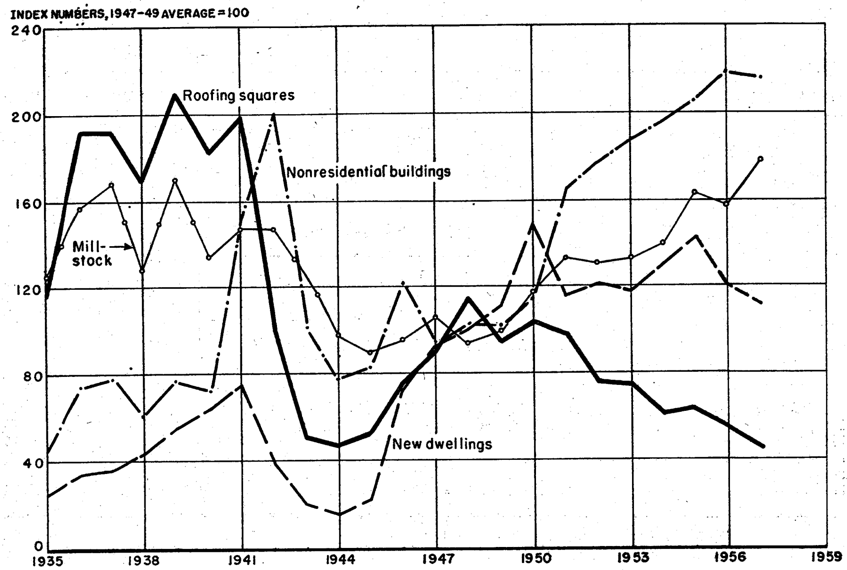

FIGURE 1.—Sales of roofing slate and millstock compared with number of new dwelling units, and value of certain new nonresidential construction, adjusted to 1947–49 prices, 1935–57. Data on number of new dwelling units in nonfarm areas from U. S. Department of Labor; data on nonresidential construction from U. S. Department of Commerce and U. S. Department of Labor.

TABLE 5.—Dimension slate sold by producers in the United States, 1948–52 (average) and 1953–57

Year	Roofing			Millstock		Other [1]		Total	
	Squares	Approximate short tons	Value	Approximate short tons	Value	Approximate short tons	Value	Approximate short tons	Value
1948–52 (average)	189, 694	71, 192	$3. 969, 877	14, 686	$1, 927, 076	65, 834	$1, 189, 468	151, 712	$7, 086, 421
1953	142, 292	53, 470	3, 005, 649	16, 995	2, 220, 504	82, 438	1, 458, 651	152, 903	6, 684, 804
1954	117, 729	43, 549	2, 401, 087	17, 796	2. 378, 323	90, 281	1, 569, 409	151, 626	6, 348, 819
1955	121, 480	45, 611	2, 568, 213	20. 732	2, 747, 215	74, 478	1, 266, 937	140, 821	6, 582, 365
1956	107, 054	40, 337	2, 588, 971	20, 151	3, 114, 155	58. 542	1, 098, 910	119, 030	6, 802, 036
1957	85, 086	32, 705	2, 002, 857	22, 699	3, 226, 961	64, 962	1, 389, 710	120, 366	6, 619, 528

[1] Includes flagstones, walkways, stepping stones, and miscellaneous slate.

The consumption of granules declined both in quantity and value in 1957 compared with 1956. Figure 2 indicates that sales of roofing slate were only about 18 percent in value of the total sales of slate in 1957.

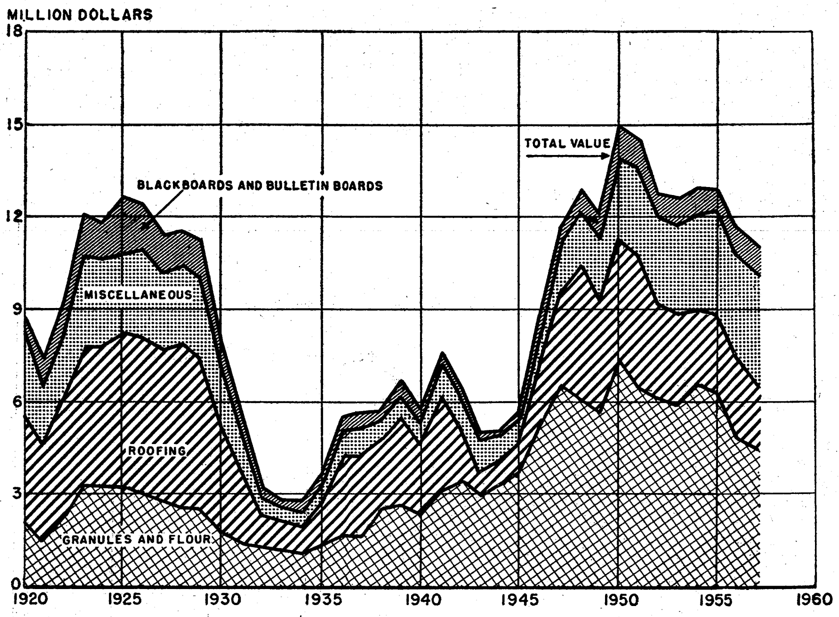

FIGURE 2.—Value of slate sold in the United States, 1920–57, by principal uses.

TABLE 6.—Crushed slate (granules and flour) sold by producers in the United States, 1948–52 (average) and 1953–57

Year	Granules [1]		Flour		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	502,024	$5,670,611	152,070	$709,700	654,094	$6,380,311
1953	395,881	5,105,429	149,805	848,232	545,686	5,953,661
1954	474,336	5,889,062	134,959	722,733	609,295	6,611,795
1955	466,604	5,539,315	153,015	792,097	619,619	6,331,412
1956	397,534	4,102,505	128,915	760,983	526,449	4,863,488
1957	390,294	3,730,824	121,126	678,692	511,420	4,409,516

[1] 1954–57 includes crushed slate used for lightweight aggregate.

PRICES

The average price of all slate products at the quarries decreased from $18.07 per ton in 1956 to $17.46 in 1957.

Roofing Slates.—The average value per square of roofing slate decreased 3 percent in 1957 compared with 1956—from $24.18 to $23.54. Decreases occurred in Pennsylvania and Vermont but average value increased in Virginia.

Millstock.—The average value of millstock per square foot remained at 89 cents in 1957. Electrical slate declined in value per square foot from $2.07 in 1956 to $1.62 in 1957, and structural and sanitary products from 84 to 77 cents per square foot; blackboards and bulletin boards increased from 71 cents to 83 cents per square foot; and billiard-table tops increased from 71 cents per square foot in 1956 to 81 cents in 1957.

Flagstones.—The average sales value of flagstones at the quarry increased from 11 cents per square foot in 1956 to 12 cents in 1957.

Granules and Flour.—Granules (including crushed slate for aggregates) decreased in price per ton from $10.32 in 1956 to $9.56 in 1957; and flour declined from $5.90 in 1956 to $5.60 per ton in 1957.

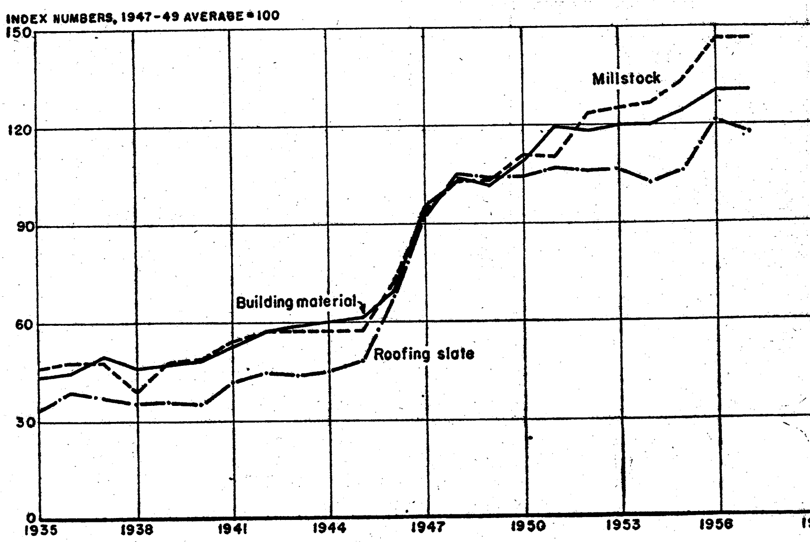

FIGURE 3.—Average selling price of slate compared with wholesale prices of building materials in general, 1935–57. Wholesale prices from U. S. Department of Labor.

FOREIGN TRADE [3]

Imports.—The value of slate imported into the United States increased 16 percent, from $247,621 in 1956 to $288,379 in 1957. Italy and Portugal accounted for 99 percent of the imports in 1957, and most of the remainder originated in West Germany. A small quantity same from the Union of South Africa.

Exports.—The value of slate exported from the United States, as reported by producers to the Bureau of Mines, declined 15 percent from $331,313 in 1956 to $282,345 in 1957. Exports consisted chiefly of blackboards, granules, and flour. Most of the exports were to Canada with small quantities to Latin American countries.

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

TABLE 7.—Slate imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955 [1]	1956 [1]	1957 [1]
North America:						
Canada	$3,279	$2,790		$323		$285
Mexico	37					
Total	3,316	2,790		323		285
South America: Brazil	240					
Europe:						
Germany [2]	6,973	35,299	$23,013	10,886	$21,748	12,828
Italy	80,958	127,076	74,480	75,314	126,266	132,618
Netherlands	44					
Norway	195		1,996			
Portugal	30,898	57,481	45,262	61,675	98,913	142,076
Spain	254					
Switzerland	178					
United Kingdom	851	1,403		24		
Total	120,351	221,259	144,751	147,899	246,927	287,522
Asia:						
China	40					
Japan	164	96		23		310
Total	204	96		23		310
Africa: Union of South Africa				600	694	262
Oceania: Australia	14					
Grand total	124,125	224,145	144,751	148,845	247,621	288,379

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable to years before 1954.
[2] West Germany, 1952–57.

TABLE 8.—Slate exported from the United States, 1948–52 (average) and 1953–57, by uses [1]

Use	1948–52 (average)	1953	1954	1955	1956	1957
Roofing	$10,610	$9,132	$17,129	$12,801	$6,747	$6,168
School slate [2]	11,366	1,796	(3)			
Electrical	10,578	23,225	9,085			
Blackboards	70,376	89,346	[3] 91,257	107,566	135,516	
Billiard tables	71,941	65,129	71,961			276,177
Structural (including floors and walkways) and granules and flour	351,138	175,770	231,312	271,268	189,050	
Total	526,009	364,398	420,744	391,635	331,313	282,345

[1] Figures collected by the Bureau of Mines from shippers of products named.
[2] Includes slate used for pencils and educational toys.
[3] School slates included with blackboards.

WORLD REVIEW

United Kingdom.—North Wales production of roofing slates reached 210,000 squares in 1956, about 4 percent less than in 1955. At the end of 1956 there were 3,314 employees in the Welsh slate industry.

It was reported late in 1957 that in the Dorothea Slate Quarries, North Wales, the working staff had been considerably reduced because of a recession in the market for certain grades of slate.

TECHNOLOGY

The discharge of light powder charges in deep drill holes is a well-known method of making primary breaks in slate quarries; but large-scale blasting is unusual. A blast large enough to dislodge 50,000 tons of slate was discharged in the Broughton Moor Green Slate Quarries near Coniston, Lancashire, England. The mass to be broken was first separated by making a wire-saw cut between it and the adjoining mountain of slate. An adit was driven 40 feet directly in from the quarry face and then turned at right angles for another 120 feet. A charge of 4½ tons of explosives was distributed in 5 lots at evenly spaced points in the 120-foot section of the adit at the back of the mass to be dislodged. The charges were fired simultaneously, and the result was said to be highly satisfactory. Most of the broken slate was used for roofing, but an increasing market was developing for slate as building stone to face large buildings and shop fronts, as well as for steps, sills, and other millstock products.[4]

Facing a bank building with slabs 4 feet long and 1½ feet wide was the first recorded use of slate in Cornwall, England, as a building stone. The slabs were chiseled to give a ribbed finish.[5]

A small plant was built near North Bangor, Pa., in 1955 to make lightweight aggregate from slate. Fine waste slate with addition of about 6 percent pulverized coal was calcined on a traveling grate. The plant operated for about 1 year and is said to have made a satisfactory product, but there has been no recent activity.

There was some prospect of using blocks of waste slate from the North Wales quarries in making seawalls. They had been used with success in making a seawall 1 mile long at Portmadoc.

A patent was issued for a new type of roofing and siding composition, consisting of 35 to 50 percent slate flour, 25 to 35 percent portland cement, and 15 to 20 percent asbestos.[6]

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[4] Quarry Managers' Journal, World's Biggest Slate-Quarry Blast: Vol. 40, No. 10, April 1957, pp. 589–592.
[5] Quarry Managers' Journal, New Bank With Slate Facing: Vol. 40, No. 10, April 1957, p. 574.
[6] Blake, C. L., Cementitious Material Containing Slate Flour: U. S. Patent 2,785,987, Mar. 19, 1957.

Sodium and Sodium Compounds

By Robert T. MacMillan[1] and Annie L. Mattila[2]

SODA-ASH production from natural deposits was about the same in 1957 as in 1956. On the other hand, production of manufactured soda ash declined 7 percent. Of the total soda ash sold or used in the United States, 13 percent was derived from natural sources in 1957 compared with 12 percent in 1956.

TABLE 1.—Manufactured sodium carbonate produced[1] and natural sodium carbonates sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Manufactured soda ash (ammonia-soda process)[2] (short tons)	Natural sodium carbonates[3]	
		Short tons	Value
1948–52 (average)	4,403,809	[4] 302,901	[4] $6,905,367
1953	4,879,396	419,206	10,627,460
1954	4,701,364	527,282	13,536,345
1955	4,906,971	613,594	15,000,966
1956	4,997,579	652,891	17,400,347
1957[5]	4,650,588	652,717	17,792,301

[1] U. S. Bureau of the Census.
[2] In 1957 reported as total crude bicarbonate. Before January 1953 reported as total wet and dry (98–100 percent Na_2CO_3). Includes quantities consumed in manufacturing finished light and finished dense soda ash, caustic soda, and quantities consumed in manufacturing refined sodium bicarbonate.
[3] Soda ash and trona (sesquicarbonate).
[4] Exclusive of Wyoming in 1948–49.
[5] Preliminary figures.

DOMESTIC PRODUCTION

Natural soda ash was produced in two States—California and Wyoming. In California American Potash & Chemical Corp. and West End Chemical Co. operated plants at Trona and Westend, respectively, on Searles Lake. Columbia Southern Chemical Corp., an affiliate of Pittsburgh Plate Glass Co., operated a plant near Bartlett on Owens Lake.

In Wyoming the Intermountain Chemical Co.—a subsidiary of Food Machinery & Chemical Corp.—mined a large deposit of trona in Sweetwater County near Westvaco. The deposit, which is at a depth of about 1,500 feet, was mined by the room-and-pillar method; continued expansion of output was expected.

Production of sodium sulfate (crude salt cake), including both manufactured and natural varieties, decreased about 5 percent in 1957; however, production from natural sources increased about 1

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

percent and supplied nearly 31 percent of the sodium sulfate sold or used in the United States.

The following firms and individuals produced natural sodium sulfates in 1957: American Potash & Chemical Corp. and West End Chemical Co. continued production from brines of Searles Lake, in California; Ozark Mahoning Co. produced sodium sulfate from subterranean brines in Texas; and Wm. E. Pratt and Sweetwater Chemical Co. (formerly Iowa Soda Products Co.) worked natural deposits in Wyoming.

More salt cake was produced as byproduct or coproduct of various industries than was yielded by natural sources. Chief among the producers of sodium sulfate as a byproduct were the Mannheim hydrochloric-acid plants. Rayon and cellophane factories and plants producing sodium dichromate, phenol, boric acid, formic acid, and lithium salts also produced byproduct sodium sulfate.

Although the total supply of sodium sulfate was expected to remain ample, some shifting in the sources of supply resulted from decreased rayon production and developments in hydrochloric-acid production. Increased production from natural sources helped to offset the loss from these sources.

TABLE 2.—Sodium sulfate produced and sold or used, by producers in the United States, 1948–52 (average) and 1953–57

Year	Production (manufactured [1] and natural), short tons			Sold or used by producers (natural only)	
	Salt cake (crude)	Glauber's salt (100 percent $Na_2SO_4 \cdot 10H_2O$)	Anhydrous refined (100 percent Na_2SO_4)	Short tons [2]	Value
1948–52 (average)	627,449	184,975	185,205	227,849	$3,144,449
1953	737,146	204,159	219,751	248,230	3,340,760
1954	658,638	146,992	204,668	249,701	3,890,303
1955	737,599	149,177	256,549	284,549	5,381,313
1956	[3] 763,274	[3] 143,300	[3] 248,039	[3] 326,760	6,327,551
1957	[4] 727,292	[4] 117,708	[4] 292,720	325,152	6,432,296

[1] U. S. Bureau of the Census.
[2] Includes Glauber's salt converted to 100-percent Na_2SO_4 basis.
[3] Revised figure.
[4] Preliminary figure.

Production of metallic sodium was 132,977 short tons in 1957, according to the Bureau of the Census, United States Department of Commerce—a 2-percent decrease compared with the 1956 production of 136,017 tons. The metal was produced at 4 plants by the following 3 companies: National Distillers Chemical Co., with a plant at Ashtabula, Ohio; E. I. du Pont de Nemours & Co., Inc., with a plant at Niagara Falls, N. Y.; and Ethyl Corp., with plants at Baton Rouge, La., and Houston, Tex.

The interrelationship of soda ash and the chlor-alkali industry was discussed in the trade press.[3] The continued increase in demand for chlorine threatened an oversupply of caustic soda, as the two are coproducts of salt electrolysis. Thus far, new uses and markets for caustic soda have kept pace with its production; however, the soda-

[3] Clark, M. E., and Gerlock, C. F., The Interrelationship between Soda Ash and the Chlor-Alkali Industry: Chem. Eng. Prog., vol. 53, No. 11, 1957, pp. 537–540.

ash market has been considered to be a possible outlet for excess caustic soda if the barriers of price and traditional usage can be overcome. Many newer plants are designed for using either caustic soda or soda ash.

Much of the gain in electrolytic caustic-soda capacity has been at the expense of lime-soda caustic, although an estimated 8 percent of the total caustic produced in 1957 came from lime-soda plants. Eliminating all production of lime-soda caustic would delay but not solve the potential problem of caustic soda oversupply.

CONSUMPTION AND USES

Soda ash has a wide variety of uses. A report [4] on 1956 consumption disclosed that the glass industry, as in previous years, absorbed the largest tonnage. Other chemicals, metals processing, pulp and paper, caustic and bicarbonate, soap, other cleaners, and water treatment also consumed important tonnages, as follows:

End use:	*Soda ash (short tons)*
Glass	1, 590, 000
Caustic and bicarbonate	696, 000
Water treatment	120, 000
Other chemicals	1, 383, 000
Soap	80, 000
Other cleaners	160, 000
Pulp and paper	339, 000
Metals processing	614, 000
Exports and miscellaneous	672, 000
Total	5, 654, 000

The Kraft pulp industry continued to be the chief user of sodium sulfate, absorbing about three-fourths of the production. In 1957 the decline in pulp production was reflected in decreased demand for salt cake. Other uses of sodium sulfate were in glass manufacture, synthetic detergents, ceramics, stock feed, pharmaceuticals, textiles, and chemicals.

About 60 percent of the output of metallic sodium was consumed in making tetraethyl lead, a gasoline antiknock compound. The outlook was favorable for expanded sodium production, based on new and growing uses for the metal. Sodium metal, in addition to having physical properties that make it one of the most efficient heat-transfer substances, has chemical properties that are useful in producing sodium peroxide, hydride, amide, and cyanide.

Other important uses of sodium metal are in the reduction of titanium, zirconium, niobium, beryllium, and silicon. Metallic sodium also was used in borohydride production, which was important in the field of high-energy fuels.[5]

PRICES

Prices for soda ash, salt cake, and the various grades of sodium sulfate were stable in 1957. According to Oil, Paint and Drug Reporter, domestic salt cake in bulk at the plant sold for $28 per ton;

[4] Work cited in footnote 3.
[5] Chemical Age (London), Outlook Good for U. S. Sodium Producers: Vol. 78, No. 1999, Nov. 2, 1957, p. 730.

rayon- and detergent-grade sodium sulfate per ton was $31 in bulk and $34 in paper bags. Chemical grades of sodium sulfate (U. S. P. grade granular and crystalline and N. F. VII grade dried powder) sold for $0.17½ per pound and $0.22½ per pound, respectively.

Oil, Paint and Drug Reporter quoted prices for soda ash, dense, 58 percent Na_2O, carlots, works, per hundred pounds at $1.60 in bulk and $1.90 in paper bags. On the same basis, light soda ash was quoted at $1.55 and $1.85. The prices of soda ash were steady throughout 1957 and the last 3 months of 1956.

Prices of sodium metal quoted in Oil, Paint and Drug Reporter were substantially the same as those at the end of 1956. Sodium metal in tank cars, works, was quoted at $0.17 per pound in 1957, an increase of 1 cent per pound over prices quoted on the same basis for most of 1956. In bricks, 14,000-pound lots or larger, the price was $0.19½ per pound at the plant.

FOREIGN TRADE [6]

Imports of sodium sulfate decreased nearly 27 percent in 1957 compared with 1956. The largest foreign suppliers were Canada, with 49 percent, and Belgium and Luxemburg, with 48 percent; the remainder was supplied by West Germany and the Netherlands.

TABLE 3.—Sodium sulfate imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Crude (salt cake)		Crystallized (Glauber's salt)		Anhydrous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	48,139	$648,660	11	$230	2,964	$70,935	51,114	$719,825
1953	53,468	875,599			7,730	206,645	61,198	1,082,244
1954	116,403	2,062,172			2,109	78,768	118,512	2,140,940
1955	120,795	2,412,372			3,679	117,411	124,474	2,529,783
1956	98,828	2,046,522			4,421	127,486	103,249	2,174,008
1957	72,519	1,450,383			1,592	60,810	74,111	1,511,193

TABLE 4.—Sodium carbonate and sodium sulfate exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Sodium carbonate		Sodium sulfate	
	Short tons	Value	Short tons	Value
1948–52 (average)	121,450	$5,115,900	(1)	(1)
1953	165,405	5,819,304	28,192	$804,887
1954	163,548	5,527,442	24,965	822,684
1955	153,257	4,933,040	24,561	870,182
1956	[2] 241,948	[2] 8,219,095	[2] 29,933	[2] 1,037,015
1957	173,756	6,281,929	23,667	858,545

[1] Data not separately classified before 1949: 14,440 short tons ($500,000) (revised figure); 1950: 16,834 short tons ($422,263); 1951: 25,634 short tons ($797,360); 1952: 27,909 short tons ($781,582).
[2] Revised figure.

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

Imports were approximately 7 percent of the total salt cake produced in the United States.

Exports of soda ash and salt cake decreased 28 and 21 percent in 1957 and were about 3 and 2 percent, respectively, of United States production of these commodities.

WORLD REVIEW

NORTH AMERICA

Canada.—A strike was reported at two sodium sulfate plants owned and operated by the Saskatchewan Provincial Government. One plant on strike was the Chaplin plant, the largest in Canada. This plant is valued at $10 million and is capable of producing annually sodium sulfate worth $5 million.[7]

SOUTH AMERICA

Venezuela.—A new chlorine and caustic soda plant was reported to have been opened by Petroquimica Nacional.[8]

EUROPE

Netherlands.—Dutch Soda Ash Co., Ltd., was expected to have its soda ash plant at Delfzil in production by the end of 1957. A caustic-soda plant also was under construction, and a vacuum salt installation was planned as part of a large chemical industry.[9]

ASIA

India.—Output of soda ash totaled 77,272 long tons in 1955. To meet increasing demand, a soda-ash plant was under construction at Porbander (Bombay State), and 2 others were planned—1 at Tuticorin (Madras State) and 1 at Dalmianagar (Bihar).[10]

Iraq.—A large-scale industrial development planned by the Government of Iraq included a chlorine caustic plant and allied chemical plants.[11]

AFRICA

Kenya.—Output of soda ash in 1956 was 146,326 long tons compared with 124,744 tons in 1955—an increase of 17 percent.[12]

TECHNOLOGY

The history, geology, and technology of salines in California were described in a publication of the State Department of Natural Resources.[13] The author described in detail the recovery of sodium carbonate, sodium sulfate, and other salts from the brines of Searles and Owens Lakes and included a map of the deposits, flowsheets, and product analyses.

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[7] Chemical Week, Saskatchewan Sulfate Strikes: Vol. 80, No. 14, Apr. 6, 1958, p. 69.
[8] Chemical Age (London), Venezuelan Chlorine, Caustic Soda Plant: Vol. 77, No. 1962, Feb. 16, 1957, p. 293.
[9] Oil, Paint and Drug Reporter, Dutch Soda Ash Firm to Start Up New Plant: Vol. 172, No. 24, Dec. 9, 1957, p. 5.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, pp. 31–32.
[11] Foreign Commerce Weekly, vol. 58, No. 7, Aug. 12, 1957, p. 10.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 42.
[13] Ver Planck, W. E., Salines; chap. in Mineral Commodities of California: State of California, Dept. of Nat. Resources, Div. of Mines, Bull. 176, 1957, pp. 475–482.

Two patents were issued relating to the crystallization of products from deposits of trona. The first describes a procedure for crystallizing substantially pure sodium sesquicarbonate ($Na_2CO_3.NaHCO_3.2H_2O$) from a water solution of trona by maintaining in the pregnant solution a higher than normal ratio of Na_2CO_3 to $NaHCO_3$ and considerable NaCl.[14]

The second patent describes a process for producing soda ash from trona by dissolving the trona in a circulating aqueous mother liquor, from which sodium sesquicarbonate is crystallized and calcined to produce soda ash. The ratio of sodium carbonate to sodium bicarbonate in solution, needed to crystallize the sesquicarbonate, is maintained by recycling small quantities of Na_2CO_3 or adding CO_2 to the mother liquor.[15]

Deposits of natural sodium sulfate along the shore of Great Salt Lake were described in a publication of the Bureau of Mines.[16] The beds range from 3 to 6 feet in thickness and are covered by 1 to 3 feet of sandy overburden. Prevailing winds over Great Salt Lake are believed to have formed the beds by piling floating crystals of sodium sulfate onto the beaches in winter.

About 95 percent of the output of metallic sodium in 1957 was reported to come from Downs cells by the electrolysis of a molten mixture of sodium and calcium chlorides. The calcium chloride is added to the electrolyte to reduce the melting temperature from 803° C. (for pure salt) to 505° C. for the eutectic mixture. On leaving the bath, the molten sodium metal and some calcium (about 2 percent) are cooled enough to precipitate the calcium alloy, which is returned to the bath, where it reacts to form more of the eutectic melt. Chlorine is produced at the anode as a coproduct of the cell.[17]

Metallic sodium is very active chemically, and its rate of reaction with moist air was found to be strongly catalyzed by the presence of small quantities of impurity in the metal. For example, high-purity distilled sodium had a much slower reaction rate with air than less pure, filtered sodium. The difference between the two rates decreased with increasing temperature, and at the melting point of the sodium (97.8° C.), the catalyzing effect of the impurities was no longer apparent.[18]

A new way to produce tetraethyl lead was described.[19] Several different reactions are possible between nonhalide lead compounds and metalorganics, such as triethylaluminum, diethylzinc, or ethylsodium. Advantages claimed for the new process include low temperatures and pressures in the reacting zone, moderate to good reaction rates, and high yields. No plans for commercializing the new process were reported; the older process involving the reaction between sodium-lead alloy and ethyl chloride is firmly established.

[14] Pike, R. D., Ray, K. B., and the Stamford Trust Co., executors of Pike, R. D. (deceased), Production of Sodium Sesquicarbonate: U. S. Patent 2,798,790, July 9, 1957.
[15] Pike, R. D., Ray, K. B., and the Stamford Trust Co., executors of Pike, R. D. (deceased), Method of Producing Refined Soda Ash From Trona: U. S. Patent 2,792,282, May 14, 1957.
[16] Wilson, S. R., and Wideman, F. L., Sodium Sulfate Deposits Along the Southeast Shore of Great Salt Lake, Salt Lake and Tooele Counties, Utah: Bureau of Mines Inf. Circ. 7773, 1957, 10 pp.
[17] Sittig, M., Manufacture and Availability of the Alkali Metals: Chem. Eng. Prog., vol. 52, No. 8, August 1956, pp. 337–341.
[18] Howland, W. H., and Epstein, L. F., Reaction Rate of Solid Sodium With Air: Ind. Eng. Chem., vol. 49, No. 11, November 1957, pp. 1931–1932.
[19] Chemical and Engineering News, Ethyl Has New Way to TEL: Vol. 35, No. 16, Apr. 22, 1957, pp. 76–77.

Stone

By Wallace W. Key[1] and Nan C. Jensen[2]

CONTINUED expansion of the domestic stone industries in 1957 resulted in another sales record, but output did not increase at the anticipated rate because of setbacks in private construction. The Interstate Highway Program remained in an early stage with design and land acquisition as predominant features.

TABLE 1.—Salient statistics of the stone industry in the United States,[1] 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Dimension stone:						
Thousand short tons	1, 761	1, 949	2, 382	2, 533	2, 517	2, 515
Value (thousand dollars)	54, 539	59, 311	67, 097	75, 993	76, 123	77, 424
Crushed stone:						
Thousand short tons	255, 876	304, 893	409, 678	467, 958	503, 714	536, 443
Value (thousand dollars)	337, 515	424, 018	547, 437	632, 302	689, 219	746, 279
Total sold or used by producers:						
Thousand short tons	257, 637	306, 842	412, 060	470, 491	506, 231	538, 958
Value (thousand dollars)	392, 054	483, 329	614, 534	708, 295	765, 342	823, 703
Imported for consumption:[2]						
Value (thousand dollars)	2, 937	5, 073	[3] 5, 216	[3] 5, 579	[3] 7, 609	[3] 8, 504
Exported:						
Value (thousand dollars)	[4] 902	4, 333	4, 514	5, 491	5, 602	6, 003

[1] Includes Territories of the United States, possessions, and other areas administered by the United States. Excludes slate. 1954-57 includes ground sandstone, quartz, and quartzite used for abrasives and other uses; shell for various uses; and limestone, cement rock, calcareous marl, and dolomite used in making cement, lime, and dead-burned dolomite. 1957 includes calcareous marl for agricultural use.
[2] Includes whiting.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known not to be comparable with years before 1954.
[4] Excludes crushed, ground, or broken stone not separately classified before Jan. 1, 1952.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

TABLE 2.—Stone sold or used by producers in the United States,[1] 1948–52 (average) and 1953–57, by kinds

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone and dolomite	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1948–52 (average)	19,026	46,601	24,820	36,826	255	11,035	186,799	257,328
1953	23,485	55,110	30,098	46,480	454	12,190	225,126	317,972
1954	23,450	56,705	30,808	49,593	538	13,794	[2] 316,500	[2] 423,622
1955	26,079	59,581	35,851	56,141	1,092	19,786	[2] 361,524	[2] 489,002
1956	29,636	65,447	38,052	63,021	947	18,380	[2] 380,371	[2] 515,799
1957	41,636	75,985	43,147	71,616	1,423	23,707	385,426	536,304

Year	Sandstone		Other stone [3]		Shell		Total	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1948–52 (average)	8,158	22,345	18,579	17,919	(4)	(4)	257,637	392,054
1953	8,655	28,271	19,024	23,306	(4)	(4)	306,842	483,329
1954	12,119	35,321	16,287	20,179	12,358	15,320	412,060	614,534
1955	13,108	38,624	17,706	22,531	15,131	22,630	470,491	708,295
1956	13,446	46,388	23,927	27,939	19,852	28,368	506,231	765,342
1957	16,294	49,102	30,606	38,417	18,510	26,768	[5] 538,958	[5] 823,703

[1] Includes Territories of the United States, possessions, and other areas administered by the United States. 1954–57 includes ground sandstone, quartz, and quartzite used for abrasives and other uses; shell for various uses; and limestone, cement rock, calcareous marl, and dolomite used in making cement, lime, and dead-burned dolomite. 1957 includes calcareous marl for agricultural use.
[2] Includes calcareous marl used in making cement.
[3] Includes mica schist, conglomerate, argillite, various light-colored volcanic rocks, serpentine not used as marble, soapstone sold as dimension stone, etc.
[4] Data not available.
[5] Also includes 1,916,000 tons of calcareous marl valued at $1,804,000.

TABLE 3.—Stone sold or used by producers in the United States,[1] 1956–57, by uses

Use	1956		1957	
	Thousand short tons (unless otherwise stated)	Value (thousand dollars)	Thousand short tons (unless otherwise stated)	Value (thousand dollars)
Dimension stone:				
Building stone:				
Rough construction	322	3,228	324	1,966
Cut stone, slabs, and mill blocks [2] ... thousand cubic feet	16,500	47,557	16,947	49,321
Approximate equivalent in short tons	1,257		1,288	
Rubble	470	1,588	373	1,628
Monumental stone [3] ... thousand cubic feet	2,833	18,016	2,986	18,942
Approximate equivalent in short tons	235		247	
Paving blocks ... number (thousand)	988	88	400	84
Approximate equivalent in short tons	6		4	
Curbing ... thousand cubic feet	1,462	3,551	1,486	3,575
Approximate equivalent in short tons	120		122	
Flagging ... thousand cubic feet	1,354	2,095	1,968	1,908
Approximate equivalent in short tons	107		157	
Total dimension stone	2,517	76,123	2,515	77,424
Crushed and broken stone:				
Riprap	13,134	15,565	14,462	17,699
Concrete and roadstone	276,269	369,883	302,754	414,114
Railroad ballast	15,481	16,545	16,581	18,019
Furnace flux (limestone)	37,789	52,486	39,384	56,113
Refractory [4]	1,436	11,054	1,734	11,930
Agricultural (limestone)	19,864	32,087	[5] 19,206	[5] 31,556
Portland and natural cement (limestone, cement rock, shell, and calcareous marl)	86,452	91,604	79,944	84,071
Lime and dead-burned dolomite	17,495	24,028	17,162	25,780
Other uses	35,794	75,967	45,216	86,997
Total crushed and broken stone	503,714	689,219	536,443	746,279
Grand total	506,231	765,342	538,958	823,703

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] To avoid disclosing individual outputs, dimension stone for refractory use is included with building stone.
[3] Includes granite used for precision surface plates.
[4] Ganister (sandstone and quartzite) and dolomite.
[5] Limestone and calcareous marl.

TABLE 4.—Stone sold or used by noncommercial producers in the United States,[1] 1956–57, by uses

(Included in total production)

Use	1956		1957	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
Building stone	17	112	18	122
Rubble	91	78	12	13
Riprap	5,435	5,908	6,668	6,187
Concrete and roadstone	24,633	27,040	38,740	45,636
Agricultural (limestone)	390	551	358	535
Other uses	2,510	1,416	9,443	5,331
Total	33,076	35,105	55,239	57,824

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

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TABLE 5.—Stone sold or used by producers in the United States, 1956–57, by States

State	1956		1957	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
Alabama	[1] 12,343	[1] 14,702	[1] 9,519	[1] 11,972
Arizona	1,623	2,474	2,101	2,982
Arkansas	6,325	8,113	7,278	8,378
California	32,583	46,109	41,351	53,591
Colorado	2,250	5,217	2,438	4,168
Connecticut	[1] 4,428	[1] 6,590	6,199	10,040
Delaware	83	232	(2)	(2)
Florida	18,779	25,183	21,786	30,467
Georgia	[1] 9,196	[1] 20,714	[1] 9,065	[1] 15,833
Idaho	1,791	2,752	1,542	2,759
Illinois	31,855	40,859	31,861	41,835
Indiana	14,700	31,575	14,460	33,094
Iowa	14,035	17,256	15,214	18,768
Kansas	[1] 13,433	[1] 15,682	[1] 10,412	[1] 11,926
Kentucky	11,553	15,324	12,718	16,714
Louisiana	4,405	6,674	4,383	7,152
Maine	942	2,238	889	3,076
Maryland	6,229	13,305	6,140	13,392
Massachusetts	5,442	13,753	4,877	13,165
Michigan	33,999	31,010	34,495	34,176
Minnesota	[1] 3,084	[1] 7,552	[1] 2,968	[1] 8,175
Mississippi	656	656	[1] 60	[1] 54
Missouri	24,578	33,577	22,098	29,836
Montana	1,247	1,816	2,567	3,654
Nebraska	3,063	4,142	3,065	3,749
Nevada	1,401	2,281	925	1,585
New Hampshire	(2)	(2)	(2)	(2)
New Jersey	9,012	20,825	8,792	21,222
New Mexico	1,268	1,272	1,348	1,618
New York	22,805	36,135	24,265	43,276
North Carolina	[1] 8,352	[1] 11,472	[1] 9,455	[1] 12,839
North Dakota	83	87	29	52
Ohio	[1] 33,418	[1] 50,947	[1] 37,451	[1] 61,847
Oklahoma	10,547	12,417	12,016	14,064
Oregon	6,098	7,890	10,311	11,405
Pennsylvania	[1] 44,913	[1] 73,831	43,258	73,090
Rhode Island	[1] 42	[1] 221	[1] 4	[1] 14
South Carolina	[1] 3,304	[1] 4,285	[1] 3,413	[1] 4,581
South Dakota	2,200	5,725	1,718	5,068
Tennessee	[1] 15,556	[1] 23,796	[1] 15,354	[1] 24,155
Texas	32,773	36,350	30,660	35,358
Utah	2,322	3,298	7,854	8,540
Vermont	621	11,622	557	11,404
Virginia	14,082	23,076	[1] 14,244	[1] 21,158
Washington	8,057	11,660	8,454	10,600
West Virginia	6,579	10,766	6,989	11,934
Wisconsin	11,126	20,402	12,434	22,455
Wyoming	1,333	2,076	1,291	2,266
Undistributed	5,193	17,266	10,067	28,121
Total	499,707	755,205	528,375	805,608
Alaska	195	595	528	1,953
American Samoa	2	6	34	37
Canton Island	2	5	---	---
Guam	341	311	1,034	1,132
Hawaii	3,494	6,076	2,585	4,632
Midway Island	203	304	3,875	6,700
Panama Canal Zone	177	230	59	99
Puerto Rico	2,076	2,556	2,452	3,505
Virgin Islands	12	32	11	31
Wake Island	22	22	5	6
Total	6,524	10,137	10,583	18,095
Grand Total	506,231	765,342	538,958	823,703

[1] To avoid disclosing individual company confidential data, certain State totals are incomplete, the part 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] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

Actual road construction in 1957, although higher than in 1956, fell short of expectations. Cement and asphalt production dropped, and home building declined. Nevertheless, concrete and roadstone production increased 9.6 percent, mainly because of the quantity of stone needed for fill and road base. Total stone production reached 539 million tons, an increase of over 6 percent compared with record 1956.

Construction was somewhat uneven geographically in 1957, owing in part to the availability of funds to the various States.[3] However, progress was made, and the industry anticipated that in 1958–68 construction in the United States would be at the highest rate in history and that the road program would have a tremendous effect on the stone output. In addition to 10 billion tons of aggregate needed for the 13-year Federal Highway Program, billions of tons will be needed for access roads, new plants, homes, schools, and other construction. School construction plans outlined in 1957 called for completion of 450,000 classrooms in the 3-year period 1958–61. The aggregate industry in 1957 found zoning problems difficult in some areas.

DIMENSION STONE

Sales of dimension stone decreased slightly in 1957 because of continued competition from manufactured products. The decline in home building did not materially affect the dimension-stone industry because it depended mainly on public-building construction and monumental use for its market.

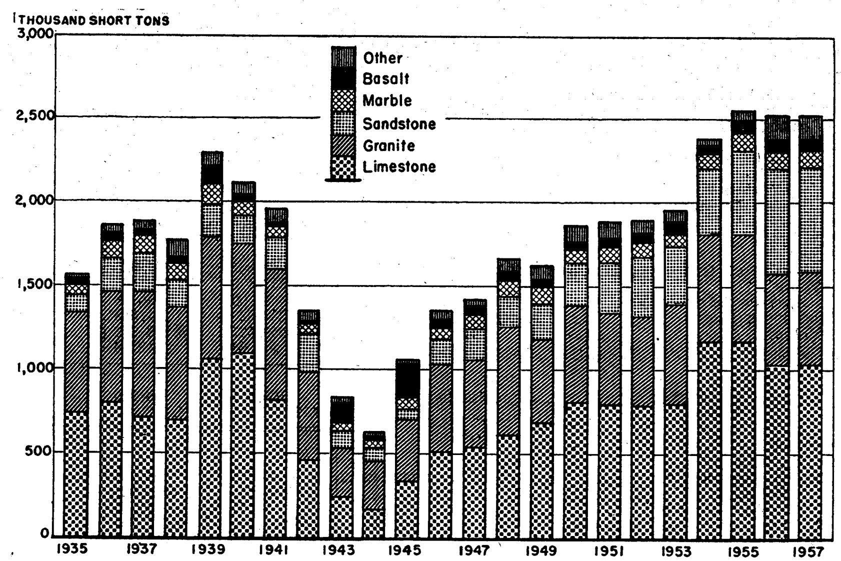

FIGURE 1.—Sales of dimension stone in the United States, by kinds, 1935–57.

[3] Engineering News-Record, Roadbuilders Dominate Scene: Vol. 160, No. 7, Feb. 14, 1958, pp. 155–200; Engineering News-Record, $2.875 Billion Allocated for Highways: Vol. 159, No. 6, Aug. 8, 1957, p. 26.

Production (including slate) totaled 2.6 million short tons valued at $84 million. Unit value increased slightly. The figures in table 6 include slate, but details of that branch of the industry appear in the Slate chapter.

Quarries that produced dimension stone (excluding slate) were operated in 42 States, Hawaii, and Puerto Rico in 1957. Indiana led the other States in value of sales, followed by Vermont; Ohio, Georgia, and Massachusetts were also high in value of sales. Dimension slate was quarried in six States; Pennsylvania, Vermont, and Virginia led in value of production.

TABLE 6.—Dimension stone sold or used by producers in the United States,[1] 1956–57, by kinds and uses

Kind and use	1956	1957	Change from 1956, percent
Granite:			
Building stone:			
Rough construction...short tons..	50,711	37,260	−27
Value	$481,172	$395,380	−18
Average per ton	$9.49	$10.61	+12
Cut stone, slabs, and mill blocks...cubic feet..	901,025	1,003,807	+11
Value	$6,375,753	$7,110,928	+12
Average per cubic foot	$7.08	$7.08	----------
Rubble...short tons..	77,683	73,069	−6
Value	$228,691	$178,455	−22
Monumental stone...cubic feet..	2,575,064	2,694,548	+5
Value	$14,755,609	$15,242,758	+3
Average per cubic foot	$5.73	$5.66	−1
Paving blocks...number..	988,309	400,171	−60
Value	$88,361	$83,780	−5
Curbing...cubic feet..	1,433,223	1,439,333	----------
Value	$3,464,905	$3,430,891	−1
Total:			
Quantity...approximate short tons..	540,238	539,186	----------
Value	$25,394,491	$26,442,192	+4
Basalt and related rocks (traprock):			
Building stone (rough, dressed, and rubble) and monumental stone...short tons..	72,299	61,216	−15
Value	$330,571	$479,512	+45
Average per ton	$4.57	$7.83	+71
Total:			
Quantity...short tons..	72,299	61,216	−15
Value	$330,571	$479,512	+45
Marble:			
Building stone (cut stone, slabs, and mill blocks)..cubic feet..	981,887	1,531,025	+56
Value	$8,837,470	$10,373,495	+17
Average per cubic foot	$9.00	$6.78	−25
Monumental stone...cubic feet..	257,925	291,688	+13
Value	$3,260,527	$3,698,862	+13
Average per cubic foot	$12.64	$12.68	----------
Total:			
Quantity...approximate short tons..	105,431	148,946	+41
Value	$12,097,997	$14,072,357	+16
Limestone:			
Building stone:			
Rough construction...short tons..	43,708	134,067	+207
Value	$164,976	$366,027	+122
Average per ton	$3.77	$2.73	−28
Cut stone, slabs, and mill blocks...cubic feet..	9,621,070	9,915,704	+3
Value	$19,608,249	$20,056,236	+2
Average per cubic foot	$2.04	$2.02	−1
Rubble...short tons..	236,599	216,262	−9
Value	$612,191	$570,539	−7
Flagging...cubic feet..	389,577	581,662	+49
Value	$310,759	$344,406	+11
Total:			
Quantity...approximate short tons..	1,028,759	1,131,376	+10
Value	$20,696,175	$21,337,208	+3

See footnotes at end of table.

TABLE 6.—Dimension stone sold or used by producers in the United States,[1] 1956–57, by kinds and uses—Continued

Kind and use	1956	1957	Change from 1956, percent
Sandstone:			
Building stone:			
Rough construction .... short tons..	166,690	91,736	−45
Value	$2,259,605	$724,559	−68
Average per ton	$13.56	$7.90	−42
Cut stone, slabs, and mill blocks .... cubic feet..	4,559,620	4,054,477	−11
Value	$10,130,903	$9,215,386	−9
Average per cubic foot	$2.22	$2.27	+2
Rubble .... short tons..	41,008	47,815	+17
Value	$218,932	$289,728	+32
Curbing .... cubic feet..	29,214	46,517	+59
Value	$85,576	$144,124	+68
Flagging .... cubic feet..	886,041	1,326,462	+50
Value	$1,711,353	$1,489,867	−13
Total:			
Quantity .... approximate short tons..	623,826	555,258	−11
Value	$14,406,369	$11,863,664	−18
Miscellaneous stone:[2]			
Building stone .... cubic feet..	436,031	442,412	+1
Value	$2,605,008	$2,565,622	−2
Average per cubic foot	$5.97	$5.80	−3
Rubble .... short tons..	102,879	36,014	−65
Value	$519,295	$589,327	+13
Flagging .... cubic feet..	78,072	59,682	−24
Value	$72,972	$74,436	+2
Total:			
Quantity .... approximate short tons..	146,211	78,697	−46
Value	$3,197,275	$3,229,385	+1
Total dimension stone, excluding slate:			
Quantity .... approximate short tons..	2,516,764	2,514,679	....
Value	$76,122,878	$77,424,318	+2
Slate as dimension stone[3] .... approximate short tons..	119,030	120,366	+1
Value	$6,802,036	$6,619,528	−3
Total dimension stone, including slate:			
Quantity .... approximate short tons..	2,635,794	2,635,045	....
Value	$82,924,914	$84,043,846	+1

[1] Includes Hawaii and Puerto Rico.
[2] Includes soapstone, mica schist, volcanic rocks, argillite, and other varieties that cannot be classified in the principal groups.
[3] Details of production, by uses, are given in the Slate chapter of this volume.

Many continued to favor stone for use as ornamental veneer in constructing large dignified structures, but, as indicated in figure 2, the percentage of the total value of nonresidential construction attributed to stone continued to decline. Demand for house veneer appeared to be gaining favor in some sections of the country; demand was especially keen for stone that presented a rustic appearance, such as the flagstone of Tennessee and Virginia. Because of the weight of the product, transportation added greatly to the delivered price, and freight rates were important considerations in competitive marketing. Nevertheless, stone was shipped long distances to satisfy architectural demands for certain textures and colors. Competition from imported stone was a matter of some concern in 1957, as tariffs continued to be reduced on several products.

TABLE 7.—Dimension stone sold or used by producers in the United States,[1] 1943–57, by uses

Year	Building			Rubble		Monumental			Paving blocks		
	Thousand cubic feet	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand cubic feet	Thousand short tons	Value (thousand dollars)	Number (thousand)	Thousand short tons	Value (thousand dollars)
1943	3,917	318	2,807	253	403	2,541	210	9,731	652	7	67
1944	2,530	200	2,769	135	231	2,940	243	11,397	655	4	45
1945	4,914	382	5,485	390	549	3,039	251	11,361	213	2	22
1946	9,166	707	13,768	293	650	3,678	300	17,435	579	5	50
1947	9,621	739	18,610	269	715	3,778	312	19,815	684	5	56
1948	11,770	904	24,772	276	574	3,724	307	20,541	392	3	33
1949	11,890	916	29,910	339	709	3,125	258	18,758	276	2	28
1950	15,994	1,229	36,665	247	615	2,878	237	17,062	348	4	51
1951	16,101	1,237	38,827	253	591	2,744	226	15,971	431	3	52
1952	15,516	1,199	35,354	320	827	2,675	221	16,169	683	2	38
1953	14,966	1,148	35,380	403	1,126	3,041	251	18,995	348	2	40
1954	20,049	1,534	42,729	390	904	2,842	235	18,105	208	1	18
1955	22,009	1,687	51,685	375	1,372	2,831	234	16,843	1,054	6	127
1956	20,345	1,579	50,785	470	1,588	2,833	235	18,016	988	6	88
1957	20,892	1,612	51,287	373	1,628	2,986	247	18,942	400	4	84

Year	Curbing			Flagging			Total	
	Thousand cubic feet	Thousand short tons	Value (thousand dollars)	Thousand cubic feet	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1943	148	12	172	416	32	187	832	13,367
1944	207	16	194	264	21	219	619	14,855
1945	158	13	204	268	21	228	1,059	17,849
1946	375	31	544	476	38	525	1,374	32,972
1947	635	52	1,110	520	42	586	1,419	40,892
1948	769	63	1,382	520	41	585	1,594	47,887
1949	738	59	1,689	556	45	652	1,619	51,746
1950	950	78	2,430	713	57	878	1,852	57,701
1951	1,006	83	2,872	641	51	977	1,853	59,290
1952	1,053	86	2,576	721	58	1,108	1,886	56,072
1953	1,016	83	2,500	776	62	1,270	1,949	59,311
1954	1,555	128	3,408	1,203	94	1,933	2,382	67,097
1955	1,469	121	3,916	1,405	110	2,050	2,533	75,993
1956	1,462	120	3,551	1,354	107	2,095	2,517	76,123
1957	1,486	122	3,575	1,968	157	1,908	2,515	77,424

[1] Includes Hawaii and Puerto Rico.

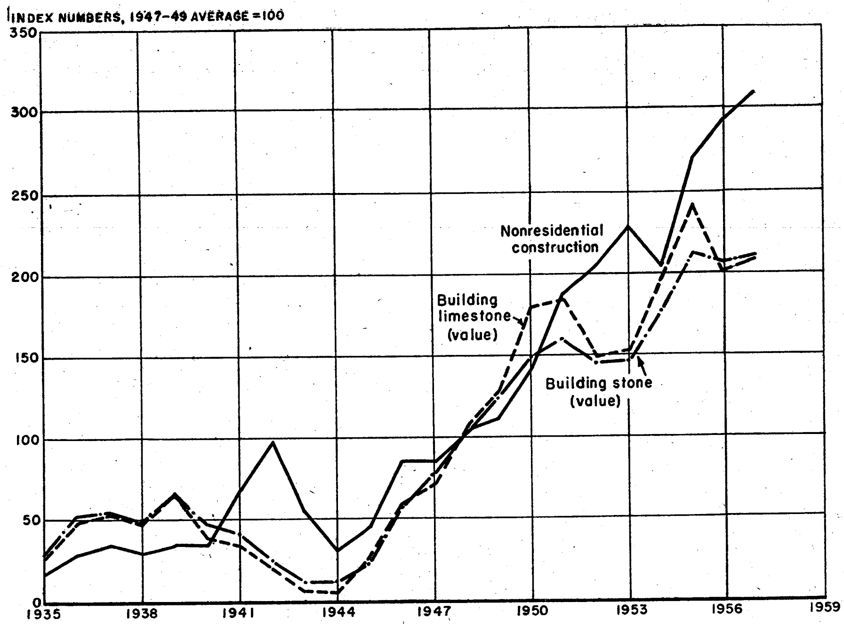

FIGURE 2.—Sales of all building stone, compared with sales of building limestone and value of all nonresidential construction, 1935–57.

(Data on nonresidential-building construction from Survey of Current Business, U. S. Department of Commerce.)

Portland and bituminous concretes have almost entirely replaced paving stones, but some were used in areas subjected to heavy traffic. Also, natural curbstones served particularly well for corner curbs where wheel shock was especially intense.

Patios, walks, and gardens around small commercial buildings and residences used flagging for decoration, utility, and lawn protection. Use of precision surface plates made from granite and basalt continued to increase in plants where extremely hard and durable, nonwarping, rustproof, and corrosionproof plates were required. Marble and other ornamental stones were valuable for making table tops, lamp bases, book ends, ash trays, and various novelties.

Waste blocks, "rough-backs" (ends of blocks), and spalls or fines were sold in limited quantities as riprap or for crushed stone. Waste limestone and marble rarely were used for lime manufacture.

TABLE 8.—Building stone sold or used by producers in the United States [1] in 1957, by kinds

Kind	Rough			
	Construction		Architectural	
	Thousand cubic feet	Value (thousand dollars)	Thousand cubic feet	Value (thousand dollars)
Granite	452	395	178	659
Basalt	[2] 729	[2] 480	---	---
Marble	---	---	176	641
Limestone	1,587	366	3,984	3,607
Sandstone	1,177	725	[3] 1,705	[3] 2,732
Miscellaneous	---	---	---	---
Total	[2] 3,945	[2] 1,966	[3] 6,043	[3] 7,639

Kind	Finished				Total	
	Sawed		Cut			
	Thousand cubic feet	Value (thousand dollars)	Thousand cubic feet	Value (thousand dollars)	Thousand cubic feet	Value (thousand dollars)
Granite [4]	433	1,819	393	4,633	1,456	7,506
Basalt	---	---	---	---	729	480
Marble	946	2,743	409	6,989	1,531	10,373
Limestone	4,445	7,957	1,487	8,492	11,503	20,422
Sandstone	[3] 1,870	[3] 5,370	479	1,113	5,231	9,940
Miscellaneous	[3,5] 442	[3,5] 2,566	---	---	442	2,566
Total	[3,5] 8,136	[3,5] 20,455	2,768	21,227	20,892	51,287

[1] Includes Puerto Rico.
[2] Dressed basalt is included with rough stone. Basalt used for monuments, precision surface plates, and rubble also included to avoid disclosing individual company outputs.
[3] Includes stone for refractory use to avoid disclosing individual company outputs.
[4] Sawed stone corresponds to dressed stone for construction work (walls, foundations, bridges) and cut stone to architectural stone for high-class buildings.
[5] Rough and cut miscellaneous stone included with sawed stone.

GRANITE

Granite sales remained about the same as in the preceding year, fluctuating somewhat among the various uses. The decline in building granite was offset by gains made by the monumental-granite industry. Some of the increases in sales might be attributed to sales campaigns by the industry.

Dimension granite was quarried in 22 States. The average value for all uses of dimension granite increased $2.03 a ton to $49.04 in 1957 compared with 1956.

TABLE 9.—Granite (dimension stone) sold or used by producers in the United States in 1957, 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	11	3,359	$25,275	(1)	(1)	(1)	(1)	------	------	54,019	$414,019	(1)	(1)	------	------	(1)	(1)	13,579	$1,146,603
Colorado	3	------	------	------	------	5,953	$22,600	------	------	11,550	29,325	900	$20,000	------	------	------	------	1,667	71,925
Connecticut	5	309	3,090	(1)	(1)	43,647	115,637	918	$13,900	(1)	(1)	------	------	------	------	3,180	$7,610	5,597	179,906
Georgia	21	200	800	15,500	$18,000	------	------	20,980	47,481	801,108	1,689,600	(1)	(1)	(1)	(1)	(1)	(1)	126,346	3,321,421
Maine	6	(1)	(1)	(1)	(1)	(1)	(1)	------	------	365	1,600	(1)	(1)	------	------	(1)	(1)	(1)	(1)
Massachusetts	8	(1)	(1)	(1)	(1)	(1)	(1)	6,455	14,800	------	------	------	------	------	------	(1)	(1)	(1)	(1)
Minnesota	25	332	12,000	(1)	(1)	(1)	(1)	(1)	(1)	64,056	197,259	131,268	1,120,149	------	------	------	------	57,246	3,328,235
Missouri	1	------	------	4,274	16,030	------	------	------	------	15,728	55,772	14,602	155,450	------	------	------	------	2,889	227,252
Montana	1	------	------	------	------	------	------	------	------	------	------	229	460	------	------	------	------	18	460
North Carolina	8	3,741	26,800	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Oklahoma	6	------	------	------	------	------	------	------	------	44,117	183,455	22,511	373,565	------	------	------	------	5,497	557,020
Oregon	1	------	------	------	------	------	------	------	------	------	------	130	1,850	------	------	------	------	11	1,850
South Dakota	10	------	------	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	190,335	2,448,657	------	------	------	------	19,763	2,613,395
Washington	3	------	------	27,248	19,980	------	------	------	------	------	------	2,645	11,380	------	------	1,733	3,575	2,609	34,935
Wisconsin	8	(1)	(1)	------	------	(1)	(1)	------	------	79,310	957,545	(1)	(1)	------	------	------	------	10,194	1,518,903
Undistributed [2]	19	29,319	327,415	131,497	605,152	775,688	6,313,529	44,716	102,274	1,051,535	5,402,325	210,140	2,180,347	400,171	83,780	1,434,420	3,419,706	293,770	13,440,287
Total	136	37,260	395,380	178,519	659,162	825,288	6,451,766	73,069	178,455	2,121,788	8,930,900	572,760	6,311,858	400,171	83,780	1,439,333	3,430,891	539,186	26,442,192
Average unit value	------	------	$10.61	------	$3.69	------	$16.00	------	$2.44	------	$4.21	------	$11.02	------	$0.21	------	$2.38	------	$49.04
Short tons (approximate)	------	(3)	------	15,084	------	68,217	------	------	------	174,759	------	47,833	------	3,833	------	119,131	------	------	------

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes data indicated by footnote 1 and New Jersey and South Carolina, 1 plant each; New Hampshire and Texas, 2 plants each; Maryland and Pennsylvania, 3 plants each; and Vermont, 7 plants.
[3] 452,100 cubic feet (approximate).

BASALT AND RELATED ROCKS (TRAPROCK)

Basalt and related rocks were not used extensively as dimension stone because of their dark color. The basaltic-type rocks used for memorials, formerly classed in the trade as "black granite" and included with the figures for monumental granite, are incorporated in table 10.

Total sales decreased 15 percent compared with 1956, and the number of plants decreased from 8 to 7.

A relatively recent application of dimension diabase has been in manufacturing precision surface plates for checking instruments, small assemblies, and engineering works requiring a smooth, flat surface.

Dark-colored, polished dimension stone for veneer appeared to be in greater demand. The dimension basalt used in larger memorials is included under building stone.

TABLE 10.—Basalt and related rocks (traprock) (dimension stone) [1] sold or used by producers in the United States, 1956–57

Year	Active plants [2]	Short tons	Value	
			Total	Average per ton
1956	8	72,299	$330,571	$4.57
1957	7	61,216	479,512	7.83

[1] Includes rough and dressed building stone, rubble, monumental stone, and stone used for precision plates.
[2] Includes: 1956—1 plant each in California, Hawaii, Oregon, and Wisconsin; and 2 plants each in Massachusetts and Pennsylvania; 1957—1 plant each in California, Connecticut, and Oregon; and 4 plants in Pennsylvania.

MARBLE

Dimension marble used for construction and for monumental and memorial work increased 41 percent in quantity and 16 percent in value over 1956.

The average value of marble sold for memorial purposes was $12.68 per cubic foot, and that of marble for building was $6.78 per cubic foot in 1957.

The Colorado marble quarry, which was the source of stone used in building many notable structures such as the Lincoln Memorial and the Tomb of the Unknown Soldier, now produces crushed stone exclusively.[4]

In the stone industry the term "marble" was usually applied to any carbonate rock that would take a high polish. The classification of carbonate rock either as limestone or marble depended mainly on its ability to take a polish.

[4] Utley, H. F., Colorado White Marble Processed for Lime, Hydrate, Varied Products: Pit and Quarry, vol. 49, No. 12, June 1957, pp. 100–101, 137.

TABLE 11.—Marble (dimension stone) sold by producers in the United States, 1956–57, by uses

Use	1956		1957	
	Cubic feet	Value	Cubic feet	Value
Building stone:				
Rough:				
Exterior	134, 745	$525, 633	41, 848	$207, 863
Interior	70, 106	209, 938	134, 450	434, 015
Finished:				
Exterior	444, 244	3, 173, 808	986, 992	4, 012, 604
Interior	332, 792	4, 928, 091	367, 735	5, 719, 013
Total exterior	578, 989	3, 699, 441	1, 028, 840	4, 220, 467
Total interior	402, 898	5, 138, 029	502, 185	6, 153, 028
Total building stone	981, 887	8, 837, 470	1, 531, 025	10, 373, 495
Monumental stone (rough and finished)	257, 925	3, 260, 527	291, 688	3, 698, 862
Total building and monumental	1, 239, 812	12, 097, 997	1, 822, 713	14, 072, 357
Approximate short tons	105, 431		148, 946	

TABLE 12.—Marble (dimension stone) sold by producers in the United States in 1957, by States and uses

State	Active plants	Building		Monumental		Total		
						Quantity		
		Cubic feet	Value	Cubic feet	Value	Cubic feet	Short tons (approximate)	Value
Colorado	3	7, 840	$28, 692	11	$70	7, 851	669	$28, 762
Tennessee	13	(1)	(1)	(1)	(1)	632, 130	53, 624	3, 909, 953
Undistributed [2]	14	1, 523, 185	10,344,803	291, 677	3, 698, 792	1, 182, 732	94, 653	10, 133, 642
Total	30	1, 531, 025	10,373,495	291, 688	3, 698, 862	1, 822, 713	148, 946	14, 072, 357
Average unit value			$6. 78		$12. 68			[3] $7. 72
Short tons (approximate)		124, 421		24, 525				

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes data indicated by footnote [1] and Alabama, Georgia, Maryland, Missouri, North Carolina, and Vermont.
[3] Average value per cubic foot.

LIMESTONE

Dimension-limestone production totaled over a million short tons, valued at more than $21 million. Total tonnage and value increased over 1956, but the unit value per ton decreased. Limestone used as dimension stone was quarried in 1957 by 128 producers in 21 States and 2 Territories.

Limestone was the most widely used of all types of building stone in the United States. Although limestone production was reported from various sections of the country, the Bedford-Bloomington (Ind.) district maintained the lead in dimension-limestone output in 1957 as in previous years. Tables 14 and 15 show a breakdown of the limestone in the Indiana district. Many dimension-limestone producers in this area used scrap that resulted from block and slab production to supply local crushed-stone markets.

Sales of dimension limestone produced in the Carthage district, Missouri, are included in table 16.

Because of the increased potential for marketing crushed stone, some producers of dimension stone ventured further into that field.

TABLE 13.—Limestone (dimension stone) sold or used by producers in the United States in 1957, by States and uses

State	Active plants	Building								Curbing and 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
Florida	4			(1)	(1)	(1)	(1)	1,214	$9,560	2,759	$8,000	10,533	$322,910
Georgia	2							6,419	6,780			6,419	6,780
Hawaii	1							340	680			340	680
Illinois	5			(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	3,030	66,785
Indiana	22	520	$599	2,936,811	$2,928,327	4,296,833	$12,151,107	(1)	(1)	(1)	(1)	594,932	15,236,121
Iowa	3							(1)	(1)	(1)	(1)	3,102	10,004
Kansas	9	1,080	27,000	6,982	4,877	165,345	399,570	4,315	15,506	5,110	1,504	20,477	448,457
Michigan	4	(1)	(1)			(1)	(1)	(1)	(1)	(1)	(1)	34,741	105,854
Minnesota	3	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	24,084	1,017,955
Missouri	15	3,526	20,748			32,820	54,905	49,263	140,881	2,916	2,488	55,827	219,022
Oklahoma	3	646	3,876			17,610	17,382	100	500	5,294	3,000	2,692	24,758
Puerto Rico	7	105,150	200,350	602,638	102,107			21,395	35,675	10,000	18,000	178,619	356,132
Tennessee	1	430	351									430	351
Texas	8	3,000	36,000	221,488	200,177	343,250	854,034	500	2,500			44,444	1,092,711
Wisconsin	26	2,458	15,741	33,146	24,437	726,244	1,250,427	10,676	32,386	111,989	159,185	82,844	1,482,176
Wyoming	1	25	25									25	25
Undistributed [2]	14	17,232	61,337	182,556	346,841	349,981	1,722,045	122,040	326,071	443,594	152,229	68,837	946,487
Total	128	134,067	366,027	3,983,621	3,606,766	5,932,083	16,449,470	216,262	570,539	581,662	344,406	1,131,376	21,337,208
Average unit value			$2.73		$0.91		$2.77		$2.64		$0.59		$18.86
Short tons (approximate)		(3)		296,851		440,272				43,924			

[1] Included with "Undisbributed" to avoid disclosing individual company confidential data.
[2] Includes data indicated by footnote [1] and Alabama, Connecticut, South Dakota, 1 plant each; Nebraska and Ohio, 2 plants each; California, 3 plants; and Michigan and Pennsylvania, 4 plants.
[3] 1,587,300 cubic feet (approximate).

TABLE 14.—Limestone sold by producers in the Indiana oolitic limestone district, 1948–52 (average) and 1953–57, by classes

Year	Construction					
	Rough blocks		Sawed and semifinished		Cut	
	Thousand cubic feet	Value (thousand dollars)	Thousand cubic feet	Value (thousand dollars)	Thousand cubic feet	Value (thousand dollars)
1948–52 (average)	2,231	2,195	2,660	3,820	863	4,417
1953	2,155	2,381	3,212	4,813	682	3,740
1954	2,494	3,141	4,059	6,381	995	5,046
1955	3,260	3,878	4,405	7,777	1,142	6,512
1956	2,969	3,378	2,801	5,626	812	4,921
1957	2,937	2,928	3,289	6,044	1,007	6,106

Year	Construction—continued			Other uses		Total	
	Total						
	Thousand cubic feet	Thousand short tons (approximate)	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons (approximate)	Value (thousand dollars)
1948–52 (average)	5,754	417	10,432	165	306	582	10,738
1953	6,049	439	10,934	154	284	593	11,218
1954	7,548	547	14,568	136	408	683	14,976
1955	8,807	639	18,167	201	575	840	18,742
1956	6,582	477	13,925	163	452	640	14,377
1957	7,233	524	15,078	161	388	685	15,466

TABLE 15.—Purchased Indiana limestone sold by mills in the Indiana oolitic limestone district, 1948–52 (average) and 1953–57, by classes

Year	Sawed and semifinished		Cut		Total	
	Thousand cubic feet	Value (thousand dollars)	Thousand cubic feet	Value (thousand dollars)	Thousand cubic feet	Value (thousand dollars)
1948–52 (average)	180	254	838	4,373	1,018	4,627
1953	174	308	606	3,169	780	3,477
1954	882	1,568	1,029	5,244	1,911	6,812
1955	786	1,594	971	5,590	1,757	7,184
1956	759	1,761	1,006	6,309	1,765	8,070
1957	610	1,481	765	4,601	1,375	6,082

TABLE 16.—Limestone and marble sold by producers in the Carthage district, Jasper County, Mo., 1948–52 (average) and 1953–57, by classes

Year	Thousand short tons	Value (thousand dollars)	Year	Thousand short tons	Value (thousand dollars)
1948–52 (average)	249	1,239	1955	245	1,533
1953	246	1,169	1956	[1] 267	[1] 1,495
1954	253	1,265	1957	(2)	(2)

[1] Includes dimension marble and crushed limestone only.
[2] Figure withheld to avoid disclosing individual company operations.

SANDSTONE

The output of dimension sandstone, except for flagging, rubble, and curbing stone, decreased considerably in 1957. The average value decreased $1.76 to $21.37 per short ton, but there were some fluctuations in unit prices for different uses.

Dimension sandstone was quarried in 28 States; Ohio furnished 28 percent of the total production and 52 percent of the value. Salient statistics for bluestone in 1957 are shown in table 18. This type of sandstone splits readily into thin, uniform sheets and was used for flagging, building, and curbing.

TABLE 17.—Sandstone (dimension stone) sold or used by producers in the United States in 1957, by States and uses

State	Active plants	Building										Curbing		Flagging		Total	
		Rough construction		Rough architectural		Dressed				Rubble							
						Sawed		Cut									
		Short tons	Value	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value	Short tons	Value	Cubic feet	Value	Cubic feet	Value	Short tons (approximate)	Value
Alabama	2			17,628	$19,100									3,846	$4,200	1,675	$23,300
Arizona	11	200	$50					38,800	$65,081					162,380	144,756	15,453	209,887
Arkansas	15	13,083	151,910					202,560	216,453	494	$6,324					28,769	374,687
California	4	(1)	(1)	(1)	(1)					(1)	(1)					1,138	25,680
Colorado	10	16,804	178,114	(1)	(1)	5,063	$7,175	(1)	(1)	6,510	64,781	265	$812	150,213	43,285	44,319	462,595
Georgia	2									700	3,100			6,197	29,044	1,182	32,144
Indiana	5	(1)	(1)			324,936	626,122	(1)	(1)							(1)	(1)
Kentucky	4			23,400	32,000					10	20			3,144	3,800	2,222	35,820
Massachusetts	1			17,219	34,438											1,378	34,438
Michigan	3	970	8,400	4,875	3,900			1,738	3,000	5,034	26,590			141,951	28,252	17,889	70,675
Missouri	4			22,500	32,775	(1)	(1)			(1)	(1)			2,500	1,900	(1)	(1)
Nevada	5			(1)	(1)	9,846	29,760	11,666	16,425	(1)	(1)			4,551	9,754	2,294	62,350
New Mexico	1							645	1,200					3,871	3,000	350	4,200
New York (bluestone)	11	3,490	71,800			(1)	(1)	50,056	309,451	(1)	(1)	982	1,796	583,472	638,597	63,633	1,281,420
North Carolina	1			3,483	3,483									540	240	201	3,723
Ohio	17			575,451	1,284,865	1,430,006	4,398,442	30,348	232,068			44,644	140,712	31,450	86,584	153,113	6,142,671
Oklahoma	2	98	1,176					2,700	2,500							314	3,676
Pennsylvania [2]	24	31,271	210,467	372,801	178,780			3,907	17,092	25,754	148,162	626	804	126,106	251,703	96,849	807,008
Tennessee	7			542,760	822,501	(1)	(1)							(1)	(1)	50,367	1,101,052
Texas	2									2,263	4,325					2,263	4,325
Utah	3	(1)	(1)			(1)	(1)									1,075	28,350
Virginia	2	212	1,696											(1)	(1)	(1)	(1)
Undistributed [3]	13	25,608	100,946	125,092	319,927	100,332	308,648	136,665	250,200	7,050	36,426			106,241	244,752	70,774	1,156,196
Total	149	91,736	724,559	1,705,209	2,731,769	1,870,183	5,370,147	479,085	1,113,470	47,815	289,728	46,517	144,124	1,326,462	1,489,867	555,258	11,863,664
Average unit value			$7.90		$1.60		$2.87		$2.32		$6.06		$3.10		$1.12		$21.37
Short tons (approximate)		(4)		129,421		138,493		36,877				3,390		107,516			

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes 103,418 cubic feet of bluestone (approximately 8,739 tons) valued at $157,166 sold for rubble and flagging.
[3] Includes data indicated by footnote [1] and Kansas, New Jersey, and Oregon, 1 plant each; West Virginia, 2 plants; Washington, 3 plants; and Wisconsin, 5 plants.
[4] 1,176,100 cubic feet (approximate).

TABLE 18.—Bluestone (dimension stone) sold or used in the United States, 1948–52 (average) and 1953–57 [1]

Year	Thousand cubic feet	Value (thousand dollars)	Year	Thousand cubic feet	Value (thousand dollars)
1948–52 (average)	337	530	1955	583	1,244
1953	322	602	1956	666	1,412
1954	314	936	1957	856	1,438

[1] New York and Pennsylvania were the only producing States.

MISCELLANEOUS STONE

Statistics on the types of stone not included in the major types discussed under other headings are incorporated in table 19. The principal varieties are mica schist, argillite, soapstone, greenstone, and light-colored volcanic rocks. The total tonnage decreased in 1957, but the average unit value of $41.04 per ton almost doubled the 1956 figures. The increase was mostly in building stone. The miscellaneous varieties of building stone averaged $68.23 per ton.

TABLE 19.—Miscellaneous varieties of stone (dimension stone) sold or used by producers in the United States in 1957, by States and uses

State	Active plants	Building				Flagging		Tota	
		Rough and dressed		Rubble					
		Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
California	26	(1)	(1)	(1)	(1)	756	$16,383	37,699	$738,314
Oregon	2	1,424	$57,375	400	$2,000	150	9,000	1.974	68,375
Undistributed [2]	10	36,181	2,508,247	35,619	587,327	4,167	49,053	39,024	2,422,696
Total	38	[3] 37,605	2,565,622	36,019	589,327	[4] 5,073	74,436	78,697	3,229,385
Average unit value			$68.23		$16.36		$14.67		$41.04

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes data indicated by footnote 1 and Arizona and New Jersey, 1 plant each; Maryland and Virginia, 2 plants each; and Pennsylvania, 4 plants.
[3] Approximately 442, 412 cubic feet.
[4] Approximately 59,682 cubic feet.

FOREIGN TRADE [5]

Building- and ornamental-stone imports increased in total value, but the quantity used of the various types reported fluctuated compared with 1956. Most of the imports were marbles from Italy, Spain, France, Belgium, Portugal, and England. Granite, chiefly for memorials, was imported from Finland, Sweden, and Canada. Travertine was imported from Italy and onyx marble from Mexico.

Exportation of building and monumental stone increased 21 percent in quantity and 19 percent in value compared with 1956. Crushed, ground, or broken stone combined decreased 22 percent in quantity but increased 2 percent in value compared with 1956. Other manufactures of stone rose 34 percent in value compared with the preceding year.

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

WORLD REVIEW

North America

Canada.—The value of all varieties of dimension stone in 1956 totaled Can$6.3 million, about the same as in 1955. Production of granite was higher but the value was lower compared with 1955. Most of the granite, marble, and limestone was produced in Quebec. Sandstone came from Ontario and Nova Scotia. Imports remained about the same as 1955; about 70 percent of the marble was imported from Italy, and the remainder came from the United States. Granite was imported from the United States, Sweden, and Finland.[6]

Asia

Pakistan.—A plant was scheduled to begin dressing marble in Karachi in 1957. Full production was anticipated by 1958, when output of finished marble and marble blocks valued at PRs. 10 million a year is expected to be achieved.[7]

Africa

Algeria.—The Filfila marble quarry, 20 miles from Philippeville, resumed operations in mid-1956. The installations had been destroyed during the nationalist uprising in August 1955.[8]

Union of South Africa.—Sales of marble as building block increased about 15 percent to 23,000 cubic feet in 1956. In addition, marble chips and metallurgical applications supplied about 2,000 tons.[9]

TECHNOLOGY

Saws.—A new wet-cutting abrasive saw blade was developed. Reinforced with fiber glass, the 14-inch-diameter blade reportedly has a variety of modifications for cutting all types of masonry materials.[10]

Another wire stone-sawing machine was patented.[11]

A patent was issued on a gangsaw, with auxiliary movement of the saw frame, for cutting large blocks of stone.[12] Also, a new saw blade was patented for use on gangsaws. The blade is relatively narrow with teeth inserts mounted below a wide backup blade of plate. The narrow blade can be stretched very tight to cut perfectly straight.[13]

A gangsaw was invented for cutting vertical grooves in stone, thus making it possible to cut long slabs suitable for use as columns.[14]

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[6] Canadian Department of Mines and Technical Surveys, Building and Ornamental Stone in Canada, 1956 (Preliminary): Ottawa, 7 pp.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, pp. 27–28.
[8] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 5, May 1957, p. 30.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, p. 32.
[10] Rock Products, vol. 60, No. 5, May 1957, p. 200.
[11] Garrison, L. I. (assigned to the John Swenson Granite Co., Inc., Concord, N. H.), Wire Stone-Sawing Machine: U. S. Patent 2,795,222, June 11, 1957.
[12] Blum, H. T. (assigned to the Briar Hill Stone Co., Glenmont, Ohio), Gang Saw Machine With Auxiliary Reciprocal Movement of Saw Frame: U. S. Patent 2,797,679, July 2, 1957.
[13] Blum, H. T. (assigned to the Briar Hill Stone Co., Glenmont, Ohio), Saw Blade for Stone-Cutting Machine: U. S. Patent 2,798,473, July 9, 1957.
[14] Woodward, W. W., Gang Saw Construction for Cutting Stone: U. S. Patent 2,815,745, Dec. 10, 1957.

Stone-Cutting Machines.—A dimension-stone cutting apparatus that recycles the cutting abrasive was invented,[15] and another apparatus was patented for cutting stone along a curved surface.[16]

A design for a dimension-stone cutting machine, using enclosed spring-loaded cams for operating each of the breaker knives independently, was patented. A lubricant was fed under pressure to the knives to prevent accumulation of cuttings.[17] Another stone-cutting machine consists of rows of chisellike knives hydraulically actuated.[18]

A machine, which reportedly improves the separation of stone into uniform slabs, was patented.[19]

Artificial Stone.—Precast white artificial marble slabs were produced on a large scale for facing a 28-story bank building in Colorado.[20]

Production was begun on another artificial dimension stone in varying sizes and color schemes.[21]

Miscellaneous.—A modified coal cutter used for cutting out sandstone blocks in a sandstone quarry in Scotland was described.[22]

A magazine article outlined the principles of attaching stone veneer.[23]

A new glossary of terms for building stone in Great Britain was published.[24]

CRUSHED AND BROKEN STONE

Over 2,400 producers of crushed and broken stone operating in nearly every State sold over a half billion tons of crushed-stone products valued at almost three-quarters of a billion dollars. Thus, the 6-percent increase in tonnage maintained the upward trend that established crushed stone as one of the principal mineral commodities both in tonnage and value.

Either directly or indirectly, stone was required in virtually every phase of construction and in many industrial applications. Limestone, one of the most vital raw materials, was consumed in greater tonnages than any other stone, but large tonnages of granite, basalt, marble, and sandstone were also used in construction and industrial applications.

Concrete and roadstone applications consumed about 56 percent of the total. In addition to this quantity, much of the stone reported under "other uses" actually went into road construction as fill and base-course materials.

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15 Mackinson, C. (assigned to Terry Machinery Co., Ltd., St. Lauret, Quebec, Canada), Rock Sawing: U. S. Patent 2,808,821, Oct. 8, 1957.

16 Ghiglieri, A. (one-third each assigned to Frederick B. Cardova, Jr., South San Gabriel, Calif., and George Aspetti, Los Angeles, Calif.), Circular Cutting of Masonry Slabs: U. S. Patent 2,804,065, Aug. 27, 1957.

17 Crowl, P. S., Stone-Cutting Machine: U. S. Patent 2,778,354, Jan. 22, 1957.

18 Celapino, A. D. (assigned to R. R. Celapino and E. Ruffini, as executrices), Stone-Cutting Machine: U. S. Patent 2,808,822, Oct. 8, 1957.

19 Van Hoose, N. C. (assigned to Agatan Stone & Machinery Co., East St. Louis, Ill.), Stone-Cutting Machine: U. S. Patent 2,798,475, July 9, 1957.

20 Sparks, Truman, Precast the White Marble Face: Concrete, vol. 65, No. 8, August 1957, pp. 20–21, 26–27.

21 Nieberding, Velma, Color Stone—A Versatile New Concrete Product: Rock Products, vol. 60, No. 5, May 1957, p. 188.

22 Mine and Quarry Engineering (London), Cutting Sandstone at Auchinlea Quarry: Vol. 23, No. 6, June 1957, pp. 230–237.

23 Ritchie, T., Principles of Fixing Natural Stone Facings: Architecture and Building, vol. 32, No. 9, September 1957, pp. 363–364.

24 British Standards Institute (London), Glossary of Terms for Stone Used in Building: BS2847, 1957, 38 pp.

TABLE 20.—Crushed and broken stone sold or used by producers in the United States,[1] 1956–57, by principal uses

Use	1956			1957		
	Thousand short tons	Value		Thousand short tons	Value	
		Total (thousand dollars)	Average per ton		Total (thousand dollars)	Average per ton
Concrete and roadstone	276, 269	369, 883	$1. 34	302, 754	414, 114	$1. 37
Railroad ballast	15, 481	16, 545	1. 07	16, 581	18, 019	1. 09
Portland and natural cement [2]	86, 452	91, 604	1. 06	79, 944	84, 071	1. 05
Furnace flux (limestone)	37, 789	52, 486	1. 39	39, 384	56, 113	1. 42
Agricultural limestone	19, 864	32, 087	1. 62	[3] 19, 206	[3] 31, 556	1. 64
Lime and dead-burned dolomite [4]	17, 495	24, 028	1. 37	17, 162	25, 780	1. 50
Riprap	13, 134	15, 565	1. 19	14, 462	17, 699	1. 22
Alkali works	5, 723	5, 965	1. 04	4, 899	4, 551	. 93
Refractory [5]	1, 436	11, 054	7. 70	1, 734	11, 930	6. 88
Asphalt filler	1, 613	3, 592	2. 23	2, 054	5, 343	2. 60
Glass factories	987	2, 928	2. 97	1, 204	3, 589	2. 98
Calcium carbide works	1, 245	1, 060	. 85	857	839	. 98
Sugar factories	725	1, 750	2. 41	780	1, 866	2. 39
Paper mills	518	1, 454	2. 80	504	1, 356	2. 69
Other uses	24, 983	59, 218	2. 37	34, 918	69, 453	1. 99
Total	503, 714	689, 219	1. 37	536, 443	746, 279	1. 39
Asphaltic stone	1, 459	4, 114	2. 82	1, 169	3, 221	2. 76
Slate granules and flour [6]	526	4, 863	9. 24	512	4, 409	8. 61

[1] Includes Territories of the United States, possessions, and other areas administered by the United States
[2] Limestone, cement rock, shell, and calcareous marl.
[3] Limestone and calcareous marl.
[4] Limestone, dolomite, and shell.
[5] Ganister (sandstone and quartzite) and dolomite.
[6] Includes a small quantity of crushed slate used for lightweight aggregate.

Despite a decline in home building in 1957, the crushed-stone industry increased production facilities, being bolstered to some extent by the construction phase of the Federal Highway Program, which was under way in some areas. Emphasis shifted from a record volume of private construction in 1956 to a record volume of public works in 1957. The 9-percent increase in public construction was the sharpest rise since 1952. Largest dollar gains during 1957 were in highways (8 percent) and school construction (11 percent).[25]

Several magazine articles predicted a long-range outlook for the crushed-stone industry.[26]

The crushed-stone industry depends heavily on highway paving for volume. Fortunately, highway construction showed a substantial upward trend that was expected to continue for many years under the present and anticipated highway construction programs.

[25] U. S. Department of Commerce, Construction Review: Vol. 4, No. 2, February 1958, 57 pp.
[26] Pit and Quarry, The Highway Construction Picture: Vol. 49, No. 7, January 1957, pp. 134–137; Bell, J. N., Rock Products Forecast: Rock Products, vol. 60, No. 1, January 1957, pp. 68–79; American Roadbuilders' Association, The Highway Construction Industry in a Long-Range National Highway Program: 1957, 16 pp.

TABLE 21.—Crushed and broken stone sold or used by producers in the United States,[1] 1943–57, by uses

Year	Riprap		Concrete and roadstone		Railroad ballast		Fluxing stone (limestone)	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1943	4,950	4,835	82,412	83,398	17,236	11,346	31,570	24,506
1944	4,011	4,948	64,796	66,144	18,285	12,557	31,080	25,130
1945	4,801	5,590	64,108	65,536	21,265	14,894	27,639	22,076
1946	3,848	5,010	90,359	97,765	16,908	13,127	25,158	20,792
1947	5,733	6,514	107,078	125,753	16,350	13,567	32,570	28,688
1948	5,707	7,553	121,619	150,017	18,181	16,316	34,902	34,250
1949	7,568	9,830	124,367	158,358	17,054	15,377	30,752	32,268
1950	6,898	7,807	146,496	191,534	18,614	17,519	35,970	37,932
1951	6,989	8,438	168,766	216,418	21,368	20,337	39,930	45,622
1952	8,779	11,156	187,114	245,977	21,383	20,019	34,909	41,119
1953	7,735	10,053	189,159	251,515	20,778	20,533	40,881	53,041
1954	7,642	10,979	216,614	289,442	15,173	14,871	33,162	40,934
1955	10,286	13,680	254,588	336,260	15,871	16,758	40,068	52,906
1956	13,134	15,565	276,269	369,883	15,481	16,545	37,789	52,486
1957	14,462	17,699	302,754	414,114	16,581	18,019	39,384	56,113

Year	Refractory		Agriculture (limestone)		Other uses		Total	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1943	2,708	4,577	14,522	19,057	17,113	23,234	170,511	170,953
1944	2,314	3,922	18,941	25,316	15,534	22,770	154,961	160,787
1945	2,527	4,545	17,396	25,892	14,610	22,926	152,346	161,459
1946	2,088	4,157	22,782	32,483	16,335	28,033	177,478	201,367
1947	2,704	5,537	22,605	35,076	19,096	33,317	206,136	248,452
1948	2,557	6,531	20,942	32,035	20,033	34,396	223,941	281,098
1949	1,828	5,764	21,483	33,251	19,356	34,848	222,408	289,696
1950	2,158	5,849	19,349	30,393	20,158	40,323	249,643	331,357
1951	2,366	7,810	19,401	31,052	24,869	46,982	283,689	376,659
1952	1,951	7,262	21,152	34,464	24,412	48,769	299,700	408,766
1953	1,937	8,079	18,428	30,104	25,975	50,693	304,893	424,018
1954	1,078	5,191	18,247	30,199	[2] 117,762	[2] 155,821	[2] 409,678	[2] 547,437
1955	1,169	5,778	18,360	29,455	[2] 127,616	[2] 177,465	[2] 467,958	[2] 632,302
1956	1,436	11,054	19,864	32,087	[2] 139,741	[2] 191,599	[2] 503,714	[2] 689,219
1957	1,734	11,930	[3] 19,206	[3] 31,556	[2] 142,322	[2] 196,848	[2 3] 536,443	[2 3] 746,279

[1] Includes Territories of the United States, possessions, and other areas administered by the United States 1943–53 excludes ground sandstone, quartz, and quartzite used for abrasives and other uses; shell for various uses; and limestone, cement rock, calcareous marl, and dolomite used in making cement, lime, and dead-burned dolomite.

[2] Includes the following quantities of limestone, cement rock, shell, calcareous marl, and dolomite used in making cement, lime, and dead-burned dolomite: 1954—88,796,000 tons valued at $95,471,000; 1955—100,618,000 tons, $111,405,000; 1956—103,947,000 tons, $115,632,000; 1957—97,106,000 tons, $109,851,000. Also includes ground sandstone, quartz, quartzite, and shell used for miscellaneous purposes.

[3] Includes calcareous marl for agricultural use.

TABLE 22.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States,[1] 1948–52 (average) and 1953–57

Year	Concrete and roadstone		Railroad ballast		Total	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1948–52 (average)	149,672	192,461	19,320	17,914	168,992	210,375
1953	189,159	251,515	20,778	20,533	209,937	272,048
1954	216,614	289,442	15,173	14,871	231,787	304,313
1955	254,588	336,260	15,871	16,758	270,459	353,018
1956	276,269	369,883	15,481	16,545	291,750	386,428
1957	302,754	414,114	16,581	18,019	319,335	432,113

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

TABLE 23.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States in 1957, by States

State	Concrete and roadstone		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	[1] 2,625,195	[1] $3,298,696	(2)	(2)	[1] 2,625,195	[1] $3,298,696
Alaska	349,452	1,543,873			349,452	1,543,873
American Samoa	3,197	7,040			3,197	7,040
Arizona	[1] 567,300	[1] 325,700			[1] 567,300	[1] 325,700
Arkansas	[1] 2,283,374	[1] 2,455,710	[1] 8,112	[1] $10,302	[1] 2,291,486	[1] 2,466,012
California	15,467,253	17,786,122	172,409	184,870	15,639,662	17,970,992
Colorado	344,600	425,000			344,600	425,000
Connecticut	[1] 5,424,197	[1] 8,259,183	(2)	(2)	[1] 5,424,197	[1] 8,259,183
Florida	[1] 16,620,456	[1] 22,549,865			[1] 16,620,456	[1] 22,549,865
Georgia	[1] 7,114,501	[1] 10,126,784	635,589	777,309	[1] 7,750,090	[1] 10,904,093
Guam	630,316	914,980			630,316	914,980
Hawaii	2,468,364	4,509,175			2,468,364	4,509,175
Idaho	[1] 1,043,467	[1] 1,805,157			[1] 1,043,467	[1] 1,805,157
Illinois	23,081,191	31,056,816	1,093,438	1,373,798	24,174,629	32,430,614
Indiana	9,062,663	11,383,874	270,857	326,379	9,333,520	11,710,253
Iowa	11,415,716	13,946,187	(2)	(2)	[1] 11,415,716	[1] 13,946,187
Kansas	[1] 5,924,724	[1] 7,403,101	1,482,856	833,064	[1] 7,407,580	[1] 8,236,165
Kentucky	10,285,302	13,669,894	553,234	475,505	10,838,536	14,145,399
Maine	[1] 187,929	[1] 459,050			[1] 187,929	[1] 459,050
Maryland	4,142,452	6,884,044	240,371	401,596	4,382,823	7,285,640
Massachusetts	[1] 3,770,725	[1] 6,310,634	(2)	(2)	4,053,858	6,708,521
Michigan	4,970,530	6,131,587	(2)	(2)	[1] 4,970,530	[1] 6,131,587
Midway	3,875,001	6,700,000			3,875,001	6,700,000
Minnesota	[1] 1,974,302	[1] 2,396,866	[1] 346,921	[1] 336,393	[1] 2,321,223	[1] 2,733,259
Missouri	11,443,418	15,008,613	[1] 602,400	[1] 170,138	[1] 12,045,818	[1] 15,178,751
Montana	[1] 415,863	[1] 986,176	[1] 295	[1] 383	878,566	1,530,950
Nebraska	820,900	1,221,200	(2)	(2)	[1] 820,900	[1] 1,221,200
Nevada	28,763	36,930	139,830	147,437	168,593	184,367
New Jersey	[1] 7,283,291	[1] 16,564,323	[1] 201,341	[1] 322,683	[1] 7,484,632	[1] 16,887,006
New Mexico	1,116,900	1,328,200	161,500	164,700	1,278,400	1,492,900
New York	16,671,556	31,262,387	[1] 530,946	[1] 804,822	[1] 17,202,502	[1] 32,067,209
North Carolina	[1] 8,910,827	[1] 12,208,913	[1] 10,772	[1] 16,158	[1] 8,921,599	[1] 12,225,071
Ohio	16,955,497	21,548,070	1,451,842	1,684,424	18,407,339	23,232,494
Oklahoma	9,502,936	10,498,530	[1] 866,149	[1] 471,159	[1] 10,369,085	[1] 10,969,689
Oregon	[1] 5,067,817	[1] 6,360,665	(2)	(2)	6,501,557	7,817,626
Panama Canal Zone	38,925	74,607			38,925	74,607
Pennsylvania	[1] 16,407,684	[1] 24,734,958	1,166,649	1,915,052	[1] 17,574,333	[1] 26,650,010
Puerto Rico	729,434	1,515,625			729,434	1,515,625
Rhode Island	[1] 4,200	[1] 14,154			[1] 4,200	[1] 14,154
South Carolina	[1] 2,957,570	[1] 4,254,876	225,600	176,300	[1] 3,183,170	[1] 4,431,176
South Dakota	[1] 931,900	[1] 1,460,700	(2)	(2)	[1] 931,900	[1] 1,460,700
Tennessee	[1] 11,304,989	[1] 13,870,606	755,090	842,262	[1] 12,060,079	[1] 14,712,868
Texas	[1] 19,261,598	[1] 19,900,661	[1] 501,637	[1] 416,338	[1] 19,763,235	[1] 20,316,999
Utah	130,900	80,600	(2)	(2)	[1] 130,900	[1] 80,600
Virginia	8,443,328	12,165,178	730,914	907,879	9,174,242	13,073,057
Virgin Islands	11,500	31,000			11,500	31,000
Wake Island	5,000	6,340			5,000	6,340
Washington	5,852,114	6,144,899	(2)	(2)	[1] 5,852,114	[1] 6,144,899
West Virginia	[1] 1,719,360	[1] 2,939,972	(2)	(2)	[1] 1,719,360	[1] 2,939,972
Wisconsin	8,723,893	8,617,756	[1] 589,309	[1] 692,181	[1] 9,313,202	[1] 9,309,937
Wyoming	[1] 7,200	[1] 6,400	[1] 113,000	[1] 119,000	[1] 120,200	[1] 125,400
Undistributed [3]	14,374,250	20,922,049	3,730,180	4,448,791	15,925,149	22,971,601
Grand total	302,753,820	414,113,726	16,581,241	18,018,923	319,335,061	432,132,649

[1] To avoid disclosing confidential information, total is incomplete; the part not included is combined with "Undistributed."
[2] Included with "Undistributed."
[3] Includes data indicated by footnote [2] and Delaware, Louisiana, New Hampshire, and Vermont.

TABLE 24.—Crushed stone for concrete and roadstone sold or used by commercial and noncommercial operators in the United States,[1] 1948–52 (average) and 1953–57

(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	
	Thousand short tons	Average value per ton	Percent of change in quantity from preceding year	Percent of total quantity	Thousand short tons	Average value per ton	Percent of change in quantity from preceding year	Percent of total quantity	Thousand short tons	Percent of change in quantity from preceding year
1948–52 (average)	133,589	$1.29		89	16,083	$1.22		11	149,672	
1953	169,352	1.33	+1	90	19,807	1.29	+6	10	189,159	+1
1954	199,157	1.35	+18	92	17,457	1.22	−12	8	216,614	+15
1955	223,254	1.35	+12	88	31,334	1.14	+79	12	254,588	+18
1956	251,636	1.36	+13	91	24,633	1.10	−21	9	276,269	+9
1957	264,014	1.40	+5	87	38,740	1.18	+57	13	302,754	+10

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

Roofing-granule manufacture and sales were used as an indicator of building construction and maintenance. Manufacture of roofing materials, both the natural and artificially colored, declined in 1957, following the lag in home building. A new roofing-granule plant was erected near Charleston, S. C., to accommodate the firm's southeastern market. The $2.5-million plant houses under one roof every phase of granule processing from crushing to firing in the kiln.[27]

TABLE 25.—Roofing granules [1] sold or used in the United States, 1948–52 (average) and 1953–57, by kinds

Year	Natural		Artificially colored [2]		Total	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1948–52 (average)	417	3,659	1,156	20,032	1,573	23,691
1953	337	3,187	1,282	24,633	1,619	27,820
1954	344	3,208	1,362	26,877	1,706	30,085
1955	366	3,406	1,470	30,452	1,836	33,858
1956	323	2,873	1,361	30,854	1,684	33,727
1957	312	3,208	1,313	31,798	1,625	35,006

[1] Manufactured from stone, slate, slag, and brick.
[2] A small quantity of brick granules is included with artificially colored granules.

[27] Herod, Buren C., Bird and Son's New Roofing Granule Plant: Pit and Quarry, vol. 49, No. 12, June 1957, pp. 116–118, 138.

SIZE OF PLANTS

Over 2,400 plants crushed stone in the Nation in 1957. The number of plants and the percentage of total production in the larger sized groups remained fairly constant. The plants producing over 900,000 tons constituted only 3 percent of the total number but 25 percent of the tonnage. A thousand smaller plants produced only about 3 percent of the total output.

Portable plants, mounted on pneumatic-tired wheels, were reported to be increasing in number. Such plants were usually in places where freight costs on stone from permanent plants made the use of portable plants more economical.

TABLE 26.—Number and production of commercial crushed-stone plants in the United States,[1] 1956–57, by size of output

Size of output	1956				1957			
	Number of plants	Production		Cumulative total (thousand short tons)	Number of plants	Production		Cumulative total (thousand short tons)
		Thousand short tons	Percent of total			Thousand short tons	Percent of total	
Less than 1,000 tons	76	32	0.01	32	76	33	0.01	33
1,000 to 25,000	564	5,378	1.14	5,410	640	6,269	1.30	6,302
25,000 to 50,000	284	10,267	2.18	15,677	285	10,222	2.12	16,524
50,000 to 75,000	220	13,489	2.88	29,166	219	13,531	2.81	30,055
75,000 to 100,000	163	15,261	3.24	44,427	174	15,050	3.13	45,105
100,000 to 200,000	386	55,231	11.73	99,658	409	57,708	12.00	102,813
200,000 to 300,000	201	48,596	10.32	148,254	205	49,962	10.38	152,775
300,000 to 400,000	116	40,554	8.61	188,808	126	43,913	9.12	196,688
400,000 to 500,000	91	40,899	8.69	229,707	97	43,376	9.01	240,064
500,000 to 600,000	71	39,026	8.29	268,733	61	33,005	6.86	273,069
600,000 to 700,000	39	25,162	5.34	293,895	42	26,735	5.56	299,804
700,000 to 800,000	25	19,421	4.12	313,316	30	22,645	4.70	322,449
800,000 to 900,000	26	22,015	4.68	335,331	24	20,399	4.24	342,848
900,000 tons and over	74	135,416	28.77	470,747	75	138,386	28.76	481,234
Total	2,336	470,747	100.00	470,747	2,463	481,234	100.00	481,234

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

TRANSPORTATION

The value of crushed stone is relatively low per ton, and transportation cost in some areas was over half the delivered price. Truck transportation increased and the use of portable plants shortens transportation distances. Restrictions on wheel loads did not permit the use on highways of the large trucks used in quarries. Water transport continued to be a factor of importance in some places, notably northern Michigan and near New York City.

Output on 1 quarry was increased 50 percent (to 4,800 tons per 8-hour day) by replacing the old 15-ton, road-type trucks with 300-horsepower diesel tractors and side-dump trailers that haul 40 tons of material from the quarry face to the primary crusher.[28]

[28] Rock Products, Needed: More Rock Tonnage Solution—Larger Haulage Units: Vol. 60, No. 10, October 1957, pp. 172, 174, 176.

TABLE 27.—Crushed stone sold or used in the United States [1] in 1957, by methods of transportation

Method of transportation	Commercial operations		Commercial and noncommercial [2] operations	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Truck	270, 556	56	325, 765	61
Rail	96, 562	20	96, 562	18
Waterway	56, 893	12	56, 893	10
Unspecified	57, 223	12	57, 223	11
Total	481, 234	100	536, 443	100

[1] 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.

A high-speed conveyor-belt system carried aggregates nearly 2 miles to the wharf, and a fleet of barges on the Great Salt Lake hauled 2,000 cubic yards of the material each trip. A 13-mile fill will require about 32 million cubic yards of crushed stone and sand and gravel aggregates.[29]

GRANITE

Production of granite increased considerably in both tonnage and value in 1957 compared with the preceding year, but the value per ton decreased 17 cents to $1.21. California led in tonnage, followed by North Carolina, Georgia, and South Carolina. The major increases were in concrete and roadstone and other uses. Much of the granite reported under other uses was used for road construction as fill and base-course materials.

[29] Engineering News-Record, How Barges Are Building a Railroad Fill Over Salt Lake: Vol. 158, No. 23, June 6, 1957, pp. 34-36, 38, 42-44.

TABLE 28.—Granite (crushed and broken stone) sold or used by producers in the United States in 1957, 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	12,830	$13,250	171,887	$417,911			78,000	$72,000	262,717	$503,161
California	(2)	(2)	3,598,420	4,023,651	(2)	(2)	8,849,546	5,061,904	12,730,834	9,418,319
Colorado	16,700	39,500							16,700	39,500
Georgia	99,091	162,419	6,696,753	9,374,194	594,539	$717,787	366,137	278,693	7,756,520	10,533,093
Idaho			9,100	7,000					9,100	7,000
Maine	(2)	(2)	(2)	(2)			(2)	(2)	110,227	480,276
Massachusetts	(2)	(2)	1,152,172	2,002,659			(2)	(2)	(2)	(2)
Michigan			700	1,375					700	1,375
Minnesota	(2)	(2)	125,646	226,067	346,921	336,393	(2)	(2)	511,835	724,288
Missouri	2,480	4,371							2,480	4,371
Montana	131,465	103,088							131,465	103,088
Nevada			1,540	1,540			3,000	3,000	4,540	4,540
New Hampshire	2,687	1,881	(2)	(2)			843	590	(2)	(2)
New Jersey	(2)	(2)	504,536	1,082,956	(2)	(2)	18,000	36,000	(2)	(2)
North Carolina	(2)	(2)	8,910,827	12,208,913	(2)	(2)	(2)	(2)	9,454,310	12,835,698
North Dakota	29,000	51,900							29,000	51,900
Oklahoma	8,380	8,380	303,000	453,000					311,380	461,380
South Carolina	(2)	(2)	2,957,570	4,254,876	225,600	176,300	(2)	(2)	3,413,429	4,580,511
South Dakota	30,800	30,800							30,800	30,800
Virginia	(2)	(2)	2,124,128	3,072,688	(2)	(2)			2,416,689	3,508,744
Washington	563,087	1,008,032	(2)	(2)	(2)	(2)	(2)	(2)	698,139	1,142,182
Wyoming	9,300	14,500	7,200	6,400	113,000	119,000	6,100	4,700	135,600	144,600
Undistributed[3]	351,235	600,064	1,380,580	1,927,928	549,490	597,710	744,634	1,039,621	3,070,459	4,968,215
Total	1,257,055	2,038,185	27,944,059	39,061,158	1,829,550	1,947,190	10,066,260	6,496,508	41,096,924	49,543,041
Average unit value		$1.62		$1.40		$1.06		$0.65		$1.21

[1] Includes stone used for fill material, poultry grit, roofing granules, stone sand, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes data indicated by footnote 2 and Arizona, Connecticut, Delaware, Maryland, Oregon, Rhode Island, Tennessee, Texas, Vermont, and Wisconsin.

BASALT AND RELATED ROCK (TRAPROCK)

Dark-colored igneous rocks, including basalt, gabbro, diorite, and diabase, were used widely for concrete and roadstone and railroad ballast. Traprock was also valued for riprap and roofing granules because of its blocky fracture and high resistance to abrasion. Output increased 13 percent in 1957, and the value per ton remained the same as in 1956. Production costs have been estimated to be substantially higher than for limestone because of its greater resistance to drilling and processing. The unit value of basalt and related rocks was over 25 percent higher than the unit value reported for limestone used in concrete and roadstone. Oregon was the leading producer, followed by New Jersey and Washington.

TABLE 29.—Basalt and related rocks (traprock) (crushed and broken stone) sold or used by producers in the United States in 1957, 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	42,840	$223,560	70,978	$482,675					113,818	$706,235
American Samoa	10,125	18,750	3,002	6,927			519	$1,113	13,646	26,790
California	77,882	86,799	1,708,216	2,242,078			166,199	102,809	1,952,297	2,431,686
Colorado							3,500	65,000	3,500	65,000
Connecticut	48,043	60,288	5,424,197	8,259,183	(2)	(2)			(2)	(2)
Hawaii	(2)	(2)	1,461,878	2,961,024			(2)	(2)	1,547,102	3,046,383
Idaho	(2)	(2)	1,023,367	1,781,657			(2)	(2)	1,089,925	1,835,981
Maryland	(2)	(2)	(2)	(2)	(2)	(2)			591,654	1,085,250
Massachusetts	(2)	(2)	2,618,553	4,307,975	(2)	(2)	9,705	32,388	2,867,372	4,665,388
Michigan			40,593	60,138					40,593	60,138
Montana	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	1,171,171	1,421,719
Nevada	18,137	13,435							18,137	13,435
New Jersey	(2)	(2)	6,778,755	15,481,367	201,341	$322,683	(2)	(2)	7,634,425	17,344,644
New Mexico	9,300	6,100							9,300	6,100
Oregon	(2)	(2)	5,067,817	6,360,665	(2)	(2)			7,663,638	8,022,371
Panama Canal Zone	232	290	38,925	74,607					39,157	74,897
Pennsylvania	(2)	(2)	2,226,681	3,785,609	748,013	1,248,583	(2)	(2)	(2)	(2)
Virginia	(2)	(2)	(2)	(2)	(2)	(2)			973,568	1,609,120
Virgin Islands			11,500	31,000					11,500	31,000
Washington	698,755	828,083	4,683,202	5,098,354	(2)	(2)	(2)	(2)	5,578,608	6,193,603
Undistributed [3]	3,739,543	3,876,367	4,194,976	8,357,568	1,297,901	1,773,816	660,640	3,186,010	11,765,904	22,497,161
Total	4,644,857	5,113,672	35,352,640	59,290,827	2,247,255	3,345,082	840,563	3,387,320	43,085,315	71,136,901
Average unit value		$1.10		$1.68		$1.49		$4.03		$1.65

[1] Includes stone sold for fill material, filter rock, roofing granules, stone sand, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes data indicated by footnote 2 and Arizona, Minnesota, New York, North Carolina, Texas, and Wisconsin.

MARBLE

In some instances defective marble blocks at dimension-stone plants were crushed and sold for various purposes. In addition, several plants that formerly produced dimension stone crushed marble exclusively. Forty plants reported output of crushed marble in 1957. Marble of relatively high purity was interchangeable with high-calcium limestone for a variety of uses. It was used also as a roofing granule and as a major component in manufacturing artificial dimension stone. Colored varieties were highly prized as terrazzo, usually commanding a high price. Marble also was used to some extent in concrete, and as roadstone. Because the characteristic fracture along crystal planes tends to reduce the cohesive bond, marble is considered by some to be inferior for use as an aggregate in concrete. The average unit value for crushed and broken marble, f. o. b. plant, increased slightly over 1956 to $7.56 per ton.

Marble reported for terrazzo, except in 1956, has been increasing in recent years; 377,000 short tons, valued at $4.5 million, was reported in 1957.

TABLE 30.—Marble (crushed and broken stone) sold by producers in the United States in 1957, by States [1]

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
Alabama	4	190,682	$1,311,915	Other States [2]	24	1,063,507	$8,030,374
Alaska	1	200	6,500				
Arizona	1	1,700	29,500	Total	40	1,274,004	9,634,379
Colorado	1	10	20				
Tennessee	9	17,905	256,070	Average unit value			$7.56

[1] Includes stone used for agriculture, asphalt filler, concrete and roadstone, poultry grit, roofing, spalls, stucco, terrazzo, whiting (excluding marble whiting made by companies that purchase marble), and unspecified uses.

[2] Includes Maryland, Missouri, New Jersey, New York, North Carolina, Texas, and Virginia, 1 plant each; Vermont, 2 plants; California, 4 plants ;Georgia, 5 plants; and Washington, 6 plants.

LIMESTONE

Limestone, one of the most vital raw materials produced in the United States, was consumed in greater tonnages than any other stone in 1957. It was used in virtually every phase of construction and in many industrial applications.

Tonnage in 1957 increased 1 percent, and value increased 4 percent compared with 1956. The increased sales of limestone for concrete and roadstone, flux, and railroad ballast offset the decline in sales for riprap and agricultural and other uses.

Considerably less limestone was used for soil treatment in 1957 than was deemed necessary to maintain the Nation's soil in proper fertility.[30]

The Federal Geological Survey published a bibliography of high-calcium limestone deposits in the United States.[31]

[30] Abbott, B. T., Ag-Lime: Why Isn't More of It Used: Rock Products, vol. 60, No. 4, April 1957, pp. 96–98, 156–158.
Koch, Robert M., The Soil Bank Program—What It Means to the Ag-Lime Industry: Rock Products, vol. 60, No. 4, April 1957, pp. 94–95, 146.

[31] Gasdik, G. C., and Tagg, K. M., Annotated Bibliography of High-Calcium Limestone Deposits in the United States, Including Alaska, to April 1956: Geol. Survey Bull. 1019–I, 1957, pp. 675–713.

The Internal Revenue Service ruled that limestone rock that has a magnesium carbonate content of 35 percent or more was to be designated as dolomite and allowed the flat rate of 10-percent depletion, irrespective of use. Before the adoption of this policy, the end use of the product governed its proper depletion allowance. The Internal Revenue Service modified its policy in this respect because of a 1957 ruling by the Tax Court of the United States involving a product of The Virginian Limestone Corp. The court ruled:

> The term "dolomite" when used with reference to rock, is one of specific designation and has reference to a particular class of sedimentary rock, commonly known by that name, which is rich in magnesium carbonate; whereas, "stone" and "limestone" are terms of more general classification and may refer to rocks which contain little or no magnesium carbonate.[32]

[32] Internal Revenue Service, Revenue Ruling 57-288: Internal Revenue Bull. 1957-I, CB-518, p. 518.

TABLE 31.—Limestone (crushed and broken stone) sold or used by producers in the United States in 1957, by States and uses

State	Riprap		Fluxing stone		Concrete and road-stone		Railroad ballast		Agriculture		Miscellaneous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	([1])	([1])	1,992,420	$2,711,752	2,625,195	$3,298,696	([1])	([1])	420,643	$620,908	4,170,573	$3,827,014	9,292,275	$10,566,825
Arizona			([1])	([1])	([1])	([1])					1,012,100	1,307,500	1,138,200	1,504,000
Arkansas	46,556	$23,278	([1])	([1])	1,969,000	2,128,619	8,112	$10,302	103.109	157,074	([1])	([1])	([1])	([1])
California	94,271	88,157	([1])	([1])	1,066,563	1,112,229	720	425	([1])	([1])	11,658,019	19,639,874	13,119,168	21,745,781
Colorado	13,200	16,400	431,100	747,100	341,100	422,500					1,505,100	2,052,900	2,290,500	3,238,900
Connecticut			([1])	([1])	([1])	([1])			([1])	([1])	([1])	([1])	151,894	575,717
Florida	([1])	([1])			16,620,456	22,549,865			588,655	1,684,349	([1])	([1])	20,271,913	28,130,348
Georgia	1,000	1,000			417,748	752,590	41,050	59,522	([1])	([1])	([1])	([1])	1,174,628	1,939,392
Hawaii					241,596	412,324			1,335	10,266	21,895	21,895	264,826	444,485
Illinois	180,346	231,969	363,108	709,422	23,081,191	31,056,816	1,093,438	1,373,798	3,236,650	4,387,019	3,902,402	4,001,783	31,857,135	41,760,807
Indiana	105,897	126,935	139,958	175,705	9,062,663	11,383,874	270,857	326,379	2,229,299	2,946,525	1,851,952	1,837,424	13,660,626	16,796,842
Iowa	309,365	397,433	([1])	([1])	11,415,716	13,946,187	([1])	([1])	1,106,109	1,508,908	2,308,772	2,802,868	15,210,673	18,758.285
Kansas	344,465	313,634			5,658,525	7,297,115	([1])	([1])	196,606	256,034	([1])	([1])	8.850,949	10,829.906
Kentucky	([1])	([1])	([1])	([1])	10,278,302	13,654,894	553,234	475,505	1,101,930	1,444,770	([1])	([1])	12,708,531	16,663.337
Maryland	([1])	([1])	([1])	([1])	3,507,463	5,702,910	([1])	([1])	74,116	187,916	1,223,291	3,191,913	5,224,372	9,713,913
Massachusetts			([1])	([1])	([1])	([1])			175,729	545,054	([1])	([1])	587,744	1,512,783
Michigan	24,715	26,463	14,687,374	15,368,555	4,929,237	6,070,074	([1])	([1])	586,558	740,042	([1])	([1])	34,259,103	33,862,511
Minnesota	29,670	20,099	150	525	1,848,656	2,170,799	([1])	([1])	327,747	518,491	([1])	([1])	2,344,809	3,059.917
Mississippi									60,000	54,000			60,000	54,000
Missouri	1,530,212	1,518,813	([1])	([1])	10,931,656	14,509,494	([1])	([1])	1,902,930	2,650,786	6,179,910	7,532,662	20,880,672	27,050,398
Montana	9,896	3,032	([1])	([1])	22,978	9,867	295	383			([1])	([1])	782,607	1,036,408
Nebraska	1,158,353	1,227,050			820,900	1,221,200	([1])	([1])	99,200	166,200	([1])	([1])	3,062,453	3,742.750
New Mexico			18,800	36,000	655,600	1,033,100					41,500	78,300	715,900	1,147,400
New York	127,294	187,219	115,451	239,420	14,300,919	25,887,836	530,946	804,822	418,836	1,200,134	6,080,238	7,793,464	21,573,684	36,112,895
North Carolina					([1])	([1])	10,772	16,158	681	1,362			([1])	([1])
Ohio	410,868	275,000	5,629,422	8,090,051	16,852,044	21,436,743	1,451,842	1,684,424	2,125,569	3,414,108	10,112,701	15,699,171	36,582,446	50,599,497
Oklahoma	156,337	202,686			8,866,449	9,836,082	([1])	([1])	33,834	42,306	([1])	([1])	10,237,730	12,041,047
Oregon			([1])	([1])	([1])	([1])			([1])	([1])	967,839	1,224,243	985,355	1,275,431
Pennsylvania	([1])	([1])	8,958,591	16,151,026	13,358,435	19,558,660	291,856	451,693	([1])	([1])	14,913,221	19,652,771	([1])	([1])
Puerto Rico	12,450	33,150			681,173	1,451,277			12,000	36,000	1,519,516	1,564,316	2,225,139	3,084,743
South Dakota					644,800	955,800	([1])	([1])			([1])	([1])	1,111,600	1,632,600
Tennessee	8,191	11,061	101,753	151,603	11,304,989	13,870,606	755,090	842,262	751,395	1,002,832	2,310,491	3,009,501	15,231,909	18,887,865
Texas	147,277	204,708	464,264	457,468	12,238,309	11,401,689	501,637	416,338	66,435	73,495	5,961,022	6,862,448	19,378,944	19,416,146
Utah	15,900	40,700	808,700	1,021,500	([1])	([1])	([1])	([1])			867,700	1,276,300	1,723,300	2,359,600
Virginia	([1])	([1])	564,491	945,608	5,325,510	7,451,638	([1])	([1])	585,751	1,131,716	3,678,358	5,103,153	10,643,335	15,209,819
Washington			359	717	([1])	([1])			([1])	([1])	([1])	([1])	900,954	1,394,850
West Virginia	([1])	([1])	2,879,829	5,145,448	1,719,360	2,939,972	([1])	([1])	51,694	125,143	1,762,852	3,109,500	6,985,701	11,928,076
Wisconsin	116,007	138,670	26,965	37,981	8,319,137	8,251,175	589,309	692,181	1,167,538	1,587,462	213,190	294,176	10,432,146	11,001,645
Wyoming	153,500	283,200	([1])	([1])	([1])	([1])	([1])	([1])			([1])	([1])	1,098,400	2,073,300
Undistributed [2]	373,774	548,798	2,201,352	4,123,243	3,206,414	4,403,553	2,265,410	2,811,336	1,516,886	4,904,900	27,660,314	33,509,893	47,274,853	73,814,941
Total	5,369,544	5,919,455	39,384,087	56,113,124	202,312,084	266,178,184	8,364,568	9,965,528	18,941.235	31,397,800	[3] 109,922,956	[3] 145,393,069	384,294,474	514,967,160
Average unit value		$1.10		$1.42		$1.32		$1.19		$1.66		$1.32		$1.34

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes data indicated by footnote 1 and Idaho, Maine, Nevada, New Jersey, Rhode Island, South Carolina, and Vermont.
[3] Includes limestone, dolomite, and cement rock used in making cement, lime, and dead-burned dolomite; does not include shell.

TABLE 32.—Limestone (crushed and broken stone) sold or used by producers in the United States,[1] for miscellaneous uses, 1956–57

Use	1956		1957	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
Alkali works	5,723	5,965	4,899	4,551
Calcium carbide works	1,245	1,060	857	839
Cement—portland and natural	81,008	85,230	73,592	77,191
Coal-mine dusting	497	1,955	565	2,231
Filler (not whiting substitute):				
Asphalt	1,613	3,592	2,054	5,343
Fertilizer	406	818	345	718
Other	506	1,884	541	2,162
Filter beds	95	161	120	234
Glass factories	954	2,763	1,204	3,589
Lime and dead-burned dolomite	16,850	23,338	17,162	25,780
Limestone sand	2,560	3,433	2,311	3,054
Limestone whiting [2]	711	6,129	809	6,019
Magnesia works (dolomite)[3]	248	751	143	406
Mineral food	443	2,651	453	2,657
Mineral (rock) wool	12	17	7	8
Paper mills	518	1,454	504	1,356
Poultry grit	164	965	129	825
Refractory (dolomite)	266	446	539	1,162
Road base	267	218	130	130
Sugar factories	725	1,750	780	1,866
Other uses [4]	1,606	4,567	1,764	3,784
Use unspecified	1,209	1,704	1,015	1,488
Total	117,626	150,851	109,923	145,393

[1] Includes Hawaii and Puerto Rico.
[2] Includes stone for filler for calcimine, caulking compounds, ceramics, chewing gum, explosives, floor coverings, foundry compounds, glue, grease, insecticides, leather goods, paint, paper, phonograph records, picture-frame moldings, plastics, pottery, putty, roofing, rubber, toothpaste, wire coating, and unspecified uses. Excludes limestone whiting made by companies from purchased stone.
[3] Includes stone for refractory magnesia.
[4] Includes stone for acid neutralization, carbon dioxide, chemicals (unspecified), concrete blocks and pipes, dyes, electric products, fill material, litter and barn snow, oil-well drilling, patching plaster, rayons, rice milling, roofing granules, silicones, spalls, stucco, terrazzo, artificial stone, target sheets, and water treatment.

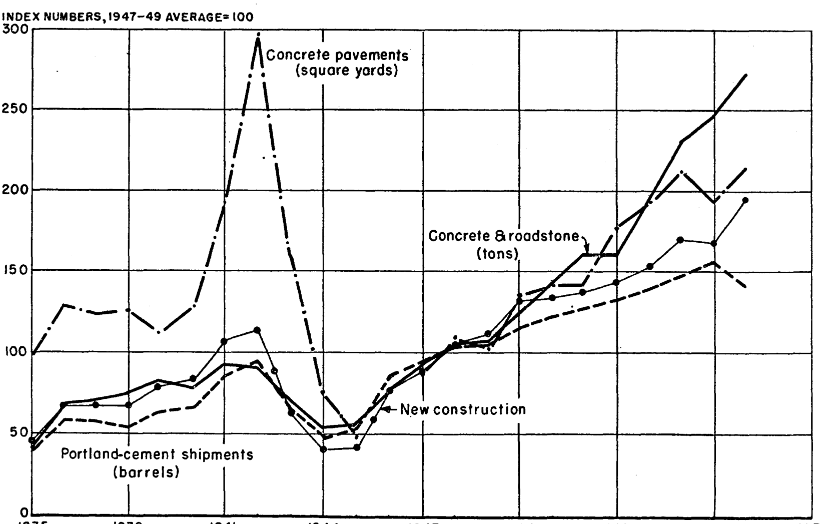

FIGURE 3.—Crushed-stone aggregates (concrete and roadstone) sold or used in the United States compared with shipments of portland cement, total new construction (value), and concrete pavements (contract awards, square yards), 1935–57.

(Data on construction from Construction and Costs and on pavements from Survey of Current Business, U. S. Department of Commerce. Construction value adjusted to 1947–49 prices.)

Most uses of dolomite were the same as for limestone, such as for concrete aggregates and roadstone. Raw dolomite of comparatively high quality was used for producing dead-burned dolomite, as a refractory material for patching furnace floors, and as a source of magnesium metal. Statistical data on dead-burned dolomite are in the Lime and Magnesium Compounds chapters of this volume. Sales of high-quality dolomite and dolomitic lime are shown by consuming industries in table 33.

Metallurgical uses of fluxing stone are indicated in table 34. The increased use of limestone as flux reflected the higher output of iron and steel.

Production of shell, which has about the same composition as limestone, declined slightly in both tonnage and value, but nearly $27 million was received from sales of shell, indicating the importance of shell as a component of the calcium carbonate materials. Texas was the leading producer, followed by Louisiana. Tables 35 and 36 show the States producing shell and its uses.

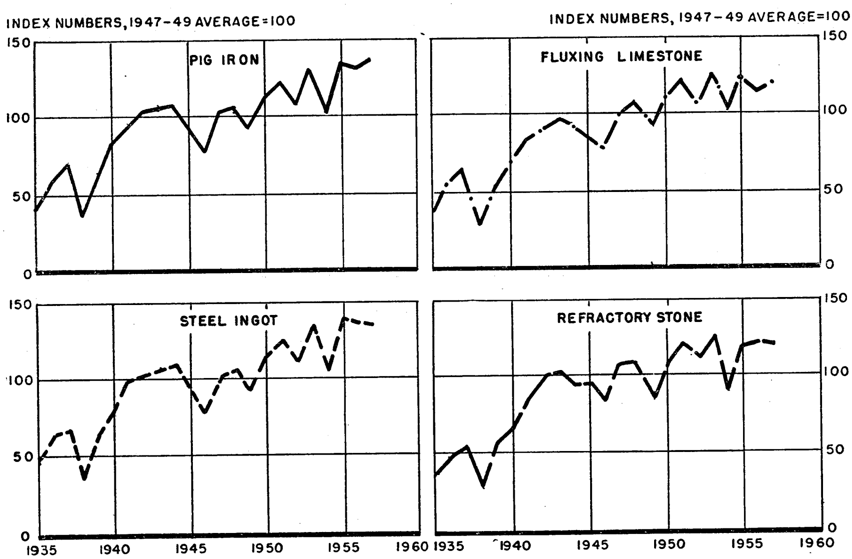

FIGURE 4.—Sales (tons) of fluxing limestone and refractory stone (including that used in making dead-burned dolomite) compared with production of steel ingot and pig iron, 1935–57.

(Statistics of steel-ingot production compiled by American Iron and Steel Institute.)

TABLE 33.—Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1956–57

	1956		1957	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
Dolomite for—				
Basic magnesium carbonate [1]	248	751	143	406
Refractory uses	266	446	538	1,162
Dolomitic lime for—				
Refractory (dead-burned dolomite)	2,424	37,740	2,251	35,871
Paper mills	87	1,042	73	875
Total (calculated as raw stone) [2]	5,536		5,329	

[1] Includes dolomite for refractory magnesia.
[2] 1 ton of dolomitic lime is equivalent to 2 tons of raw stone.

TABLE 34.—Sales of fluxing limestone, 1948–52 (average) and 1953–57, by uses

Year	Blast furnaces		Open-hearth plants		Other smelters [1]		Other metallurgical [2]		Total	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
1948–52 (average)	27,735	29,374	6,629	7,746	692	834	237	284	35,293	38,238
1953	32,650	40,555	7,062	10,977	944	1,216	225	293	40,881	53,041
1954	26,478	32,395	5,412	7,031	1,096	1,289	176	219	33,162	40,934
1955	31,674	40,380	6,578	9,933	1,423	2,018	393	575	40,068	52,906
1956	28,914	38,939	7,494	11,488	1,006	1,329	375	730	37,789	52,486
1957	29,352	41,733	9,012	12,924	809	1,086	211	370	39,384	56,113

[1] Includes flux for copper, gold, lead, zinc, and unspecified smelters.
[2] Includes flux for foundries and for cupola and electric furnaces.

TABLE 35.—Shell sold or used by producers in the United States, 1956–57, by States

State	1956		1957	
	Short tons	Value	Short tons	Value
Florida	(1)	(1)	1,503,964	$2,013,478
Louisiana	4,364,067	$6,633,385	4,382,947	7,152,176
Pennsylvania	(1)	(1)	552	10,941
Texas	12,017,878	15,483,005	9,061,761	11,844,231
Virginia	(1)	(1)	19,874	215,939
Other States [2]	3,470,062	6,251,446	3,541,037	5,530,773
Total	19,852,007	28,367,836	18,510,135	26,767,538

[1] Included with "Other States" to avoid disclosing individual company confidential data.
[2] Includes States indicated by footnote 1 and Alabama, California (1957), Maryland, and New Jersey.

TABLE 36.—Shell sold or used by producers in the United States, 1956–57, by uses

Use	1956		1957	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
Concrete and roadstone	9,248	12,733	11,334	16,721
Cement	5,444	6,374	4,701	5,234
Lime	645	690	735	852
Poultry grit	376	2,111	438	2,184
Other uses [1]	4,139	6,459	1,302	1,777
Total	19,852	28,367	18,510	26,768

[1] Includes agriculture, alkali, asphalt filler, chemicals, filter beds, magnesium metal, mineral food, paper, railroad ballast, road base, road fill, and unspecified uses.

Calcareous marl is a statistical grouping of unconsolidated calcium carbonate materials some of which contain high percentages of impurities, mainly clay. These materials are used in manufacturing cement and in agricultural applications.

TABLE 37.—Calcareous marl sold or used by producers in the United States in 1957

	Short tons	Value
Indiana	103,452	$65,011
Michigan	137,020	70,635
Wisconsin	10,747	5,276
Other States [1]	1,665,242	1,663,330
Total [2]	1,916,461	1,804,252

[1] Includes the following States: Minnesota, Mississippi, Nevada, Ohio, South Carolina, Virginia, and West Virginia.
[2] Includes 264,841 short tons, valued at $158,527, for agricultural use and 1,651,620 tons, $1,645,725, used in manufacturing cement. To avoid disclosing individual company confidential data, a small quantity of marl used in manufacturing poultry and livestock feeds is included with cement.

SANDSTONE, QUARTZ, AND QUARTZITE

Production of crushed and broken sandstone, quartz, and quartzite increased in both quantity and value, for use mainly in concrete and roadstone, riprap, and miscellaneous uses.

Quartz heat lamps used for cooking moved beyond the research laboratory to the production line, as temperatures up to 1,500° F. were produced. Since quartz can withstand high temperatures the bulb can be made so small that it almost touches the incandescent filament inside.[33]

High-quality silica that may supplant Brazilian rock quartz (laska) in ray-transmitting and optical glasses was produced in North Carolina.[34]

A new class of glass materials with ceramic properties was described. The process involved turning glass into a hard, nonporous crystalline material by addition of "nucleating agents." [35]

[33] Rock Products, vol. 60, No. 11, November 1957, p. 12.
[34] The Glass Industry, vol. 38, No. 10, October 1957, p. 560.
[35] Wall Street Journal, vol. 149, No. 102, May 24, 1957, p. 16.

TABLE 38.—Sandstone, quartz, and quartzite (crushed and broken stone) sold or used by producers in the United States in 1957, by States and uses

State	Refractory stone (ganister)		Riprap		Concrete and roadstone		Railroad ballast		Miscellaneous [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)			(2)	(2)	34,501	$70,070
Alaska					2,000	$6,000					2,000	6,000
Arizona			400	$1,000	527,300	313,700			359,900	$885,500	887,600	1,200,200
Arkansas	(2)	(2)	361,839	171,779	314,374	327,091					(2)	(2)
California	(2)	(2)	1,035,833	2,070,888	2,994,071	4,144,157	1,445	$2,168	(2)	(2)	4,221,073	6,654,288
Colorado	51,300	$186,400	24,000	11,400					2,000	61,200	77,300	259,000
Idaho			2,500	2,500	11,000	16,500			(2)	(2)	(2)	(2)
Illinois	726	7,260									726	7,260
Kentucky					7,000	15,000					7,000	15,000
Maine			2,000	3,500	183,300	434,900					185,300	438,400
Michigan			5,000	5,000							5,000	5,000
Montana			4,537	8,485	392,885	976,309	(2)	(2)	(2)	(2)	(2)	(2)
Nevada									4,425	47,832	4,425	47,832
New Mexico					453,200	287,900	161,500	164,700	10	45	614,710	452,645
Ohio	349,523	4,437,313	108,391	279,508	103,453	111,327			154,235	276,808	715,602	5,104,956
Oklahoma			252,848	290,637	52,600	78,900					305,448	369,537
Oregon	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)	232,936	494,358
Pennsylvania	306,194	3,838,049	253	333	822,568	1,390,689	126,780	214,776	38,162	206,249	1,293,957	5,650,096
South Dakota	12,000	30,700	229,800	228,100	287,100	504,900			5,000	15,000	533,900	778,700
Texas	80	250	450	500	1,800,237	1,568,370			6,500	13,500	1,807,267	1,582,620
Utah	(2)	(2)	(2)	(2)	(2)	(2)					122,100	126,800
Virginia					35,075	81,400	8,414	7,658	88,019	293,288	131,508	382,346
Washington			(2)	(2)	(2)	(2)			(2)	(2)	205,197	345,722
Undistributed [3]	475,947	2,267,564	180,718	289,361	1,364,511	1,908,037	117,884	175,284	1,909,311	8,578,537	4,351,048	13,247,422
Total	1,195,770	10,767,536	2,208,569	3,362,991	9,350,674	12,165,180	416,023	564,586	2,567,562	10,377,959	15,738,598	37,238,252
Average unit value		$9.00		$1.52		$1.30		$1.36		$4.04		$2.37

[1] Includes stone for uses listed in table 39.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes data indicated by footnote 2 and Connecticut, Georgia, Indiana, Kansas, Maryland, Minnesota, Nebraska, New York, North Carolina, Tennessee, West Virginia, and Wisconsin.

TABLE 39.—Sandstone, quartz, and quartzite (crushed and broken stone) [1] sold or used by producers in the United States, 1956–57, for miscellaneous uses

Use	1956		1957	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
Abrasives	24	128	77	387
Ferrosilicon	247	826	133	503
Filter	10	41	32	92
Flux	464	852	505	1,276
Foundry	116	350	562	1,307
Glass	33	165	221	529
Other uses [2]	1,094	5,014	1,038	6,284
Total	1,988	7,376	2,568	10,378

[1] Includes ground sandstone, quartz, and quartzite. Friable sandstone is reported in the Sand and Gravel chapter.
[2] Includes cement, filler, fill material, pottery, porcelain, tile, road base, roofing granules, spalls, stone sand, and unspecified uses.

MISCELLANEOUS STONE

Light-colored volcanic rocks, schists, phyllites, serpentine, chats, chert, conglomerate, and other stone that could not logically be classified into any of the five principal types are grouped under miscellaneous stone. The average value of $1.15 per ton was considerably lower than other rock types.

TABLE 40.—Miscellaneous varieties of stone (crushed and broken stone) sold or used by producers in the United States in 1957, 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	42,760	$89,340	104,587	$637,287			1,965	$4,585	149,312	$731,212
American Samoa			195	113			19,890	10,343	20,085	10,456
Arizona			40,000	12,000					40,000	12,000
California	141,121	233,793	6,099,983	6,264,007	(2)	(2)	(2)	(2)	(2)	(2)
Colorado	300	100	3,500	2,500					3,800	2,600
Guam	(2)	(2)	630,316	914,980			(2)	(2)	1,033,546	1,131,571
Hawaii			764,890	1,135,827			7,350	4,557	772,240	1,140,384
Idaho	48,300	34,500	(2)	(2)					(2)	(2)
Kansas			266,199	105,986	1,273,875	$541,889			1,540,074	647,875
Maine			4,629	24,150					4,629	24,150
Midway Island			3,875,001	6,700 000					3,875,001	6,700,000
Missouri			511,762	499,119	602,400	170,138	3,177	81,643	1,117,339	750,900
Nevada	4,885	6,839	27,223	35,390	139,830	147,437	(2)	(2)	(2)	(2)
New Mexico			8,100	7,200					8,100	7,200
Oklahoma	4,933	3,933	280,887	130,548	866,149	471,159	890	604	1,152,859	606,244
Oregon	294,571	404,825	(2)	(2)					(2)	(2)
Panama Canal Zone	20,250	24,000							20,250	24,000
Puerto Rico			48,261	64,348					48,261	64,348
Rhode Island			4,200	14,154					4,200	14,154
Utah	10,500	16,800	400	1,700			5,996,500	6,006,800	6,007,400	6,025,300
Wake Island			5,000	6,340					5,000	6,340
Washington	167,875	161,702	(2)	(2)			(2)	(2)	1,047,020	997,975
Wisconsin	306	123	145,581	145,581					145,887	145,704
Undistributed [3]	246,084	289,149	3,639,588	3,996,737	841,591	865,914	3,331,516	4,919,132	13,532,317	16,144,859
Total	981,885	1,265,104	16,460,302	20,697,967	3,723,845	2,196,537	9,361,288	11,027,664	30,527,320	35,187,272
Average unit value		$1.29		$1.26		$0.59		$1.18		$1.15

[1] Includes stone for fill material, flux, rock dust, roofing granules, spalls, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Includes data indicated by footnote 2 and Arkansas, Maryland, Montana, New York, Pennsylvania, South Dakota, Texas, Virginia, and Wyoming.

FOREIGN TRADE [36]

Imports of crushed and broken stone were small. They consisted chiefly of quartzite from Canada and chalk and whiting from Europe. Exports were virtually limited to border shipments.

TABLE 41.—Stone and whiting imported for consumption in the United States, 1956–57, by classes

[Bureau of the Census]

Class	1956		1957	
	Quantity	Value	Quantity	Value
Marble, breccia, and onyx:				
Sawed or dressed, over 2 inches thick---cubic feet--	900	[1] $10,589	2,305	$7,432
In blocks, rough, etc---do----	225,449	[1] 1,189,036	216,461	1,210,567
Slabs or paving tiles---superficial feet--	1,715,452	[1] 1,232,619	2,029,529	[1] 1,537,328
All other manufactures---	-----------	[1] 1,989,318	-----------	[1] 2,430,440
Total---	-----------	[1] 4,421,562	-----------	[1] 5,185,767
Granite:				
Dressed---cubic feet--	169,938	[1] 1,090,126	101,965	[1] 1,071,233
Rough---do----	68,028	[1] 284,783	64,350	293,916
Paving blocks, wholly or partially manufactured number--	5,168	115,946	46,671	53,499
Total---	-----------	[1] 1,490,855	-----------	[1] 1,418,648
Quartzite---short tons--	246,613	775,750	203,201	782,791
Travertine stone (unmanufactured)---cubic feet--	87,816	241,670	92,687	268,098
Stone (other):				
Dressed:				
Travertine, sandstone, limestone, etc. cubic feet--	24,490	38,309	22,777	[1] 73,528
Rough (monumental or building stone) cubic feet--	3,957	9,485	5,255	14,956
Rough (other)---short tons--	61,589	[1] 199,787	100,962	[1] 265,390
Marble chip or granito---do----	23,397	[1] 219,457	18,491	[1] 228,750
Crushed or ground, n. s. p. f---	-----------	18,869	-----------	44,395
Total---	-----------	[1] 485,907	-----------	[1] 627,019
Whiting:				
Chalk or whiting, precipitated---short tons--	1,076	48,417	1,266	76,649
Whiting, dry, ground, or bolted---do----	9,849	[1] 144,707	8,595	[1] 144,766
Whiting, ground in oil (putty)---do----	1	[1] 269	-----------	-----------
Total---	-----------	[1] 193,393	-----------	[1] 221,415
Grand total---	-----------	[1] 7,609,137	-----------	[1] 8,503,738

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable with years before 1954.

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

TABLE 42.—Stone exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Building and monumental stone		Crushed, ground, or broken				Other manufactures of stone (value)
			Limestone		Other		
	Cubic feet	Value	Short tons	Value	Short tons	Value	
1948–52 (average)	241,555	$544,040	(1)	(1)	(1)	(1)	$358,347
1953	411,196	960,468	691,811	$703,833	153,105	$2,204,139	464,692
1954	466,177	1,009,313	570,013	702,526	142,622	2,395,903	406,227
1955	437,644	1,024,299	936,766	1,148,781	169,074	2,923,813	394,228
1956	344,210	975,777	1,060,560	1,358,783	175,364	2,890,139	377,407
1957	415,903	1,157,728	1,080,460	1,639,890	129,559	2,699,023	506,180

1 Not separately classified before Jan. 1, 1952.

WORLD REVIEW

North America

Canada.—In Canada output of aggregates from all sources was estimated to be 151 million short tons valued at Can$102 million in 1956. Only about a third of the production was crushed stone. Most of the tonnage was sand and gravel.[37] The record limestone production of 1956 (36 million tons) was an increase of almost 10 percent over the 1955 figure and included that used in cement and lime manufacture.[38] Production of silica in Canada totaled 2 million tons in 1956, an increase of 13 percent over the 1955 record. Imports of silica, except for a small quantity from Belgium, came from the United States and totaled 850,000 tons at Can$2.6 million. Export of 180,000 tons of quartzite, valued at Can$564,000, was reported.[39] Plans were completed to market silica from Black Island, Lake Winnipeg.[40]

Whiting-substitute production in Canada totaled 16,950 tons valued at Can$172,520 in 1956, compared with 16,007 tons at Can. $162,731 in 1955. No whiting produced from chalk or precipitated calcium carbonate was reported in 1956.[41]

Roofing granules consumed in manufacturing asphalt roofing and siding in 1956 totaled 133,691 tons valued at Can$3,884,963; this slightly lower tonnage and value reflected the decline in residential construction. Domestic consumption increased and imports decreased, compared with 1955. Colored granules, comprising 92 percent igneous rocks and 8 percent slate, totaled 82 percent of the total imports. The remaining imports were of natural color.[42]

High-grade limestone for cement was mined on the west coast of Newfoundland, and reserves were reported as adequate for many years. The Geological Survey of Newfoundland investigated other

37 Canadian Department of Mines and Technical Surveys, Sand, Gravel and Crushed Stone in Canada, 1956 (Preliminary): Ottawa, 4 pp.
38 Canadian Department of Mines and Technical Surveys, Limestone (General) in Canada, 1956 (Preliminary): Ottawa, 4 pp.
39 Canadian Department of Mines and Technical Surveys, Silica in Canada, 1956 (Preliminary): Ottawa, 7 pp.
40 Precambrian, Manitoba Metallics and Crude Oil Produced Near Double: Vol. 29, No. 2, February 1956, p. 24.
41 Canadian Department of Mines and Technical Surveys, Whiting in Canada, 1956 (Preliminary): Ottawa, 3 pp.
42 Canadian Department of Mines and Technical Surveys, Roofing Granules in Canada, 1956 (Preliminary): Ottawa, 5 pp.

deposits of high-grade limestone, including one on the north coast, that might be of future interest as an export item.[43]

British West Indies (Bahama Islands).—The output of limestone in 1956 totaled 16,000 short tons valued at $105,000. Most of the production was used for paving. Smaller quantities were used for lime and in building construction.[44] In Trinidad the output of limestone totaled 690,000 long tons valued at BWI$730,000 in 1956.[45] Diorite production in Trinidad totaled 4,000 long tons valued at BWI$8,000, in 1956.[46]

Europe

Austria.—Output of quartzite totaled 54,736 metric tons in 1956 compared with 45,217 tons in 1955.[47]

Norway.—Output of dolomite in 1956 was estimated at 110,000 metric tons.[48]

Asia

India.—The State Geology and Mining Department of India estimated that limestone deposits near Rishikesk contained 35 million short tons.[49] An estimated reserve of 150 million tons was reported in the Macherla area of Guntur district.[50] The production of limestone in 1956 totaled 8 million tons compared with 7 million tons in 1955.[51]

Africa

Rhodesia and Nyasaland, Federation of.—The output of limestone in Northern Rhodesia in 1956 totaled 411,000 short tons valued at £372,000 compared with 305,000 tons at £333,000 in 1955. Southern Rhodesian production in 1956 totaled 786,000 short tons at £126,000 compared with 664,000 tons at £90,000.[52]

Uganda.—A deposit of high-grade limestone estimated at 30 million short tons was found on the Hima River, as a result of 248 drill holes.[53]

Union of South Africa.—Production of lime and limestone totaled 7.2 million short tons in 1956, about the same as in 1955.[54]

TECHNOLOGY

Drilling.—The Bureau of Mines conducted research on diamond-bit performance in several different types of stone. One report was published during the year.[55]

Vacuum drilling was reportedly faster and more efficient than the jackhammer for certain drilling operations.[56]

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[43] Western Miner and Oil Review, vol. 30, No. 8, August 1957, p. 36.
[44] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 2, August 1957, p. 26.
[45] Work cited in footnote 44, p. 26.
[46] Work cited in footnote 44, p. 33.
[47] Work cited in footnote 44, p. 33.
[48] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 6, June 1957, p. 23.
[49] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 30.
[50] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 2, February 1957, p. 27.
[51] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 28.
[52] Work cited in footnote 44, pp. 26–27.
[53] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 39.
[54] Work cited in footnote 51, pp. 27–28.
[55] Hansen, D. M., and Long, A. E., Diamond-Bit Performance in Schist: Bureau of Mines Rept. of Investigations 5291, 1957, 14 pp.
[56] Rock Products, There's Something New In Drilling: Vol. 60, No. 4, April 1957, pp. 101–103, 188.

One limestone producer made a systematic study of drilling and blasting practices and discovered that by increasing the blast-hole size and expanding the drill pattern, fragmentation was improved.[57]

Excavating.—Removing heavy overburden at lower cost has been made possible by continued improvements in earth-moving equipment. A company in Ohio ordered a new stripping shovel, having a dipper capacity of 11 cubic yards, for removing overburden to a depth of 130 feet.[58]

Blasting.—Blasting costs were reportedly reduced about 50 percent at one operation by using a patented ammonium nitrate-base explosive.[59]

The largest nonatomic blast ever fired produced 2 million yards of rock to be used for the 13-mile causeway across Great Salt Lake.[60]

The Bureau of Mines carried on research on explosives, drilling, and blasting. A Bureau of Mines publication presented experimental data on crater formation resulting from explosives in four rock types. Physical processes involved in breaking rock by explosives are deduced from analysis of these data.[61]

Plants.—Principles of automation were applied to three South Carolina plants. Conveyors and processing machinery were electrically interlocked so that when one operation was interrupted all movement behind it stopped.[62]

A dense-medium plant was developed for easy assembly at the installation site and ready transportation from deposit to deposit. Capacity of the plant ranges from 25 tons per hour and more, depending upon the material to be separated.[63]

A compact layout in Virginia quarried limestone at the rate of 200 tons per hour. Significant features were dust control and centralized electrical-control systems. The nozzles at each crusher discharged a mixture of water and wetting agent through solenoid valves that opened only when the conveyor belts were fully loaded.[64]

Disposal of dirty and seemingly unprofitable scalpings at a dolomite quarry became a problem. Special washing and screening methods were developed, and profitable recovery of 90 percent of the 80,000-ton stockpile was achieved.[65]

Details were given in an article concerning a British crushing and screening plant designed for flexibility in meeting changing demands. The design was based largely on American and Belgian practices.[66]

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[57] Vonderau, John C., Effect of Changes in Drilling and Blasting Practices at Hillsville Limestone Quarry: Min. Cong. Jour., vol. 43, No. 9, September 1957, pp. 59–61.

[58] Pit and Quarry, $1,370,000 Electric Shovel Ordered by Marquette for Operation at Superior: Vol. 50. No. 4, Octoberl 957, p. 37.

[59] Persons, Hubert C., Blasting—With Low-Cost Explosives: Rock Products, vol. 60, No. 3, March 1957, pp. 74–75, 135.

[60] Construction Methods and Equipment, Giant Blast Shatters Cliff 200 Ft. High: Vol. 39, No. 9, September 1957, pp. 194–196.

[61] Duvall, Wilbur I., and Atchison, Thomas C., Rock Breakage by Explosives: Bureau of Mines Rept. of Investigations 5356, 1957, 52 pp.

[62] Persons, Hubert C., Here Are Three Complex Operations Where Efficient Engineering Paid Off: Rock Products, vol. 60, No. 7, July 1957, pp. 86, 88, 92, 118, 120.

[63] Engineering News-Record, Heavy Media Separator Now Ready for Aggregates: Vol. 159, No. 17, Oct. 31, 1957, p. 54.

[64] Gutschick, K. A., This Small Plant Uses Big Plant Ideas: Rock Products, vol. 60, No. 2, February 1957, pp. 92–93, 133, 138.

[65] Binkley, H. M., and Jones, M. G., Waste Fines Reclaimed at a Profit: Pit and Quarry, vol. 49, No. 10, April 1957, pp. 130–131, 150.

[66] Mine and Quarry Engineering (London), Enderby Warren Quarry: Vol. 56, No. 334, October 1957, pp. 419–428.

Quartzite is an excellent aggregate, but the properties that make it a premium material also make it difficult to process. High production costs and competition from softer materials defeated operators in a Minnesota quartzite locality for over half a century. In 1956, a plant was installed, and many of the problems were overcome successfully.[67]

Two 100-ton screening and crushing plants of the type usually mounted on solid foundations were put on wheels. They followed alongside construction of an airfield in North Dakota.[68]

Underground Operations—An Arkansas open-pit limestone quarry was converted to underground recently when surface mining became increasingly difficult and uneconomical. The mine was designed for use of high-production machinery.[69]

The shift from block caving to large-scale room-and-pillar mining was successful at a California limestone mine. Mining costs, including depreciation and increased labor rates, were reportedly very close to the block-caving costs. A crawler-tread, jumbo drill used for drilling horizontally aided in cost reduction.[70]

A Georgia dimension-marble producer began crushing stone. Unlike dimension-stone surface mining in the area, crushed stone was produced from three undergound quarries. Current technology was described.[71]

The Bureau of Mines published a report on mining methods and costs at an undergound limestone quarry in Virginia.[72]

A worked-out limestone mine in Missouri was converted into a warehouse—reportedly economical and radiation-proof. Each of the 6 rooms was approximately 55,000 square feet in area and 20 feet high and had 8-inch reinforced-concrete partitions, fireproof doors, asphalt flooring, and walls and ceilings painted white for maximum lighting. Large circular limestone pillars were left to support the mine roof and to prevent cave-ins. A 60-degree temperature was maintained. The warehouse was equipped with automatic humidity control and a sprinkler system and exhaust fans to combat smoke or gas in case of fire. A railroad spur led into the hillside to underground docks that could handle 15 freight cars at once.[73]

Miscellaneous.—A patented hydraulic excavator developed by a Florida operator was used for removing detrital material from sinkholes in the rock surface. The irregularities of the holes had defied previous methods of excavation.[74]

Research.—The National Crushed Stone Association was testing the soundness of rock by a method that will indicate performance in service, and that can be done in a reasonably short time. The method

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67 Meschter, Elwood, Producer Digs Out Some New Markets for Quartzite Rock: Rock Products, vol. 60, No. 10, October 1957, pp. 136, 138, 140, 142, 200.

68 Construction Methods and Equipment, Big Agg Plants Go Mobile: Vol. 39, No. 9, September 1957, pp. 98, 100–102, 105, 109–110.

69 Rock Products, Success—How One Company Achieved It: Vol. 60, No. 4, April 1957, pp. 130–131, 133–134, 192, 194.

70 Wightman, R. H., Nalle, P. B., and Chandler, C. D., Crestmore Makes a Change: Min. Eng., vol. 9, No. 4, April 1957, pp. 450–454.

71 Severinghaus, Jr., Nelson, Current Technology in the Georgia Marble Industry: Min. Eng., vol 9, No. 12, December 1957, pp. 1341–1343.

72 Evans, Thaddeus B., and Eilertsen, N. A., Mining Methods and Costs at the Sunbright Limestone Mine, Foote Mineral Co., Sunbright, Va.: Bureau of Mines Inf. Circ. 7793, July 1957, 44 pp.

73 Pit and Quarry, Former Limestone Mine of Southwest Lime Co. Doubles as Warehouse: Vol. 50, No. 1, July 1957, p. 40.

74 Pit and Quarry, Unique Excavator Solves Quarrying Problem of Florida Operator: Vol. 49, No. 12, June 1957, pp. 84–86.

assumes that volume change or dilation of pore space is equidimensional, and therefore precise measurements of changes in length of test specimens after regular increments of freezing and thawing cycles are a measure of soundness.[75]

A limestone quarry near Buxton, Derbyshire, England, was described—reportedly the largest quarry outside the United States.[76] The working methods at a quarry and processing plant in Scotland were described.[77]

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[75] Gray, Joseph E., Rapid Method of Determining the Durability of Ledge Rock: Crushed Stone Jour., vol. 32, No. 3, September 1957, pp. 6–9, 14.
[76] Mine and Quarry Engineering (London), Tunstead Quarry: Vol. 23, No. 11, November 1957, pp. 462–471.
[77] Mine and Quarry Engineering (London), Cruicks Quarry: Vol. 23, No. 5, May 1957, pp. 182–189.

Strontium

By Albert E. Schreck[1] and Anne M. Quinn[2]

DOMESTIC OUTPUT of strontium minerals in 1957 was considerably smaller than in 1956. Demand was again satisfied primarily by imports.

DOMESTIC PRODUCTION

Although deposits of strontium minerals are known to exist in many States, commercial production for the past decade has been restricted to California and Washington.

In 1957 two firms accounted for all the domestic output—Pan Chemical Co., Los Angeles, Calif., from a celestite deposit in San Diego County, Calif., and Manufacturers Mineral Co., Seattle, Wash., from a deposit in Skagit County, Wash.

The following firms converted strontium minerals to various strontium compounds: Barium Products, Ltd., Modesto, Calif.; E. I. du Pont de Nemours & Co., Grasselli, N. J.; Foote Mineral Co., Philadelphia, Pa.; and Pan Chemical Co., Los Angeles, Calif.

A strontianite deposit a few miles north of Schoharie, N. Y., was described.[3] Some material was mined from this deposit in the late 19th century and shipped to New York City for processing.

The strontium-mineral localities in California and the history of their production as well as general information on geology, uses, and markets of strontium minerals were discussed in a publication.[4] A location map of the deposits accompanied the article.

CONSUMPTION AND USES

Most of the strontium minerals mined were converted to strontium compounds such as the carbonate, hydroxide, nitrate, oxalate, and peroxide. The latter three compounds are used chiefly in the fireworks and pyrotechnics industries because they impart a brilliant crimson color to a flame. Some of the products in which they were used were tracer bullets, highway and railway warning fusees, marine distress signals and rockets and tactical military signaling devices.

Strontium carbonate was used in ceramics, primarily frits and glazes, and in zinc refining. Other strontium compounds were used in greases, corrosion inhibitors, depilatories, medicines, plastics, and luminous paints.

Strontium metal serves as a getter to remove traces of gas from vacuum tubes.

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1 Commodity specialist.
2 Statistical clerk.
3 Gosse, Ralph C., Strontianite at Schoharie, N. Y.: Rocks and Minerals, vol. 32, Nos. 9 and 10, September–October 1957, pp. 462–463.
4 Ver Planck, William E., Strontium Minerals: Mineral Commodities of California, Bull. 176, Calif. Dept. of Nat. Res., Div. of Mines, December 1957, pp. 607–611.

Ground celestite and strontianite also are employed to purify caustic soda and to desulfurize steel.

PRICES

The prices of various strontium compounds during 1957, as quoted in Oil, Paint and Drug Reporter, were as follows: Strontium sulfate, air-floated, 90 percent, 325-mesh, bags, works, $56.70–$66.15 per short ton. This price remained stable throughout the year. Strontium carbonate, pure, drums, 5-ton lots or more, works, 35 cents per pound; 1-ton lots, works, 37 cents per pound; Technical grade, drums, works, 19 cents per pound. Strontium nitrate, barrels, carlots, works, $11 per 100 pounds; less than carlots, works, $12 per 100 pounds.

FOREIGN TRADE[5]

Strontium-mineral imports declined compared with 1956. Again, as in the previous several years, the United Kingdom and Mexico were the principal sources of the imports; Italy, for the second consecutive year, supplied a small tonnage.

No imports of strontium chemicals were reported.

TABLE 1.—Strontium minerals[1] imported for consumption in the United States 1955–57, by countries, in short tons

[Bureau of the Census]

Country	1955		1956		1957	
	Short tons	Value	Short tons	Value	Short tons	Value
North America: Mexico	2,072	$27,400	2,313	$28,225	1,896	$22,911
Europe:						
Italy			7	1,646	5	1,321
United Kingdom	4,053	100,781	7,119	161,676	4,624	106,499
Total	4,053	100,781	7,126	163,322	4,629	107,820
Grand total	6,125	128,181	9,439	191,547	6,525	130,731

[1] Strontianite or mineral strontium carbonate and celestite or mineral strontium sulfate.

WORLD REVIEW

The United Kingdom and Mexico continued to be the world's largest producers of strontium minerals. Pakistan and Germany also probably were small producers.

In Pakistan celestite has been produced from the Thana Bula Khan, Badu district, by the Sind Minerals and Refractories Co. Hyesons Electric Co., Ltd., Karachi, has applied for a lease to mine celestite in the same area. It was also reported that a celestite deposit, estimated at 7,000 to 10,000 tons, occurs near Daudkhel in the Salt Range.[6]

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

[6] Bureau of Mines, Mineral Trade Notes: Spec. Suppl. No. 50 to vol. 45, No. 6, December 1957, p. 30.

TABLE 2.—World production of strontium minerals by countries,[1] 1953–57, in short tons

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1953	1954	1955	1956	1957
Argentina				401	[2] 441
Canada [3]	43				
Italy			77	234	1,226
Mexico [3]	2,441	1,906	2,072	2,313	1,896
Morocco: So. zone					270
Pakistan	918	391	486	246	956
United Kingdom	3,321	2,352	5,320	10,304	(4)
United States	50	12	177	4,022	(5)
World total [1]	6,773	4,661	8,132	17,520	[2] 10,500

[1] In addition to countries listed, strontium minerals are produced in Germany, Poland, and U. S. S. R., but data on production are not available; no estimates are included in the total for these countries.
[2] Estimate.
[3] United States imports.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Production included in total; Bureau of Mines not at liberty to publish.

TECHNOLOGY

A patent was issued on the use of strontium nitrate in combination with boron in pyrotechnic mixtures. The mixture composed of 65 to 80 percent strontium nitrate and 35 to 20 percent boron could be used in flares and incendiary devices.[7]

A fluorescent material composed of strontium phosphate and up to 50 percent by weight of barium phosphate in a solid solution, with an activator of either divalent tin or a mixture of divalent tin and manganese, was patented.[8]

[7] Jackson, L. D. (assigned to the United States of America as represented by the Secretary of the Navy) Pyrotechnic Composition: U. S. Patent 2,796,339, June 18, 1957.
[8] McKeag, Alfred H. (assigned to General Electric Co., a corporation of New York), Divalent Tin Activated Strontium and Strontium Barium Tetraphosphate Phosphors: U. S. Patent 2,809,167, Oct. 8, 1957.

Sulfur and Pyrites

By Leonard P. Larson [1] and Annie L. Mattila [2]

HIGHLIGHTING the events in the sulfur industry in 1957 were the emergence of Mexico as a major producer and the increased competition for world and domestic markets that led to reduction in the price of Frasch sulfur.

TABLE 1.—Salient statistics of the sulfur industry in the United States, 1948–52 (average) and 1953–57, in long tons of sulfur content

	1948–52 (average)	1953	1954	1955	1956	1957
Production (all forms)	5,874,061	6,247,971	6,675,200	7,026,778	7,818,112	7,003,888
Imports (pyrites and sulfur)	93,078	92,229	135,128	206,188	[1] 387,455	664,770
Producers' stocks (Frasch and recovered sulfur)	[2] 2,995,960	3,129,830	3,337,086	3,301,465	4,055,896	4,579,623
Exports (sulfur)	1,377,060	1,271,011	1,675,130	1,635,652	1,675,331	1,579,721
Apparent domestic consumption (all forms)	4,631,965	5,049,400	4,912,600	5,625,400	[1] 5,744,300	5,563,200

[1] Revised figure.
[2] Frasch sulfur only before 1952.

DOMESTIC PRODUCTION

Production of sulfur in all forms during 1957 totaled about 7 million tons, down 10 percent from 1956. Of this output 5.5 million tons (78 percent) was produced at Frasch-process mines.

NATIVE SULFUR

Production in the United States of native sulfur declined to a 4 year low in 1957 when it dropped 15 percent below the output recorded in 1956. The output of native sulfur from mines other than Frasch in California and Nevada increased by about 31 percent.

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

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TABLE 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States, 1948–52 (average) and 1953–57, in long tons

	1948–52 (average)		1953		1954		1955		1956		1957	
	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	5,075,560	5,075,561	5,155,342	5,155,342	5,514,640	5,514,640	5,738,978	5,738,978	6,423,883	6,423,883	5,491,212	5,491,212
From other mines [1]	4,664	1,455	151,819	38,257	214,157	64,333	199,899	60,902	212,476	60,402	276,868	87,313
Total native sulfur		5,077,016		5,193,599		5,578,973		5,799,380		6,484,285		5,578,525
Recovered elemental sulfur:												
Brimstone	133,663	133,248	342,297	340,827	361,107	359,135	400,754	398,601	466,848	464,629	511,936	510,307
Paste	5,442	2,519	1,723	833	284	136	380	179	287	129	452	204
Total recovered elemental sulfur		135,767		341,660		359,271		398,780		464,758		510,511
Pyrites (including coal brasses)	952,039	402,110	922,647	379,545	908,715	405,310	1,006,943	409,826	1,069,904	431,687	1,067,396	436,012
Byproduct sulfuric acid (basis 100 percent) produced at Cu, Zn, and Pb plants	651,390	212,804	775,069	253,000	791,049	258,600	992,903	324,580	1,064,406	347,954	1,194,230	390,394
Other byproduct sulfur compounds [2]	53,373	46,363	92,787	80,167	85,255	73,046	106,129	93,712	102,300	89,428	102,157	88,446
Total equivalent sulfur		5,874,060		6,247,971		6,675,200		7,026,778		7,818,112		7,003,888

[1] Sulfur content estimated for 1948-52.
[2] Hydrogen sulfide and liquid sulfur dioxide. In addition, a quantity of acid sludge is converted to H_2SO_4, but is excluded from the above figures.

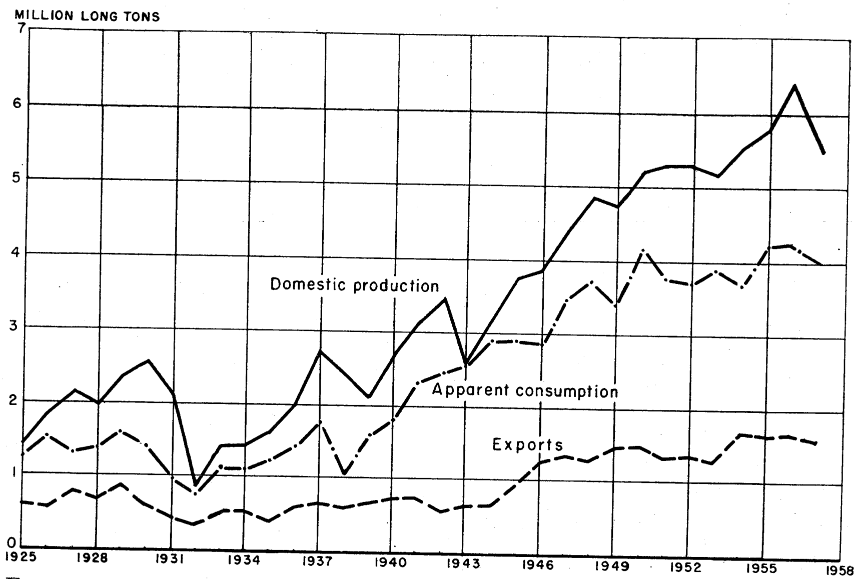

FIGURE 1.—Domestic production, apparent consumption, and exports of native sulfur, 1925–57.

Frasch Sulfur.—In 1957 the Frasch sulfur industry, which consisted of 5 companies operating a total of 13 mines, produced 5.5 million long tons. Texas contributed 61 percent of the ouptut and Louisiana 39 percent. Only 4 mines—3 in Louisiana and 1 in Texas—reported increased production; the output of all others declined and on a monthly basis was consistantly lower than in 1956. Decreases ranged from 3 percent in March and May to 26 percent in July.

Production of sulfur by the Texas Gulf Sulphur Co. from its Boling, Spindletop, and Moss Bluff domes in Texas fell. Designed with a daily water capacity of 2 million gallons, the new Texas Gulf Sulphur Co. Frasch plant at the Fannett dome in Texas was tested, and production was scheduled to begin early in 1958. The company was also constructing new facilities at Spindletop dome to permit shipment of liquid sulfur by barges or larger vessels. The company announced that it had not found sulfur in commercial quantities on the six tracts of land obtained in the first sale of offshore sulfur leases by the State of Texas following passage of the Federal Submerged Land Act of 1953. Exploratory drilling of this property had proved the dome to be noncommercial, in view of the high cost of offshore construction and operation. Exploration was continued, however, at the company dome deposit 40 miles east of Galveston, Tex.

Freeport Sulphur Co. in 1957 produced sulfur from four Louisiana salt-dome deposits. The Grande Ecaille and Garden Island Bay mines accounted for most of its output, and Bay Ste. Elaine and Chacahoula for the balance. The total was, however, 16 percent lowe than in the preceeding year. Construction and development at the company Lake Pelto and Grand Isle properties were continued. Lake Pelto had been drilled and the wells equipped for production.

TABLE 3.—Sulfur produced and shipped from Frasch mines in the United States, 1948–52 (average) and 1953–57

Year	Produced (long tons)			Shipped	
	Texas	Louisiana	Total	Long tons	Approximate value
1948–52 (average)	3,835,818	1,239,742	5,075,560	5,080,486	$99,605,000
1953	3,514,771	1,640,571	5,155,342	5,224,202	141,054,000
1954	3,505,087	2,009,553	5,514,640	5,328,040	142,014,000
1955	3,657,717	2,081,261	5,738,978	5,839,300	163,156,000
1956	3,994,393	2,429,490	6,423,883	5,675,913	150,356,000
1957	3,366,377	2,124,835	5,491,212	5,035,240	122,915,000

Preparation of the mining plant site continued. Upon completion of the mining operations at the company Bay Ste. Elaine property, the barge-mounted plant in operation there in 1957 was to be moved to Lake Pelto.

In accordance with the Leasing and Operating Regulations for the Submerged Lands of the Outer Continental Shelf (43 C. F. R. 201.61) the Secretary of the Interior approved transfer of development rights of the Grand Isle sulfur deposit from Humble Oil & Refining Co. to the Freeport Sulphur Co. Construction of facilities at Grand Isle, estimated to cost approximately $30 million, was begun. Grand Isle, which will be the first offshore sulfur mine in the history of the industry, will have unusual design features to permit offshore mining. Production was expected to be underway in 1960.

Jefferson Lake Sulphur Co. produced sulfur at Long Point and Clemens domes in Texas and Starks dome in Louisiana.

Duval Sulphur & Potash Co. produced sulfur at Orchard dome, Fort Bend County, Tex.

Standard Sulphur Co. operated its property at Damon Mound in Texas until April when it was shut down.

TABLE 4.—Sulfur ore (10–70 percent S) produced and shipped in the United States, 1948–52 (average) and 1953–57, in long tons[1]

Year	Produced (long tons)	Shipped	
		Long tons	Value
1948–52 (average)	4,664	3,794	$71,849
1953	151,819	152,473	769,140
1954	214,157	185,085	1,507,429
1955	199,899	199,899	1,697,052
1956	212,476	185,532	1,577,857
1957	276,868	172,169	1,521,425

[1] California, Colorado (1948–49 only), Nevada (except 1954), Texas (1948 only), Utah (1952 only), and Wyoming (except 1948 and 1953–57).

RECOVERED ELEMENTAL SULFUR

Eight new plants to obtain sulfur from the purification of natural and other industrial gases were completed or under construction during 1957, and the productive capacity of three existing facilities was being expanded. Of the total added capacity (274,750 long tons), 264,250 tons or 96 percent was at oil refineries and 10,500 tons or 4 percent at natural-gas-cleaning plants.

Production data for recovered elemental sulfur are included in table 2. In December the annual rate of production of recovered sulfur in the United States was about 577,000 tons.

Notable among the new installations completed or under construction at oil refineries were: The Tidewater Oil Co. 340-ton-a-day plant at Delaware City, Del.; Anlin Co. of New Jersey 35-ton-a-day plant at Perth Amboy, N. J.; Allied Chemical & Dye Corp. 50-ton-a-day plant at Bayway, N. J.; American Oil Co. 60-ton-a-day plant at Yorktown, Va.; Pontiac Eastern Corp. 25-ton-a-day plant at Hattiesburg, Miss.; and Olin Mathieson Chemical Corp. new plant at Beaumont, Tex.

New installations for recovering elemental sulfur from sour gas completed in 1957 included the Pan American Petroleum Corp. 25-ton-a-day plant at Worland, Wyo., and the Barnhart Hydrocarbon Co. plant in Reagan County, Tex. In addition, the following companies expanded capacity at existing facilities: Consolidated Chemical Industries at Baytown, Tex., Gulf Oil Co. at Port Arthur, Tex., and Wilshire Oil Co. at Norwalk, Calif.

PYRITES

Production of pyrites (ores and concentrates) in 1957 was slightly less than the record quantity mined in 1956. The sulfur content of the pyrites averaged 41 percent compared with 40 percent in 1956.

The quantity of pyrites (ores and concentrates) sold or consumed by the producing companies totaled 1,066,151 long tons compared with 1,102,721 tons in 1956.

TABLE 5.—Pyrites (ores and concentrates) produced in the United States, 1948–52 (average) and 1953–57, in long tons

Year	Quantity		Value	Year	Quantity		Value
	Gross weight	Sulfur content			Gross weight	Sulfur content	
1948-52 (average)	952,039	402,066	$4,303,200	1955	1,006,943	409,826	$8,391,000
1953	922,647	379,545	5,007,000	1956	1,069,904	431,687	10,062,000
1954	908,715	405,310	7,159,000	1957	1,067,396	436,012	9,087,000

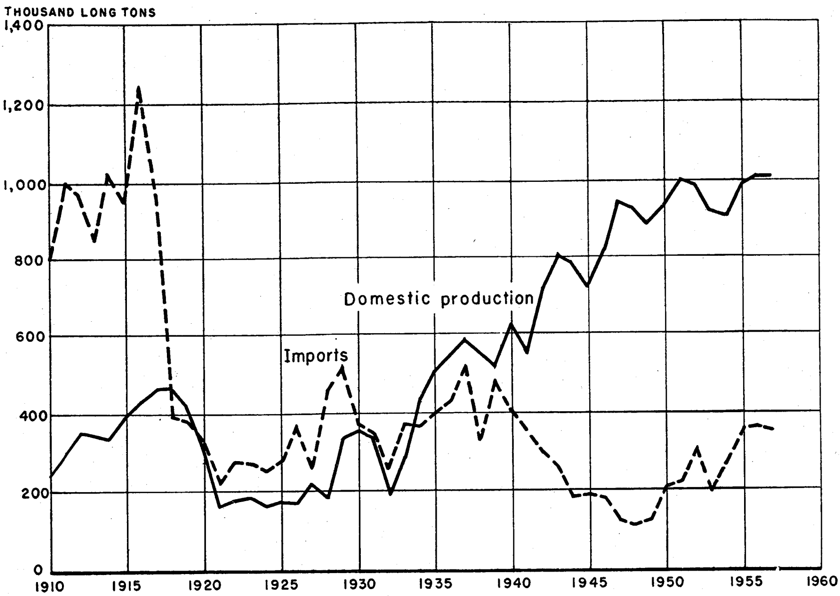

FIGURE 2.—Domestic production and imports of pyrites, 1910–57.

The output of pyrites in the Eastern United States came mainly from Tennessee, where the Tennessee Copper Co.—the largest producer—recovered it as a flotation concentrate in beneficiating copper ore from the Boyd, Burra, Calloway, Eureka, and Mary mines. The concentrate was roasted and the recovered gases converted to sulfuric acid and other products. General Chemical & Dye Corp. produced a substantial quantity of pyrites at the Cliffview mine in Carroll County. Bethlehem Steel Corp. recovered pyrites in Lebanon, Pa. Appalachian Sulphides, Inc., sold pyrites from the South Strafford mine, Orange County, Vt.

In the West a substantial quantity of pyrite was produced by the Mountain Copper Co., Ltd., at the Hornet mine in Shasta County, Calif. In Colorado pyrites was recovered by the Rico Argentine Mining Co. at the Mountain Springs mine, Dolores County, and by Climax Molybdenum Co. from its operations in Lake County. The Anaconda Co. produced pyrites from its Butte, Mont., mines.

In 1957 Tennessee was the largest producing State, followed by Virginia, California, Colorado, Montana, Arizona, Pennsylvania, and Vermont.

BYPRODUCT SULFURIC ACID

Output of byproduct sulfuric acid (100 percent H_2SO_4) at copper, lead, and zinc smelters increased 12 percent during the year from 1.2 million short tons in 1956 to 1.3 million short tons in 1957. Of this total, 855,357 tons (64 percent) was recovered at zinc plants and the balance at copper and lead smelters. Production at copper and lead plants increased 25 percent during the year and that at zinc plants 6 percent. The increased production of sulfuric acid within the past several years can be attributed in part to the increased use of sulfuric acid in processing uranium ore in the Western States.

In 1957 byproduct acid was produced at 18 plants in California, Idaho, Illinois, Indiana, Kansas, Montana, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, Washington, and Arizona.

TABLE 6.—Byproduct sulfuric acid[1] (basis, 100 percent) produced at copper, zinc, and lead plants in the United States, 1948–52 (average) and 1953–57, in short tons

	1948–52 (average)	1953	1954	1955	1956	1957
Copper plants[2]	146,228	231,213	273,725	329,114	384,659	482,181
Zinc plants[3]	583,329	636,864	612,250	782,938	807,477	855,357
Total	729,557	868,077	885,975	1,112,052	1,192,136	1,337,538

[1] Includes acid from foreign materials.
[2] Includes acid produced at a lead smelter. Excludes acid made from pyrites concentrate in Montana and Tennessee.
[3] Excludes acid made from native sulfur.

TABLE 7.—Production of new sulfuric acid (100 percent H_2SO_4) by geographic divisions and States, 1953–57, in short tons

[U. S. Department of Commerce]

Division and State	1953	1954[1]	1955[1]	1956[1]	1957[1]
New England[2]	190,456	169,880	183,698	201,758	183,092
Middle Atlantic:					
Pennsylvania	798,484	713,074	855,913	815,016	795,929
New York and New Jersey	1,504,408	1,441,943	1,547,113	1,577,476	1,469,591
Total Middle Atlantic	2,302,892	2,155,017	2,403,026	2,392,492	2,265,520
North Central:					
Illinois	1,131,632	1,257,759	1,305,576	1,272,453	1,241,474
Indiana	487,892	440,166	562,315	519,853	493,151
Michigan	226,254	217,888	261,493	220,604	241,587
Ohio	661,492	656,226	745,051	714,454	713,201
Other[3]	548,985	536,234	720,435	789,369	760,127
Total North Central	3,056,255	3,108,273	3,594,870	3,516,733	3,449,540
South:					
Alabama	306,565	269,576	243,024	251,314	314,669
Florida	900,099	1,185,883	1,233,281	1,497,155	1,738,945
Georgia	229,104	212,732	256,075	339,751	318,325
North Carolina	163,762	142,048	152,159	137,127	120,207
South Carolina	188,514	163,373	160,711	146,046	131,933
Virginia	532,003	463,897	537,095	527,257	488,707
Kentucky and Tennessee	857,874	944,404	974,827	1,035,739	995,277
Texas	996,601	1,212,530	1,477,179	1,552,202	1,605,445
Delaware and Maryland	1,210,674	1,203,399	1,353,567	1,325,004	1,094,275
Louisiana	602,858	730,021	788,311	782,330	727,144
Other[4]	437,816	467,898	459,035	402,121	428,682
Total South	6,425,870	6,995,761	7,635,264	7,996,046	7,963,609
West[5]	1,051,435	1,127,560	1,502,502	1,630,319	1,834,777
Total United States	13,026,908	13,556,491	15,319,360	15,737,348	15,696,538

[1] Includes information for Government-owned and privately operated plants.
[2] Includes data for plants in Maine, Rhode Island, Massachusetts, and Connecticut.
[3] Includes data for plants in Missouri, Wisconsin, Iowa, and Kansas.
[4] Includes data for plants in West Virginia, Mississippi, Arkansas, and Oklahoma.
[5] Includes data for plants in Arizona, California, Colorado, Idaho, Nevada (1956–57), New Mexico (1956–57), Montana, Utah, Washington, and Wyoming.

OTHER BYPRODUCT-SULFUR COMPOUNDS

In addition to the elemental sulfur recovered, a relatively small quantity of sulfur dioxide and hydrogen sulfide also was recovered from industrial gases. Almost all of the hydrogen sulfide was recovered at oil refineries, whereas the entire production of sulfur dioxide was obtained from smelter gases. In 1957 hydrogen sulfide and/or sulfur dioxide was produced in California, Tennessee, Pennsylvania, Louisiana, and New Jersey.

CONSUMPTION AND USES

Domestic consumption of sulfur in all forms declined 3 percent from the 5.7 million tons consumed in 1956. The decline in the use of sulfur reflected the decline of business in the major consuming industries, such as fertilizers, chemicals, steel, paper, pigments, and rayon. Nonacid uses decreased, although the demand for sulfuric acid for use in oil refining, uranium, and titanium-pigment products remained high.

TABLE 8.—Apparent consumption of native sulfur in the United States, 1948–52 (average) and 1953–57, in long tons

	1948–52 (average)	1953	1954	1955	1956	1957
Apparent sales to consumers [1]	5, 135, 996	5, 201, 711	[2] 5, 373, 439	[2] 5, 846, 702	[2] 5, 730, 800	[2] 5, 090, 660
Imports	1, 467	1, 229	1, 214	34, 627	[3] 212, 229	495, 668
Total	5, 137, 463	5, 202, 940	5, 374, 653	5, 881, 329	[3] 5, 943, 029	5, 586, 328
Exports:						
Crude	1, 345, 350	1, 241, 536	1, 645, 000	1, 600, 951	[3] 1, 651, 307	1, 562, 301
Refined	31, 710	29, 475	30, 130	34, 701	[3] 24, 024	17, 420
Total	1, 377, 060	1, 271, 011	1, 675, 130	1, 635, 652	1, 675, 331	1, 579, 721
Apparent consumption	3, 760, 403	3, 931, 929	3, 699, 523	4, 245, 677	[3] 4, 267, 698	4, 006, 607

[1] Production adjusted for net change in stocks during the year.
[2] Includes native sulfur from mines that do not use the Frasch process. A small quantity was consumed before 1954; however, this tonnage was not included in the above figures.
[3] Revised figure.

TABLE 9.—Apparent consumption of sulfur in all forms in the United States, 1948–52 (average) and 1953–57, in long tons [1]

	1948–52 (average)	1953	1954	1955	1956	1957
Native sulfur [2]	3, 760, 405	3, 931, 900	3, 699, 500	4, 245, 700	[3] 4, 267, 700	4, 006, 600
Recovered sulfur shipments	118, 700	313, 800	342, 300	380, 100	432, 300	472, 700
Pyrites:						
Domestic production	402, 120	379, 500	405, 300	409, 800	431, 700	436, 000
Imports	91, 620	91, 000	133, 900	171, 500	175, 200	169, 100
Total pyrites	493, 740	470, 500	539, 200	581, 300	606, 900	605, 100
Smelter-acid production	212, 760	253, 000	258, 600	324, 600	348, 000	390, 400
Other production [4]	46, 360	80, 200	73, 000	93, 700	89, 400	88, 400
Total	4, 631, 965	5, 049, 400	4, 912, 600	5, 625, 400	[3] 5, 744, 300	5, 563, 200

[1] Crude sulfur or sulfur content.
[2] In addition, a small quantity of native sulfur from mines that do not use the Frasch process was consumed, however, this tonnage was not included in the above figures before 1954.
[3] Revised figure.
[4] 1948–49, hydrogen sulfide; 1950–57, 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 10.—Estimates of principal nonacid uses of sulfur and pyrites (sulfur equivalent) in the United States, 1955–57, in thousand long tons

[Chemical Engineering]

Use	1955	1956	1957[1]
Wood pulp [2]	425	450	450
Carbon bisulfide	300	275	270
Other chemicals, dyes	125	130	130
Insecticides, fungicides	125	130	130
Rubber	80	80	80
Other	195	175	160
Total	1,250	1,240	1,220

[1] Bureau of Mines estimate.
[2] Includes an estimated 10,000 tons of S equivalent in pyrites used in making sulfite liquor.

TABLE 11.—Estimates of United States use of sulfuric acid [1] (basis, 100 percent), 1955–57, in thousand short tons

[Chemical Engineering]

Industry	1955	1956 [2]	1957 [3]	Industry	1955	1956 [2]	1957 [3]
Fertilizers:				Iron and steel	1,160	1,265	1,020
Superphosphate	4,650	4,650	4,550	Other metallurgical	248	265	270
Ammonium sulfate	1,650	1,600	1,600	Industrial explosives	450	475	450
Chemicals	4,195	4,350	4,400	Textile finishing	30	30	30
Petroleum refining	1,800	1,900	2,000	Miscellaneous [4]	675	675	[4] 640
Inorganic pigments	1,400	1,450	1,380				
Rayon and film	750	850	780	Total	17,008	17,510	17,120

[1] Recycled acid, including reused, concentrated, fortified, and reconstituted acid is estimated at about 2,024,000 short tons in 1955, 1,822,000 tons in 1956, and 1,700,000 (estimate) tons in 1957.
[2] Chemical Engineering estimate.
[3] Bureau of Mines estimate.
[4] Includes estimated total acid going into military explosives. About ⅔ goes into recycled acid later.

STOCKS

On December 31, 1957, producers' stocks of Frasch sulfur totaled 4,422,548 tons, up 12 percent from the end of 1956. Of this total 4,039,047 tons was held at the mines and 383,501 tons was elsewhere. Stocks of recovered sulfur totaled 157,075 tons at the end of 1957 compared with 119,446 tons at the end of 1956—a net gain of about 32 percent. Inventory statistics on pyrites are not available.

PRICES

During 1957 competition increased in both the domestic and foreign markets. In an effort to meet competition Texas Gulf Sulphur Co., on September 18, announced a price reduction of $3 per ton on bright sulfur and $2.50 per ton on dark sulfur to United States and Canadian consumers. Shortly thereafter Freeport Sulphur Co. announced a straight $3-per-ton reduction on domestic, Canadian, and other exports. Texas Gulf then modified its prices accordingly. Other domestic producers followed with similar reductions. The new schedules of United States producers' prices thus pegged bright sulfur at $23.50 per long ton f. o. b. mines and dark at $22.50 per ton. Export prices were reduced to $25 per ton for bright and $24 per ton for dark f. o. b. port. Trade-journal quotations of Mexican prices dropped from $25 to $23 for bulk filtered crude, f. o. b. Coatzacoalcos in October, but in December Mexican sulfur was raised to $24 per ton.

In December 1957 sulfur was quoted in E&MJ Metal and Mineral Markets at $23.50 per long ton bright and $22.50 per ton dark f. o. b. mines; for United States buyers f. o. b. vessel, Galveston, $25 per long ton; for foreign buyers f. o. b. vessel, Galveston, $25 to $28 per long ton. Oil, Paint and Drug Reporter quoted crude domestic bright bulk f. o. b. cars, mines, $23.50 per long ton; export f. o. b. vessel, Gulf ports, $25 per long ton.

E&MJ Metal and Mineral Markets quoted domestic and Canadian pyrites per long ton nominal at $9 to $11 delivered to consumers' plants. Oil, Paint and Drug Reporter quoted pyrites, Canadian works, 48–50 percent sulfur, $5 to $6 per long ton. The f. o. b. mine valuation reported by domestic producers to the Bureau of Mines ranged from $3.19 to $10.09 per long ton.

FOREIGN TRADE [3]

Imports.—Imports of elemental sulfur into the United States increased from 212,229 tons in 1956 to 495,668 tons in 1957 as receipts from Mexico rose sharply.

Exports.—Foreign demand for United States Frasch sulfur declined slightly below the 1.6 million tons that had prevailed several years. This decline in exports has been attributed to loss of market in United Kingdom, France, Australia, and New Zealand in the face of increased competition from Mexico and the availability of increased amounts of indigenous sulfur in the importing countries.

TABLE 12.—Sulfur imported into and exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

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
1948–52 (average)	1,342	$38,633	125	$19,183	1,345,350	$30,699,150	31,710	$2,021,125
1953	525	18,456	704	32,658	1,241,536	34,553,709	29,475	2,019,670
1954	110	2,289	1,104	[1] 55,958	1,645,000	50,361,661	30,130	2,161,979
1955	24,152	595,485	10,475	264,172	1,600,951	48,707,725	34,701	2,453,756
1956	14,750	358,893	[2] 197,479	4,975,324	[2] 1,651,307	[2] 48,305,416	[2] 24,024	[2] 1,776,843
1957	14,454	350,382	481,214	11,881,736	1,562,301	43,437,565	17,420	1,527,938

[1] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.
[2] Revised figure.

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

TABLE 13.—Sulfur exported from the United States, 1956–57, by countries of destination

[Bureau of the Census]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1956		1957		1956		1957	
	Long tons	Value	Long tons	Value	Pounds	Value	Pounds	Value
North America:								
Canada	406,400	$11,938,649	347,856	$9,920,295	6,345,661	$278,729	6,072,121	$282,790
Central America	39	1,861			566,461	25,258	889,759	34,220
Mexico			27	984	367,076	37,921	331,145	37,409
West Indies	20,703	581,400	19,591	529,309	240,472	10,968	473,062	16,413
Total	427,142	12,521,910	367,474	10,450,588	7,519,670	352,876	7,766,087	370,832
South America:								
Argentina	44,495	1,359,643	45,284	1,284,979			129,775	21,954
Bolivia			19	914			50,000	2,160
Brazil	87,962	2,540,262	99,335	2,701,415	657,484	66,758	9,619,220	209,281
Chile							2,200	584
Colombia					1,029,831	48,882	717,549	41,499
Ecuador					77,350	4,020		
Paraguay	132	4,026	97	3,028	82,700	3,883		
Peru			976	32,205	2,129,152	52,372	485,596	16,792
Uruguay	2,739	80,231	4,420	123,760	44,000	2,400	136,289	5,291
Venezuela	1,483	50,987	1,784	59,666	1,292,718	56,068	1,127,047	57,941
Total	136,811	4,035,149	151,915	4,205,967	5,313,235	234,383	12,267,676	355,502
Europe:								
Austria	21,216	784,566	19,350	636,050				
Belgium-Luxembourg	55,103	2,038,169	84,620	2,563,513	80,000	2,100	85,992	2,765
France	147,470	4,274,560	132,092	3,647,320			43,592	1,240
Germany, West	43,700	1,239,000	67,335	1,928,710	313,500	58,917	416,950	80,693
Greece					21,347,232	409,658	213,887	6,488
Netherlands			10,800	287,250	76,500	9,950		
Norway					80,000	2,080	174,500	7,522
Portugal					57,200	9,235	81,400	12,851
Sweden			11,610	317,730	36,000	7,439	91,150	18,929
Switzerland	43,213	1,249,592	29,675	810,292	166,500	33,738	113,450	22,761
United Kingdom	323,844	8,989,743	246,405	6,467,445				
Yugoslavia			2,000	85,000				
Other Europe	31,344	972,528	35,088	937,155	72,800	12,812	64,000	12,902
Total	665,890	19,548,158	638,975	17,680,465	22,229,732	545,929	1,284,921	166,151
Asia:								
India	[1] 66,063	[1] 1,878,268	102,590	2,790,780	[1] 12,845,021	[1] 349,945	7,429,766	210,421
Indonesia	6,380	186,680	1,781	45,735	381,000	25,058	2,649,585	85,999
Iran	2,973	118,634	14,972	537,334				
Israel					118,192	6,513	237,036	8,668
Japan	23,256	664,112	49	1,862	43,000	7,965	76,620	15,760
Korea, Republic of	393	15,920	596	21,242	1,720,363	40,592	3,632,174	104,339
Lebanon			1,300	32,500	109,480	2,481	218,460	4,608
Pakistan	1,151	42,318	1,986	66,613				
Philippines	1,128	54,501	7,651	211,494	381,877	20,700	856,707	43,704
Syria					1,044,336	28,123	407,340	10,355
Turkey					18,400	4,315		
Other Asia	3,419	[1] 118,924	2,197	67,330	307,712	7,987	774,672	24,933
Total	[1] 104,763	[1] 3,079,357	133,122	3,774,890	[1] 16,969,381	[1] 493,679	16,282,360	508,787
Africa:								
Algeria	19,335	559,380	16,111	427,588				
Egypt	3,048	110,900	2,617	100,873	17,100	2,907		
Morocco			7,000	196,000				
Tunisia	12,325	351,588	12,743	330,575				
Union of South Africa	71,500	2,075,500	80,350	2,218,800	936,450	67,670	685,135	33,718
Other Africa	3,000	93,000	7,949	204,012				
Total	109,208	3,190,368	126,770	3,477,848	953,550	70,577	685,135	33,718
Oceania:								
Australia	121,623	3,472,039	80,185	2,119,440	153,600	34,195	299,300	56,181
New Zealand	85,870	2,458,435	63,860	1,728,367	674,779	45,204	435,191	36,767
Total	207,493	5,930,474	144,045	3,847,807	828,379	79,399	734,491	92,948
Grand total	**[1] 1,651,307**	**[1] 48,305,416**	**1,562,301**	**43,437,565**	**[1] 53,813,947**	**[1] 1,776,843**	**39,020,670**	**1,527,938**

[1] Revised figure.

TABLE 14.—Pyrites, containing more than 25 percent sulfur, imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries

[Bureau of the Census]

Country	1948–52 (average)		1953		1954		1955		1956		1957	
	Long tons	Value	Long tons	Value	Long tons	Value [1]	Long tons	Value [1]	Long tons	Value [1]	Long tons	Value
North America:												
Canada	181,846	$423,915	190,227	$662,566	[2] 46,649	[2] $292,025	[2] 80,305	[2] $519,756	[2] 73,278	[2] $479,590	[2] 70,522	[2] $407,838
Cuba											110	504
Mexico			247	753								
Total	181,846	423,915	190,474	663,319	46,649	292,025	80,305	519,756	73,278	479,590	70,632	408,342
Europe:												
Germany, West			(3)	182								
Malta, Gozo, Cyprus	4	12										
Portugal	46	3,253										
Spain	9,030	25,265							18	360		
Total	9,080	28,530	(3)	182					18	360		
Oceania: Australia	4	48										
Grand total	190,930	452,493	190,474	663,501	[2] 46,649	[2] 292,025	[2] 80,305	[2] 519,756	[2] 73,296	[2] 479,950	[2] 70,632	[2] 408,342

[1] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

[2] In addition to data shown an estimated 232,920 long tons ($627,620) was imported in 1954; 277,860 long tons ($711,740) in 1955; 292,520 long tons ($865,020) in 1956; and 282,400 long tons ($889,100) in 1957, all from Canada.

[3] Less than 1 ton.

TABLE 15.—Pyrites, containing more than 25 percent sulfur, imported for consumption in the United States, 1948–52 (average) and 1953–57, by customs districts, in long tons

[Bureau of the Census]

Customs district	1948–52 (average)	1953	1954	1955	1956	1957
Buffalo	179,767	172,375	[1] 30,594	[1] 38,954	[1] 30,214	[1] 40,772
Chicago	7					
Connecticut	7				18	70
Duluth and Superior	9					
Michigan	1		260	24,348	25,188	20,744
New York	54	(2)				
Philadelphia	11,013					
Pittsburgh				682	763	54
Rochester	10					208
St. Lawrence	39	2,656	7,115	8,973	10,032	
Vermont	23	15,443	8,680	7,348	7,063	8,766
Washington					18	18
Total	190,930	190,474	[1] 46,649	[1] 80,305	[1] 73,296	[1] 70,632

[1] In addition to data shown an estimated 232,920 long tons was imported through Buffalo customs district in 1954; 277,020 long tons through Buffalo customs district and 840 long tons through Michigan customs district in 1955; 292,520 long tons through Buffalo customs district in 1956; and 282,400 long tons through Buffalo customs district in 1957.

[2] Less than 1 ton.

WORLD REVIEW

NORTH AMERICA

Canada.—Prompted by the rapid expansion in the demand for natural gas as a fuel, the Canadian producers planned to increase sulfur-recovery capacity substantially. Before 1957 only three producers recovered sulfur from natural gases. These plants, capacities, and startup dates were: Shell Oil Co. 80-long-ton-per-day Jumping Pond (Alberta) plant (May 1951), Royalite Oil Co. 30-long-ton-per-day Turner Valley (Alberta) plant (1952), and Imperial Oil Co. 20-long-ton-per-day Redwater (Alberta) plant (1956).

On January 31, 1957, the British American Oil Co. began operating a sulfur-recovery plant at Pincher Creek near Lethbridge having a rated daily capacity of 225 long tons of sulfur; this plant tripled Canada's output of sulfur recovered from sour gases.

At the end of 1957 sulfur-recovery plants in operation, under construction, or planned for completion in 1958 had a combined annual capacity of nearly 800,000 short tons. These plants include those mentioned above and the following: Jefferson Lake Sulphur Co. projected 425-ton-per-day plant at Calgary, Shell Oil, Gulf, Devon Palmer 350-ton-per-day plant at Okotoks, and the 600-ton-per-day Jefferson Lake plant at Coleman.

TABLE 16.—World production of native sulfur, by countries,[1] 1948–52 (average) and 1953–57, in long tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Mexico	8,452	5,900	52,407	475,487	758,415	1,007,915
United States	5,077,016	5,193,599	5,578,973	5,799,880	6,484,285	5,578,525
South America:						
Argentina	9,865	16,000	17,000	17,651	27,298	28,788
Bolivia (exports)	5,197	2,458	2,565	3,975	3,418	783
Chile	23,260	32,275	43,100	56,338	37,272	[3] 37,000
Colombia	1,660	2,657	5,118	5,413	4,921	[3] 5,000
Ecuador	537	100	64	1,550	----------	----------
Peru	2,271	4,916	----------	----------	----------	----------
Europe:						
France (content of ore)	9,203	10,710	----------	----------	----------	----------
Greece (content of ore)	----------	1,200	2,507	3,600	1,200	[3] 1,200
Italy (crude)[4]	202,067	224,161	194,064	181,629	170,094	171,730
Spain [3]	5,160	5,100	5,400	6,500	5,900	3,600
Asia:						
Japan	101,890	186,556	184,745	199,676	243,312	253,501
Philippines	----------	1,089	761	[3] 3,700	----------	[3] 1,300
Ryukyu Islands	----------	----------	----------	----------	254	1,003
Taiwan	2,466	3,423	5,873	4,854	7,864	9,433
Turkey	5,404	9,626	9,862	11,318	13,681	12,893
Total (estimate)[1 2]	5,600,000	5,800,000	6,300,000	7,000,000	8,000,000	7,300,000

[1] Native sulfur believed to be also produced in U. S. S. R., but complete data are not available, estimates by senior author of chapter are included in the total.
[2] This table incorporates a number of revisions of data published in previous Sulfur and Pyrites chapters. Data do not add to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] In addition, the following tonnages of ground sulfur rock (30 percent S) were produced and used as an insecticide: 1948–52 (average), 18,754 tons; 1953, 16,940 tons; 1954, 22,803 tons; 1955, 21,560 tons; 1956, 22,219 tons; 1957, 19,904 tons.

Mexico.—Production of all forms of sulfur in Mexico during 1957 totaled 1,018,663 long tons, of which 990,122 tons was Frasch, 6,889 tons other native sulfur, and 21,652 tons recovered sulfur. Stocks of Frasch sulfur on hand on December 31, 1957, totaled 660,396 long tons.[4]

Pan American Sulphur Co., the world's third largest producer, mined 723,000 long tons of Frasch sulfur in 1957, equivalent to 72 percent of the total Mexican output. The company shipped 678,000 tons. On December 31, 1957, the company stockpile was 538,000 tons. Construction of its second loading facility on the Coatzacoalcos River was completed in November and placed in operation, thus bringing the combined loading capacity to 1,500 tons per hour. Storage facilities at the port can accommodate approximately 50,000 tons. As construction during the year resulted in completion of Pan American's second relay and collection station to service an additional 10 wells, 20 wells may be operated simultaneously.[5]

[4] U. S. Embassy, Mexico City, Mexico, State Department Dispatch 1027: Apr. 22, 1957, 1 p.; State Department Dispatch 104: July 23, 1957, 2 pp.; State Department Dispatch 443: Oct. 23, 1957, 1 p.; State Department Dispatch 812: Jan. 30, 1958, 2 pp.
[5] Pan American Sulphur Co., Annual Report, 1957.

TABLE 17.—World production of pyrites (including cupreous pyrites), by countries,[1] 1948–52 (average) and 1953–57, in long tons[2]

[Compiled by Helen L. Hunt]

Country [1]	1948–52 (average) gross weight	1953		1954		1955		1956		1957	
		Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
North America:											
Canada (sales)	311,803	364,515	166,651	614,221	277,820	784,331	360,701	934,588	422,861	1,106,789	553,571
Cuba	[3] 10,000	[4] 50,000	[4] 24,200	118,105	56,690	127,497	62,473	65,230	31,832	35,638	16,782
United States	952,039	922,647	379,545	908,715	405,310	1,006,943	409,826	1,069,904	431,687	1,067,396	436,012
South America: Venezuela	------	------	------	------	------	------	------	59,053	14,173	49,211	11,811
Europe:											
Austria	10,097	69	26	------	------	------	------	------	------	------	------
Finland	196,266	255,095	108,263	248,528	105,310	298,064	126,963	289,440	127,554	292,462	[4] 125,800
France	239,294	293,293	132,395	294,612	135,264	300,532	133,240	299,054	125,603	318,506	133,773
Germany:											
East	[4] 72,800	117,416	[4] 41,300	128,046	[4] 46,300	140,742	[4] 48,200	[4] 151,600	[4] 53,100	[4] 147,600	[4] 49,200
West	458,370	506,375	180,073	556,480	193,868	579,796	206,021	634,241	253,405	596,226	237,167
Greece	97,558	233,576	[4] 102,000	206,503	[4] 90,200	229,127	[4] 100,000	232,274	102,200	[4] 226,000	[4] 98,000
Italy	913,410	1,215,072	546,827	1,231,193	562,968	1,296,212	592,494	1,349,384	634,225	1,444,909	[4] 680,000
Norway	715,962	733,095	332,105	782,362	343,697	830,453	361,776	827,327	364,158	818,178	[4] 350,000
Poland	87,240	130,309	[4] 52,000	150,879	[4] 60,000	154,127	55,608	[4] 168,000	[4] 60,800	[4] 167,000	[4] 59,000
Portugal	646,250	709,810	288,385	641,803	258,822	724,693	297,071	659,200	296,641	656,771	295,547
Spain	1,569,295	1,773,374	[4] 860,000	1,864,233	903,505	2,289,606	1,110,008	2,259,373	1,084,499	2,181,923	1,047,199
Sweden	402,221	382,848	189,178	392,896	193,563	387,852	191,009	485,672	238,939	[4] 492,000	[4] 246,000
United Kingdom	13,223	10,244	4,134	7,011	2,756	5,514	2,165	4,207	1,673	3,597	1,476
Yugoslavia	195,632	170,271	[4] 77,000	159,718	[4] 71,800	223,103	116,014	251,906	130,990	308,058	160,190
Asia:											
Cyprus	865,175	994,345	[4] 477,000	1,103,367	[4] 529,500	1,318,363	[4] 632,800	1,603,340	[4] 769,700	1,080,088	523,872
India	[5] 1,349	277	[4] 120	------	------	800	[4] 300	------	------	------	------
Japan	1,867,841	2,306,260	963,938	2,635,564	1,106,281	2,692,939	1,131,034	3,048,576	1,295,676	2,993,701	1,289,458
Korea, Republic of	148	765	[4] 350	------	------	------	------	------	------	541	217
Philippines	[3] 29	1,945	680	5,202	2,080	30,296	13,600	------	------	17,566	[4] 6,100
Taiwan	7,934	24,892	8,961	23,857	9,543	28,559	10,700	29,194	11,122	32,746	12,401
Turkey	[3] 19,045	22,727	[4] 11,300	33,935	16,928	16,137	[4] 8,100	18,793	[4] 9,400	47,767	22,735
Africa:											
Algeria	29,586	29,352	12,915	33,012	14,668	21,326	9,703	5,968	2,507	18,503	7,771
Morocco: Southern Zone	1,126	2,005	799	1,537	575	1,397	600	1,524	451	6,191	2,031
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	17,977	36,086	15,517	36,387	15,283	21,268	8,933	18,674	7,843	19,985	[4] 8,400
Tunisia	[6] 1,363	------	------	------	------	------	------	------	------	------	------
Union of South Africa	33,870	92,362	36,259	225,534	86,809	351,650	137,882	429,964	[4] 163,400	388,216	[4] 155,300
Oceania: Australia	130,662	167,008	77,812	206,780	97,649	223,477	105,837	187,394	88,137	239,033	113,876
World total (estimate) [1] [2]	11,800,000	13,600,000	5,700,000	14,700,000	6,200,000	16,300,000	6,800,000	17,300,000	7,300,000	17,000,000	7,100,000

[1] In addition to countries listed, Brazil, China, Czechoslovakia, Kenya, North Korea, Rumania, and U. S. S. R., produce or have produced pyrites, but production data are not available; estimates by senior author of chapter included in total.

[2] This table incorporates a number of revisions of data published in previous Sulfur and Pyrites chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.

[3] Average for 1 year only, as 1952 was first year of commercial production.

[4] Estimate.

[5] Average for 1951–52.

[6] Average for 1948–50.

TABLE 18.—Exports of sulfur (Frasch) from Mexico, 1953–57, by countries of destination, in long tons [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
North America:					
Canada				1,018	
United States	529		30,547	239,146	489,455
South America:					
Brazil			1,623		
Panama			5,000		
Europe:					
Belgium			5,001	9,250	5,783
France			11,507	69,586	105,267
Germany, West		49	5,951	7,922	10,723
Netherlands			14,737	11,412	29,040
Spain	3,933				
Sweden			5,882	10,105	
Switzerland				5,479	
United Kingdom			28,821	48,063	80,997
Asia:					
India				9,102	
Indonesia			4,401		
Israel			4,001		24,036
Africa:					
Union of South Africa			17,570	42,303	29,719
Oceania:					
Australia			42,460	40,606	58,066
New Zealand					30,261
Total	4,462	49	117,501	493,992	863,347

[1] Compiled from Customs Returns of Mexico.

Central Minera S. A., the Mexican subsidiary of Texas International Sulphur Co., Houston, Tex., was constructing a $3.5-million Frasch-sulfur plant on its 123,000-acre sulfur concession on the Isthmus of Tehuantepec in Mexico. Designed for a daily capacity of 1,000 tons of sulfur, the plant was scheduled for completion March 1, 1958.[6]

An agreement reportedly signed between Freeport Sulphur Co. of New York and Sulphur Exploration Co. of Houston, Tex., will permit Freeport to drill an additional 26 wells during 1958 on the Sulphur Exploration 29,000-acre concession on the Isthmus of Tehuantepec, in return for a share of any profits yielded.[7]

The Mexican Gulf Sulphur San Cristobal Dome property was closed owing to depletion of reserves. The company was to continue exploration of a nearby area.[8]

Cia. de Azufre Veracruz, a subsidiary of Gulf Sulphur Corp., increased its daily production capacity to 1,000 tons, with the addition of 5 new wells. Designed capacity was reached on November 4, when the output reached 1,023 tons.

Cia. Exploradora del Istmo, an affiliate of Texas Gulf Sulphur Co., increased the annual production rate at its Nopalapa dome property to 170,000 tons. The company, which was constructing new dock facilities, expected to begin shipments in 1958.[9]

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[6] Mining Congress Journal, Plans Mexican Sulphur Plant: Vol. 43, No. 3, March 1957, p. 94.
[7] Oil, Paint and Drug Reporter, Sulfur Deposits in Mexico To Be Tapped by Freeport: Vol. 173, No. 1, Jan. 6, 1958, p. 5.
[8] Chemical and Engineering News, vol. 35, No. 21, May 27, 1957, p. 11.
[9] Sulphur, Sulphur in Mexico: British Sulphur Corp. (London), Quart. Bull. 19, December 1957, pp. 19–21.

SOUTH AMERICA

Brazil.—Iron pyrites from Ouro Preto mines will be used at a new 125-ton-per-day, 100-percent sulfuric acid plant to be built by the State-controlled company, Sociedad Industrial de Minerios e Acidos and Fertilisantes Minas Gerais S. A., at Belo Horizonte.[10]

Chile.—Braden Copper Co. at Sewell, O'Higgins Province, will use exit gases from the copper converter at its new 75-ton-per-day, 100-per cent contact sulfuric acid plant under construction. The concentration of the gases varies between 4 and 6 percent SO_2.[11]

EUROPE

Eire.—Construction and mine development at the Avoca mine of the St. Patrick Copper Mines, Ltd., were progressing. When completed the facility was expected to have an annual production capacity of 120,000 tons of pyrite concentrate.[12]

France.—Production of elemental sulfur from the sulfur-rich gases from the Lacq natural-gas field was begun on April 21, 1957, by the Société Nationale de Pétroles d'Aquitaine (S. N. P. A.). Natural gas obtained from this field is reported to contain approximately 15.3 percent H_2S., which is removed by the Girbotol system. Acid gases, containing 66 percent H_2S, stripped from the amine solution is converted by the modified Claus process to elemental sulfur.[13]

Germany, West.—The output of sulfur in West Germany totaled 77,140 long tons; 20,861 tons was recovered from spent oxide with carbon disulfide and trichlorethylene, 15,143 tons was recovered in the wet purification of coke oven gases by Claus kiln treatment, and the balance came from hydrogen sulfide contained in oil-refinery gases extracted by the amine process and converted to elemental sulfur in Claus kilns.[14]

Italy.—Legislation authorizing the Italian Sulphur Board (Ente Zolfi Italiani) to subsidize Italian sulfur producers was approved by the Sicilian Parliament. The Italian Senate authorized the Ministry of Industry and Trade to spend 450 million lire a year for 2 years to offset the difference between Italian and world prices of sulfur used at Italian textile factories.[15] The use of sulfur ores and concentrates was reported to be growing in importance on the Italian mainland. Increased production of sulfur from central Italy and the discovery of a 10-million-ton sulfur deposit near Pomezia were reported. A partnership of three companies—Olin Mathieson Chemical Corp., Societa Italiani Squibb, and Societa Rumianca—was formed to exploit this deposit.[16]

Prospecting work carried out by the Italian Sulfur Board (Ente Zolfi Italiani) was reported to have delineated 38 sulfur-bearing areas,

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10 Chemical Week, vol. 80, No. 3, Jan. 19, 1957, p. 24.
11 Sulphur, British Sulphur Corp. (London), Quart. Bull. 17, June 1957, p. 44.
12 Work cited in footnote 11, p. 42.
13 Sulphur, Sulphur Recovery at Lacq: British Sulphur Corp. (London), Quart. Bull. 17, June 1957, pp. 22–25.
14 Chemical Age (London), German Sulphur Production: Vol. 78, No. 2000, Nov. 9, 1957, p. 763.
15 Chemical Age (London), Assistance for Italian Sulphur Industry: Vol. 77, No. 1976, May 25, 1957, p. 885.
16 Sulphur, Sulphur in Italy: British Sulphur Corp. (London), Quart. Bull. 19, December 1957, pp. 27–30.

5 of which were surveyed in detail. Commercial sulfur beds were found at S. Rosalia Sinatra, Quattrofinaite, S. Gaetano Lavanche, and Bubbonia. Small beds were found at Palma Montechiaro and Contrada Gessi.[17]

Norway.—A proposal presented to the Council of State provided for reorganization of the Group Mining Concern and formation of Als Groug Bergverk. The first objects were to be exploitation of the pyrite deposits in the Gjersvik area, estimated to contain 1.4 million tons, and development of deposits in the Juma area estimated to contain 30 million tons.[18]

Poland.—Preliminary estimates of sulfur deposits in the region of Tarnobrzeg, Rzeszow Voivodship, and Piaseczno and Szydlow, Kielce Voivodship, indicated a reserve of 95 million tons of sulfur. Waterlogging and large quantities of hydrogen sulfide gases are the main obstacles encountered in the development of these deposits. Scheduled production in 1958 was to be about 55,000 tons of crude and 10,000 tons of refined sulfur. In 1959–60 it was estimated that Poland would produce at an annual rate of 60,000 tons of sulfur.[19]

Sweden.—Sulfur was reportedly consumed in Sweden at the rate of 325,000 long tons annually in 1956, of which about 98,000 tons was in the form of brimstone, 217,000 tons in pyrites, and 7,000 tons in byproduct sulfuric acid. Slightly more than one-third of Sweden's requirements was imported; Norway was the chief source, supplying 39,357 tons of brimstone and 49,000 tons of sulfur in pyrites. Italy, Chile, and Mexico furnished 78,000 tons of brimstone in 1956. Domestic production of sulfur was reported to be stabilized at about 212,000 tons in pyrites, 30,000 tons of recovered sulfur, and 15,000 tons in byproduct sulfuric acid from Boliden's smelter gases. The competitive position of Sweden's sulfur industry was assured by the fine quality of the Boliden pyrites, which yield a high-grade iron residue in great demand by blast-furnace operators, primarily in Germany.

The combined output by Sweden's two pyrite producers (Boliden's Gruv A/B and Stora Kopparbergs Bergslag A/B) has been fairly constant at about 394,000 tons of pyritic concentrates per year. The annual output for the next 3 to 5 years is expected to total 413,000 to 443,000 tons of pyrite concentrate containing 197,000 to 221,000 tons of sulfur.[20]

ASIA

Japan.—A survey of Japan's resources disclosed that the estimated reserve of pyrites in 1956 was 136 million tons, compared with only 30 million tons in 1951. The 1956 reserves included 29.3 million tons of proved recoverable crude ore.[21]

The output from the Yanahara mine, operated by the Dowa Mining Co. in Okayama Prefecture, was to be increased. An ore

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[17] Chemical Age (London), New Sulphur Beds Discovered in Sicily: Vol. 77, No. 1969, Apr. 6, 1957, p. 605.

[18] Chemical Trade Journal and Chemical Engineer, Sulphur Pyrites in Norway: Vol. 141, No. 3661, Aug. 2, 1957, p. 289.

[19] Mining Journal, vol. 248, No. 6347, Apr. 12, 1957, p. 462.

[20] Sulphur, The Sulphur Industry of Sweden: British Sulphur Corp. (London), Quart. Bull. 16, March 1957, pp. 3–12.

[21] U. S. Embassy, Tokyo, Japan, State Department Dispatch 1159: Mar. 30, 1957, Encl. No. 2.

body discovered in 1955 on the lower side of a major fault is believed to be an offset continuation of the deposit originally mined. Development in progress included sinking a 600-meter shaft equipped with a 1,100-horsepower hoist to mine the ore body, which lies at 400 meters depth. It was reported that, when development is completed in 1960, the output will be 720,000 tons of pyrite containing 48 percent sulfur, 36,000 tons of pyrrhotite with a sulfur content of 35 percent, and 24,000 tons of cupreous pyrite containing 42 percent sulfur. The ore reserve was estimated at 20 million tons.[22]

South Korea.—The Korean Ministry of Commerce and Industry disclosed plans for constructing a sulfuric acid plant at the Chunghang smelter in Chungchong-Namdo Province. The plant, which will have a monthly capacity of 1,800 tons of 60° acid, will obtain raw material from the nearby gold, silver, copper, and lead smelter.[23]

Turkey.—Annual capacity for the newly constructed sulfuric acid plant attached to the copper refinery at Murgul, Turkey, was reported to be 70,000 tons of acid. An extension of the facilities was planned.[24]

OCEANIA

Australia.—The production capacity of Australia's sulfuric acid industry is reported to be 1,060,000 long tons per year, 95 percent of which was being used in 1956. Of the sulfuric acid produced, less than half was manufactured from indigenous materials and the balance from brimstone imported mainly from the United States. Sulfuric acid production in Australia during 1956 totaled 904,500 tons, of which 360,000 tons (40 percent) was made from domestic materials. Estimated production of sulfuric acid in 1957 was expected to total 977,600 tons, including 474,000 tons from Australian materials.

The Sulfuric Acid Bounty Bill 1957 was given its second reading.[25]

The Electrolytic Refining & Smelting Co. (Pty.), Ltd., announced plans to modernize its smelter at Port Kembla through addition of an updraft Dwight-Lloyd sintering machine. A portion of the sulfur dioxide gas obtained at the sintering plant would be cleaned and used in manufacturing sulfuric acid.[26]

Simon Curves (Australia) Pty. began construction at Geelong, Victoria, of the first plant in Australia to produce sulfuric acid from oil-refinery gases. The plant was being built for Shell Refining (Australia) Pty.[27]

TECHNOLOGY

An article discussed the mechanism of the depression of pyrite by alkali cyanides. Gaudin's work on the use of ferro- and ferri-cyanides used as depressants was verified by contact-angle measurements on pyrite conditioned with ethyl xanthate and ferro- and ferri-cyanides. Determinations were made on the rate of developing the contact angle of galena and pyrite in K-ethyl xanthate solution. Graphs showing

[22] Mining World, vol. 19, No. 4, April 1957, p. 95; Sulphur, Japan—New Pyrites Ore Body Discovered: British Sulphur Corp. (London), Quart. Bull. 19, December 1957, p. 37.
[23] Chemical Age (London), New Sulphuric Acid Plant for South Korea: Vol. 78, No. 1990, Aug. 31, 1957, p. 327.
[24] Chemical Age (London), Turkish Sulphuric Acid Plant: Vol. 77, No. 1956, Jan. 5, 1957, p. 14.
[25] Chemical Age (London), Australian Sulphuric Acid: Vol. 78, No. 1991, Sept. 7, 1957, p. 356.
[26] Mining World, vol. 19, No. 3, March 1957, p. 111.
[27] Chemical Trade Journal and Chemical Engineer, vol. 141, No. 3661, Aug. 2, 1957, p. 268.

the "development of contact angle in galena and pyrite," and another showing the rate of decrease of contact angle of xanthate-treated pyrite in water are included.[28]

A new oil-treated grade of sulfur was developed for use in rubber compounding. Fire hazards encountered in handling ordinary sulfur are reduced by this new grade, which has an extraordinarily low dusting level. The new oil-treated grade has the added advantage of dispersing more easily in rubber formulations.[29]

The equipment, experimental methods, and results of an investigation of sulfide roasting were described in an article in the trade press. Examination of partly roasted particles by micrographic, X-ray-diffraction, and chemical methods disclosed that a majority of the sulfide minerals investigated showed marked selectivity in oxidation of their contained elements.[30]

Details on the monohydrate process of waste-pickle-liquor disposal recently commercialized in Europe were presented at the 12th Purdue Industrial Waste Conference, May 13–15, 1957, at Lafayette, Ind. The process, developed in this country by Dr. E. D. Martin and Joseph Shaw, was perfected for commercial practice by Zahn & Co. in Germany.[31]

Hewitt-Robins and Freeport engineers designed a new traveling shiploader, with a special telescoping chute for loading sulfur. The chute was designed to rotate in either direction and discharge material in all positions. Material can be thrown 20 feet beyond the end of the chute. Danger of flash fires from static electricity is minimized.[32]

Basic operating principles and typical applications of impingement baffle-plate scrubbers were described in an article.[33]

The effects of sulfur in sponge-base titanium, iodide-base titanium, and various commercial and experimental titanium alloys were reported in a paper presented at the 38th Annual Convention of the American Society for Metals. The study showed that additions of up to about 0.025 percent sulfur result in considerable strengthening of titanium, with a corresponding sharp decline in ductility. The initial sharp increase in strength occurs before sulfides are encountered in the microstructure and appear to be caused by solid-solution hardening. Addition of 0.2 percent sulfur to titanium alloys containing molybdenum, vanadium, or aluminum plus vanadium cause a considerable increase in yield strength, with only a slight decline in ductility. This amount of sulfur was also sufficient to cause grain refinement in both the as-cast and wrought conditions.[34]

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[28] Majumdar, K. K., Depression of Pyrite by Cyanide Ions: Min. Mag. (London), vol. 97, No. 3, September 1957, pp. 137–139.
[29] Chemical Engineering, Vulcanizing Agents: Vol. 64, No. 4, April 1957, pp. 182–184.
[30] Thornhill, P. G., and Pidgeon, L. M., Micrographic Study of Sulfide Roasting: Jour. Metals (sec. 1), vol. 9, No. 7, July 1957, pp. 989–995.
[31] Atwood, J. S., Joseph, J. S., and Hodge, W. W., Regeneration of Waste Pickle Liquor to Produce Ferrous Sulfate Monohydrate: Blast Furnace and Steel Plant, vol. 45, No. 9, September 1957, pp. 1018–1123.
[32] Chemical Engineering, Sulfur Sparks New Bulk Loading Ideas: Vol. 64, No. 6, June 1957, pp. 164, 166.
[33] Chemical Engineering Progress, Impingement Baffle-Plate Scrubbers: Vol. 53, No. 9, September 1957, pp. 78, 86, 88.
[34] Materials and Methods, Effects of Sulfur on Titanium Alloys: Vol. 45, No. 3, March 1957, pp. 204, 206.

Talc, Soapstone, and Pyrophyllite

By Donald R. Irving [1] and Betty Ann Brett [2]

DECREASED demand for talc in ceramic products was the major cause of sharp declines in domestic mine production and sales of talc, soapstone,[3] and pyrophyllite in 1957 from the record highs of 1956. The quantity of these commodities imported for consumption dropped to the 1948–52 average.

TABLE 1.—Salient statistics of the talc, soapstone, and pyrophyllite industries in the United States, 1948–52 (average) and 1953–57

(In thousand short tons and thousand dollars)

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Mine production:						
Short tons	[1] 569	632	619	726	739	684
Value	(2)	[3] $3,524	[3] $3,493	[3 4] $4,517	[3] $4,859	[3] $4,796
Sold by producers: [5]						
Short tons	[1] 566	609	600	719	735	692
Value	[1] $9,816	$11,380	$12,634	$15,225	$15,026	$14,411
Imports for consumption: [6]						
Short tons	20	23	22	29	23	20
Value	$642	$717	$678	$986	$749	$701
Exports: [7]						
Short tons	(2)	(2)	(2)	(2)	(2)	(2)
Value	$2,146	$1,994	$1,931	$2,206	$2,454	$2,587
World: Production (estimate): Short tons	1,502	1,630	1,590	1,750	1,935	1,875

[1] Includes pinite for 1948.
[2] Data not available.
[3] Partly estimated.
[4] Revised figure.
[5] Includes some crushed material.
[6] Exclusive of "Manufactures, n. s. p. f. (not specially provided for), except toilet preparations."
[7] Includes "Manufactures, n. e. s. (not elsewhere specified)."

DOMESTIC PRODUCTION

Mine production of talc, soapstone, and pyrophyllite decreased 7 percent in quantity and 1 percent in value in 1957 compared with 1956. The quantity of talc and soapstone produced was 8 percent less; that of pyrophyllite was 4 percent less.

New York, California, and North Carolina again ranked first, second, and third in the quantity and value of talc, soapstone, and pyrophyllite produced in 1957. North Carolina continued as the major pyrophyllite-producing State, followed by Pennsylvania (sericite schist) and California.

[1] Assistant chief, Branch of Ceramic and Fertilizer Materials.
[2] Statistical clerk.
[3] Excludes soapstone sold in slabs and blocks, which is part of the stone industry.

TABLE 2.—Talc, soapstone, and pyrophyllite[1] sold by producers in the United States, 1948–52 (average) and 1953–57, by classes

Year	Crude			Sawed and manufactured		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1948–52 (average)	17,933	$182,125	$10.16	887	$295,771	$333.45
1953	18,423	185,184	10.05	935	354,847	379.52
1954	19,052	190,685	10.01	1,012	290,697	287.25
1955	47,032	340,243	7.23	1,311	397,476	303.19
1956	42,085	265,631	6.31	1,052	441,848	420.01
1957	57,382	330,131	5.75	1,212	519,664	428.77

Year	Ground[2]			Total		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1948–52 (average)	547,301	$9,338,050	$17.06	566,121	$9,815,946	$17.34
1953	589,516	10,840,283	18.39	608,874	11,380,314	18.69
1954	579,934	12,152,651	20.96	599,998	12,634,033	21.06
1955	671,043	14,487,640	21.59	719,386	15,225,359	21.16
1956	691,661	14,318,414	20.70	734,798	15,025,893	20.45
1957	633,330	13,561,497	21.41	691,924	14,411,292	20.83

[1] Includes pinite, 1948.
[2] Includes some crushed material.

TABLE 3.—Pyrophyllite[1] produced and sold by producers in the United States, 1948–52 (average) and 1953–57

Year	Production (short tons)	Sales					
		Crude		Ground		Total	
		Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	112,226	5,192	$28,187	106,274	$1,424,355	111,466	$1,452,542
1953	123,457	2,480	15,564	119,057	1,581,826	121,537	1,597,390
1954	126,702	3,015	18,552	114,998	1,644,337	118,013	1,662,889
1955	158,460	19,830	124,904	[2] 135,506	2,005,069	155,336	2,129,973
1956	167,756	20,847	121,497	141,143	1,808,502	161,990	1,929,999
1957	160,538	26,414	127,865	135,368	1,925,973	161,782	2,053,838

[1] Includes sericite schist, 1953–57.
[2] Includes a small quantity of sawed material.

Total sales of crude, sawed and manufactured, and ground talc, soapstone, and pyrophyllite decreased 6 percent in quantity and 4 percent in value in 1957, compared with 1956. The average value of crude material continued to decline. It was 9 percent below 1956 and 43 percent below the 1948–52 average. The average values per ton of sawed and manufactured and ground material increased from 1956.

During 1957 the Virginia Division of Mineral Resources announced that field studies and geologic mapping of areas containing soapstone

TABLE 4.—Crude talc, soapstone, and pyrophyllite produced in the United States, 1956–57, by States

State	1956		1957	
	Short tons	Value [1]	Short tons	Value [1]
Alabama	2,200	$4,500	1,600	$3,200
California	153,710	1,419,227	133,915	1,525,660
Georgia	57,916	122,166	49,372	106,000
Maryland and Virginia	26,574	90,107	24,690	100,346
Montana	22,197	210,139	(2)	(2)
Nevada	10,540	98,506	7,467	57,162
North Carolina	125,487	529,205	120,905	557,850
Texas	41,332	244,368	47,780	199,387
Washington	(2)	(2)	4,065	24,525
Other States [3]	299,083	2,141,141	294,659	2,222,182
Total	739,039	4,859,359	684,453	4,796,312

[1] Partly estimated.
[2] Included with "Other States."
[3] Includes States indicated by footnote 2 and Arkansas, New York, Pennsylvania, and Vermont.

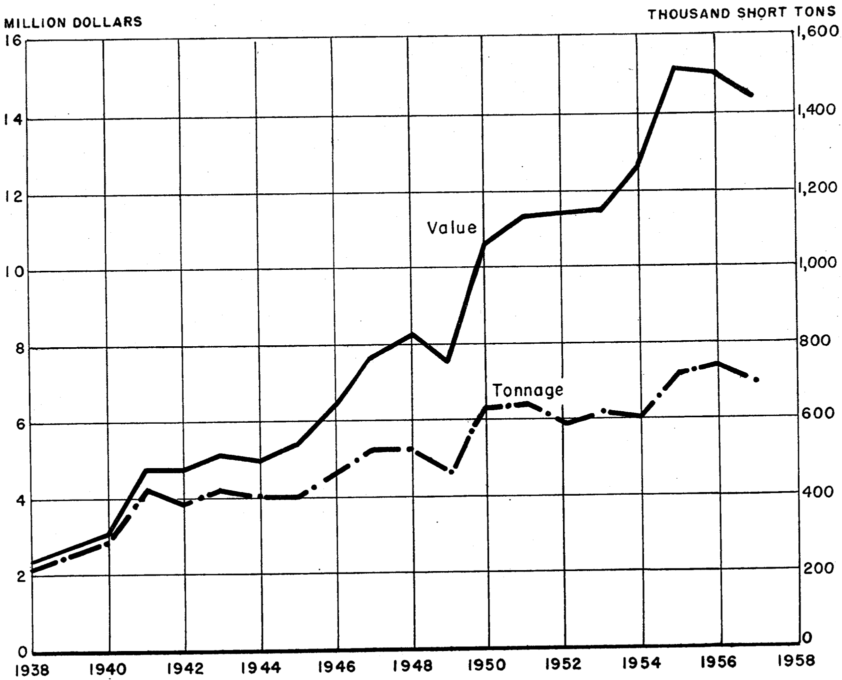

FIGURE 1.—Sales of domestic talc, soapstone, and pyrophyllite, 1938–57.

deposits were being initiated. Carolina Pyrophyllite Co. was constructing two water reservoirs in the Bowling Mountain area, near Stem, Granville County, N. C., preliminary to beginning pyrophyllite mining in the area. Long-range plans included a flotation plant to upgrade the ore.

TABLE 5.—Ground talc, soapstone, and pyrophyllite sold or used by grinders in the United States, 1956–57, by States

State	1956		1957	
	Short tons	Value	Short tons	Value
Alabama	2,200	$39,600	1,600	$20,000
California	140,571	3,542,920	122,367	3,383,221
Georgia	57,521	577,475	49,132	426,479
Maryland and Virginia	23,776	234,198	23,631	218,058
Montana	15,365	453,681	(1)	(1)
North Carolina	100,637	1,501,467	97,741	1,636,103
Texas	23,076	318,362	26,364	421,458
Washington	(1)	(1)	2,139	41,293
Other States [2]	328,515	7,650,711	310,356	7,414,885
Total	691,661	14,318,414	633,330	13,561,497

[1] Included with "Other States."
[2] Includes States indicated by footnote 1 and Arkansas, Nebraska, New York, Oregon, Pennsylvania, Utah, and Vermont.

CONSUMPTION AND USES

Ceramics, paints, insecticides, roofing, rubber, asphalt filler, and paper consumed 84 percent of the talc and soapstone sold by producers in 1957, compared with 88 percent in 1956 and 87 percent in 1955. Sales reported for all of these major uses declined, except that for paper, which remained virtually unchanged.

Insecticides, ceramics, refractories, and paints consumed 64 percent of the pyrophyllite sold by producers in 1957, compared with 72 percent in 1956 and 85 percent in 1955. The largest decrease was for use in paints—49 percent.

TABLE 6.—Talc and soapstone sold or used by producers in the United States, 1955–57, by uses

Use	1955		1956		1957	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ceramics	174,700	31	204,261	36	170,326	32
Paints	118,908	21	128,159	22	119,848	23
Insecticides	63,472	11	54,793	10	45,184	9
Roofing	60,537	11	45,671	8	39,124	7
Rubber	33,272	6	30,253	5	28,532	6
Asphalt filler	22,608	4	21,438	4	19,073	4
Paper	17,339	3	15,931	3	15,980	3
Toilet preparations	9,912	2	9,611	2	10,390	2
Textiles	8,286	1	8,647	2	7,393	1
Foundry facings	9,131	2	8,169	1	7,352	1
Rice polish	1,125	(1)	1,676	(1)	1,785	(1)
Crayons	766	(1)	792	(1)	712	(1)
Other [2]	43,994	8	43,407	7	64,443	12
Total	564,050	100	572,808	100	530,142	100

[1] Less than 1 percent.
[2] Includes cement admixture, composition floor and wall tile, export fertilizer, pipe-coating enamel, plaster, plastics, and stucco.

TABLE 7.—Pyrophyllite sold by producers in the United States, 1955–57, by uses

Use	1955		1956		1957	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Insecticides	54,329	35	43,132	27	42,166	26
Ceramics	38,460	25	36,468	23	33,722	21
Refractories	23,400	15	23,486	14	21,452	13
Asphalt filler	15,752	10	29,199	18	(1)	(1)
Rubber	5,037	3	5,640	3	(1)	(1)
Paints	14,778	10	12,200	8	6,223	4
Plaster products					4,766	3
Other [2]	3,580	2	11,865	7	53,453	33
Total	155,336	100	161,990	100	161,782	100

[1] Figure included with "Other" to avoid disclosing individual company confidential data.
[2] Includes uses indicated by footnote 1 and heavy clay products, joint cement filler, stucco, and related products.

PRICES

The price quotations in trade journals for talc remained unchanged during the year. These quotations merely indicate the range of prices; actual prices are negotiated between buyer and seller on the basis of a wide range of specifications.

TABLE 8.—Prices quoted on ground talc, in bags, carlots, 1957, per short ton

[Oil, Paint and Drug Reporter]

Grade	1957
Domestic, f. o. b. works:	
Ordinary:	
California	$33.00–$39.50
Vermont	19.40
Fibrous (New York):	
Off-color	28.00
325-mesh:	
99.5 percent	31.00
99.95 percent, micronized	38.00
Imported (Canadian), f. o. b. mines	20.00– 35.00

TABLE 9.—Prices quoted on talc, carlots, 1957, per short ton, f. o. b. works

[E&MJ Metal and Mineral Markets]

Grade [1]	1957
Georgia: 98 percent minus-200-mesh:	
Gray, packed in paper bags	$10.50–$11.00
White, packed in paper bags	12.50– 15.00
New Jersey: Mineral pulp, ground, bags extra	10.50– 12.50
New York: Double air-floated, short fiber, 325-mesh	18.00– 20.00
Vermont:	
100 percent through 200-mesh, extra white, bulk basis [2]	12.50
99½ percent through 200-mesh, medium white, bulk basis [2]	11.50– 12.50
Virginia:	
200-mesh	10.00– 12.00
325-mesh	12.00– 14.00
Crude	5.50

[1] Containers included, unless otherwise specified.
[2] Packed in paper bags, $1.75 per ton extra.

FOREIGN TRADE [4]

Imports.—The quantity and value of unmanufactured "talc, steatite or soapstone, and French chalk" imported for consumption in the United States decreased 13 percent in quantity and 6 percent in

TABLE 10.—Talc, steatite or soapstone, and French chalk imported for consumption in the United States, by classes in 1948–52 (average) and 1953–55 (totals), and 1956–57, by countries

[Bureau of the Census]

Country	Crude and unground		Ground, washed, powdered, or pulverized, except toilet preparations		Cut and sawed		Total unmanufactured		Manufactures, n. s. p. f., except toilet preparations (value)
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	
1948–52 (average)	140	$19,637	20,050	$588,168	113	$33,900	20,303	$641,705	$7,092
1953	198	35,474	22,478	641,332	127	39,903	22,803	716,709	7,974
1954	36	6,230	22,076	[1] 653,850	45	18,149	22,157	[1] 678,229	11,508
1955	125	20,300	28,882	[1] 936,312	72	29,363	29,079	[1] 985,975	
1956									
North America: Canada			2,123	30,051			2,123	30,051	903
Europe:									
France			4,527	89,907	1	259	4,528	90,166	
Italy			15,622	542,650	14	4,936	15,636	547,586	
Total			20,149	632,557	15	5,195	20,164	637,752	
Asia:									
India	117	17,555	856	22,346			973	39,901	
Japan					91	41,566	91	41,566	
Total	117	17,555	856	22,346	91	41,566	1,064	81,467	
Africa: British East Africa									257
Grand total	117	17,555	23,128	[1] 684,954	106	46,761	23,351	[1] 749,270	1,160
1957									
North America:									
Canada			2,119	27,322			2,119	27,322	299
Mexico			261	4,722			261	4,722	
Total			2,380	32,044			2,380	32,044	299
Europe:									
France			3,325	74,618	2	615	3,327	75,233	
Germany, West					1	343	1	343	2,824
Italy			13,572	495,078	3	828	13,575	495,906	
Norway					7	1,344	7	1,344	
Sweden									354
United Kingdom									522
Total			16,897	569,696	13	3,130	16,910	572,826	3,700
Asia:									
India	277	42,265	755	20,732			1,032	62,997	
Japan					73	33,486	73	33,486	
Malaya									561
Vietnam, Laos, and Cambodia									75
Total	277	42,265	755	20,732	73	33,486	1,105	96,483	636
Grand total	277	42,265	20,032	622,472	86	36,616	20,395	701,353	4,635

[1] Owing to changes in tabulating procedures by the Bureau of the Census data known to be not comparable with years before 1954.

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

value in 1957, compared with 1956. Italy continued to be the major supplier, with 67 percent of the quantity and 71 percent of the value of total unmanufactured imports. Canada, France, and India again supplied most of the remainder. Imports of 261 short tons of ground talc were received from Mexico in 1957. Imports of manufactures, n. s. p. f. (not specifically provided for), except toilet preparations, increased in value from $1,160 in 1956 to $4,635 in 1957.

Exports.—In 1957, crude and ground talc, steatite, soapstone, and pyrophyllite exports declined 6 percent in quantity from the record high of 1956 but increased 12 percent in value to a new high. Manufactures, n. e. s. (not elsewhere specified), increased in both quantity and value; powders—talcum (in packages), face, and compact—decreased slightly in value.

TABLE 11.—Talc, pyrophyllite, and talcum powders exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Talc, steatite, soapstone, and pyrophyllite: Crude and ground: Short tons	Crude and ground: Value	Manufactures, n. e. s.: Short tons	Manufactures, n. e. s.: Value	Powders—talcum (in packages), face, and compact (value)
1948–52 (average)	19,724	$538,598	(1)	(1)	$1,561,376
1953	23,071	602,454	159	$95,778	1,295,533
1954	23,348	744,828	259	110,558	1,075,592
1955	35,230	858,755	135	101,571	1,245,993
1956	42,333	1,009,315	69	73,806	1,371,120
1957	39,985	1,127,157	291	137,536	1,321,868

[1] Beginning Jan. 1, 1949, manufactures, n. e. s., 1 ton ($455); 1950, 51 tons ($25,492); 1951, 106 tons ($60,589); 1952, 265 tons ($142,356).

WORLD REVIEW

The world production of talc, soapstone, and pyrophyllite decreased 3 percent in 1957 from the alltime high set in 1956 but was the second highest ever recorded.

Afghanistan.—Reserves of high-quality talc in eastern Afghanistan, north of Safed Koh, were reported to exceed 10 million tons.

Austria.—West Germany and Poland received 76 percent of talc exports from Austria in 1957, compared with 64 percent in 1956. Exports for 1953–57, by countries of destination, are given in table 13.

Canada.—According to the official preliminary estimates, Canada produced 21,453 short tons of talc and pyrophyllite (value Can$268,401) and 11,600 tons of soapstone (value Can$165,000) in 1957.[5] Imports of talc and soapstone in 1957 were given as 14,949 tons (value Can$536,189) and exports of talc as 2,353 tons (value Can$29,848). In 1957 the average value of the Canadian dollar was US$1.04.

[5] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, Preliminary Report on Mineral Production, 1957: P. 37. (Prepared in the Mineral Statistics Section of the Industry and Merchandising Division, Ottawa, Canada.)

TABLE 12.—World production of talc, soapstone, and pyrophyllite, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada (shipments)	27,637	27,408	28,143	27,160	29,326	33,053
United States	568,555	631,518	618,994	725,708	739,039	684,453
Total	596,192	658,926	647,137	752,868	768,365	717,506
South America:						
Argentina	15,645	[3] 16,500	[3] 16,500	25,353	25,478	[3] 27,600
Brazil	15,668	23,466	21,967	27,190	30,684	30,069
Chile	120	----------	----------	----------	----------	----------
Paraguay	----------	99	132	[3] 100	[3] 100	[3] 100
Peru	[4] 141	----------	131	3,708	4,031	[3] 3,300
Uruguay	1,315	982	1,167	1,249	1,580	1,566
Total	32,889	[3] 41,000	[3] 39,900	57,600	61,873	[3] 62,600
Europe:						
Austria	63,462	56,477	68,310	77,905	72,819	80,915
Finland	360	4,065	8,197	5,265	8,146	9,259
France	108,442	120,693	132,154	132,683	145,064	156,528
Germany, West (marketable)	29,997	32,991	36,170	38,889	[3] 38,600	[3] 33,000
Greece	2,001	----------	1,275	2,315	[3] 2,200	[3] 2,200
Italy	78,715	91,049	94,440	110,292	105,005	102,065
Norway	69,707	67,848	80,771	88,598	[3] 127,000	[3] 66,000
Portugal	8	18	6	11	95	[3] 90
Spain	20,779	20,720	22,896	25,168	30,405	32,064
Sweden	12,998	9,806	14,689	13,695	14,492	12,804
United Kingdom	2,978	4,413	4,447	5,641	4,270	[3] 4,400
Yugoslavia	----------	----------	----------	2,922	----------	----------
Toral [1] [3]	407,000	430,000	485,000	525,000	570,000	525,000
Asia:						
Afghanistan	[5] 400	800	1,200	700	899	[3] 770
India	26,699	32,632	47,405	47,476	52,478	44,268
Japan	332,750	362,193	246,197	251,479	345,846	[3] 370,000
Korea, Republic of	5,981	26,983	20,965	12,092	15,719	12,434
Taiwan	[5] 1,082	2,001	7,791	5,807	6,758	5,938
Total [1] [3]	444,000	480,000	390,000	395,000	510,000	545,000
Africa:						
Egypt	5,110	2,509	2,822	6,878	7,706	[3] 6,600
Kenya	401	173	111	----------	----------	----------
Union of South Africa	6,305	7,974	7,974	1,581	1,968	2,315
Total	11,816	10,656	10,907	8,459	9,674	[3] 8,915
Oceania: Australia	10,109	11,127	14,699	14,075	14,979	15,998
World total (estimate)[1] [2]	1,502,000	1,630,000	1,590,000	1,750,000	1,935,000	1,875,000

[1] In addition to countries listed, talc or pyrophyllite is reported in China, Rumania, and U. S. S. R., but data are not available; estimates for these countries are included in total.
[2] This table incorporates a number of revisions of data published in previous Talc, Soapstone, and Pyrophyllite chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Average for 1951–52.
[5] Average for 1949–52.

The Canadian talc and soapstone industry in 1956 was described as follows:[6]

During 1956 the Canadian producers of talc, soapstone, pyrophyllite and steatite shipped 29,326 short tons valued at $365,226 compared with 27,160 tons valued at $338,967 in the preceding year. Production of pyrophyllite in Newfoundland was on a fairly regular basis during the latter half of the year. Quebec mines produced ground talc and steatite, also soapstone blocks and crayons.

[6] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, The Talc and Soapstone Industry, 1956: Ind. Merchandising Div., Mineral Statistics Section, Ottawa, 1957, 5 pp.

Talc of various particle sizes was shipped from the Madoc, Ontario, area. There has been no production of talc or pyrophyllite from British Columbian properties in recent years.

The average number of persons employed in the industry was 67 to whom $169,120 were paid as salaries. Fuel cost $6,790 and 1,261,206 kwh. of electricity were purchased for $23,700. Containers and process supplies cost $83,043.

Imports of talc and soapstone in 1956 amounted to 16,268 tons valued at $496,001. Exported were 2,613 tons worth $34,408.

TABLE 13.—Talc exported from Austria, 1953–57, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Belgium-Luxembourg	1,079	1,258	1,425	2,124	2,419
Denmark	17	143	44	126	76
France	1,002	1,242	1,554	1,115	957
Germany:					
East	2,546	2,502	2,177	2,960	1,431
West	15,385	16,577	17,935	18,496	17,576
Hungary	2,183	3,508	5,563	6,389	2,003
Italy	295	627	1,275	2,392	2,241
Netherlands	715	666	1,109	1,152	1,048
Philippines					109
Poland	10,558	19,914	21,074	16,914	25,082
Saar					89
Sweden	11	14	58	55	50
Switzerland	1,808	2,228	2,039	2,638	2,716
Trieste	17	44			
United Kingdom	864	582	505	650	563
Yugoslavia	17	95	62	22	28
Other countries	3	2	71	16	3
Total	36,500	49,402	54,891	55,049	56,391

[1] Compiled from Customs Returns of Austria.

[2] This table incorporates a number of revisions of data published in the preceding Talc, Soapstone, and Pyrophyllite chapter.

TABLE 14.—Consumption of ground talc and soapstone in Canada, by uses, 1953–55, in short tons [1]

Use	1953	1954	1955
Roofing	8,050	7,772	9,414
Paints	7,838	7,240	7,872
Insecticides and miscellaneous chemicals	8,557	9,704	5,503
Clay products	2,164	2,345	3,302
Rubber	1,620	1,330	1,392
Textiles and linoleum	1	(2)	975
Coal tar distillation	694	2,195	783
Pulp and paper	1,510	814	687
Toilet preparations	424	455	540
Medicinal preparations	321	352	408
Electrical apparatus	490	598	311
Miscellaneous nonmetallic mineral products	82	146	83
Soaps and cleaning preparations	81	106	64
Asbestos products	1	1	9
Polishes and dressings	11	13	8
Tanneries	5	2	6
Total	31,849	33,073	31,357

[1] Source: Canada, Department of Trade and Commerce, Dominion Bureau of Statistics.

[2] Not reported separately.

France.—Exports of talc and soapstone declined 21 percent in 1956 from 1955 to virtually the 1954 figure. Only exports to Switzerland increased during 1956.

Italy.—In 1957 the United States, United Kingdom, and West Germany received 69 percent of the talc exported from Italy, compared with 73 percent in 1956 and 78 percent in 1955.

TABLE 15.—Talc and soapstone exported from France, 1952–56, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1952	1953	1954	1955	1956
Algeria	2,112	1,927	2,030	3,713	2,006
Belgium-Luxembourg	3,071	3,133	3,206	4,145	3,607
Finland	----------	893	874	857	----------
Germany, West	2,222	2,020	4,011	5,760	4,942
Morocco: Southern Zone	----------	968	1,169	2,140	867
Netherlands	1,206	1,842	1,643	1,269	1,099
Sweden	856	5,163	----------	----------	----------
Switzerland	5,909	276	6,064	6,327	7,016
United Kingdom	6,126	6,023	7,395	8,298	5,718
United States	1,579	2,413	2,066	4,322	4,160
Other countries	2,808	2,534	3,624	4,325	3,125
Total	25,889	27,192	32,082	41,156	32,540

[1] Compiled from Customs Returns of France.
[2] This table incorporates a number of revisions of data published in the preceding Talc, Soapstone, and Pyrophyllite chapter.

TABLE 16.—Talc exported from Italy, 1953–57, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Austria	382	360	349	538	632
Belgium-Luxembourg	435	700	538	464	(3)
Canada	1,117	756	1,130	1,526	(3)
France	966	763	1,079	1,285	3,851
Germany:					
East	110	147	70	----------	(3)
West	3,590	4,251	5,507	6,317	6,812
Netherlands	988	691	988	656	(3)
Portugal	269	284	290	190	(3)
Switzerland	627	691	473	951	(3)
Union of South Africa	140	559	659	1,361	(3)
United Kingdom	9,150	7,486	9,246	9,237	9,676
United States	15,607	13,686	21,117	16,329	14,071
Other countries	3,156	3,467	4,406	4,610	9,472
Total	36,537	33,841	45,852	43,464	44,514

[1] Compiled from Customs Returns of Italy.
[2] This table incorporates a number of revisions of data published in the preceding Talc, Soapstone, and Pyrophyllite chapter.
[3] Data not separately recorded

TABLE 17.—Talc and soapstone exported from Norway, 1952–56, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1952	1953	1954	1955	1956
Belgium-Luxembourg	3,694	3,277	3,086	5,033	4,271
Denmark	4,902	5,733	7,882	9,091	7,372
Finland	2,744	393	2,432	1,729	1,382
France	668	423	536	651	830
Germany:					
East	----------	168	83	----------	----------
West	4,561	4,326	6,599	6,063	6,368
Indonesia	2,142	1,499	1,335	2,710	1.506
Netherlands	6,099	7,662	7,454	9,085	7,896
Poland	226	510	328	----------	617
Sweden	5.342	6,816	8,604	8,368	7,304
Switzerland	148	98	79	----------	----------
United Kingdom	12,263	12,607	15,764	17,065	18,433
Other countries	1,653	1,170	2,021	2,242	1,988
Total	44,442	44,682	56,203	62,037	57,967

[1] Compiled from Customs Returns of Norway.

Norway.—Talc and soapstone exported from Norway in 1956 decreased 7 percent over 1955. The United Kingdom remained the major recipient.

Union of South Africa.—The quantity of "wonderstone," a massive pyrophyllite, produced in 1957 increased 124 percent over 1956; the quantity exported increased 139 percent.

TABLE 18.—Salient statistics of the pyrophyllite (wonderstone) industry in Union of South Africa, 1953–57 [1]

	1953	1954	1955	1956	1957
Production	408	377	239	266	595
Exports:					
Quantity (short tons)	272	174	126	232	554
Value (US$)	22,408	16,758	12,110	22,630	54,544
Local sales:					
Quantity (short tons)	116	1,158	106	81	115
Value (US$)	8,260	10,623	8,036	6,308	8,714

[1] U. S. Embassy, Johannesburg, Union of South Africa, State Department Dispatch 262: May 3, 1957, p. 3; Dispatch 292, June 14, 1957, p. 3; Dispatch 223, Mar. 10, 1958, p. 3.

TECHNOLOGY

The geology of talc, soapstone, and pyrophyllite deposits in California was described.[7] The controls used in producing ceramic-grade talc and pyrophyllite were noted.[8] The use of talc, soapstone, and pyrophyllite in ceramic bodies was discussed.[9]

Patents were issued during 1957 suggesting the use of talc in a wood-pulp suspension used to make yarn-carrying cones,[10] a pressure-sensitive adhesive tape capable of accepting pencil marks,[11] resistors,[12] an improved dimensionally stable sheet used for production drawings,[13] greaseproof floor tile,[14] packings,[15] and fireproofing and fire-extinguishing compositions.[16] A patent was issued on a ceramic composition with good plasticity, low shrinkage, high strength, and high resistance to thermal shock using fibrous talc in place of bentonite or other clays.[17]

[7] Wright, L. A., Talc and Soapstone; chap. in Mineral Commodities of California: California Div. Mines Bull. 176, December 1957, pp. 623–634. Pyrophyllite: Pp. 455–458.

[8] Treischel, C. C., Availability and Control of Ceramic-Grade Talc and Pyrophyllite: Bull. Am. Ceram. Soc., vol. 36, No. 5, May 15, 1957, pp. 177–178.

[9] Bock, P., [Use of Talc and Soapstone in Ceramic Bodies]: Ber. deut. Keram. Gesell. (Bonn, Germany), vol. 34, No. 4, April 1957, pp. 92–97; Ceram. Abs., vol. 40, No. 1, Oct. 1, 1957, p. 241.

Misra, M. L., Saxena, R. P., and Upadhyaya, V. G., Pyrophyllite: A New Raw Material for Ceramists: Ceram. Digest, vol. 1, 1957, pp. 450–454; Chem. Abs., vol. 51, No. 18, Sept. 25, 1957, p. 14229g.

Zapp, Friedrich, [Improving the Strength of Fire-Clay Bodies by the Addition of Soapstone]: Glas-Email-Keramo-Tech. (Hamburg, Germany), vol. 8, No. 6, June 1957, pp. 205–211; No. 7, July 1957, pp. 252–256; Ceram. Abs., vol. 41, No. 1, Jan. 1, 1958, p. 19.

[10] Ednell, D. F., Method for Producing Cones From a Fibrous Pulp Suspension: U. S. Patent 2,777,367, Jan. 15, 1957.

[11] Franer, V. R., and Steinhauser, A. H., Pressure-Sensitive Adhesive Marking Tape: U. S. Patent 2,785,087, Mar. 12, 1957.

[12] Kahan, G. J. (assigned to Sprague Electric Co.), Metal Film Resistor: U. S. Patent 2,786,925, Mar. 26, 1957.

Smith, R. W., and Schwartzwalder, K. (assigned to General Motors Corp.), Resistor: U. S. Patent 2,786,819, Mar. 26, 1957.

[13] Eichorn, A. (assigned to Screen Engineering Co.), Photographic Method for Making Templates: U. S. Patent 2,801,919, Aug. 6, 1957.

[14] Lerch, R. L. (assigned to Armstrong Cork Co.), Resilient Tile: U. S. Patent 2,802,797, Aug. 13, 1957.

[15] Zagorski, Johann, and Zagorski, Johann, Method for Preparing Self-Lubricating, Asbestos-Containing Stuffing-Box Packings: U. S. Patent 2,809,397, Oct. 15, 1957.

[16] Hooks, R. M. (assigned to Southwestern Petroleum Co., Inc.), Method of Preserving and Fireproofing a Structural Member and Resultant Article: U. S. Patent 2,804,398, Aug. 27, 1957.

Warnock, W. R. (assigned to Ansul Chemical Co.), Foam-Compatible Fire-Extinguishing Composition: U. S. Patent 2,816,864, Dec. 17, 1957.

[17] Bellamy, H. T., Ceramic Compositions: U. S. Patent 2,816,844, Dec. 17, 1957.

Methods of making artificial block talc from powdered talc, barium carbonate, and Florida kaolin [18] and of producing sterilized, free-flowing talc in micron sizes were patented.[19] Also, a patent was granted on a turntable device for feeding sticky materials from an open-end cylindrical bin. Fine powders, such as talc and clay, were said to be handled efficiently.[20]

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[18] Koch, W. J. (assigned to the U. S. Secretary of Commerce), Artificial Block Talc: U. S. Patent 2,781,273, Feb. 12, 1957.

[19] Masci, J. N. (assigned to Johnson & Johnson), Sterilization of Crystalline Powders Using Epoxide: U. S. Patent 2,809,879, Oct. 15, 1957.

[20] Isserlis, M. D., Material Feed Bin: U. S. Patent 2,786,609, Mar. 26, 1957.

Thorium

By James Paone [1]

THORIUM-MAGNESIUM alloys consumed more thorium than all other nonenergy uses during 1957. Five major nuclear reactor projects using thorium were underway during the year.

The major source of thorium for the United States and United Kingdom was Union of South Africa. Most domestic production came as a byproduct of placer deposits in South Carolina, Florida, and Idaho. Thorium was produced for the first time on a commercial basis from thorite mined near Cripple Creek, Colo., and from a thorium-uranium deposit on Hall Mountain, Idaho.

The refining installation opened during the previous year at Baltimore, Md., closed down, but another facility capable of processing thorium from concentrates to finished reactor-grade material was opened at Erwin, Tenn.

The thorium reserve of the Blind River area, Canada, was more accurately evaluated. The year marked the entrance of private firms into the production of high-purity thorium; at least six companies offered to supply thorium metal on a commercial basis.

Thorium in magnesium alloys played an important role in the fabrication of some guided missiles and supersonic aircraft.

Research on the nuclear use of thorium was underway at several laboratories in the United States. Details of a new process for manufacturing high-purity thorium were released during the year. Thorium deliveries to the Atomic Energy Commission (AEC) in the year ended June 30, 1957, totaled the equivalent of 223 tons of thorium metal in the form of thorium salts; nearly 450 tons was expected to be acquired in the following year ending June 30, 1958.

LEGISLATION AND GOVERNMENT PROGRAMS

Under the Defense Minerals Exploration Administration (DMEA), Government participation in exploration for thorium was reduced from 75 percent to 50 during the year.

Thorium requirements of the AEC have been limited to relatively small quantities for research and development, particularly in nuclear applications. Research requirements and a stockpile for possible future needs have been met by purchases of thorium salts produced from monazite sands. Thorium deliveries in the year ended June 30, 1957, totaled an equivalent of 223 tons of thorium metal in the form of thorium salts; double that amount was expected to be acquired in the following year, ending June 30, 1958.[2]

Expenditures by the AEC for thorium-reactor research were about $4 million during the year.

[1] Commodity specialist.
[2] AEC, Progress in the Peaceful Uses of Atomic Energy: July–December 1957, pp. 146–147.

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The AEC indicated that it would provide limited quantities of thorium for research, within its capability and in the absence of commercial thorium production. AEC requirements for thorium in Government programs were being met by its own facilities, and it did not anticipate purchases from private producers in the near future.[3]

TABLE 1.—Defense Minerals Exploration Administration contracts for thorium

Contractor and State	County	Date approved	Total amount of contract
COLORADO			
Rare Earth Mining Co	Gunnison	Oct. 29, 1953	$35,638
Schweigert, Geo. D	Custer	Jan. 4, 1954	2,888
Cunac Minerals, Inc	Fremont	July 24, 1957	20,760
Cotter Corporation	Custer	Aug. 29, 1957	18,876
IDAHO			
Defense Metals, Inc	Lemhi	Aug. 8, 1952	68,265
Alfred G. Hoyl & Asso	Custer	Sept. 20, 1956	26,986
ILLINOIS			
William G. Reynolds	Hardin	Jan. 26, 1956	5,620
MONTANA			
Elkhorn Mining Co	Beaver Head	Sept. 14, 1951	10,215
Total			$189,248

Research on thorium applications in the atomic energy field were described in Metal Progress (vol. 7, No. 2, February 1957, p. 108).

DOMESTIC PRODUCTION

Exploration and Mine Production.—Exploration for and development of deposits containing thorium-bearing minerals continued in Colorado and Idaho. The first shipment of thorium ore from Colorado was made when Trail Mines, Inc., Colorado Springs, Colo., shipped over 40 tons of thorite ore from its mine near Cripple Creek. The average mill sample was reported to be about 10.5 percent thorium oxide.[4] Northwest Prospecting & Development Co., Spokane, Wash., organized in 1956 to prospect for and develop thorium-uranium deposits on Hall Mountain near Porthill, Idaho, shipped its first ton of thorium concentrate. Exploration for thorium-bearing minerals continued in the Wet Mountain area, Colo.

Marine Minerals, Inc., a subsidiary of Heavy Minerals Co., Chattanooga, Tenn., continued to produce monazite sand from dredging in the Horse Creek area near Aiken, S. C. The monazite sand was shipped to the Heavy Minerals multimillion-dollar processing plant at Chattanooga, Tenn. Some production of monazite sand came from operations of the Rutile Mining Co. of Florida, Jacksonville, Fla., as a byproduct of the ilmenite-rutile-zircon deposit. Porter Bros. Corp. continued to dredge near Bear Valley, Idaho, about 95 miles north of Boise, principally to produce euxenite con-

[3] Labowitz, Allan M., AEC Policy on Thorium: Metal Progress, vol. 7, No. 2, February 1957, p. 108.
[4] The Mining Record (Denver), vol. 68, No. 47, Nov. 21, 1957, p. 5.

centrate. The operation included dredging of black sands, concentration by jigging, and separation by a combination of electrostatic and high-intensity electromagnetic separators producing euxenite concentrate, which was shipped to Mallinkrodt Chemical Works, St. Louis, Mo., for chemical separation. A byproduct monazite concentrate was recovered at the Bear Valley operation. Baumhoff-Marshall, Inc., Boise, Idaho, remained inactive, and its stockpile from previous operations included some monazite concentrates.

Refinery Production.—Thorium and thorium compounds were produced by four firms, principally from monazite concentrate.

Monazite processors and estimated annual capacity

Company:	*Estimated capacity, tons monazite*
Lindsay Chemical Co	12, 000
Davison Chemical Co	1, 000
Maywood Chemical Works	1, 000
Heavy Minerals Co	1, 500
	15, 500

The Lindsay Chemical Co., West Chicago, Ill., remained the world's largest manufacturer of refined thorium compounds. Production was chiefly from monazite concentrate from the Union of South Africa. The principal thorium salt of commerce was thorium nitrate; others of importance were thorium oxide, thorium chloride, thorium fluoride, and thorium sulfate. Davison Chemical Co., a Division of W. R. Grace and Company, Baltimore, Md., concluded its contract with the AEC after processing a portion of the Government stockpile of monazite into crude rare earths and thorium. The installation was inadequate to handle the wide variation in monazite quality encountered in the stockpile. The plant was converted to the cracking of thorite ores to produce feed for Davison's refining and metals plant in Erwin, Tenn., completed during the year. The Erwin operation includes the first commercial solvent-extraction facility in the United States for producing ultrapure nuclear-grade thorium oxide, as well as a plant for making thorium metal and thorium alloys. The solvent-extraction plant went on stream in September with a capacity of 1,000 pounds per day, and the metals plant was completed in December with a capacity of 500 pounds per day. Heavy Minerals Co., Chattanooga, Tenn.—the first firm to reduce monazite by the caustic soda process—maintained production of thorium hydroxide, rare-earth oxides, fluorides, and chlorides at the Chattanooga plant. Mallinckrodt Chemical Works, St. Louis, Mo., processed euxenite from Idaho to separate and recover columbium, thorium, uranium, and rare-earth compounds. Maywood Chemical Works, Maywood, N. J., processed some thorium and rare-earth compounds, but during the year it had temporarily suspended operations. Wah Chang Corporation, New York, N. Y., milled thorite ore at Boulder, Colo., to produce concentrates running from 20 to 40 percent ThO_2, at its research laboratory at Boulder. Wah Chang investigated the upgrading of thorium-mineral concentrate beyond the milling state to a chemical product.

Metal Hydrides, Inc., Beverly, Mass., made its first shipment of high-purity crystal-bar thorium, produced by the Van Arkel-de Boer iodide process developed by Metal Hydrides in cooperation with Battelle Memorial Institute.[5] The Westinghouse Electric Corp., Lamp Division, Bloomfield, N. J., produced a small quantity of thorium metal. The AEC used thorium metal for research purposes from its Feed Materials Production Center at Fernald, Ohio, operated by National Lead Co. of Ohio. The Bureau of Mines continued investigating production methods and techniques for making ultrapure thorium.

Companies offering to supply thorium metal on a commercial basis included Davison Chemical Co., Horizons, Inc., National Research Corp., Sylvania-Corning Nuclear Corp., Nuclear Materials & Equipment Corp., and Vitro Corp. of America.

Specifications for uranium–233 (converted thorium) produced in private nuclear reactors in the United States were published in December.

CONSUMPTION AND USES

Nonenergy Uses.—Authorization from the AEC for the purchase of thorium, as prescribed in the Atomic Act of 1954, was required in 1957. The AEC authorizations revealed data from which consumption of thorium for 1956 and 1957 could be estimated and are shown in table 2.

TABLE 2.—Authorizations for thorium purchases by the Atomic Energy Commission for nonenergy purposes, in pounds of contained ThO_2

Use	1952	1953	1954	1955	[1] 1956	[1] 1957
Magnesium alloys	----------	3,600	4,647	23,944	50,000	100,000
Gas-mantle manufacture	25,427	8,707	9,765	44,566	40,000	40,000
Refractories and polishing compounds	1,157	236	24	105	200	----------
Chemical and medical products	11,064	5,179	3,738	3,898	4,000	4,000
Electronic products	277	1,222	2,016	926	1,000	1,000
Total	37,925	18,944	20,190	73,439	95,200	145,000

[1] Estimate.

The increased use of thorium in magnesium alloys contributed to the 100-percent increase in consumption of thorium over 1956. A newer alloy, HM215A, developed by Dow Chemical Co., is said to withstand the highest temperature of any metal of equal density used during 1957. The most widely used alloy, HK31, contained 3 percent thorium and 0.7 percent zirconium, with the remainder magnesium. Magnesium-thorium alloys were used in the Air Force *Bomarc* missile, the Navy satellite *Vanguard* launching vehicle, and in the Air Force supersonic bomber, the B–58 *Hustler*. The alloys were to be used in several missiles in the Intermediate Range Ballistic Missile or Intercontinental Ballistic Missile class. The alloys were found to be the least expensive airframe material that retained its strength at temperatures encountered above speeds of 1,500 miles per hour.[6] Other advantages of magnesium-thorium alloys are weight-saving over aluminum in some jet-engine castings and excellent uniformity in castings.[7]

[5] Chemical Engineering Progress, vol. 53, No. 3, March 1957, p. 96.
[6] American Metal Market, vol. 65, No. 22, Jan. 31, 1958, p. 14.
[7] Northern Miner (Toronto), vol. 43, No. 43, Jan. 16, 1958, p. 5.

Use of thorium in manufacturing incandescent gas mantles remained nearly the same as in 1956. Used principally in portable light sources, gas mantles have provided a consistent rate of thorium consumption since 1955. Thorium metal also was utilized as a deoxidant in preparing molybdenum and its high alloys and in electronic tubes and lamps for controlling starting voltages and maintaining stability. Nonenergy uses of thorium were described in detail during the year.[8] Thoria ceramics were investigated; results of research on thoria ceramics carried out at Armour Research Foundation at the Argonne National Laboratory were published.[9]

Energy Uses.—Research on the nuclear use of thorium was underway at several United States laboratories. Argonne National Laboratory, Lemont, Ill., was investigating thorium metal and thorium oxide for use in boiling-water reactors; Atomics International, a subsidiary of North American Aviation, Canoga Park, Calif., was studying the feasibility of utilizing thorium metal in the SRE (sodium-reactor experiment reactor); the Oak Ridge National Laboratory, Oak Ridge, Tenn., was investigating a slurry of thorium oxide for use in a homogeneous reactor; the Brookhaven National Laboratory, Upton, N. Y., was engaged in basic studies on the use of a thorium-bismuth slurry in the LMFRE (liquid-metal-fueled reactor experiment); Babcock & Wilcox Co. continued tests at its Critical Experiment Laboratory, Lynchburg, Va., on the core of the power reactor being built for the Consolidated Edison Co. at Indian Point, N. Y. Application of thorium in power reactors was under active consideration by Power Reactor Development Company in Detroit and by Westinghouse-Pennsylvania Power & Light Company.

The Consolidated Edison Test Reactor (CETR) in New York is a pressurized water, thorium-converter, power reactor designed to operate with zircalloy-clad fuel plates of U–235 alloy and a zirconium-clad thorium blanket. The U–Zr alloy fuel element can be left in the reactor until at least 1 percent of all the atoms in the element have reacted; at this point about half of the U–235 will have fissioned, and enough U–233 will be formed in the thorium to equal nearly 1 percent of the thorium in the reactor.

The sodium-graphite reactor (SGR) was planned to operate with a Th–U alloy clad in a sheath of Type 304 stainless steel.[10]

In the liquid-metal-fueled reactors employing a thorium-containing bismuth slurry, fission products may be kept at low concentrations by continuous chemical processing of the slurry.

An article reported that thorium could potentially contribute more energy in the world than the expected total from our fossil-fuel reserve. The growth of thorium for energy purposes would not be apparent until some time in the 1960's. Based on an estimate that 10 percent of the power produced in the United States will be nuclear by 1975, principally in 100,000-kw. reactors, and equal amounts of thorium in process and in reactors, it was predicted that about 11,000 tons of thorium would be required in 1975, with a replacement rate

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[8] Lilliendahl, W. C., Nonnuclear Uses of Thorium: Metal Progress, vol. 71, No. 2, February 1957, pp. 104–107.

[9] Arenberg, C. A., Rice, H. H., Schofield, H. Z., and Handwerk, J. H., Thoria Ceramics: Am. Ceram. Soc. Bull., vol. 36, No. 8, August 1957, pp. 302–306.

[10] Howe, John P., Thorium's Role in Atomic Power: Metal Progress, vol. 71, No. 2, February 1957, pp. 97–103.

of 2 to 4 tons per year.[11] However, the outcome of research work on thorium as well as its future as a nuclear fuel had not been clearly established by the end of 1957.

PRICES

The price for 10-percent thorium concentrate was about $1.75 per pound of ThO_2 content in thorite ores. Monazite quotations listed in E&MJ Metal and Mineral Markets remained steady during 1957 as follows:

Type and grade, rare-earth oxide including thoria, percent:	*Price per pound, c.i.f. United States ports, cents*
Massive; 55	13
Sand; 55	15
Sand; 66	18
Sand; 68	20

Prices established by the AEC for nuclear materials remained in effect during the year. The price for high-purity thorium metal remained at $43 per kilogram ($19.55 per pound), f. o. b. Feed-Materials Production Center, Fernald, Ohio. The AEC established a "buy back" price for U–233 nitrate of $15 per gram of uranium for the material produced abroad through the use of the fuel obtained from the Commission under agreements for cooperation.

A private commercial company that came into production in 1957 quoted the following prices per pound for nuclear-grade thorium metal:

	Powder or pellets	*Thorium ingot*
Less than 10 lb	$50	$54
10 to 100 lb	41	45
100 to 500 lb	34	38
500 to 2,000 lb	26	30
Over 2,000 lb	20	24

Thorium metal of Commercial grade (chief impurities—calcium, about 0.05 percent; iron, about 0.05 percent; thorium oxide, about 1.0 to 1.5 percent) was available in small lots during 1957 at the following prices per gram and in the following forms:

Form of metal:	*Less than 200 grams*	*More than 200 grams*
Powder	$0. 45	$0. 35
Unsintered bars	. 50	. 40
Sintered bars	. 65	. 50

Principal thorium compounds were quoted by a leading producer in 1957 for 100-pound lots or more as follows:

Thorium compound:	*ThO_2 percent*	*Price per pound*
Carbonate	80–85	[1] $7. 25–8. 80
Chloride	50	7. 00
Fluoride	80	6. 50
Nitrate (mantle grade)	46	3. 00
Oxide	97–99	6. 50–8. 50

[1] Variable, depending on rare-earth content.

[11] Work cited in footnote 10.

FOREIGN TRADE

Import-export data regarding thorium ore and concentrate, thorium compounds, and thorium metal were not available for publication. Union of South Africa and Australia provided a source of monazite, but India and Brazil retained their embargo on the export of source materials.

WORLD REVIEW

Monazite (the principal commercial mineral of thorium) from Union of South Africa continued to supply the Free World requirements for the commodity.

Intensive research on the nuclear applications of thorium in Great Britain was underway during the year.

NORTH AMERICA

Canada.—Uranium deposits in the Blind River area were found to contain about one-half pound of thorium per ton. Potential thorium recovery per year is about 3 to 4 million pounds of ThO_2. Although the economics of the discovery had not been fully evaluated, considerable interest in byproduct thorium was noted. Rio Tinto Mining Co. of Canada and Dow Chemical Co. of Canada continued research on the recovery of thorium from waste liquors produced in the processing of uranium at Algom Uranium Mines' Quirke Lake operation. Pilot-plant results were expected to yield feasible methods of recovery of thorium and rare earths. Recovery units would be installed at other plants if the demand increased.

SOUTH AMERICA

Brazil.—Restriction of exports of source material continued in effect during 1957. Late in the year, it was expected that discussions would take place between the Governments of Brazil and the United Kingdom regarding an agreement on the exchange of British nuclear technology for supplies of Brazilian thorium, contained in the large reserves of monazite.

EUROPE

France.—Output of thorium products continued to rise. Produced principally by Société de Produits Chemiques des Terres Rares, La Rochelle, thorium-content material from France was said to exceed quantities produced in any other country in the world.

United Kingdom.—Thorium as a nuclear fuel was undergoing study. Design work and construction of a zero-energy assembly for the experimental reactor were being done by General Electric Co. of Great Britain under contract to the British Atomic Energy Authority (AEA). Thorium was expected to play an important role in future British nuclear power developments.[12] A concentrated program of research into the application of thorium and thorium alloys in future British nuclear power stations was being carried out by the British Non-Ferrous Metals Research Association in collaboration with the AEA.

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[12] Atomic Energy Newsletter, vol. 18, No. 2, Sept. 3, 1957, p. 4.

The principal applications would be in high-temperature, gas-cooled reactors.

ASIA

Ceylon.—Monazite production in Ceylon continued to supply a small quantity of thorium for Free World requirements.

India.—Results of preliminary surveys by the Indian Government indicated that there are large deposits in northeastern India. The ore was estimated to be capable of producing about 330,000 tons of 10-percent thorium concentrate, 10,000 tons of 0.3- to 0.4-percent uranium concentrate, and approximately 80 million tons of ilmenite.[13] The discovery was expected to overshadow the well-known beach-sand deposits of Travancore.

Korea, Republic of.—Production of thorium in South Korea also contributed to world requirements for the commodity.

AFRICA

Madagascar.—Deposits in Madagascar, in the French Union, were reported to contain 1,000 tons of thorianite, which contains 10 to 20 percent uranium and 60 to 70 percent thorium.[14] Results of the thorianite-pyroxenite under investigation in the Fort Dauphin-Mandrare River area had not been reported by the end of the year.

Nigeria.—Concentrations of thorite were found in certain Nigerian granites and the eluvial and placer deposits derived from them. Mechanical concentrates from operations in Nigeria usually contain, in addition to thorite and columbite, a number of other heavy minerals, including zircon.

Union of South Africa.—Monazite from the Van Rhynsdorp deposit was mined, concentrated, and exported by the Monazite and Mineral Ventures (Pty.), Ltd. Since 1953 this monazite deposit has been the source of most of the rare-earth and thorium production in the United States and England. The Van Rhynsdorp district of Union of South Africa continued to supply the world market. Estimated reserves of the deposit, based on drilling and mining, totaled about 250,000 tons of monazite, containing 6 percent thorium and 45 percent rare-earth oxide.[15]

OCEANIA

Australia.—Monazite in the heavy black sands on the east coast of Australia was mined in 1957, and some material was exported to the United States or the United Kingdom. The Australian Minister for National Development announced in June that further exports of monazite would be prohibited because of Australia's limited monazite reserve and its potential importance as a source of thorium for nuclear energy. The Government planned to purchase domestic production for stockpiling.

Surveys were made to determine the extent of a euxenite deposit on the south coast of Western Australia, near Albany.

New Zealand.—Thorium was expected to be recovered from New Zealand's huge deposits of iron-bearing sands. Exploitation of the

13 South African Mining and Engineering Journal, vol. 68, pt. 1, No. 3355, May 31, 1957, p. 1053.
14 American Metal Market, vol. 64, No. 56, March 22, 1957, p. 1.
15 Kremers, H. E., Commercial Thorium Ores: Pres. at Annual Meeting, AIME, Feb. 19, 1958, New York, N. Y.

North Island ore was under the W. J. Scollay, New Zealand representative of Phillip Bros. Ore Corp. (New York) and of Darby & Co. (London).[16]

WORLD RESERVES

The investigation and evaluation of monazite resources in the United States conducted by the Bureau of Mines from the close of 1948 until 1955 resulted in estimate of an indicated and inferred reserve of 18,000 tons of thorium oxide. Assuming a 100-percent conversion ratio of thorium into uranium–233, this quantity of thorium could theoretically supply some 14 million thermal megawatt-hours.

The largest reserves in the world were in India. In the Kerala area the reserve was estimated to be 150,000 to 180,000 tons of ThO_2; additional deposits were known to occur on other beaches in India. Although the African deposit seemed adequate for years to come, the vast potential presented by the thorium in the Blind River area uranium deposits in Canada assured the world of ample supplies. New discoveries in India and Madagascar also contributed to increased reserves of thorium.

The most important potential source of thorium in North America is the Blind River area, Ontario, Canada. The uranium ore bodies under development contain about 1 part thorium to 2 parts uranium. The ratio indicated that the reserve included at least 25,000 tons of ThO_2.

Brazilian beach deposits containing well over 10,000 tons of thorium occur in the Baía, Rio de Janeiro, and Espirito Santo districts.

Thorium reserves were also known to exist in Nigeria, Malaya, Taiwan, Australia, Ceylon, Indonesia, Korea, New Zealand, Egypt, Senegal, Tasmania, Japan, and Norway.

TABLE 3.—World reserves of thorium

Country	Reserves	
	Content (tons, ThO_2)	Average grade (percent ThO_2)
India	180,000	8.5
Canada	25 to 50,000	.05
United States	18,000	4.5 to 6.0
Union of South Africa	15,000	6.0
Brazil	10,000	6.0

TECHNOLOGY

Several thorium blanket systems for breeder reactors received serious consideration during the year.[17] The blanket form found to be most adequate consisted of aluminum-jacketed metal slugs. Thorium oxide slurry in deuterium oxide also appeared promising. Thorium fuel cycles may prove to be cheaper than the uranium cycle.[18]

[16] Chemical Week, vol. 81, No. 19, Nov. 9, 1957, p. 65.
[17] Lietzke, M. H., and Stoughton, R. W., Feasible Chemical Forms for Thorium Breeder Blanket: Ind. Eng. Chem., vol. 49, No. 2, February 1957, pp. 202-207.
[18] Mattern, K. L., A Study of Fuel-Cycle Costs for SGR-Type Power Reactors: Document IDO-14363, Part II, Tech. Inf. Extension, Oak Ridge, Tenn., April 1956.

TABLE 4.—Thorium reactor types [1]

	Solid fuel		Fluid fuel	
	CETR	SGR	HRT (HRE-2)	LMFR
Purpose	Powerplant demonstration.	Powerplant	Test of power breeder.	Test of power breeder
Fuel	Uranium-235 alloyed in Zirconium.	Uranium-235 alloyed with Th at start, converting to U-233.	UO_2SO_4 in D_2O.	U dissolved in molten Bi.
Moderator	H_2O at 1,500 p. s. i.	Graphite	D_2O	Graphite.
Fertile material	Thorium metal, Zirconium clad.	Th metal	ThO_2 slurry in D_2O.	Th_3Bi_5 suspended in molten Bi.
Heat exchange	Pressurized water to water and steam.	Na to NaK to water and steam.	Fuel solution to water-steam.	Bi-U to NaK to water-steam.
Thermal power	500,000 kw	240,000 kw	About 10,000 kw.	550,000 kw., full scale.
Electrical power	130,000-89,000 kw. from superheat by oil, total 219,000 kw.	76,800 kw	2,300 kw	210,000 kw.
Uranium required	275 kg.	360 kg.		175 kg.
Th in reactor	9,700 kg	8,100 kg		21,000 kg.
Th consumption per year.	125 kg	72 to 90 kg		180 kg.

[1] Howe, John P., Thorium's Role in Atomic Power: Metal Progress, vol. 71, No. 2, February 1957, pp. 97–103.

The process at the AEC Feed-Materials Facility at Fernald, Ohio, to make thorium ingots included the following steps:

(a) Dissolution of thorium nitrate tetrahydrate in water.
(b) Precipitation of thorium as thorium oxalate by oxalic acid.
(c) Predrying and calcination of the thorium oxalate to thorium dioxide.
(d) Hydrofluorination of the thorium dioxide to form thorium tetrafluoride.
(e) Thermite reduction of the thorium tetrafluoride with calcium in the presence of zinc chloride to a low-melting thorium-zinc alloy.
(f) Vacuum distillation of the thorium-zinc alloy to thorium-metal sponge.
(g) Arc melting of the metal sponge to produce thorium ingots.[19]

Thorium metal canned in aluminum was the only form of thorium successfully irradiated and processed for uranium–233. Isolation of U–233 includes dissolution of the slugs in aqueous solutions and a costly process of recasting the metal and refabricating the slugs.

Some details of a new process for manufacturing high-purity thorium were released by the AEC during the year. Under the new process thorium oxycarbonate is precipiated from a solution of the nitrate by adding sodium carbonate. The oxycarbonate is next ignited to the oxide, which is then mixed with finely divided carbon black and treated with chlorine at temperatures ranging from 1,350° to 1,400° F. The resultant tetrachloride (70 parts) is mixed with sodium chloride (30 parts) and the molten mixture used as an electrolyte in a cell lined with graphite, which constitutes the positive electrode. The electrolytic process produces metal of the required purity for nuclear use (99.9 percent) at a cost of $2.00 per pound; hitherto, metallic thorium was made mainly by the Ames process at production costs ranging from $15 to $20 per pound.

The Van Rhynsdorp deposit in the Union of South Africa was mined through shafts extending to 300-feet depth. The ore was mined by room-and-pillar methods. In the mill, ore is crushed in jaw and cone crushers and then ground in a ball mill in closed circuit with a classi-

[19] Atomic Energy Facts, A Summary of Atomic Activities of Interest to Industry: U. S. Atomic Energy Commission, September 1957, p. 72.

fier. The overflow slurry is treated by flotation, in which pine oil and xanthates remove the sulfides. Monazite is next floated and the thorium product dried and bagged. As local water is unsuitable for the flotation process, water for the milling operations is trucked in 65 miles.[20]

[20] Kremers, H. E., Commercial Thorium Ores: Pres. at Annual Meeting, AIME Feb. 19, 1958, New York, N. Y.

Tin

By J. W. Pennington [1] and John B. Umhau [2]

THE PREDOMINANT factor in the world tin situation in 1957 was the International Tin Agreement. Actions sponsored by the Tin Council under the agreement included export controls restricting the flow of tin; the removal of 15,300 long tons of tin buffer stock from the market to regulate supply and demand; steps to maintain a floor price for tin at £730 per ton (91.25 cents a pound); and authorization to sell from the buffer stock at £780 per ton (97.50 cents a pound) to prevent excessive rise in prices.

Other outstanding features were the cessation of domestic tin smelting under Government sponsorship and the sale of the Longhorn tin smelter at Texas City, Tex., to Wah Chang Corp.

In the United States, despite declining tin consumption, tinplate production rose to a new peak and aluminum cans were introduced.

Elsewhere, the British and Canadian Governments announced plans to sell 5,500 long tons of tin from their stockpiles; shipments of Soviet tin entered European markets; and Australia began producing tinplate.

TABLE 1.—Salient statistics of tin in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Production:						
From domestic mines [1] long tons	70.78	56.0	204.68	99.24	----------	----------
From domestic smelters [2] do	32,062	37,562	27,407	22,329	17,631	1,564
From secondary sources do	28,071	27,600	26,190	28,340	29,440	24,260
Imports for consumption:						
Metal do	60,211	74,570	65,599	64,815	62,590	56,183
Ore (tin content) do	31,575	35,973	22,140	20,112	16,688	94
Exports (domestic and foreign) do	587	203	822	1,107	[3] 890	1,531
Consumption:						
Primary do	56,085	53,959	54,427	59,828	60,470	54,429
Secondary do	30,764	31,681	28,464	30,655	29,854	28,078
Monthly price of Straits tin at New York:						
Highest cents per pound	135.00	121.50	101.00	110.00	113.75	103.00
Lowest do	90.33	78.25	84.25	85.75	92.88	87.13
Average do	108.57	95.77	91.81	94.73	101.26	96.17
World:						
Mine production long tons	173,800	189,700	189,400	190,700	192,300	191,500
Smelter production do	177,500	193,200	196,700	191,700	193,000	185,900

[1] Includes Alaska.
[2] Includes tin content of alloys made directly from ores.
[3] Revised figure.

[1] Assistant chief, Branch of Base Metals.
[2] Commodity-industry analyst.

LEGISLATION AND GOVERNMENT PROGRAMS

The Export Control Act of 1949, extended to June 30, 1958, governed shipments of tin by destinations. Exports were under general license to the Free World.

The foreign assets control regulations of the United States Treasury Department prohibited the entry of Chinese tin. Tin of U. S. S. R. origin could enter the United States but required a permit (none was issued) on the presumption it might be of Chinese origin. Entrance of alloys that might include Chinese and/or Soviet tin also was prohibited.

A Defense Minerals Exploration Administration (DMEA) tin exploration contract with Keenan Properties, Lawrence County, S. Dak., for $48,931 (Government participation, 90 percent) continued in force. The contract had been made in 1951. Government participation in DMEA contracts for tin was reduced from 90 percent to 50 percent, effective October 22.

The real and personal property of the United States Tin Corp. was offered to the highest bidder at the United States Marshal's sale held at the mine office October 30, 1957. The sale was to satisfy a judgment in favor of the United States of America. No acceptable bid was submitted; therefore, the Government took possession of the property.

H. R. 2394, introduced January 10, would authorize a Federal purchase program for tin. The bill set a base price of $1.35 per pound for tin in concentrate from lode mines and $1.20 per pound for tin in concentrate from placer mines. Purchase was to be limited to 10,000 long tons of tin in concentrate or to receipts in a 10-year period, whichever was completed sooner; this concentrate was to have been produced in the United States, its Territories, or possessions.

DOMESTIC PRODUCTION

MINE OUTPUT

No tin ore or concentrate of marketable grade was produced in the United States in 1957. A small quantity of tin concentrate recovered from treating molybdenum ore during 1956 and 1957 was unsold.

A report was published[3] on the tin-producing potential of the placer deposits in the Tofty area of the Hot Springs district, Central Alaska.

SMELTER OUTPUT

Domestic tin-smelter production was 1,564 long tons, compared with 17,631 tons in 1956. The entire output came from the Government-owned Longhorn smelter at Texas City, Tex. Production comprised 948 tons of Three Star grade, 449 tons of Two Star grade B, and 167 tons of Two Star grade C. In addition, 14 tons of Three Star (remelts) was recast, the remnants of lots produced before January 1957, and previously shown in the statistics. Production of tin at the smelter, which began in 1942 under Government sponsorship, ceased January 31, 1957. The plant was sold to Wah Chang Corp., which took title and possession February 15, 1957. Wah Chang Corp. rehabilitated much of the plant and storage area, reducing tin-producing facilities and sub-leasing some buildings to

[3] Thomas, Bruce I., Tin-Bearing Placer Deposits Near Tofty, Hot Springs District, Central Alaska: Bureau of Mines Rept. of Investigations 5373, 1957, 56 pp.

other industries. During Government ownership the smelter had been managed by the Tin Processing Corp., a Delaware corporation, and a subsidiary of N. V. Billiton Maatshappij.

According to the 1958 Federal budget:[4]

Public Law 608, approved June 22, 1956, provided for operation of the tin smelter until January 31, 1957. It also authorizes and directs the Corporation (Federal Facilities Corp.) to take steps immediately to sell or lease the tin-producing facilities. Should no contract of sale or lease be affected by January 31, 1957, the tin smelter will be reported as excess property for transfer and disposal in accordance with the provisions of the Federal Property and Administration Services Act of 1949.

A report to the Congress on the liquidation of the Reconstruction Finance Corp. contains the following:[5]

After exhaustive negotiations, an agreement for the sale of the smelter was signed on January 3, 1957, with the Wah Chang Corp. The sale price was $1,350,000 with a 10-percent cash downpayment and the balance in annual installments over a period of 10 years. The purchaser also agreed to make additional payments up to $2 million contingent upon the volume of tin metal, tin alloys, and tungsten produced.

Effective June 30, 1957, responsibility for liquidating the remnants of the Government's tin program passed from the Secretary of the Treasury to the Administrator of General Services in accord with the provisions of Executive Order 10720 (July 11, 1957). At that time, the remaining assets of the tin program consisted primarily of $1,215,000 due on the purchase-money mortgage taken in the sale of the smelter.

TABLE 2.—Longhorn-tin smelter production 1942–57, in long tons

Year	Long tons	Year	Long tons
1942	15,696	1950	32,136
1943	20,727	1951	30,934
1944	30,619	1952	22,592
1945	40,591	1953	37,562
1946	43,468	1954	27,002
1947	33,292	1955	22,329
1948	36,678	1956	17,631
1949	36,053	1957	1,564

SECONDARY TIN[6]

Domestic recovery of secondary tin in 1957 decreased about 18 percent in quantity and 22 percent in value from 1956. Of the total tin recovered, copper-base scrap furnished 43 percent; lead base, 33 percent; tin-base, 10 percent; and tinplate scrap, the remainder. Only 15 percent was recovered as unalloyed tin, reclaimed mostly at detinning plants.

Treatment of tinplate clippings at detinning plants increased for the fifth successive year to a new high. Material treated totaled 649,000 long tons, compared with the previous peak of 630,000 tons in 1956. The average quantity of tin recovered per long ton of tinplate scrap treated was 11.45 pounds in 1957 against 11.93 pounds in 1956. The lower recovery (for the 11th consecutive year) continued to reflect treatment of a larger proportion of electrolytic tinplate carrying a thinner coating of tin.

[4] Bureau of the Budget, The Budget of the United States Government for the Fiscal Year Ending June 30, 1958: Jan. 16, 1957, p. 919.

[5] Department of the Treasury, Report to the Congress-Liquidation of Reconstruction Finance Corporation: Dec. 10, 1957, p. 13.

[6] The assistance of Archie J. McDermid and Edith E. den Hartog is acknowledged.

TABLE 3.—Secondary tin recovered in the United States, 1948–52 (average) and 1953–57, 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	Value
1948–52 (average)	2,974	410	3,384	3,209	24,862	28,071	$68,628,020
1953	2,650	450	3,100	2,850	24,750	27,600	59,212,676
1954	2,660	530	3,190	2,930	23,260	26,190	53,863,091
1955	2,580	620	3,200	2,970	25,370	28,340	60,140,288
1956	2,700	690	3,390	3,260	26,180	29,440	66,776,900
1957	2,840	500	3,340	3,540	20,720	24,260	52,266,470

TABLE 4.—Tin recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1956–57, in long tons

Kind of scrap	1956	1957	Form of recovery	1956	1957
New scrap:			As metal:		
Tinplate	3,350	3,310	At detinning plants	2,975	3,100
Tin-base	1,630	1,260	At other plants	285	440
Lead-base	4,130	2,800			
Copper-base	2,700	2,150			
Total	11,810	9,520	Total	3,260	3,540
Old scrap:					
Tin cans	40	30	In solder	6,260	5,170
Tin-base	1,590	1,110	In tin babbitt	625	280
Lead-base	6,340	5,200	In chemical compounds	745	560
Copper-base	9,660	8,400	In lead-base alloys	4,870	3,480
			In brass and bronze	13,680	11,230
Total	17,630	14,740	Total	26,180	20,720
Grand total	29,440	24,260	Grand total	29,440	24,260

TABLE 5.—Secondary tin recovered from scrap processed at detinning plants in the United States, 1956–57

	1956	1957
Scrap treated:		
Clean tinplate clippings ... long tons	629,097	648,343
Old tin-coated containers ... do	6,045	4,056
Total ... do	635,142	652,399
Tin recovered:		
From new tinplate clippings ... do	3,350	3,310
From old tin-coated containers ... do	40	30
Total ... do	3,390	3,340
Form of recovery:		
As metal ... do	2,700	2,840
In compounds ... do	690	500
Total [1] ... do	3,390	3,340
Weight of tin compounds produced ... do	1,125	1,020
Average quantity of tin recovered per long ton of clean tinplate scrap used ... pounds	11.93	11.45
Average quantity of tin recovered per long ton of old tin-coated containers used ... pounds	15.47	15.50
Average delivered cost of clean tinplate scrap ... per long ton	$44.20	$39.20
Average delivered cost of old tin-coated containers ... do	$44.37	$42.41

[1] Recovery from tinplate clippings and old containers only. In addition, detinners recovered 325 tons from these sources in 1956, and 315 tons of tin as metal and in compounds from tin-base scrap and residues in 1957.

TABLE 6.—Stocks and consumption of new and old tin scrap in the United States in 1957, gross weight in long 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	20	532		529	529	23
No. 1 pewter	19	57		53	53	23
High-tin babbitt	63	709		629	629	143
Drosses and residues	478	1,986	2,009		2,009	455
Total	580	3,284	2,009	1,211	3,220	644
Foundries and other manufacturers:						
Block-tin pipe, scrap, and foil	2	20		13	13	9
High-tin babbitt	1	3		3	3	1
Drosses and residues	1					1
Total	4	23		16	16	11
Grand total:						
Block-tin pipe, scrap, and foil	22	552		542	542	32
No. 1 pewter	19	57		53	53	23
High-tin babbitt	64	712		632	632	144
Drosses and residues	479	1,986	2,009		2,009	456
Total	584	3,307	2,009	1,227	3,236	655

[1] Revised figures.

CONSUMPTION BY USES

Total tin consumption in the United States declined 9 percent in 1957. Five items—tinplate, solder, bronze and brass, babbitt, and tinning—supplied 91 percent of the tin used in 1957, virtually unchanged from 1956 and 1955. Consumption of tin in tinplate (the leading use of primary, which took almost 60 percent of the annual totals for 1952–57) dropped 2,700 tons from 1956. Consumption increased 9 percent for electrolytic but decreased 36 percent for hot-dipped. In 1957, 74 percent of the tin used to make tinplate was for electrolytic and 26 percent for hot-dipped; use of solder ranked second, consuming 1,680 tons less; bronze, the largest use of secondary tin, decreased 2,285 tons; babbitt declined 285 tons, mainly in primary tin; and the quantity used in tinning was 430 tons smaller. Tin used for white metal (highest since 1941) advanced 7 percent; the tonnage going into britannia metal increased the most.

Tinplate production reached an alltime high of 5.7 million short tons. Of the total output, electrolytic furnished 87 percent compared with 81 percent in 1956, and the hot-dipped type only 13 percent compared with 19 percent in 1956. Hot-dipped-tinplate production was the smallest since 1909.

The United States, the leading producer and consumer of tinplate, required about 50 percent of the world consumption of tin for tinplate. Of the nearly 90 percent of tinplate consumed in making cans, about 60 percent was used for food packing and 40 percent for nonfood products. During 1957 one company began processing tinplate directly from coils weighing up to 7½ tons in can plants.

The manufacture of aluminum cans for motor oil, grated cheese, and meat began in 1957. It was stated in the 1957 annual report of the Continental Can Co., Inc., however, that aluminum was not

TABLE 7.—Consumption of primary and secondary tin in the United States, 1948–52 (average) and 1953–57, in long tons

	1948–52 (average)	1953	1954	1955	1956	1957
Stocks on hand Jan. 1 [1]	26,011	23,105	24,525	23,326	27,757	28,446
Net receipts during year:						
Primary	57,370	57,969	52,673	64,544	62,099	59,215
Secondary	2,918	2,582	2,351	2,191	2,185	2,868
Terne	673	604	[2] 226	------	------	------
Scrap	28,952	29,754	28,601	30,262	28,999	26,758
Total receipts	89,913	90,909	83,851	96,997	93,283	88,841
Available	115,924	114,014	108,376	120,323	121,040	117,287
Stocks on hand Dec. 31 [1]	25,483	24,525	23,326	27,757	28,446	32,030
Total processed during year	90,441	89,489	85,050	92,566	92,594	85,257
Intercompany transactions in scrap	2,399	2,566	2,159	2,083	2,270	2,750
Tin consumed in manufactured products	[3] 88,042	[3] 86,923	82,891	90,483	90,324	82,507
Primary	56,085	53,959	54,427	59,828	60,470	54,429
Secondary	30,764	31,681	28,464	30,655	29,854	28,078

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1953, 525 tons; 1954, 240 tons; 1955, 1,340 tons; 1956, 2,005 tons; 1957, 1,815 tons; and 1958, 1,310 tons.
[2] January–June only, earlier reported as tin content of terne metal consumed in terneplate manufacturing. Beginning July 1954 reported as tin consumed in making terne metal.
[3] Includes tin losses in manufacturing.

considered a substitute for tinplate, but rather a means of extending the metal-container line of products.

The Tin Industry (Research and Development) Board of Malaya has announced[7] the availability of a special fund of M$500,000 (U. S. $166,666) for use to refute publicity in favor of tin-less cans.

Receipts of tin for industrial consumption totaled 88,840 long tons (5 percent less than 1956), of which 67 percent was primary tin, unchanged from 1956 and 1955. "Straits" brand comprised 70 percent of the primary receipts in 1957 and 1956.

TABLE 8.—Tin content of tinplate produced in the United States, 1948–52 (average) and 1953–57

Year	Total tinplate (all forms)			Tinplate (hot-dipped)			Tinplate (electrolytic)			Tinplate waste-waste, strips, cobbles, etc.		
	Gross weight (short tons)	Tin content (long tons)[1]	Tin per short ton of plate (pounds)	Gross weight (short tons)	Tin content (long tons)	Tin per short ton of plate (pounds)	Gross weight (short tons)	Tin content (long tons)	Tin per short ton of plate (pounds)	Gross weight (short tons)	Tin content (long tons)	Tin per short ton of plate (pounds)
1948–52 (average)	4,277,244	30,868	16.2	1,641,312	19,263	26.3	2,437,551	10,412	9.6	198,381	1,192	13.6
1953	5,067,010	31,327	13.9	1,375,606	14,807	24.1	3,331,386	14,605	9.8	360,018	1,915	11.9
1954	5,017,227	33,026	14.7	1,339,611	15,906	26.6	3,526,982	16,115	10.2	[2] 150,634	[3] 1,005	------
1955	5,422,444	33,549	13.9	1,062,850	13,395	28.2	4,002,068	20,154	11.3	357,526	------	------
1956	5,689,061	34,761	13.7	1,006,196	13,041	29.0	4,305,774	21,720	11.3	377,091	------	------
1957	5,715,384	32,046	12.6	686,616	8,370	27.3	4,593,587	23,676	11.6	435,181	------	------

[1] Includes small tonnage of secondary pig tin and tin acquired in chemicals.
[2] Not reported during January-June 1954; figures shown are for period July-December only.
[3] For period January-June only; thereafter not separately reported but included in above figures on tinplate.

[7] Tin (London), August 1957, p. 177.

TABLE 9.—Consumption of tin in the United States, 1955–57, by finished products, in long tons of contained tin

Product	1955			1956			1957		
	Primary	Secondary [1]	Total	Primary	Secondary [1]	Total	Primary	Secondary [1]	Total
Tinplate	[2] 33,549		[2] 33,549	[2] 34,761		[2] 34,761	[2] 32,046		[2] 32,046
Terne metal	149	174	323	175	114	289	181	181	362
Solder	12,063	10,167	22,230	10,555	10,027	20,582	8,987	9,917	18,904
Babbitt	2,611	1,760	4,371	2,615	2,141	4,756	2,440	2,031	4,471
Bronze and brass	4,204	15,508	19,712	4,815	14,627	19,442	4,274	12,883	17,157
Collapsible tubes and foil	845	78	923	928	50	978	765	53	818
Tinning	2,568	45	2,613	2,525	52	2,577	2,091	53	2,144
Pipe and tubing	82	74	156	129	26	155	100	24	124
Type metal	175	1,312	1,487	164	1,347	1,511	85	1,464	1,549
Bar tin	1,439	140	1,579	1,317	115	1,432	1,070	162	1,232
Miscellaneous alloys	254	232	486	288	162	450	271	145	416
White metal	1,088	91	1,179	1,304	141	1,445	1,400	140	1,540
Chemicals including tin oxide	645	1,047	1,692	779	1,012	1,791	594	966	1,560
Miscellaneous	156	27	183	115	40	155	125	59	184
Total	59,828	30,655	90,483	60,470	29,854	90,324	54,429	28,078	82,507

[1] Includes 2,765 long tons of tin contained in imported tin-base alloys in 1955; 2,167 in 1956; and 3,100 in 1957.
[2] Includes small tonnage of secondary pig tin and tin acquired in chemicals.

TABLE 10.—Tinplate shipments by market classifications, 1948–52 (average) and 1953–57, in thousand short tons

American Iron and Steel Institute Annual Report on Shipments of Steel Products, by Market Classifications, AISI 16]

Market classifications	1948–52 (average)	1953	1954	1955	1956	1957
Sanitary cans:						
Hot dip	1,100	798	716	500	425	301
Electrolytic	1,125	1,446	1,530	1,978	2,070	2,070
Total	2,225	2,244	2,246	2,478	2,495	2,371
General-line cans:						
Hot dip	162	82	118	82	78	48
Electrolytic	851	1,280	1,424	1,606	1,691	1,773
Total	1,013	1,362	1,542	1,688	1,769	1,821
Closure-crown caps and others:						
Hot dip	17	12	6	8	4	3
Electrolytic	242	297	298	326	301	273
Total	259	309	304	334	305	276
Total cans and closures	3,497	3,915	4,092	4,500	4,569	4,468
Other uses:						
Hot dip	85	105	80	81	77	58
Electrolytic	91	137	164	251	237	230
Total	176	242	244	332	314	288
Export:						
Hot dip	390	321	387	430	366	240
Electrolytic	156	183	265	342	316	330
Total	546	504	652	772	682	570
Total:						
Hot dip	1,754	1,318	1,307	1,101	950	650
Electrolytic	2,465	3,343	3,681	4,503	4,615	4,676
Grand total	4,219	4,661	4,988	5,604	5,565	5,326

TABLE 11.—Consumer receipts of primary tin, by brands, 1948–52 (average) and 1953–57, in long tons

Year	Banka	English	Katanga	Longhorn	Straits	Others	Total
1948–52 (average)	3,604	(1)	5,605	15,580	24,978	7,603	57,370
1953	1,731	6,798	2,826	927	42,886	2,801	57,969
1954	1,216	4,727	5,112	255	38,784	2,579	52,673
1955	3,268	3,873	6,744	30	47,844	2,785	64,544
1956	7,190	3,373	6,341	----------	43,468	1,727	62,099
1957	6,897	3,726	3,154	----------	41,460	3,978	59,215

[1] Included with "Others," not separately reported.

STOCKS

Tinplate mills, holding nearly 85 percent of plant stocks of pig tin in the United States, increased inventories 4,390 long tons. Tin in process at tin mills on December 31, 1957, was the highest quantity recorded. At the end of the year, pig-tin stocks at other industrial plants declined to the lowest point recorded.

Tin was among the materials on which all Government stockpile objectives were reached.[8]

TABLE 12.—Industry tin stocks in the United States, Dec. 31, 1953–57, in long tons

	1953	1954	1955	1956	1957
At plants:					
Pig tin—virgin	13,680	12,162	16,205	16,290	20,126
In process [1]	10,845	11,164	11,552	12,156	11,904
Total	24,525	23,326	27,757	28,446	32,030
Other pig tin:					
In transit in United States	240	1,340	2,005	1,815	1,310
Jobbers–Importers	260	1,200	260	620	660
Afloat to United States	2,700	5,200	5,340	5,500	1,735
Total	3,200	7,740	7,605	7,935	3,705
Grand total industry	27,725	31,066	35,362	36,381	35,735

[1] Includes secondary pig tin (long tons) as follows: 1953, 326; 1954, 277; 1955, 246; 1956, 304; and 1957, 327.

PRICES

Tin prices in 1957 were sustained by purchase of excess tin supplies for the international buffer stock. Following a steady decline from the 1956 high of 113.75 cents on November 1, 1956, the highest price quoted in 1957 was $1.03 on January 31. The price moved steadily downward thereafter to 87.125 cents on November 22 and 25, 1957, the low for the year.

On the London market the cash price averaged £754.8 per long ton in 1957, compared with £787.7 in 1956. The highest price on the London Metal Exchange was £804 on January 23 and the lowest £730 on October 9, where it held virtually the rest of 1957 by buffer stock buying. The 3-months price which averaged £747.5 in 1957 (£774.4 in 1956) dropped from the high of £778.5 on March 25 to the low of £680.5 on November 22. A new feature of the London Metal Ex-

[8] Office of Defense Mobilization, Stockpile Report to the Congress, July to December 1957: Pp. 4-5.

change was selling Soviet tin in the United Kingdom and on the Continent.

On the Singapore market the monthly price of Straits tin ex-works was £731.5 for 1957, compared with £760.2 for 1956. The highest price for the year was £765.3 on March 26 and the lowest, £636, on November 25.

TABLE 13.—Monthly prices of Straits tin for prompt delivery in New York, 1956–57, in cents per pound [1]

Month	1956			1957		
	High	Low	Average	High	Low	Average
January	109.000	100.750	104.82	103.000	99.250	101.35
February	105.250	98.625	100.53	102.500	97.875	100.22
March	102.125	98.500	100.57	101.875	98.250	99.48
April	100.375	98.000	99.17	100.250	98.375	99.30
May	98.000	93.750	96.88	99.125	97.750	98.32
June	95.375	93.625	94.48	98.500	97.125	98.02
July	100.250	92.875	96.16	97.875	95.625	96.46
August	100.000	98.250	98.96	95.375	92.875	94.15
September	107.375	100.125	103.57	93.875	92.750	93.31
October	112.250	102.500	105.72	93.125	90.625	91.84
November	113.750	108.125	110.26	91.000	87.125	89.23
December	110.000	99.875	104.01	93.375	90.375	92.32
Total	113.750	92.875	101.26	103.000	87.125	96.17

[1] Compiled from quotations published in the American Metal Market.

FOREIGN TRADE [9]

The principal tin items in the foreign trade of the United States in 1957 were imports of metallic tin and 94-percent tin alloys and exports of tinplate and tin cans. Of less importance was the trade in tin scrap, including tin-alloy scrap, tinplate scrap, tinplate circles, cobbles, strip, scroll, etc. Significant quantities of tin ingot, miscellaneous tin manufactures, and tin compounds were exported. Tin contained in babbitt, solder, type metal, and bronze imported and exported is shown in the Lead and Copper chapters of this volume.

Imports of metallic tin declined in 1957 for the fifth successive year and fell 10 percent below 1956. This was the longest period of continuous downtrend recorded in metallic tin imports. Of the total imports, about 70 percent came from Malaya, the principal source; however, the quantity of tin received from Malaya was the smallest since 1951. The tin imported from Indonesia shown in table 16 is believed to have been smelted in the Netherlands.

Receipts of tin contained in concentrates were only 94 tons in 1957, the smallest since 1934. As there was no tin smelting in the United States after January, the concentrate was imported for other contained metals.

In addition, 4,800 long tons of alloys, with the chief value in tin was imported, mainly from Denmark in 94-percent tin alloys.

Exports of metallic tin (including ores and concentrates) in 1957 were 1,530 long tons (890 in 1956); Canada and the United Kingdom were the principal destinations. The gross weight of tin-alloy scrap

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

exported (mostly to the United Kingdom) was 9,400 long tons in 1957, compared with 4,300 tons in 1956.

The principal tin-export item of the United States, as usual, was tinplate. Tinplate exports declined 4 percent in tonnage and only slightly in value, compared with 1956. Tinplate was exported to South America, Europe, Asia, North America, Africa, and Oceania,

TABLE 14.—Foreign trade of the United States in tin concentrate and tin, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Imports				Exports			
	Concentrate (tin content)		Bars, blocks, pigs, grain, or granulated		Ingots, pigs, bars, etc.			
					Domestic		Foreign	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
1948-52 (average)	31,575	$69,051,733	60,211	$136,028,522	201	$455,665	386	$1,070,292
1953	35,973	82,713,269	74,570	175,950,269	128	297,695	75	141,901
1954	22,140	41,724,776	65,599	133,185,565	271	467,029	551	1,125,003
1955	20,112	[1] 36,773,366	64,815	131,605,569	254	503,892	853	1,748,367
1956	16,688	32,316,702	62,590	136,412,171	[2] 439	[2] 820,578	451	1,018,417
1957	94	118,416	56,183	121,310,541	1,112	1,526,091	419	919,162

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.
[2] Revised figure.

TABLE 15.—Tin concentrate (tin content) imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	1956		1957	
	Long tons	Value	Long tons	Value
North America:				
Canada	221	$430,898	----	----
Mexico	156	205,975	9	$11,921
Total	377	636,873	9	11,921
South America:				
Argentina	----	----	(1)	384
Bolivia	8,533	15,652,803	11	5,839
Total	8,533	15,652,803	11	6,223
Europe: United Kingdom	25	36,730	----	----
Asia:				
Indonesia	3,548	7,451,014	----	----
Thailand	3,144	6,351,200	40	20,345
Vietnam, Laos, Cambodia	16	27,488	----	----
Total	6,708	13,829,702	40	20,345
Africa:				
Belgian Congo	969	1,988,234	----	----
Nigeria	----	----	34	79,927
Total	969	1,988,234	34	79,927
Oceania: Australia	76	172,360	----	----
Grand total	16,688	32,316,702	94	118,416

[1] Less than 1 ton.

TABLE 16.—Tin[1] imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	1956		1957	
	Long tons	Value	Long tons	Value
South America: Bolivia	333	$706,722	214	$407,929
Europe:				
Belgium-Luxembourg	6,275	14,081,583	3,730	8,133,880
Germany, West	439	862,618	263	561,574
Netherlands	7,109	15,965,499	6,712	14,459,675
Portugal	90	191,659	20	43,008
United Kingdom	4,700	10,333,014	4,913	10,406,539
Total	18,613	41,434,373	15,638	33,604,676
Asia:				
Indonesia	925	2,147,107	1,330	3,103,641
Malaya	42,479	91,551,930	39,001	84,194,295
Total	43,404	93,699,037	40,331	87,297,936
Africa: Belgian Congo	240	572,039		
Grand total	62,590	136,412,171	56,183	121,310,541

[1] Bars, blocks, pigs, grain, or granulated.

in that order. Electrolytic tinplate exports were 270,350 long tons valued at $60 million. Exports of hot-dipped tinplate totaled 187,100 long tons valued at $44 million. Exports of short ternes were 1,870 long tons in 1957 (2,240 in 1956).

According to the American Iron and Steel Institute, producers in 1957 shipped for export 570,000 short tons (682,000 in 1956) of tinplate; 330,000 tons was electrolytic (316,400 in 1956) and 240,000, hot-dipped (365,600 in 1956).

Tinplate scrap exported was 3,630 long tons in 1957 (3,380 in 1956), mostly to Japan through the customs district of Hawaii. Tinplate-scrap imports, mainly from Canada, were 31,400 long tons, compared with 29,200 in 1956.

TABLE 17.—Foreign trade of the United States in tinplate, taggers tin, and terneplate in various forms, 1948–52 (average) and 1953–57, in long tons

[Bureau of the Census]

Year	Tinplate, taggers tin, and terneplate		Tinplate circles, strips, cobbles, etc. (exports)	Terneplate clippings and scrap (exports)	Tinplate scrap	
	Imports	Exports			Imports	Exports
1948–52 (average)	3,781	[1] 540,716	7,237	159	43,747	988
1953	374	459,639	11,445		37,582	5,195
1954	127	635,969	11,831		29,214	944
1955	40	747,682	14,798		28,721	144
1956	586	[2] 648,517	21,858	10	29,137	3,377
1957	40	625,641	19,531		31,431	3,628

[1] Owing to changes in classifications, data for 1948–51 not strictly comparable with other years.
[2] Revised figure.

TABLE 18.—Foreign trade of the United States in miscellaneous tin, tin manufactures, and tin compounds, 1948–52 (average) and 1953–57

[Bureau of the Census]

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			
1948–52 (average)	$267,600	6,010,737	$4,516,630	34,256	$12,562,546	[1]$1,857,798	38,258	(2)
1953	605,609	15,924,059	11,894,770	29,841	12,916,664	2,418,061	5,115	183,328
1954	[3] 784,511	13,165,707	9,358,184	23,878	11,022,214	3,340,533	2,703	342,146
1955	[3] 558,964	13,702,355	[3]10,383,046	26,490	11,516,846	2,440,829	11,350	311,005
1956	[3] 604,531	11,364,288	[3] 9,429,600	30,502	13,245,030	[4] 2,323,865	22,576	375,021
1957	560,676	11,382,988	9,488,004	30,166	14,308,916	3,911,036	21,809	489,227

[1] Owing to changes in classifications, data for 1948–51 not strictly comparable to later years.
[2] Not separately classified 1948; 1949: 41,004 pounds; 1950: 122,716 pounds; 1951: 136,179 pounds; 1952: 73,131 pounds.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.
[4] Revised figure.

WORLD REVIEW

INTERNATIONAL TIN AGREEMENT

Tin control was exercised under the International Tin Agreement for the first full year in 1957. Producing countries contributed to the buffer stock, tin prices (under which the buffer stock manager operates) were revised, buffer stocks of tin were accumulated, percentages and votes of participating countries were reallocated, and export controls were established. By March 15 all the first contributions to the buffer stock were made in money and totaled £9.6 million—the equivalent of 15,000 tons of tin at £640 a ton. The International Tin Council held five meetings. Thailand formally deposited its instrument of ratification of the International Tin Agreement on March 18, 1957.

At the first meeting of the year, in March, the floor price of tin was raised from £640 per long ton (80 cents a pound) to £730 (91¼ cents a pound). The ceiling price of £880 (110 cents a pound) was left unchanged.

Under the agreement, if the price is at or above the ceiling, the buffer-stock manager must offer any tin that he has for sale. When the price is at or below the floor price, he must buy tin, if he has money. The range between the floor and ceiling continues divided into three sections: In the lower range—£730 (91¼ cents a pound) to £780 (97½ cents a pound)—the manager may buy tin; in the top range—£830 (103¾ cents a pound) to £880 (110 cents a pound)—he may sell; and in the middle range—£780 (97½ cents a pound) to £830 (103¾ cents a pound)—he abstains from selling or buying unless the Council decides otherwise.

At the June meeting in Brussels, Canada gave the Council 6 months' notice of its impending disposition of about 3,000 long tons of noncommercial stocks of tin (when the price reached £830 per ton).

At a July meeting in London the instrument of ratification of the International Tin Agreement by the Government of Austria was deposited and welcomed. The United Kingdom stated that the 2,500 tons of stock referred to at the December 1956 meeting would be sold over a period of time at prices (about £748–£750 per ton) that would not depress the market. Consumers' votes were reallocated on the basis of net imports and consumption for the 3 years, 1954–56. No tin was held in the buffer stock on March 31. The meeting was adjourned until October 23; no decision was reached on reallocation of producers' percentages. At the meeting, continued in London on October 23, new percentages and votes of the participating countries were approved.

At an October meeting cash and forward tin held by the buffer stock on June 30, 1957, was announced as equivalent to 3,915 long tons.

On September 30 the buffer stock was 4,315 tons, and the stock rose to 10,000 long tons of tin by November 21. The Tin Council issued a communique November 27 stating that the chairman had informed contributing producing governments that the second contribution of 5,000 tons to the buffer stock was due. Delegates of producing countries unanimously recommended that their governments make prompt payment of the total in cash at £730 per long ton, which they later agreed to pay by December 6.

Control of tin exports from the participating countries was decided at a December meeting. During the first control period—December 15, 1957, to March 14, 1958, inclusive—the total permissible export quantity was fixed at 27,000 long tons of tin. This was about 28½ percent below the total production rate in the 12 months ended September 30, 1957. To prevent a sharp price rise from this action, the buffer-stock manager was permitted to operate on the market, should the price reach the middle range. Consideration was also given to the third contribution of 5,000 tons, which would be due when the buffer stock held 15,000 tons of metal. This was called up December 30, 1957, and most of it had been paid in cash in advance of the due date. On December 31, 1957, the buffer stock stood at 15,300 tons.

The International Tin Council assumed publication of tin statistics in April when the Tin Study Group ceased these activities on March 31, 1957.

TABLE 19.—International Tin Agreement voting power of consuming countries

Country	At first meeting	At second, third, fourth, and fifth meetings	At sixth and seventh meetings	At eighth meeting
Australia	39	32	29	29
Austria			13	13
Belgium	32	38	38	38
Canada	105	77	71	71
Denmark	22	79	85	86
Ecuador	5	5	5	(1)
France	159	165	167	168
India	78	75	74	75
Israel		7	7	7
Italy		56	58	58
Netherlands	102	52	53	53
Spain	19	14	13	13
Turkey		20	17	17
United Kingdom	439	380	370	372
Total	1,000	1,000	1,000	1,000

1 Withdrew in November 1957.

TABLE 20.—International Tin Agreement export control—percentages, votes, and permissible export amount—first control period, Dec. 15, 1957, to Mar. 31, 1958

Producing country	Percentage [1]	Votes allocated [1]	Permissible export amount [2] (long tons)
Belgian Congo and Ruanda-Urundi	8.95	92	2,416
Bolivia	20.43	203	5,516
Indonesia	20.43	203	5,516
Malaya	37.50	369	10,125
Nigeria	5.34	57	1,442
Thailand	7.35	76	1,985
Total	100.00	1,000	27,000

1 Established at October 1957 meeting.
2 Fixed at December 1957 and January 1958 meetings.

WORLD MINE PRODUCTION

World mine production of tin decreased 800 long tons in 1957. Six countries operating under the International Tin Agreement as producers, representing 80 percent of the total, decreased their output 2 percent. Among these, the tin fields of Malaya supplied 31 percent of the world total; Bolivia and Indonesia each, 15 percent; Belgian Congo and Thailand each, 7 percent; and Nigeria, 5 percent.

TABLE 21.—World mine production of tin (content of ore), by countries, 1948–52 (average), and 1953–57, in long tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	238	287	149	220	338	275
Mexico	352	476	349	605	500	473
United States	71	56	205	99	–	–
Total	661	819	703	924	838	748
South America:						
Argentina	261	154	95	89	85	181
Bolivia (exports)	33,551	34,825	28,824	27,921	26,843	27,794
Brazil	223	209	167	146	[2] 180	[2] 180
Peru [3]	54	–	–	–	2	–
Total	34,089	35,188	29,086	28,156	27,110	28,155
Europe:						
Czechoslovakia [4]	200	200	200	200	200	200
France	122	493	525	450	433	[2] 450
Germany, East	200	563	669	669	660	[2] 670
Portugal	[5] 852	1,367	1,283	1,445	1,169	1,144
Spain	615	1,241	1,020	822	550	[2] 489
U. S. S. R.[4]	8,000	9,400	9,800	10,300	11,800	13,000
United Kingdom	963	1,103	940	1,034	1,044	1,028
Total [2]	11,000	14,400	14,400	14,900	15,900	17,000
Asia:						
Burma	1,490	1,400	950	1,130	1,050	[2] 860
China [2]	6,800	9,600	10,000	11,500	13,000	14,500
Indonesia	31,524	33,822	35,861	33,368	30,053	27,723
Japan	340	737	715	896	926	941
Laos	73	264	110	253	254	525
Malaya	54,253	56,254	60,690	61,244	62,295	59,293
Thailand	8,280	10,126	9,776	11,023	12,481	13,531
Total [2]	102,800	112,200	118,100	119,400	120,100	117,400
Africa:						
Belgian Congo [6]	13,645	15,293	15,084	15,028	14,764	14,264
British Somaliland	–	–	–	–	–	5
French Cameroon	80	86	82	85	85	74
French West Africa	50	99	73	47	56	54
Morocco: Southern Zone	6	9	5	14	5	8
Mozambique	3	–	–	–	–	–
Nigeria	8,633	8,228	7,926	8,158	9,067	9,534
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	5	7	1	–	–	–
Southern Rhodesia	62	30	14	208	329	350
South-West Africa	103	210	412	357	475	636
Swaziland	31	36	34	27	29	24
Tanganyika (exports)	83	47	37	41	15	[2] 13
Uganda (exports)	148	92	83	68	33	40
Union of South Africa	653	1,360	1,315	1,283	1,442	1,464
Total	23,502	25,497	25,066	25,316	26,300	26,466
Oceania: Australia	1,759	1,553	2,075	2,017	2,078	[2] 1,751
World total (estimate)	173,800	189,700	189,400	190,700	192,300	191,500

[1] This table incorporates a number of revisions of data published in previous Tin chapters. Data do not add to totals shown, owing to rounding where estimated figures are included in the detail.
[2] Estimated by authors of the chapter and in a few instances from the Statistical Bulletin of the International Tin Council, London, England.
[3] Minor constituent of other base-metal ores.
[4] Estimate, according to the 44th annual issue of Metal Statistics (Metallgesellschaft) through 1956.
[5] Excluding mixed concentrates.
[6] Including Ruanda-Urundi.

WORLD SMELTER PRODUCTION

World smelter production of tin in 1957 decreased 4 percent. Government smelting activities at Texas City, Tex., ceased January 31, 1957. Bolivian concentrate, formerly smelted in the United States, was shifted to the United Kingdom, where output reached the highest point since 1942. The smelters in Malaya (the most important sources of metallic tin in the world) decreased their output 3 percent but supplied 38 percent of the total in 1957 and 1956.

TABLE 22.—World smelter production of tin, by countries, 1948–52 (average) and 1953–57, in long tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	238					
Mexico	267	209	224	357	218	[2] 210
United States	32,062	37,562	27,407	22,329	17,631	1,564
Total	32,567	37,771	27,631	22,686	17,849	1,774
South America:						
Argentina	227	130	60	99	96	[2] 104
Bolivia (exports)	240	174	196	107	421	216
Brazil	142	553	1,850	1,184	[2] 1,200	[2] 1,400
Peru [3]	54				1	3
Total	663	857	2,106	1,390	1,718	1,723
Europe:						
Belgium	9,584	9,039	11,377	10,432	9,716	9,714
Germany:						
East	245	480	600	605	[2] 600	[2] 600
West	411	694		280	[2] 660	[2] 864
Netherlands	21,113	26,950	28,442	26,566	28,197	29,230
Portugal	272	471	664	1,018	1,127	982
Spain	736	823	676	608	576	[2] 714
U.S.S.R. [4]	8,000	9,400	9,800	10,300	11,800	13,000
United Kingdom [5]	29,011	28,860	27,475	27,241	26,434	34,174
Total [2]	69,400	76,700	79,000	77,100	79,100	89,300
Asia:						
China [2]	6,400	9,000	9,400	11,500	13,000	14,500
Indonesia	222	644	1,351	1,572	[2] 1,500	[2] 600
Japan	389	805	813	1,030	1,105	1,259
Laos	7					
Malaya	61,987	62,410	71,166	70,632	73,263	71,289
Thailand	4					
Total [2]	69,000	72,900	82,700	84,700	88,900	87,600
Africa:						
Belgian Congo	3,227	2,715	2,459	3,034	2,772	2,651
Morocco: Southern Zone	3		8	8	[2] 12	[2] 8
Rhodesia and Nyasaland, Federation of:						
Southern Rhodesia	76	27	19	22	12	253
Union of South Africa	731	828	752	779	756	823
Total	4,037	3,570	3,238	3,843	3,552	3,735
Oceania: Australia	1,803	1,443	2,063	2,004	1,850	1,806
World total (estimate)	177,500	193,200	196,700	191,700	193,000	185,900

[1] This table incorporates a number of revisions of data published in previous Tin chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[2] Estimated by authors of the chapter and in a few instances from Statistical Bulletin of the International Tin Council, London, England.
[3] Tin content of dross.
[4] Estimate, according to the 44th annual issue of Metal Statistics (Metallgesellschaft) through 1956.
[5] Includes production from imported scrap and residues refined on toll.

Next in rank were United Kingdom, Netherlands, China, U.S.S.R., and Belgium. These 6 countries furnished 92 percent of the world tin in 1957.

REVIEW BY COUNTRIES

South America

Bolivia.—Tin in concentrate and ore exported from Bolivia was 27,800 long tons valued at $57,377,000, a 4-percent increase in quantity, but a 3-percent decline in value compared with 1956. Shipments were greatly accelerated in December. Of the 1957 exports, 90 percent was treated in England, and the remainder mostly in Germany, Netherlands, Brazil, and Argentina. Some was smelted locally.

The permissible quota established December 15 by the International Tin Council reduced exports 31 percent beginning January 1, 1958. The Bolivian Government allocated the export quota 81 percent to the "nationalized mines," 8 percent to the "medium miners," and 11 percent to the "small miners."

The contribution due the buffer stock from Bolivia under the International Tin Agreement was the equivalent of 5,484 long tons of tin amounting to £3,693,630. Several firms, including Consolidated Tin Smelters, Ltd., Williams, Harvey & Co., Ltd., and Capper Pass & Son, Ltd., made joint loans to help the Bolivian Government participate in this phase of the tin agreement. The loan is interest-bearing and is secured on the stock of cash and tin under control of the buffer pool. The loan is being recovered on behalf of the lenders in regular installments by deduction from the proceeds of tin ore bought from Bolivia by one of the participating companies.

Krupps of Germany made melting tests on Bolivian tin ores. Tests with the Waelz volatilization procedure appeared encouraging, making a high-grade dust from low-grade concentrates. Placer Development, Ltd., approached the government for permission to erect a tin concentrator which would treat the dumps at Catavi.[10]

TABLE 23.—Tin production in Bolivia by nationalized mines, 1953–57, in long tons of contained tin

Mine	1953 [1]	1954 [1]	1955 [2]	1956 [2]	1957
Carocoles	789	447	351	340	561
Catavi	10,707	8,588	7,381	8,109	7,620
Chorolque	981	844	890	561	1,737
Colavi	330	218	191	171	(3)
Colquechaca	----	----	51	60	[4] 80
Colquiri	4,618	4,240	4,775	4,440	4,083
Hunanuni	5,236	4,308	3,637	3,431	2,874
Japo	28	65	47	63	[4] 70
Monserrat	14	4	----	----	----
Morococala	219	168	185	194	949
Ocuri	----	----	29	----	----
Oploca-Santa Ana	659	657	707	526	(5)
San Jose	1,741	1,787	1,644	1,502	1,352
Santa Fe	608	379	405	441	(6)
Tasna	1,192	664	810	693	(5)
Unificada	2,683	2,300	1,937	1,897	1,774
Viloco	214	94	75	81	92
Others	89	13	----	125	[4] 101
Total	30,108	24,776	23,115	22,634	21,293

[1] Ministerio de Minas y Petroleo, La Paz, International Tin Study Group, 1956 Statistical Yearbook, p. 92.
[2] U. S. Embassy, La Paz, Bolivia, from data furnished by Corporacion Minera de Bolivia.
[3] Included with Unificada. [4] Estimated. [5] Included with Chorolque. [6] Included with Morococala.

[10] Mining World, Annual Catalog: Vol. 20, No. 5, Apr. 15, 1958, p. 124.

TABLE 24.—Tin exports from Bolivia by groups, 1952–57, in long tons of contained tin

[Departmento de Estadistica, Ministeno de Mines y Petroleo]

Group	1952	1953	1954	1955	1956	1957
Corporation Minera de Bolivia	24,846	30,108	24,776	23,417	22,478	22,032
Banco Minero:						
Medium mines	4,111	1,782	1,686	1,957	3,914	5,435
Small mines	2,745	2,761	2,166	2,440		
Oruro smelter (tin metal)	257	174	196	107	449	329
Total	31,959	34,825	28,824	27,921	26,841	27,796

Europe

France.—The only operative tin mine in France near Nosay north of Nantes, producing 450 tons (tin content) in 1957 was shut down in December. Deposits in this area were worked as early as Phoenician times. The latest period of mining activity began in December 1951 by the Société Nantaise des Minerais de l'Ouet (S. N. M. O.) and the Société J. Carnaud. Equipment for the mine was financed with Marshall Plan credits.

Tin consumption in France was about 11,200 long tons, compared with 10,400 in 1956. About 5,000 tons (4,360 in 1956) was used for tinplate.

Portugal.—From 1950 through 1957 Portugal was the leading producer of tin-in-concentrate in Europe.

The alluvial reserves are decreasing steadily; the vein deposits appear to have a long life ahead. Beralt Tin and Wolfram, Ltd., operated a test mill with a capacity of up to 100 tons of ore per day on the Argimela property 27 miles from Panasqueira. It also had the Vale De Ermeda mine under development, looking toward large-scale mining. The Portuguese-American Tin Co., which dredged for tin on the Macainhas River, became the Portuguese-American Tin Co. Division of the Yuba Consolidated Industries, Inc.

Additional electric furnaces were reported to have been added to the tin smelter at Mangualda-Gar, which had a rated daily capacity of about 1 ton.

United Kingdom.—Mine production of about 1,000 long tons of tin was derived principally from 690 long tons of black tin (65 percent) produced by Geevor Tin Mines, Ltd., and 730 tons, by South Crofty, Ltd. In addition, Hydraulic Tin, Ltd., began treating tailing for recovering cassiterite at Truro, Cornwall. Minerals Recovery, Ltd., stopped processing beach sands for tin recovery at its plant near Gwithian, Cornwall.

The United Kingdom ranked second as a world smelter of tin ore, as a consumer of pig tin, and as a producer of tinplate. Smelter production increased about 30 percent, owing mainly to treatment of a larger tonnage of Bolivian concentrate. Tinplate production gained for the 5th consecutive year and totaled 988,900 long tons, 15 percent more than 1956 and the largest on record. Of the 1957 output, 60 percent was hot-dipped, and 40 percent, electrolytic. About 44 percent of the tinplate, or 431,100 long tons was exported in 1957, the highest quantity since 1937. The principal foreign markets were Australia and Argentina.

Year-end stocks of tin-in-concentrates afloat to United Kingdom were 2,689 tons (3,893 at beginning of year). Metal afloat increased from 140 tons at the beginning to 2,680 tons at the end of 1957.

United Kingdom tin imports came principally from Malaya, Russia, Belgium, and Netherlands. Import controls on tin were removed on August 1, 1957. Exports of tin metal went mostly to the United States.

The large increase in stocks was the result of buffer-stock procurement.

TABLE 25.—United Kingdom tin consumption, 1953–57, primary and secondary refined tin, excluding tin scrap, in long tons [1]

Use	1953	1954	1955	1956	1957
Tinplate	8,911	9,896	9,847	10,100	11,093
Tinning:					
Copper wire	405	493	527	484	539
Steel wire	78	113	112	100	99
Other	796	856	802	831	726
Solder	1,879	2,345	2,877	2,765	1,910
Alloys:					
White metal	2,901	3,581	3,741	2,935	2,779
Bronze and gunmetal	2,001	2,076	2,508	2,721	2,396
Other	393	488	479	449	390
Wrought tin: [2]					
Foil and sheets	255	319	338	290	263
Collapsible tubes	306	384	422	341	352
Pipes, wire, and capsules	71	54	50	48	56
Chemicals [3]	766	959	1,033	1,048	1,082
Other uses [4]	120	148	137	120	102
Total	18,882	21,712	22,873	22,232	21,787

[1] British Bureau of Non-ferrous Metal Statistics, World Non-Ferrous Metal Statistics: Bull., December 1957, vol. 10, No. 12, Feb. 11, 1958, p. 55.
[2] Includes compo and "B" metal.
[3] Mainly tin oxide.
[4] Mainly powder.

TABLE 26.—Tin production, imports, exports, and stocks, United Kingdom, 1953–57, in long tons

[British Bureau of Non-ferrous Metal Statistics, World Non-ferrous Metal Statistics]

	1953	1954	1955	1956	1957
Production:					
Ores and concentrates (tin content)	1,103	940	1,034	1,044	1,028
Refined tin:					
Primary	28,860	27,475	27,241	26,434	34,174
Secondary	490	525	468	402	325
Imports:					
Ores and concentrates (tin content)	28,907	27,494	27,084	26,571	39,272
Refined tin	1,039	2,406	1,227	2,226	9,834
Exports of refined tin	13,759	8,118	8,456	7,264	7,330
Reexports of refined tin	685	457	472	1,107	273
Total exports and reexports	14,444	8,575	8,928	8,371	7,603
Stocks end of period:					
Ores and concentrates (tin content)	2,450	2,473	2,181	2,393	3,872
Refined tin:					
At consumers	1,478	1,514	1,377	1,516	1,587
Official warehouse	807	1,933	622	759	12,202
Other (smelters)	800	900	1,000	697	591
Total	3,085	4,347	2,999	2,972	14,380

Asia

Indonesia.—The tin output—27,723 long tons—was 8 percent less than in 1956 and the lowest since 1947. The islands of Bangka, Billiton, and Singkep furnished 62, 33, and 5 percent, respectively, of the total.

Exports of tin-in-concentrate were about 26,920 long tons; 25,500 tons went to the Netherlands and 1,420, to the United States. The tonnage to the United States was shipped in December for smelting at Texas City, Tex., by the Wah Chang Corp.

The mining concessions in Indonesia of Billiton Joint Mining Co. were due to expire in February 1958. Political disturbances in the latter part of 1957 in Indonesia had no reported effect on the tin-producing areas.

Malaya.—Mine production of tin in Malaya decreased 5 percent to 59,290 long tons in 1957. The rate of production was highest during the last quarter; miners apparently produced as much tin as they could in December before buffer-stock collections and reduced exports became effective.

Of the 1957 total, 57 percent came from European mines (mostly by dredges) and 41 percent from Asian mines (mostly by gravel pumps), including 2 percent from dulang washing. European mines supplied 6 percent less than 1956, the lowest since 1946. Asian mines decreased their output 4 percent, but their portion was the largest since 1931.

The 1957 export duty on tin in Malaya was £6.3 million, compared with £7 million in 1956. The duty furnished nearly 71 percent of the Federation's total customs revenue in 1957.

Dredges in operation (mainly in Perak and Selangor) numbered 78 at the beginning and 76 at the end of 1957; gravel-pump units dropped from 633 to 597. The total number of active tin mines in 1957 was 743, compared with 784 in 1956. On December 31, 1957, in tin mines, 36,585 laborers were employed, compared with 39,459 on December 31, 1956.

Malaya's permitted exports of tin under the International Tin Agreement were fixed at 10,125 long tons of tin metal (equivalent to 226,196 piculs of concentrates at 75.2 percent tin) for the first quota period, December 15, 1957, to March 31, 1958, and 8,625 tons of metal for the quarter ending June 30, 1958. On the basis of production for the 5 years 1953–57, permissible export quotas were apportioned 58.66 percent to European mines, 39.55 percent to Asian mines, and 1.79 percent to dulang washers. Production, deliveries, and export of tin concentrate after December 15 were permitted only on the authority of certificates of production issued by deputy controllers. The first buffer-stock-collection period of 1 year terminated October 14, and a total of £3,589,950 was collected at the rate of M$24 a picul (£47 per ton) of concentrates. The second collection period began December 15; and another January 1, 1958, at a lesser rate of M$12 a picul of concentrate. The amount collected will be repaid on the partial or complete liquidation of the buffer stock.

The principal world source of tin metal continued to be the large plants of the Eastern Smelting Co., Ltd., on the island of Penang and the Straits Trading Co., Ltd., at Pulau Brani, Singapore, and Butter-

TABLE 27.—Federation of Malaya mine production of tin (content of ore), by methods of mining, 1952–57, in long tons [1]

Year	Dredges			Gravel pumps			Hydraulicking			Opencast			Underground			Small workings			Dulang washers	Total		
	European	Asian [2]	Total	European	Asian [2]	Total	European	Asian [2]	Total	European	Asian [2]	Total	European	Asian [2]	Total	European	Asian [2]	Total	Asian [2]	European	Asian [2]	Total
1952	29,587		29,587	1,361	20,226	21,587	1,514	91	1,605	377	409	786	1,974	252	2,226	1	144	145	902	34,814	22,024	56,838
1953	28,638		28,638	1,215	20,564	21,779	1,097	76	1,173	743	521	1,264	1,991	257	2,248	2	183	185	966	33,687	22,567	56,254
1954	31,669		31,669	1,493	21,197	22,690	1,302	86	1,388	807	548	1,355	1,975	274	2,249	12	244	256	1,082	37,258	23,431	60,689
1955	31,048		31,048	1,309	22,686	23,995	1,303	43	1,346	758	473	1,231	1,994	248	2,242	1	293	294	1,088	36,413	24,831	61,244
1956	30,705		30,705	1,323	23,612	24,935	1,446	23	1,469	719	650	1,369	1,897	503	2,400	10	307	317	1,100	36,100	26,195	62,295
1957	28,116		28,116	1,409	22,987	24,396	1,621	8	1,629	814	444	1,258	1,838	683	2,521	1	298	299	1,073	33,799	25,493	59,292

[1] Federation of Malaya, Department of Statistics, Monthly Statistical Bulletin: January 1958, p. 51.
[2] Includes Chinese only for 1952.

worth, Province Wellesley. In addition, a small quantity of metal was produced by a Chinese smelter for local consumption. Total smelter production in 1957 was 71,290 long tons (73,260 in 1956). Concentrates treated were derived mostly from Malaya and Thailand. Receipts from Thailand in 1957 reached a post-World War II high point.

Shipments to the United States declined nearly 5,000 tons; the flow was small in December. Exports to the United Kingdom more than trebled largely owing to buying for the buffer stock.

The smelter at Butterworth was strike-bound from January 10 to March 12; and, at the Penang smelter, a labor strike began as a "go slow" November 13 but was unsettled at the close of 1957, although a few men were reported as returning to work. It had been intended to transfer the bulk of the company smelting activity to the Butterworth smelter in Penang by the end of 1956 and eventually to close the obsolete Pulau Brani smelter. However, because of the labor strike at Butterworth, Straits Trading Co. resumed full production at Pulau Brani throughout 1957.

TABLE 28.—Tin-metal exports from Malaya in 1956–57 in long tons [1]

Destination	1956	1957	Destination	1956	1957
United States	41,083	36,117	Australia-New Zealand	887	1,483
Japan	6,889	6,745	South Africa	938	753
United Kingdom	1,984	6,531	Turkey	607	516
Republic of India	3,758	4,223	Germany, West	626	132
Argentina	118	2,813	Mexico	322	388
Italy	2,835	2,520	Other countries	3,755	2,694
France	3,578	2,202			
Netherlands	4,265	1,762	Total	73,275	70,599
Canada	1,630	1,720			

[1] Federation of Malaya, Department of Statistics, Monthly Statistical Bulletin: January 1958, p. 52.

TABLE 29.—Imports of tin-in-concentrate into Malaya in 1956 and 1957, in long tons

Country of origin	1956	1957	Country of origin	1956	1957
Burma	773	806	Other	42	126
Laos and Viet Nam	178	349			
Thailand	9,974	12,862	Total	10,967	14,143

Stocks of tin metal increased from 2,190 tons at the beginning to 2,830 at the end of 1957. Because of the labor strike at the smelter, tin-in-concentrates (including mine stocks) increased from 4,795 at the beginning to 6,960 at the end—the highest since 1939.

The Federation of Malaya attained independence within the British Commonwealth on August 31, 1957.

Thailand.—Thailand ranked sixth among the world tin-producing countries in 1957 as in 1956.

Aokim Tin, Ltd., off the island of Buhket, began producing early in 1957 by means of 2 deep grabs operating from a deep-sea grab dredge and capable of digging 120,000 cubic yards monthly. Values are below 60 to 70 feet of sea water. During the first 6 months of 1957 about 85 long tons of tin concentrate was produced.

The instrument of ratification by Thailand of the International Tin Agreement was deposited on March 18, 1957. A ministerial regulation specifying the responsibilities of tin mine operators and tin dealers regarding contributions to the tin buffer stock, in accordance with the agreement, was promulgated on March 1, 1957.

TABLE 30.—Exports of tin-in-concentrate from Thailand, 1956–57, in long tons

Country	1956	1957	Country	1956	1957
Belgium		42	Portugal		73
Brazil	615	292	United States	1,714	1
Chile	21				
Japan	191	243	Total	12,424	13,347
Malaya	9,883	12,696			

Africa

Belgian Congo.—Mine production of tin in Belgian Congo, including Ruanda-Urundi, was 14,264 long tons—a 3-percent decrease from 1956. December output increased to the highest for any month since December 1953. Smelting in Belgian Congo was about 5 percent below 1956. Exports of tin-in-concentrate, mostly to Belgium, totaling 12,370 long tons, reached a peak in December; lesser tonnages went to Brazil and United Kingdom. As usual, most of the tin metal exported in 1957 went to Belgium. However, the final destination of Belgian Congo tin was mainly the United States, either directly or via Belgium. Total stocks of tin in concentrates were 883 long tons at the end of the year.

Symétain Co., the principal producer, furnished over 25 percent of the tin output of Belgian Congo and Ruanda-Urundi since 1932. Production for 1957 was 5,420 long tons of cassiterite compared with 5,325 long tons in 1956. The deposits are in Maniema and extend over 400,000 hectares. Production came from 138 working places grouped in 23 camps. The company produced 4,000 tons of tin from 5,500 tons of concentrate recovered from 5 million cubic yards of ground. About 180 Europeans and 9,000 natives were employed.[11] Output per man-day increased from 0.87 cubic meters of ground excavated in 1932 to 1.66 in 1938 and 6.6 in 1957.

The Géomines Co. produced 3,745 tons of cassiterite concentrate (3,940 tons in 1956); 1,856 tons came from altered pegmatite and 1,889 tons, from unaltered pegmatite. A new crushing plant at washery No. 5 at Kitotolo reached its normal output in January 1957. A washery was installed and was expected to begin producing in January 1958. A new high-capacity crushing and washing plant was planned at the old Kahungwe open-cut mine at Manono, which has a substantial reserve of stony pegmatite-type ore. The reserve in the weathered and altered pegmatites is near exhaustion; the deposit has been mined for 40 years. In the unaltered pegmatite the reserve is estimated to exceed 100,000 tons of cassiterite.[12]

French Equatorial Africa.—The Société MINETAIN du Congo-Francais was formed on June 21, 1957, to exploit a tin deposit dis-

[11] International Tin Council, Notes on Tin: No. 5, July–August 1957, p. 63.
[12] International Tin Council, Notes on Tin (Source: Agence economique et financière No. 29-30, 1957: Report of Géomines—summarized), No. 8, November-December 1957, p. 125.

covered in 1956 in the northern part of the district of Madingou-Kayes, east of the lagoon M'Banie.[13] The deposit was reported to be "modest in size but excellent in tenor." It is not known whether the deposit is alluvial or vein. MINETAIN was expected to begin extracting the ore at the rate of 4 to 5 tons per month by the end of 1957.

Nigeria.—In 1957 Nigeria produced 13,151 long tons of tin ore (12,507 in 1956) averaging 72.5 percent tin. The entire tin-ore exports, totaling 13,577 tons (13,364 in 1956), went to the United Kingdom. About half the world supply of columbium was produced as a byproduct or coproduct of tin mining in Nigeria.

In the year ended March 31, 1957, Nigeria's largest tin producer—the Amalgamated Tin Mines of Nigeria, Ltd.—reported that 14 million cubic yards was treated by the company compared with 12.7 million in the preceding year. The value of the ground treated dropped from 0.75 pound to 0.62 pound of cassiterite per yard.

The output (in long tons) was obtained by the following methods:

	Cassiterite	*Columbite*
Gravel pumps	2, 122	203
Dragline with washing plants	864	124
Dredge	188	33
Dumpers and jig plants	88	5
Elevators, hand paddocks, tribute, and contract	690	52
Mill tailings	216	138
	4, 168	555

Rhodesia and Nyasaland, Federation of.—Tin production in Southern Rhodesia in 1957 remained virtually unchanged from 1956. Capacity of the plant of Kamativi Tin Mines, Ltd., (N. V. Billiton Maatschappij) at Bulawayo was increased late in 1957 from 600 to 1,000 tons of ore a day.

Oceania

Australia.—Mine production of tin in Australia was 1,750 long tons in 1957 or 16 percent below 1956. Smelter production was virtually unchanged. Imports of tin increased to meet expanded needs. Australia, one of the largest tinplate importers in the world, was supplied mostly by United Kingdom and the United States in 1957. Australia's first tinplate mill at Port Kembla, New South Wales, began producing August 5, 1957. Annual output was scheduled at 72,000 tons of hot-dipped tinplate. Production during December reached 4,250 tons. An electrolytic tinplate plant that is planned will make Australia self-sufficient in tinplate production by 1963.

Tableland Tin Dredging, N. L., Mount Garnet, North Queensland, the leading tin producer, began dredging new ground in 1953; yields were erratic. Grade improved in late 1957, but mine production (544 tons of tin oxide) was 244 tons less than in 1956. Ravenshoe Tin Dredging, Ltd., began producing in the same district in September on financial credit guaranteed by the Queensland Government. An annual output of 600 tons was expected from this company. The Queensland Government operated its customs milling plant for tin ore at Irvinebank. The Northern Territory Department of Mines ore-processing plant at Maranboy was inactive. The Australian Government operated its tin dredge at Dorset, Tasmania.

[13] Arundale, Joseph C., American Counsul-Elisabethville, State Department Dispatch 12: Dec. 28, 1957.

A document on the tin resources of Australia, including a selected list of literature references was published.[14]

TECHNOLOGY

Four possible methods [15] of recovering tin and tungsten from the slags at the Longhorn tin smelter were developed on a laboratory scale by the Federal Bureau of Mines. From slags averaging 1 to 1½ percent tin and ½ to 1 percent tungstic oxide, a recovery of 90 percent of the tin and tungsten was indicated.

Results of research on the recovery of tin from metallurgical slimes were published.[16] Mixtures of hydrogen chloride and reducing gases such as hydrogen, carbon monoxide, hydrogen sulfide, ethane, propane, and butane were used to treat the slimes at elevated temperatures. Over 95 percent of the tin was volatilized as a chloride. Optimum conditions were found to consist of a mixture of 3 to 1 of hydrogen and hydrogen chloride gases at 475° C.

An analytical procedure was reported [17] for determining low concentrations of tin. The method was based on using flavonol, which produced a bright blue fluorescence with quadrivalent tin in 0.5 to 0.1 normal sulfuric acid solution. Although water solution was satisfactory for qualitative determinations, 33 percent dimethylformamide was preferred for quantitative analyses. Interfering ions included those of fluoride, phosphate, and zirconium.

A special aluminum-tin-bearing alloy, containing 21.1 percent tin, 1.83 percent copper, 0.15 percent silicon, 0.13 percent iron, and the remainder aluminum, provided encouraging results in evaluation tests.[18] The large proportions of tin in the bearing tested was believed to have prevented scoring of the shaft by allowing absorption of small abrasive particles.

When iron was exposed to molten tin three layers were formed—iron, tin, and $FeSn_2$.[19] Examination of these layers showed that the $FeSn_2$ layer was the hardest phase. In addition, the $FeSn_2$ was the most noble phase in acidified NaCl or dilute citric acid and in the same mediums, the corrosion rates of $FeSn_2$ were too low to be easily measurable. At low current densities, hydrogen overvoltage values for $FeSn_2$ were intermediate between values for iron and tin. The predicted corrosion behavior of tinplate was related to these properties.

When highly purified tin was dissolved in highly purified germanium, the tin, present as a solid solution, did not significantly alter the electrical characteristics of the germanium.[20] This verified the theory that impurities with the same number of valence electrons as germanium would be neutral; the impurities would act neither as donors nor as acceptors.

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[14] Commonwealth of Australia, Bureau of Mineral Resources, Geology and Geophysics, Geology and Mineral Economics Sections: Mineral Resources of Australia, Summary Report No. 38, Tin, Commonwealth Government Printer, Canberra, 1958, 59 pp.

[15] Kenworthy, H., Starliper, A. G., and Freeman, L. L., Recovery of Tin and Tungsten From Tin-Smelter Slags: Bureau of Mines Rept. of Investigations 5327, 1957, 12 pp.

[16] Kershner, K. K., and Cochran, A. A., Volatilization of Tin Chlorides From Slime: Bureau of Mines Rept. of Investigations 5298, 1957, 10 pp.

[17] Coyle, Charles F., and White, Charles E., Fluorometric Determination of Tin With Flavonol: Anal. Chem., vol. 29, No. 10, October 1957, pp. 1486–1488.

[18] Automobile Engineer (London), Aluminum-Tin Bearings: Vol. 47, No. 1, January 1957, p. 9.

[19] Covert, Roger A., and Uhlig, Herbert H., Chemical and Electrochemical Properties of $FeSn_2$: Jour. Electrochem. Soc., vol. 104, No. 9, September 1957, pp. 537–541.

[20] Iron Age, Dissolves Tin in Germanium: Vol. 180, No. 13, Sept. 26, 1957, pp. 140–141.

As part of a long-range program to study the atomic bonding in alloys, a liquid-tin solution calorimeter was designed and operated at the University of California.[21] The calorimeter permitted the determination of the heats of formation of alloy phases from the heats of solution of the alloys and of the pure component metals in liquid tin. Results indicated that the heats of formation of alloy phases may be determined with an average uncertainty of about ± 50 calories per gram.

A study [22] of local corrosion of tin by dilute chloride solutions showed that special physical or chemical preparation of the metal surface or alloying additions to the metal did not prevent local corrosion indefinitely. Factors affecting corrosion were surface conditions, severity of attack, crevices, pH of solution, and electrical contact with a more noble metal. Local corrosion was prevented by adding sodium bicarbonate, carbonate, benzoate, chromate, phosphate, or silicate to the chloride solutions. Aluminum anodes provided cathodic protection.

Although acid sulfate and alkali stannate baths are widely used for electroplating tin industrially, pyrophosphate solutions offered advantages because of high solubility, nonpoisonous nature, stability, and low metal-ion concentration due to complex formation.[23] Good quality tin deposits over a wide range of experimental conditions are electroplated from the complex $Sn_2P_2O_4$ bath. The brightness of the deposits was increased by adding agents such as dextrin-gelatin.

Reports [24] were published describing new methods for the synthesis of tin-carbon bonds, typical organotin compounds, and addition products.

The effectiveness of a recently developed organotin compound, bis tri-n-butyl tin oxide, as a slime-control agent was demonstrated under actual operations in both newsprint and boxboard production.[25] Advantages of the new compound included less toxic effects, noncorrosive characteristics, efficiency in a wide range of pH conditions, and its ability to protect pulp and finished paper against mildew.

The manufacture of organotin compounds is growing as these chemicals strengthen their holds on current applications.[26] Uses include treating textiles, stabilizing rubber paints, polyvinyl chloride plastics, drugs, and biocides (fungicides, insecticides, herbicides). Researchers seeking new uses and new compounds found markets for organotins in veterinary medicine (anthelmintics), slime control, and catalysts for silicone polymerizations.

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[21] Orr, Raymond L., Golberg, Alfred, and Hultgren, Ralph, Liquid Tin Solution Calorimeter for Measuring Heats of Formation of Alloys: Rev. Sci. Instr., vol. 28, No. 10, October 1957, pp. 767–773.

[22] Britton, S. C., and Michael, D. G., The Corrosion of Tin and Tinned Copper in Dilute Neutral Solutions: Jour. Appl. Chem., vol. 7, pt. 7, July 1957, pp. 349–356.

[23] Vaid, J., Rama Char, T. L., Tin Plating From the Pyrophosphate Bath: Jour. Electrochem. Soc., vol. 104, No. 5, May 1957, pp. 282–287.

[24] Van Der Kerk, G. J. M., Noltes, J. G., and Luijten, J. G. A., Investigations on Organo-Tin Compounds. VII. The Addition of Organo-Tin Hydrides to Oleofinic Double Bonds: Jour. Appl. Chem., vol. 7, pt. 7, July 1957, pp. 356–365.

———. Investigations on Organo-Tin Compounds. VIII. Preparation of Some Organo-Tin Hydrides: Jour. Appl. Chem., vol. 7, pt. 7, July 1957, pp. 366–369.

———. Investigations on Organo-Tin Compounds. IX. The Preparation of Some Dialkyltin Compound With Long-Chain Alkyl Groups: Jour. Appl. Chem., vol. 7, pt. 7, July 1957, pp. 369–374.

[25] Connolly, William J., A New Slime-Control Agent: Paper Trade Jour., vol. 141, No. 31, Aug. 5, 1957, pp. 46–47.

[26] Chemical Week, Organo-tins: The Little Slice With Big Hopes: Vol. 80, No. 27, July 6, 1957, pp. 50–51.

The Tin Research Institute celebrated its twenty-fifth anniversary demonstrating techniques that have been developed or used at the Institute.[27] The exhibits included the continuous casting of bronze rods, bearings made from an alloy of aluminum and tin bonded to thin steel strip shell, improved methods of applying tin coatings to resist corrosion of steel, electroplating tin-alloy coatings, and organotin compounds for use as fungicides, wood preservatives, and slime-control agents.

A review [28] of the industrial and engineering developments in tin since 1947 described research on solders, electrodeposition, compounds, bearings, tinplate, bronze, special alloys, physical properties of tin-containing materials, and miscellaneous applications. A detailed bibliography listed publications of the research projects.

A new chemical treatment called the Hinac Process,[29] a substitute for tin in its leading use as tinplate consisted of an inorganic coating chiefly with chromium compounds, which equaled tinplate in economy and performance. It worked well on both ferrous and nonferrous metals—anywhere a surface with good corrosion resistance and paint-bonding qualities was required.

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[27] Chemistry and Industry, Twenty-Five Years of Tin Research: No. 31, Aug. 3, 1957, p. 1074.
[28] MacIntosh, Robert M., Materials of Construction: Tin and Its Alloys: Ind. Eng. Chem., vol. 49, No. 9, part II, September 1957, pp. 1653–1657.
[29] Iron Age, New Surface Treatment Substitutes for Tinplate: Vol. 179, No. 23, June 6, 1957, pp. 106–108.

Titanium

By John W. Stamper[1]

THE RAPID growth since 1948 of the titanium-sponge-metal industry in the United States halted abruptly in mid-1957, owing to sharp cutbacks in military requirements for the metal. The metal industry, as a whole, was operating at less than one-fifth of its estimated 28,000-ton-per-year capacity by the end of the year. In spite of this, sponge production for the entire year reached an alltime peak of 17,000 short tons. Ingot production decreased slightly from the preceding year, and producers increased efforts to promote civilian applications of the metal.

Other segments of the domestic titanium industry also declined. Rutile production was slightly lower than in 1956, and production and shipments of titanium pigments decreased 7 and 10 percent, respectively.

Ilmenite production increased 11 percent despite the decline in titanium pigments, the principal market for ilmenite.

The United States continued to be the world's leading producer and consumer of ilmenite and was also the principal consumer of rutile. Australia, Canada, and India still produced most of the titanium concentrates imported into the United States.

LEGISLATION AND GOVERNMENT PROGRAMS

In September 1957 the Business and Defense Services Administration (BDSA), United States Department of Commerce, issued Amendment 2 to BDSA Order M–107. The amendment reduced the required acceptance of defense-rated orders by producers from 90 percent of scheduled production to 75 percent. Moreover, in September titanium sponge was designated by the Office of Defense Mobilization as a Group II material in the Current List of Strategic and Critical Materials for Stockpiling. Materials in this group are acquired principally through transfer of Government-owned surpluses, pursuant to section 6 (a) of Public Law 520, 79th Congress, and were not under procurement.

DOMESTIC PRODUCTION

Concentrates.—Ilmenite production increased 11 percent over 1956 to a new peak of 757,000 short tons, but shipments increased only 5 percent. Production came from the following companies: American Cyanamid Co., Piney River, Va.; E. I. duPont de Nemours Co., Inc., Starke and Lawtey, Fla.; Marine Minerals, Inc., Bath, S. C.; National Lead Co., Tahawus, N. Y.; Rutile Mining Co. of Florida,

[1] Commodity specialist.

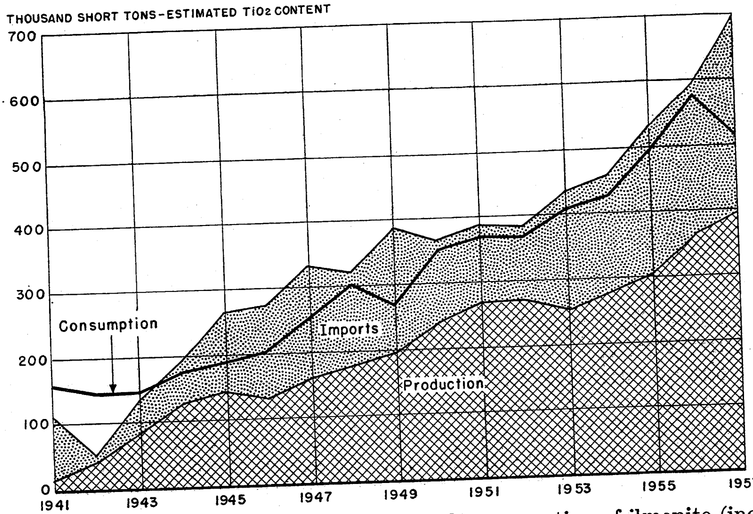

FIGURE 1.—Domestic production, imports, and consumption of ilmenite (includes titanium slag and a mixed product), 1941–57, in short tons.

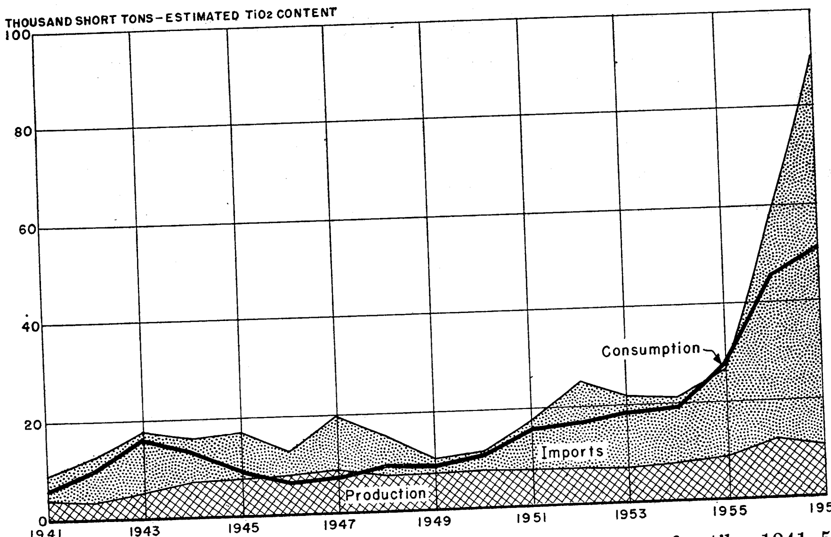

FIGURE 2.—Domestic production, imports, and consumption of rutile, 1941–57, in short tons.

Jacksonville, Fla.; Metal & Thermit Corp., Beaver Dam, Va.; and The Florida Minerals Co., Wabasso, Fla. Included in shipments was 28,400 short tons of ilmenite from stockpiles at Boise, Idaho.

Rutile production decreased 11 percent below the output of 1956, and shipments decreased 12 percent. A total production of 10,700 short tons of rutile was reported from the following companies: The Florida Minerals Co., Wabasso, Fla.; Marine Minerals, Inc., Bath,

S. C.; Metal & Thermit Corp, Beaver Dam, Va; and Rutile Mining Co. of Florida, Jacksonville, Fla.

TABLE 1.—Production and mine shipments of titanium concentrates from domestic ores in the United States, 1948–52 (average) and 1953–57, in short tons

Year	Production (gross weight)	Shipments		
		Gross weight	TiO_2 content	Value
ILMENITE [1]				
1948–52 (average)	464,760	452,289	225,321	$6,691,230
1953	513,696	512,176	258,247	7,222,641
1954	547,711	531,895	270,651	7,375,344
1955	583,044	573,192	297,835	10,267,647
1956	684,956	735,388	386,498	14,198,947
1957	757,180	782,975	407,167	17,362,176
RUTILE				
1948–52 (average)	7,247	7,991	7,443	524,501
1953	6,825	6,476	6,043	702,791
1954	7,411	7,305	6,822	869,677
1955	8,513	9,182	8,617	1,122,000
1956	11,997	12,065	11,348	1,748,883
1957	10,702	10,644	10,025	1,543,540

[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite for 1949–56, inclusive.

Metal & Thermit Corp. began mining and processing rutile and ilmenite at its plant at Beaver Dam, Va., in November. Production at the plant, scheduled to be 5,000 tons of rutile annually was described.[2]

In April, Union Carbide & Carbon Corp., parent company of the Electro Metallurgical Co., a titanium-sponge producer, announced plans to mine a deposit of titanium minerals on Amelia Island off the northeast coast of Florida. The company owns about 3,000 acres on the island and planned to begin mining by bucket dredge in the spring of 1958.[3]

Discovery of ilmenite-containing sand in the coastal plain area of central New Jersey was reported by geologists of the New Jersey Geological Survey.[4] Several firms engaged in titanium-pigment manufacturing have reportedly conducted investigations in the area.[5]

Metal.—The United States continued to be the leading Free World producer of titanium sponge, with a new peak production of 17,200 short tons in 1957. Sponge consumption was 25 percent below the preceding year. Much of the excess sponge metal was delivered to General Services Administration (GSA) under the terms of Government contracts. In 1957 deliveries to GSA totaled 10,577 short tons for a cumulative total of 19,821 short tons.

Commercial producers of titanium sponge in 1957 were as follows: Cramet, Inc., Chattanooga, Tenn.; Dow Chemical Co., Midland, Mich.; Electro Metallurgical Co., Ashtabula, Ohio; E. I. duPont de

[2] Engineering and Mining Journal, Virginia Heavy Minerals Plant Opens: Vol. 159, No. 1, January 1958, pp. 94–95.

[3] Mining Congress Journal, Union Carbide to Mine Titanium: Vol. 43, No. 6, June 1957, p. 119.

[4] Markewicz, F. J., Parrillo, D. G., and Johnson, M. E., The Titanium Sands of Southern New Jersey: Prepr. 5818A5, Soc. Min. Eng., AIME, 13 pp. (pres. at the annual meeting AIME, New York, N. Y., Feb. 16–20, 1958).

[5] Engineering and Mining Journal, Ilmenite in New Jersey: Vol. 158, No. 5, May 1957, p. 158.

Nemours & Co., Inc., Newport, Del.; and Titanium Metals Corp. of America, Henderson, Nev.

The Electro Metallurgical Co., a division of Union Carbide & Carbon Corp., was the only producer using the sodium process in reducing titanium tetrachloride to titanium metal. All other domestic producers used a magnesium-reduction process.

The following data represent activity in various branches of the titanium-metal industry in 1956 and 1957 in short tons:

	1956	*1957*
Titanium tetrachloride consumption [1]	66, 500	79, 000
Sponge production	14, 595	17, 249
Sponge consumption	10, 936	8, 221
Scrap consumption	2, 033	1, 743
Ingot production [2]	11, 688	10, 009
Ingot consumption	10, 860	10, 428
Mill product production	5, 166	5, 658

[1] Estimated.
[2] Includes alloying constituents.

TABLE 2.—Salient statistics of the titanium-metal industry, 1948–57, in short tons

Year	Sponge-metal production	Sponge in revolving-fund stockpile December 31	Mill-shape production	Year	Sponge-metal production	Sponge in revolving-fund stockpile December 31	Mill-shape production
1948	[1] 10		(2)	1953	2, 241	30	[3] 1, 114
1949	[1] 25		(2)	1954	5, 370	2, 894	[3] 1, 299
1950	[1] 75		(2)	1955	7, 398	6, 647	1, 898
1951	495		[1] 75	1956	14, 595	9, 289	5, 166
1952	1, 075	303	[1] 250	1957	17, 249	19, 821	5, 653

[1] Estimate.
[2] Data not available.
[3] Shipments.

Plant expansions proposed and in progress in mid-1957 were either suspended or activity greatly reduced as military orders for titanium metal decreased. Titanium producers laid off workers toward the end of 1957, and in December the industry as a whole was operating at less than one-fifth its estimated yearly capacity of 28,000 tons.

Late in 1957 Mallory-Sharon Titanium Corp. combined with U. S. Industrial Chemical Co. (U. S. I.) a division of National Distillers & Chemical Corp., to form Mallory-Sharon Metals Corp. The Mallory-Sharon Titanium Corp. has for many years melted titanium sponge and produced mill products at Niles, Ohio. During 1957 U. S. I. was constructing a 5,000-ton-per-year titanium-sponge plant in the same building with its zirconium plant at Ashtabula, Ohio.

On November 12, 1957, Crucible Steel Co. of America announced that, subject to Securities and Exchange Commission approval, it had acquired full ownership of Rem-Cru Titanium, Inc. The transfer was reportedly accomplished through exchange of 150,000 shares of Crucible common stock for the entire half interest owned by Remington Arms Co.[6]

[6] American Metal Market, Crucible Steel Now Full Owner of Rem-Cru Firm: Vol. 64, No. 218, Nov. 13, 1957, pp. 1, 3.

Titanium Metals Corp. of America (T. M. C. A.) began producing at its Toronto, Ohio, rolling plant in November. According to T. M. C. A., this is the first fully integrated plant in the world devoted to rolling and forging titanium. Billets and large rounds have been shipped, and rolling facilities for sheet were expected to be ready early in 1958.

The six titanium melters in 1957 were: Harvey Machine Co., Torrance, Calif.; Mallory-Sharon Metals Corp., Niles, Ohio; Oregon Metallurgical Corp., Albany, Oreg.; Rem-Cru Titanium, Inc., Midland, Pa.; Republic Steel Corp., Massillon and Canton, Ohio; and Titanium Metals Corp. of America, Henderson, Nev.

Oregon Metallurgical Corp. produced ingots and castings, and the other companies produced and processed ingots into mill products such as sheet, strip, plate, forging billets, and bar.

Pigments.—In 1957 production and shipment of titanium dioxide pigments decreased 7 and 10 percent, respectively, below 1956. This was the first decrease in titanium pigments reported since 1952, when production and shipments were 4 and 11 percent, respectively, below 1951.

Titanium pigments were produced in the United States by the following companies: American Cyanamid Co., Piney River, Va., and Savannah, Ga.; E. I. duPont de Nemours & Co., Inc., Edge Moor, Del., and Baltimore, Md.; Glidden Co., Baltimore and Hawkins Point, Md.; National Lead Co., St. Louis, Mo., and Sayreville, N. J.; and New Jersey Zinc Co., Gloucester City, N. J.

Early in 1957 E. I. duPont de Nemours & Co., Inc., disclosed that it would build a 125-ton-per-day titanium dioxide pigment plant on a 1,500 acre site near New Johnsonville, Tenn. Pigments will be produced by the chloride route whereby titanium tetrachloride is converted to titanium dioxide rather than by the sulfate route used by all the other domestic producers. The plant is expected to be in operation by early 1959.

Welding-Rod Coatings.—A total of 266,300 short tons of welding rods containing titaniferous material in their coatings was produced in 1957. This was a 6-percent decrease below the tonnage of welding rods similarly coated in the preceding year.

Of the total welding rods produced, 42 percent contained rutile only; 28 percent, ilmenite only; 13 percent, a mixture of rutile and manufactured titanium dioxide only; 12 percent, manufactured titanium dioxide only; and 5 percent, slag only.

CONSUMPTION AND USES

Concentrates.—During 1957 the consumption of ilmenite and titanium slag for making titanium pigment decreased 3 and 28 percent, respectively. This was reflected by a drop in titanium-pigment production of 7 percent. Consumption of rutile increased about 14 percent over 1956, owing partly to the slight increase in titanium-metal production. Of the 53,000 short tons of rutile used in the United States in 1957, 66 percent was used in making metal, and 27 percent was used in welding-rod coatings; the remainder went into alloys, carbides, ceramics, fiberglass, and other items.

TABLE 3.—Consumption of titanium concentrates in the United States, 1948–52 (average), 1953–55 total, and 1956–57, by products, in short tons

Product	Ilmenite [1]		Titanium slag		Rutile	
	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content
1948–52 (average)[2]	630,658	328,972	[3] 24,236	[3] 16,746	13,432	12,881
1953	687,075	354,470	73,528	52,511	20,170	19,033
1954	679,903	353,146	100,825	71,102	20,663	19,431
1955	741,450	401,146	134,953	94,522	28,762	27,192
1956						
Pigments (mfg. TiO_2)[4]	854,874	458,814	160,228	113,538		
Titanium metal	(5)	(5)	(6)	(6)	29,809	28,407
Welding-rod coatings	997	589	1,397	1,016	13,110	12,303
Alloys and carbide	9,294	4,579	(6)	(6)	1,195	1,138
Ceramics	27	17			[2] 381	[2] 357
Fiberglass					1,100	1,065
Miscellaneous [7]	19	10	809	594	[2] 1,258	[2] 1,183
Total	865,211	464,009	162,434	115,148	[2] 46,853	[2] 44,453
1957						
Pigments (mfg. TiO_2)[4]	832,350	429,019	114,168	80,866		
Titanium metal	(5)	(5)	(6)	(6)	36,048	34,488
Welding-rod coatings	1,051	614	1,460	1,066	14,490	13,654
Alloys and carbide	7,280	4,423	(6)	(6)	604	578
Ceramics	22	12			353	330
Fiberglass					1,122	1,091
Miscellaneous [7]	16	9	837	613	776	729
Total	840,719	434,077	116,465	82,545	53,393	50,870

[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite used to make pigments and metal.
[2] Revised figures.
[3] 1952 only.
[4] "Pigments" include all manufactured titanium dioxide.
[5] Included with pigments to prevent disclosing individual company confidential data.
[6] Included in "Miscellaneous" to prevent disclosing individual company confidential data.
[7] Includes consumption for chemicals and experimental purposes.

TABLE 4.—Distribution of titanium-pigment shipments, by industries, 1948–52 (average) and 1953–57, percent of total

Industry	1948–52 (average)	1953	1954	1955	1956	1957
Distribution by gross weight:						
Paints, varnishes, and lacquers	73.9	67.1	64.3	65.3	65.3	64.9
Paper	6.2	9.7	10.1	10.1	10.3	10.9
Floor coverings (linoleum and felt base)	4.5	4.8	4.5	4.6	4.2	4.1
Rubber	2.8	3.4	3.1	3.4	3.4	3.6
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	1.8	2.0	2.4	2.7	2.8	3.2
Printing ink	1.0	1.2	1.2	1.3	1.3	1.4
Other	9.8	11.8	14.4	12.6	12.7	11.9
Total	100.0	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:						
Paints, varnishes, and lacquers	66.4	58.8	55.4	58.4	58.3	57.7
Paper	9.1	14.1	14.1	13.5	13.6	14.2
Floor coverings (linoleum and felt base)	5.6	5.4	5.2	5.2	4.9	5.0
Rubber	3.6	4.5	4.0	4.4	4.4	4.6
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	2.4	2.6	3.2	3.4	3.6	4.1
Printing ink	1.5	1.6	1.6	1.7	1.8	1.9
Other	11.4	13.0	16.5	13.4	13.4	12.5
Total	100.0	100.0	100.0	100.0	100.0	100.0

Metal.—The consumption of titanium mill products, using shipments as a gage, was 5,700 short tons in 1957 compared with 5,100 short tons reported in 1956. Most of the fabricated titanium metal went into defense applications, particularly, aircraft and missiles. Titanium compressor rotors for jet engines, such as the J–57, continued to be used [7] and other titanium aircraft parts, such as fasteners [8] and slat tracks,[9] gained wider acceptance by aircraft manufacturers.

Civilian applications of titanium metal increased considerably in 1957 owing to increasing familiarity with the properties of the metal and development of titanium alloys with improved workability and heat-treating properties. Cast-titanium shapes, such as gate valves, were tested for use in the chemical industry. One company received an order for nearly 7 miles of titanium tubing for use in heat exchangers in process equipment for treating cobalt-nickel concentrate.[10]

Two experimental high-speed centrifuges, built in 1957, incorporated an alloy of titanium containing 6 percent aluminum and 4 percent vanadium. The machines can be operated 28 percent faster than stainless-steel machines for the same working stress in the rotating bowl, owing to titanium's low density, which is only 57 percent of the density of steel.[11]

Titanium mill shapes were used in work holders for anodized aluminum workracks in the chromic acid anodizing process.[12]

Titanium was used by one firm facing the problem of handling a highly corrosive acid solution of ferric chloride. Installation of a titanium pump reportedly paid for itself in the first 90 minutes of operation.[13]

STOCKS

Stocks of ilmenite, rutile, and titanium slag increased markedly in 1957. The largest increase was noted in rutile stocks, which increased 120 percent over the 1956 total. Ilmenite stocks increased 23 percent, and stocks of titanium slag increased 61 percent. At the 1957 rate of consumption the stocks of ilmenite, rutile, and slag (based on titanium dioxide content), represented about 1 year's supply.

Year-end stocks of titanium sponge held by producers and melters totaled 2,800 short tons, a slight decrease from the 3,000 tons held at the beginning of the year. An additional 19,821 tons was held in the revolving-fund stockpile. Industry stocks were enough for a 4-month supply at 1957 consumption rates.

Stocks of titanium scrap held by melters increased from 1,700 short tons at the beginning of the year to 3,600 tons.

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[7] SAE Journal, Alloy Titanium in J–57 Turbojet Engine: Vol. 65, No. 5, April 1957, pp. 17–19.

[8] American Metal Market, Sees Major Rise for Titanium Bolt Sales in '57: Vol. 64, No. 50, Mar. 14, 1957, p. 7.

[9] Materials and Methods, Titanium Used in Jet Slat Truck to Reduce Weight Inertia: Vol. 45, No. 5, May 1957, pp. 172–173.

[10] American Metal Market, T. M. C. Books Large Order for Titanium Pressure Tubing: Vol. 64, No. 170, Sept. 4, 1957, pp. 1, 7.

[11] Chemical Engineering, You Can Capitalize on Ti's Strength: Vol. 64, No. 4, April 1957, p. 146.

[12] Light Metal Age, Titanium Work Holders Speed Anodizing Process: Vol. 15, Nos. 1 and 2, February 1957, p. 37.

[13] American Metal Market, Titanium Aids Processing of Printed Circuits: Vol. 64, No. 74, Apr. 17, 1958, p. 7.

TABLE 5.—Stocks of titanium concentrates in the United States at the end of the year, 1956–57, 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
1956						
Mine	64,553	29,736			25	24
Distributors	134	79			1,673	1,598
Consumers	534,940	[1] 281,395	112,047	79,367	25,048	23,875
Total stocks	599,627	[1] 311,210	112,047	79,367	26,746	25,497
1957						
Mine	38,758	18,062			83	78
Distributors	195	116			3,680	3,512
Consumers	695,794	361,475	180,314	127,620	55,205	52,599
Total stocks	734,747	379,653	180,314	127,620	58,968	56,189

[1] Revised figure.

PRICES

Concentrates.—Oversupply of rutile in 1957 was reflected in price reductions during the year. Nominal prices for rutile (94 percent TiO_2, f. o. b. Atlantic seaboard), as quoted by E&MJ Metal and Mineral Markets, decreased from $190 to $230 per short ton in January 1957 to $120 to $125 per short ton at the end of the year. Prices of ilmenite remained unchanged throughout the year at $26.25 to $30 per gross ton (59.5 percent TiO_2, f. o. b. Atlantic seaboard), according to E&MJ Metal and Mineral Markets.

Manufactured Titanium Dioxide.—On February 18, 1957, the prices of rutile and anatase grades of manufactured titanium dioxide were advanced $0.01 per pound. The following prices were quoted in the Oil, Paint and Drug Reporter throughout the remainder of the year:

	Per pound
Anatase, chalk-resistant, regular and ceramic, carlots, delivered	$0.25½
Less than carlots, delivered	.26½
Rutile, nonchalking, bags, carlots, delivered East	.27½
Less than carlots, delivered East	.28½
Titanium pigment, calcium-rutile base, bags, carlots, delivered	.09¼
Less than carlots, delivered	.09¾

Metal.—In 1957 only one price change occurred for titanium-sponge metal and mill products. On June 3, 1957, sponge-metal producers lowered the price of Grade A–1 sponge 18 percent and Grade A–2 sponge 20 percent. Price of titanium mill products was reduced about 10 percent at the same time. Prices per pound quoted for titanium sponge and mill products in 1957 were as follows:

	Jan. 1, 1957, through June 12, 1957	*June 13, 1957, through Dec. 31, 1957*
Titanium sponge, Grade A-1	$2.75 [1]	$2.25.
Titanium sponge, Grade A-2	$2.50 [2]	$2.00.
Sheet	$11.60 to $12.10.[3]	$10.10 to $11.10.
Strip	$11.00 to $11.50.[3]	$9.50 to $10.00.
Plate	$9.25 to $9.75 [3]	$8.00 to $8.75.
Wire	$8.50 to $9.00 [3]	$7.50 to $8.00.
Forging billets	$6.85 to $7.10 [3]	$6.00 to $6.25.
Hot-rolled bars	$7.10 to $7.35 [3]	$6.15 to $6.40.

[1] Maximum iron content of 0.20 percent, with a Brinell hardness of less than 125.
[2] Maximum iron content of 0.45 percent, with a Brinell hardness of less than 170.
[3] F. o. b. mill, commercially pure grades, in lots of 10,000 pounds and over.

Ferrotitanium.—In 1957 the price of low-carbon ferrotitanium quoted in E&MJ Metal and Mineral Markets remained unchanged. The price of high-carbon and medium-carbon ferrotitanium advanced on April 4, 1957. Nominal prices quoted in E&MJ Metal and Mineral Markets in 1957 were as follows:

	Jan. 1, 1957, through Mar. 31, 1957	*Apr. 1, 1957, through Dec. 31, 1957*
Low-carbon: [1]		
Titanium, 40 percent; carbon, 0.10 percent maximum	$1.35	Unchanged.
Titanium, 25 percent; carbon, 0.10 percent maximum	1.50	Unchanged.
Medium-carbon: [2] Titanium, 17 to 21 percent; carbon 3 to 5 percent.	245	$290 to $295.
High-carbon: [2] Titanium, 15 to 19 percent; carbon, 6 to 8 percent.	220	$240 to $245.

[1] Price per pound in 1-ton lots or more, lump (½ inch, plus), packed; f. o. b. destination Northeastern United States.
[2] Price per net ton, carload lots, lump, packed; f. o. b. destination Northeastern United States.

FOREIGN TRADE [14]

Imports.—The 460,000 short tons of ilmenite concentrate imported for consumption in 1957 was a new peak and a 28-percent increase over 1956. Over 99 percent of imports originated in Canada and India. Material from Canada was mostly titanium slag containing an average of 70 percent TiO_2. Ilmenite from India was a 60-percent TiO_2 concentrate from sand deposits. Imports of 2,300 short tons of ilmenite from Malaya were less than 10 percent of those in 1956.

Imports of rutile concentrate increased 74 percent over 1956 to a new peak of 84,800 short tons, almost entirely from Australia.

Imports for consumption of titanium metal during the year were 3,532 short tons, valued at $17 million. Of this total, Japan supplied 3,418 short tons (this includes the 777 tons imported in 1956 under the barter contract with Japan and listed as general imports in 1956). The United Kingdom supplied 67 tons and Canada 47 tons.

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

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TABLE 6.—Titanium concentrates [1] imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries, in short tons

[Bureau of the Census]

Country of origin	1948–52 (average)	1953	1954	1955	1956	1957
ILMENITE						
North America: Canada	[2] 9,729	[3] 139,585	[3] 107,521	[3] 166,307	[3] 196,660	[3] 217,762
South America: Brazil	1,742					
Europe:						
France	(4)					
Norway	20,312					33
United Kingdom					40	
Total	20,312				40	33
Asia:						
Ceylon	(4)					
India	198,518	147,005	167,484	187,044	133,520	240,279
Malaya	678				28,864	2,279
Total	199,196	147,005	167,484	187,044	162,384	242,558
Africa: Egypt	144					
Oceania: Australia	42	54			197	
Grand total	231,165	286,644	275,005	353,351	359,281	460,353
Value	$1,847,596	$5,463,526	[5] $4,993,402	$7,031,060	[5] $9,197,835	$10,316,853
RUTILE						
North America: Mexico					50	
Europe:						
Norway	(4)					
Sweden					11	
Total	(4)				11	
Africa: French West						94
Oceania: Australia	9,140	16,098	14,965	19,526	48,845	84,743
Total as reported	9,140	16,098	14,965	19,526	48,906	84,837
Australia: In "zirconium ore" [6]	519	84	95			
Grand total	9,659	16,182	15,060	19,526	48,906	84,837
Value of "as reported"	$627,676	$1,791,494	$1,323,183	$1,984,431	$7,147,827	$11,843,295

[1] Classified as "ore" by Bureau of the Census.
[2] Includes titanium slag.
[3] Chiefly all titanium slag averaging about 70 percent TiO_2.
[4] Less than 1 ton.
[5] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.
[6] Rutile content of zirconium ore as reported to the Bureau of Mines by importers.

Exports.—In 1957 the United States exported 53,000 short tons of titanium dioxide and pigments, a decline of 18 percent below 1956. Canada, as in the past, the destination for most of the titanium-pigment exports, received 22,800 short tons in 1957. Other countries that received 1,000 tons or more were as follows: Argentina, 1,300; Australia, 1,600; Belgium and Luxembourg, 1,300; Colombia, 1,400; Cuba, 1,600; France, 4,100; Italy, 1,800; Mexico, 3,300; Netherlands, 3,900; Philippines, 2,100; and Venezuela, 1,600.

Of the 2,000 short tons of titanium concentrates shipped in 1957, 1,300 tons went to Canada. The remainder was exported as follows: Argentina, 11 tons; Chile, 3 tons; Hong Kong, 11 tons; Mexico, 25 tons; Philippines, 42 tons; United Kingdom, 56 tons; and West Germany, 112 tons.

Exports of titanium sponge and scrap increased considerably over 1956 but were still less than 100 tons. Canada and West Germany received about 25 tons each, the United Kingdom received 12 tons, and the remainder went to Sweden, Netherlands, Austria, Switzerland, and Portugal. Exports of titanium-metal products increased to 779 short tons in 1957, a 25-percent increase over 1956. Canada received 774 tons, mostly as ingots. The United Kingdom received 3 tons of mill shapes and about 1 ton of ingot; the rest of the titanium products went to France, Sweden, Netherlands, Belgium and Luxembourg, West Germany, Japan, and Italy.

Canada received 266 short tons of the 367 tons of ferroalloys exported in 1957. Italy received 90 tons; the remainder went to Chile, Brazil, Sweden, Turkey, Thailand, and Japan.

TABLE 7.—Exports of titanium products from the United States, 1948–52 (average) and 1953–57, by classes

[Bureau of the Census]

Year	Ore and concentrates		Metal and alloys in crude form and scrap [1]		Primary forms, n. e. c.[2]		Ferroalloys		Dioxide and pigments	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	1,015	$112,435	(3)	(3)	(4)	(4)	266	$72,583	32,797	$9,606,709
1953	1,368	109,878	2	$11,858	31	$798,077	185	48,722	39,780	11,715,798
1954	663	85,896	48	1,107,582	171	3,587,401	172	39,885	63,802	23,281,039
1955	1,143	193,752	10	36,353	35	1,211,311	245	65,091	54,353	18,332,995
1956	1,838	312,285	14	59,992	559	8,304,835	364	148,459	64,766	25,136,981
1957	2,019	276,472	71	77,629	779	9,404,232	367	130,046	52,960	19,687,188

[1] Beginning Jan. 1, 1955, classified as sponge and scrap.
[2] Beginning Jan. 1, 1955, classified as intermediate mill shapes and mill products, n. e. c.
[3] Not separately classified before 1952. 1952: 762 tons ($31,134) believed to include material other than commercially pure titanium metal.
[4] Not separately classified before 1952. 1952: 3 tons ($38,979).

WORLD REVIEW

Declining United States requirements for rutile in manufacturing titanium metal resulted in an oversupply. World rutile production increased 30 percent over 1956 to a new peak of 158,400 short tons. World ilmenite production continued to increase and reached a new peak of 1.9 million short tons. The United States was again the leading producer of ilmenite, supplying 39 percent of the total. Australia, the leading producer of rutile, supplied 93 percent of the total. Curtailment of tin production in Malaya was expected to decrease the ilmenite concentrate available for shipments.

The United States was the leading manufacturer of titanium-sponge metal; its output was 17,200 short tons. Japan was second, with a production of 3,400 short tons. Annual capacity in the United Kingdom was 1,700 short tons.

Australia.—The estimated 147,000 short tons of rutile concentrate produced in Australia was a 36-percent increase over 1956 and came from sand deposits in Queensland and New South Wales. Two new companies, Crescent Rutile N. L. at Kilcare and Kinumber, New South Wales, and Silver Valley Uranium N. L. at Evans Head, New South Wales, began production in 1957.

TABLE 8.—World production of titanium concentrates (ilmenite and rutile), by countries, 1948–52 (average) and 1953–57, in short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
ILMENITE						
Australia (sales) [2]	[3] 504	-	526	600	4,787	[4] 49,600
Brazil	1,885	-	-	-	-	-
Canada [5]	14,375	151,176	124,502	164,249	220,885	269,406
Egypt	1,063	2,787	2,900	2,694	4,547	[4] 4,400
Finland	-	3,465	55,765	93,668	113,444	116,568
Gambia (exports)	-	-	1,216	-	-	-
India	268,630	241,091	269,375	280,867	376,321	331,521
Japan [6]	[7] 661	3,199	2,638	5,097	9,634	9,055
Malaya (exports)	27,639	29,758	50,114	60,340	136,837	102,742
Norway	114,157	141,220	164,448	173,981	209,990	231,693
Portugal	384	746	563	866	679	335
Senegal	4,706	6,358	13,779	30,424	21,716	[4] 40,200
Spain	700	1,582	1,397	7,388	5,962	8,929
Thailand	-	-	-	-	385	[4] 385
Union of South Africa	-	10	-	1,917	1,855	3,118
United States [8]	464,760	513,696	547,711	583,044	684,956	757,180
World total ilmenite (estimate) [1]	899,500	1,095,100	1,234,900	1,405,100	1,792,000	1,925,100
RUTILE						
Australia	26,794	42,604	50,018	66,767	107,886	[4] 146,600
Brazil	4	-	146	174	338	[4] 330
French Cameroon	310	58	-	110	168	[4] 60
French Equatorial Africa	[9] 2	-	-	-	-	-
India	79	117	117	166	606	530
Norway	24	3	-	10	26	28
Senegal	[10] 17	-	-	-	650	[4] 115
United States	7,247	6,825	7,411	8,513	11,997	10,702
World total rutile (estimate) [1]	34,500	49,600	57,700	75,700	121,700	158,400

[1] This table incorporates a number of revisions of data published in previous Titanium chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[2] Owing to high chromium content in the ore, sales are shown.
[3] Average for 1950–52 only; previous years are not available on sales basis.
[4] Estimate.
[5] Beginning 1950, includes Ti slag containing approximately 70 percent TiO_2.
[6] Represents titanium slag.
[7] Average for 1 year only, as 1952 was the first year of commercial production.
[8] Includes a mixed product containing ilmenite, leucoxene, and rutile for 1949–57.
[9] Average for 1950–52.
[10] Average for 1951–52.

TABLE 9.—Exports of rutile concentrate from Australia, 1953–57, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957 [2]
Belgium	521	1,519	2,700	4,797	(3)
France	2,106	3,852	3,485	4,599	(3)
Germany, West	2,144	4,397	4,573	4,042	(3)
Italy	1,981	2,289	2,154	3,433	(3)
Japan	450	1,370	2,118	2,335	(3)
Netherlands	3,504	5,190	8,687	9,968	(3)
Sweden	2,824	1,742	3,093	3,591	(3)
United Kingdom	9,701	11,078	13,702	13,993	10,214
United States	15,026	16,148	23,798	51,754	62,599
Other countries	2,148	2,162	2,539	2,161	33,887
Total	40,405	49,747	66,849	100,673	106,700

[1] Compiled from Customs Returns of Australia.
[2] January through September only.
[3] Data not separately recorded.

Ilmenite mining activity in Australia increased during the year. It was reported that many companies had obtained leases to Western Australia's beaches, where sand is rich in high-quality ilmenite.

The combined estimated annual capacity of Western Titanium N. L., Capel, and Cable, Ltd., Bunbury, was over 100,000 tons of ilmenite concentrate.[15] Westralian Oil, Ltd., announced plans to build a plant with a capacity of 100,000 tons of ilmenite concentrates per year in the Capel and Yoganup districts.[16]

Canada.—The Quebec Iron & Titanium Corp. at Sorel, Quebec, continued to increase its output of titanium slag and reached a new peak of 258,900 short tons in 1957. The company operated at full capacity and began production from a new furnace in December. This raised the total number of furnaces to 6; 2 more are expected to be operating by the end of 1958.[17]

TABLE 10.—Quebec Iron & Titanium Corp. smelting operations, 1953–57, in short tons

Item	1953	1954	1955	1956	1957
Ore crushed	158,218	308,974	413,149	636,653	(1)
Ore smelted	(1)	268,139	348,578	470,745	627,255
Titanium slag produced	141,883	122,960	162,784	218,575	258,920
Titanium slag shipped	145,402	119,292	157,378	213,742	262,879
Estimated TiO_2 content of slag produced	99,318	88,408	117,042	150,640	185,360
Value of slag produced	$4,206,496	$3,841,270	$5,192,810	$6,688,416	(1)
Desulfurized iron produced	106,875	90,562	121,312	159,874	187,529
Desulfurized iron shipped	94,587	100,509	118,104	157,048	189,725

[1] Data not available.

A total of 10,500 short tons of ilmenite valued at $54,600 was shipped in 1957 from the St. Urbain area, Quebec, by Baie St. Paul Titanic Iron Co., Ltd., and Continental Iron & Titanium Mining, Ltd., for use as heavy aggregate for concrete in atomic-energy plants in the United States and for manufacturing ferrotitanium. In 1956, 5,000 short tons valued at $37,100 was shipped from the area for similar uses.[18]

The first titanium-pigment plant in Canada—that of Canadian Titanium Pigments, subsidiary of National Lead Co. of the United States—was officially opened at Varennes, Quebec, on September 11, 1957. Plant capacity was rated at 18,000 tons of titanium dioxide pigments a year. Titanium dioxide slag, crushed to minus-½-inch, containing about 70 percent titanium dioxide, was obtained from the Quebec Iron & Titanium Corp. smelter about 20 miles down the St. Lawrence River from Varennes.[19]

Ceylon.—It was reported that the Government of Ceylon planned to develop the ilmenite sands at Pulmoddai. Foreign technical experts were reportedly obtained by the Government of Ceylon to design the plant and lend technologic assistance.[20]

Finland.—Further details on the titaniferous iron-ore mine at Otanmaki, owned and operated by the Government of Finland, were pub-

[15] Mine and Quarry Engineering, Western Australia Ilmenite: Vol. 23, No. 10, October 1957, p. 460.
[16] Industrial and Mining Standard, Tailings From the West: Vol. 112, No. 2831, Apr. 4, 1957, p. 17.
[17] Kennecott Copper Corporation, Forty-Third Annual Report, 1957: P. 16.
[18] Janes, T. H., Titanium in Canada, 1957: Canadian Dept. of Mines and Tech. Surveys, 10 pp.
[19] Janes, T. H., Titanium in Canada—1957: Canadian Min. Jour., vol. 79, No. 2, February 1958, p. 141.
[20] Chemical Age (London), Ceylon Ilmenite Project: Vol. 77, No. 1960, Feb. 2, 1957, p. 206.

lished during 1957.[21] Through improved ore-dressing techniques, the Otanmaki Company was able to produce tonnages of ilmenite in excess of designed capacity. The mill began producing in 1954 after the processes involved had been extensively studied at the Mineral Dressing Laboratory of the State Institute for Technical Research in Helsinki.

Japan.—The output of titanium slag used for making titanium metal decreased slightly in 1957 from 9,600 short tons in 1956 to 9,000 tons. Output of the 4 major producers was as follows: Hokuetsu Electric Chemical Industrial Co., 2,716 short tons; Morioka Electric Chemical Co., 1,743 short tons; Nisso Steel Manufacturing Co., 2,622 short tons; and Osaka Titanium Co., Ltd., 1,916 short tons. The Tokyo Iron & Steel Co. produced 57 short tons in March and September.

The Nisso Steel Manufacturing Co. announced in July that production of titanium slag in its plant was halted because Osaka Titanium Co., its chief customer, was not accepting any more titanium slag or other titanium raw materials.[22]

The titanium-sponge-metal industry increased output, but production rates at the end of 1957 were somewhat below capacity. Output during the year was 3,393 short tons—22.6 percent above the 1956 production.

TABLE 11.—Titanium-sponge production in Japan, 1952–57, in short tons

Company	1952	1953	1954	1955	1956	1957
Osaka Titanium Co., Ltd	9	66	338	639	1,146	1,664
Toho Titanium Industry Co., Ltd		5	263	608	1,439	1,559
Nippon Soda Co., Ltd		6	37	115	183	170
Nippon Electric Metallurgical Co., Ltd		(1)	28	9		
Mitsui Mining & Smelting Co., Ltd		(1)	7	7		
Total	9	77	673	1,378	2,768	3,393

1 Less than 1 ton.

Exports of titanium sponge in 1957 totaled 2,734 short tons, of which 2,689 short tons went to the United States and 45 tons to countries in Europe.

Production of titanium dioxide continued upward to 33,700 short tons, 33 percent over 1956. In July the Ishihara Industrial Co., Ltd., the leading titanium dioxide producer in Japan, completed an expansion program, which doubled its capacity from 1,000 tons to

TABLE 12.—Titanium dioxide production, exports, and stocks in Japan, 1953–57, in short tons

Year	Production	Exports	Stocks	Year	Production	Exports	Stocks
1953	6,793	536	592	1956	25,269	10,208	1,174
1954	13,820	5,218	882	1957	36,811	16,590	2,490
1955	19,068	8,677	538				

21 Mining World, How Otanmaki Floats Ilmenite From Finland's Titaniferous Magnetite: Vol. 19, No. 4, April 1957, pp. 49–55.
22 Metal Bulletin (London), Japanese Slag Output Stops: No. 4212, July 19, 1957, p. 25.

2,000 tons monthly.[23] The plant is at Yokkaichi in Mie prefecture in southern Honshu and is designed to process rutile and anatase.

Malaya.—Ilmenite exports from Malaya in 1957 were down 25 percent compared with 1956. Ilmenite in Malaya was a byproduct of tin dredging. Curtailment of tin operations late in 1957 was expected to reduce the quantity of ilmenite available for export in 1958.

TABLE 13.—Exports of ilmenite from Malaya, 1953–57, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957
Australia				7,316	2,240
Belgium	3,607	51	112		7,030
France (including Corsica)	2,576	8,097	3,371	3,388	3,047
Germany, West				112	
Italy (including Sardinia)			425	134	392
Japan	10,527	15,892	33,799	57,896	38,478
Netherlands	1,456	1,591	30	1,232	560
United Kingdom	11,592	24,427	22,518	34,048	50,960
United States		56		32,683	
Other countries			84	28	34
Total	29,758	50,114	60,339	136,837	102,741

[1] Compiled from Customs Returns of Malaya.

Union of South Africa.—The Anglo American Corporation (South Africa) announced that Umgababa Minerals, Ltd., an associate company, would begin to produce titanium and zirconium concentrates by mid-1958 from a mine at Umgababa on the coast of Natal. This mine was formerly operated on a small scale by the Titanium Corp. of South Africa. Umgababa Minerals planned to construct additional facilities to raise capacity to 100,000 tons of ilmenite per year and to recover zircon and rutile at the rates of 10,000 and 7,000 tons per year, respectively.[24] Part of the production is expected to be utilized by a titanium dioxide-pigment plant at Umbogintwini planned by the British Titan Products Co., Ltd., and the African Explosives & Chemical Industries, Ltd.

United Kingdom.—Imperial Chemical Industries, Ltd. (I. C. I.), at Wilton, Yorkshire, continued to be the only commercial producer of titanium-sponge metal in the United Kingdom during 1957. The annual capacity in 1957 of the Wilton plant is estimated at 1,700 short tons. The company melting and fabricating plant at Witton compressed titanium granules produced by sodium reduction of titanium tetrachloride into pellets or bars, depending upon whether the metal was to be melted in a furnace employing consumable or nonconsumable electrodes. Construction of the I. C. I. new titanium-rolling plant at Waunarlwydd, near Swansea, South Wales, was expected to be completed by mid-1958. The fabrication facilities at Witton were expected to cease as the Waunarlwydd plant was com-

[23] Mining World, Asia: Vol. 19, No. 8, July 1957, p. 100.
[24] American Metal Market, Umgababa Will Start Ilmenite Zircon Mining: Vol. 64, No. 188, Sept. 28, 1957, pp. 1, 7.

pleted.[25] A 2,000-ton double-melting vacuum furnace, equipped with fully automatic, electronically controlled electrode feeder gears, and operated remotely, was being built in Hanau, West Germany, for the I. C. I. melting plant at Witton.[26]

TECHNOLOGY

One of the most significant advances in titanium-metal technology in recent years was reported by the Federal Bureau of Mines in 1957.[27] A laboratory process was developed for preparing high-purity titanium from scrap and offgrade sponge. By electrorefining the metal in a fused-salt bath, titanium containing relatively large amounts of iron, nitrogen, and oxygen and having a Brinell hardness of 314 was refined to a metal with a Brinell hardness of 78.

An arc-melting technique was reported [28] for preparing 25- to 30-pound ingots of uncontaminated titanium, binary titanium-aluminum alloys, and various ternary additions to the titanium-aluminum base. Extensive chemical and mechanical tests showed a high degree of uniformity in the ingots prepared and confirmed reports by other investigators of the high impact-strength potential of certain titanium-aluminum alloys.

A constitution diagram for the system titanium-germanium up to 30 percent germanium was proposed.[29] Metallographic, X-ray, and resistivity studies indicated a eutectic composition of 19 percent germanium at 1,360° C. and a peritectic reaction at 905° C. with 4 percent germanium. Formation of a single compound, Ti_5Ge_3 was reported in the part of the system studied.

Corrosion rates of titanium and a variety of titanium alloys with manganese, chromium, iron, vanadium, and zirconium were studied in mineral acids, nitric acid, and chloride solutions by L. B. Golden and others.[30] Comparative tests were conducted on samples from arc-melted ingots and ingots prepared by powder-metallurgy techniques.

Thermodynamic values at 298.15° and 1,600° K. for several titanium-oxygen interstitial compounds were determined in a cooperative undertaking between the Federal Bureau of Mines and the Office of Naval Research.[31] Theoretical considerations were reported and calculated partial molal free energy-composition isotherms for 800° and 1,600° C. are presented for the composition range 0 to 2 weight-percent oxygen.

Submarginal deposits of titanium minerals were investigated and a method proposed for separating columbium and iron from these ores by a fractional distillation process following chlorination.[32]

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25 Metal Bulletin (London), Titanium Progress At Waunarlwydd: No. 4195, May 17, 1957, p. 23.
26 Metallurgia, Titanium-Melting-Plant Order: Vol. 55, No. 331, May 1957, p. 247.
27 Nettle, J. R., Baker, D. H., Jr., and Wartman, F. S., Electrorefining Titanium Metal: Bureau of Mines Rept. of Investigations 5315, 1957, 43 pp.
28 Huber, R. W., and Lane, I. R., Jr., Consumable-Electrode Arc Melting of Titanium and Its Alloys: Bureau of Mines Rept. of Investigations 5311, 1957, 36 pp.
29 Peterson, V. C., and Huber, R. W., The Titanium-Germanium System From 0 to 30 Percent Germanium: Bureau of Mines Rept. of Investigations 5365, 1957, 20 pp.
30 Golden, L. B., Ackerman, W. L., and Schlain, D., The Relative Corrosion Resistance of Titanium and Some of Its Alloys: Bureau of Mines Rept. of Investigations 5299, 1957, 25 pp.
31 Mah, A. D., and others, Thermodynamic Properties of Titanium-Oxygen Solutions and Compounds: Bureau of Mines Rept. of Investigations 5316, 1957, 33 pp.
32 Nieberlein, V. A., Low-Temperature Chlorination of Columbium-Bearing Titanium Minerals: Bureau of Mines Rept. of Investigations 5349, 1957, 15 pp.

A comprehensive study of the titanium industry from raw material to semifinished product was published.[33] Extensive data on resources, geologic occurrence, prospecting, mining, beneficiation, and uses of titanium minerals as well as descriptions of processing techniques for manufacturing titanium metal, pigments, welding-rod coatings, and other miscellaneous products containing titanium, were reported.

A field method using simple, inexpensive equipment, for rapid evaluation of heavy-mineral-bearing sands was developed and has found application in expediting the work of field engineers studying sand deposits.[34]

Gamma rays from radioactive cobalt were used at one company research laboratory to determine the level of the melt in a titanium-arc melting furnace.[35] According to this laboratory, exact control of melting was maintained automatically by beaming the radiation through the furnace walls and the ingot inside.

Comparative physical-property data for titanium and other pure metals and a table of mediums in which titanium shows exceptional corrosion resistance were made available to design, materials, and production engineers interested in using titanium.[36]

Chemical and physical data for a number of important titanium alloys were reported.[37]

A literature survey was conducted [38] covering production, fabrication, and mechanical and corrosion properties of titanium metal.

Development of the iodide process of refining titanium and zirconium was reviewed.[39]

Sodium reduction of titanium tetrachloride was described.[40]

A laboratory process using ilmenite as a raw material and yielding a potassium chlorotitanate product, which can be thermally decomposed at 300° to 500° C. to titanium tetrachloride and potassium chloride, was reported in 1957.[41] Production of pure titanium tetrachloride is claimed.

Mellgren and Opie studied equilibrium concentrations of multivalent titanium in a fused sodium chloride-strontium chloride bath at various temperatures and concentrations.[42]

A method was patented for direct reduction of titanium dioxide by aluminum metal, followed by a leach with molten magnesium metal to remove excess aluminum.[43]

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[33] Miller, J. A., Titanium, A Materials Survey: Bureau of Mines Information Circ. 7791, 1957, 202 pp.

[34] Clemmons, B. H., Stacy, R. H., and Browning, J. S., Heavy-Liquid Technique for Rapid Evaluation of Sands by Prospectors and Plant Operators: Bureau of Mines Rept. of Investigations 5340, 1957, 12 pp.

[35] American Metal Market, Titanium Furnace Is Controlled by Cobalt Radiations: Vol. 64, No. 76, Apr. 19, 1957, pp. 1, 7.

[36] Industrial and Engineering Chemistry, Part I, Titanium: Vol. 49, No. 9, September 1957, p. 133A.

[37] Inglis, N. P., Titanium Research and Development: Metal Ind., vol. 90, No. 10, Mar. 8, 1957, pp. 185–188, 194.

[38] Bomberger, H. B., Titanium: Ind. Eng. Chem. pt. II, vol. 49, No. 9, September 1957, pp. 1658–1662.

[39] Shelton, R. A. J., The Development of the Iodide Process of Refining Titanium and Zirconium: Metallurgia, vol. 55, No. 331, May 1957, pp. 225–231.

[40] Milton, John, Sodium Process Extracts Titanium in Commercial Tonnages: Iron Age, vol. 179, No. 19, May 1957, pp 120–122.

[41] Chemical Engineering Progress, New Process for Titanium: Vol. 53, No. 7, July 1957, p. 94.

[42] Mellgren, S., and Opie, W., Equilibrium Between Titanium Metal, Titanium Dichloride, and Titanium Trichloride in Molten Sodium Chloride—Strontium Chloride Melts: Iron Age, vol. 9, No. 2, February 1957, pp. 266–269.

[43] Mondolfo, L. F. (assigned to Illinois Institute of Technology), Method for Producing Easily Oxidized High-Melting-Point Metals and Their Alloys: U. S. Patent 2,803,536, Aug. 20, 1957.

In another patented method for producing titanium, titanium-bearing material is reacted with calcium chloride and an alkali metal such as sodium.[44]

A method of forming a porous titanium-metal diaphragm on a nickel-wire cloth placed between the anode and cathode in a fused salt bath was patented.[45]

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[44] Whaley, T. P. (assigned to Ethyl Corp.), Method of Producing Titanium: U. S. Patent 2,777,763, Jan. 15, 1957.

[45] Kittelberger, W. W. (assigned to New Jersey Zinc Co.), Production of Titanium: U. S. Patent 2,789,943, Apr. 23, 1957.

Tungsten

By R. W. Holliday [1] and Mary J. Burke [2]

THE TUNGSTEN-MINING industry ended 7 years of expansion in December 1956 when the Government suspended purchasing concentrate from domestic producers; throughout 1957, production and prices declined.

From a domestic output of 2,896,000 pounds of contained tungsten in 1949, production had increased each year to a peak of 15,833,000 pounds in 1955 and nearly as much in 1956. The total world production during the same period increased from an estimated 31,445,000 pounds to an estimated 77,520,000 pounds in 1955 and nearly as much in 1956. Much of the increase, both domestic and foreign, went to United States Government stockpiles; United States industrial consumption was relatively stable, averaging 8,073,000 pounds for the years 1949–56. Virtually all Government acquisitions were purchased at above-market prices.

Therefore, after suspension of Government purchase from domestic sources, the available supply greatly exceeded demand; mines in the United States were capable of producing nearly twice the quantity required by industry; by the end of 1957, large stocks were held by producers and consumers; additional large quantities were available for import; and large Government stocks, though withdrawn from the market, were available for emergency use.

TABLE 1.—Salient statistics of tungsten ore and concentrate in the United States,[1] 1948–52 (average) and 1953–57, in thousand pounds of contained tungsten

	1948–52 (average)	1953	1954	1955	1956	1957
Mine production	4,808	9,259	13,166	15,833	14,761	8,032
Mine shipments	4,855	9,128	13,030	15,619	14,027	5,254
General imports [2]	9,995	29,130	23,044	20,789	21,857	14,186
Consumption	8,090	7,734	4,037	8,967	9,061	8,544
Stocks:						
Producers	410	363	362	523	1,477	4,326
Consumers and dealers	4,297	4,335	3,913	3,502	2,980	4,103
Total	4,707	4,698	4,275	4,025	4,457	8,429

[1] Includes Alaska.
[2] Ore and concentrate received in the United States; part went into consumption during the year, and the remainder entered bonded warehouses or Government stocks.

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

Although Government stocks exceeded minimum and long-term objectives, deliveries were being accepted from a few foreign producers under long-term contracts previously negotiated. Industry stocks nearly doubled during the year.

Tungsten-research emphasis was shifted largely from resources and beneficiation studies to the development of fundamental data as a basis for new and expanded use of tungsten.

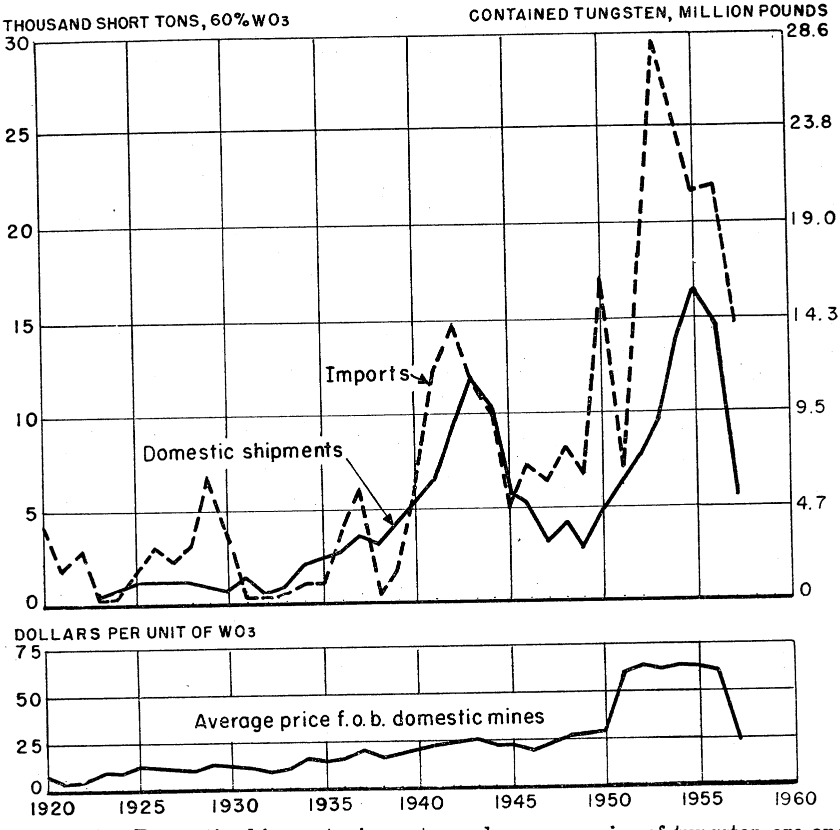

FIGURE 1.—Domestic shipments, imports, and average price of tungsten ore and concentrate, 1920–57.

LEGISLATION AND GOVERNMENT PROGRAMS

A report [3] of the Attorney General concluded that the Government program for defense expansion of tungsten supply "* * * displays no factors tending seriously toward concentration of economic power in this industry."

A report [4] by the Tariff Commission in compliance with Senate Resolution 195, 85th Congress, adopted by the Senate August 28,

[3] Report of the Attorney General, Pursuant to Section 708 (e) of the Defense Production Act of 1950, as amended: Nov. 8, 1957, 54 pp.

[4] U. S. Tariff Commission, Tungsten Ores and Concentrates: Rept. to President on Investigation 120 Under Section 336, Title III, of the Tariff Act of 1930, February 1958, 29 pp.

1957, reviewed the Government purchase program, both domestic and foreign.

Government participation in Defense Minerals Exploration Administration (DMEA) tungsten exploration projects was reduced to 50 percent from 75 percent.[5] A total of 477 tungsten applications was reported from inception of the program to December 31, 1957, an increase of 15 during the year. One hundred twenty-six contracts were executed; 15 remained in force at the end of the year. Certifications of discovery numbered 48. Maximum Government participation authorized to date was $3,740,576, and total estimated costs of the projects was $5,008,124.

TABLE 2.—Tungsten concentrate produced and shipped in the United States, 1956–57, by States [1]

State	Produced				Shipped from mines			
	1956		1957		1956		1957	
	Tungsten content (1,000 pounds)	Short ton units (WO_3) [2]	Tungsten content (1,000 pounds)	Short ton units (WO_3) [2]	Tungsten content (1,000 pounds)	Short ton units (WO_3) [2]	Tungsten content (1,000 pounds)	Short ton units (WO_3) [2]
Alaska	(3)	55	(3)	31				
Arizona	208	13,088	20	1,279	177	11,143	5	316
California	4,066	256,362	2,243	141,389	3,539	223,155	1,666	105,005
Colorado	924	58,227	819	51,621	831	52,375	43	2,684
Idaho	592	37,321	245	15,407	554	34,940	33	2,112
Montana	1,041	65,609	662	41,747	1,171	73,810	629	39,646
Nevada	5,192	327,303	1,866	117,640	5,140	324,029	1,138	71,753
New Mexico	(3)	28			(3)	28		
North Carolina	2,719	171,451	2,177	137,215	2,600	163,913	1,740	109,675
Oregon	(3)	2	(3)	4	(3)	2	(3)	4
Utah	11	680	(3)	30	11	680	(3)	
Washington	6	347	(3)	13	2	135	(3)	13
Wyoming	2	113			2	113		
Total	14,761	930,586	8,032	506,376	14,027	884,323	5,254	331,208

[1] Concentrate has been credited to State in which ore was mined, although subsequent beneficiation and sale may have been elsewhere.
[2] For conversion to short tons of 60 percent WO_3, divide by 60.
[3] Less than 1,000 pounds.

DOMESTIC PRODUCTION

Domestic production of concentrate declined 46 percent in 1957 compared with 1956. Because of this diminished output and lower prices, the value decreased 84 percent.

In 1956, Public Law 733, 84th Congress, had authorized purchase by the Government of 1,250,000 short-ton units[6] of tungsten trioxide (WO_3) at $55 per unit under a program scheduled to end in December 1958; but in December 1956, purchase was suspended for lack of funds. In the early months of 1957, there was uncertainty whether additional appropriations would be made to implement Public Law 733. Mine operators had to decide whether to close down and incur the cost of reopening, if purchase was resumed, or to carry the expense of operating without assurance of a market.

[5] DMEA Order 1, Revised, Oct. 18, 1957, Federal Register of Oct. 23, 1957 (F. R. Doc. 57-8717; Filed, Oct. 22, 1957; 8:56 a. m.).
[6] A short-ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.862 pounds of tungsten (W). 1 short ton of 60 percent WO_3 contains 951.72 pounds of tungsten.

Although 84 producers reported output, only 4 mines produced continuously throughout 1957. The leading producer was the Hamme mine of Tungsten Mining Corp. in Vance County, N. C.; others in year-long operation were the Tungsten Group of Nevada-Massachusetts Co. in Pershing County, Nev.; the Pine Creek mine of Union Carbide Nuclear Co. in Inyo County, Calif.; and the Climax mine of Climax Molybdenum Co. in Lake County, Colo. (byproduct tungsten).

Square-set methods were used at the Hamme mine; shrinkage stopes and open-pit mining were used by Nevada-Massachusetts Co.; open stoping, with sublevel ring drilling and blasting, was used at the

TABLE 3.—Tungsten concentrate shipped from mines in the United States,[1] 1948–52 (average) and 1953–57

Year	Quantity		Reported value f. o. b. mines [2]		
	Short ton units WO_3	Tungsten content (pounds)	Total	Average per unit of WO_3	Average per pound of tungsten
1948-52 (average)	306,059	4,854,724	$14,169,934	$46.29	$2.92
1953	575,448	9,127,756	35,943,533	62.46	3.94
1954	821,463	13,030,046	51,433,357	62.61	3.95
1955	984,711	15,619,486	60,841,157	61.79	3.90
1956	884,323	14,027,131	51,200,503	57.90	3.65
1957	331,208	5,253,621	[3] 8,186,232	24.72	1.56

[1] Includes Alaska.
[2] Values apply to finished concentrate and in some instances are f. o. b. custom mill.
[3] Largely estimated by Bureau of Mines.

TABLE 4.—Shipments of tungsten ore and concentrate (60 percent WO_3 basis) by States, 1948–52 (average) and 1953–57, shipments for maximum year, and total shipments, 1900–57, in short tons [1]

State	Maximum shipments		Shipments by years							Total shipments 1900–57	
								1957			
	Year	Quantity	1948–52 (average)	1953	1954	1955	1956	Quantity	Percent of total	Quantity	Percent of total
Alaska	1916	47	6	3						211	0.10
Arizona	1936	489	21	134	132	181	186	5	0.09	4,634	2.27
California	1955	4,383	2,146	2,382	3,512	4,383	3,719	1,750	31.70	61,162	29.91
Colorado	1917	2,707	317	817	927	1,152	873	45	.82	30,027	14.68
Connecticut	1916	3								11	.01
Idaho	1943	4,648	217	441	471	642	582	35	.63	18,463	9.03
Missouri	1940	13	1							37	.02
Montana	1956	1,230	8	14	678	1,211	1,230	661	11.97	4,340	2.12
Nevada	1955	6,155	1,325	3,683	5,331	6,155	5,400	1,196	21.67	64,142	31.37
New Mexico	1915	45			(2)	1	(2)			104	.05
North Carolina	1956	2,732	1,054	2,074	2,538	2,609	2,732	1,828	33.12	18,254	8.93
Oregon	1952	4	2	(2)	(2)	1	(2)	(2)		9	(3)
South Dakota	1917	270	(2)	2	(2)					1,298	.63
Texas	1946	1								1	(3)
Utah	1954	84	1	35	84	65	11			437	.21
Washington	1938	303	3	5	18	12	2	(2)		1,376	.67
Wyoming	1956	2					2			2	(3)
Total	1955	16,412	5,101	9,590	13,691	16,412	14,737	5,520	100.00	204,508	100.00

[1] Shipments are credited to the State where final concentrate was produced, except for 1953, 1954, 1955, 1956, and 1957.
[2] Less than 1 ton.
[3] Less than 0.01 percent.

Pine Creek mine; and a large-scale-caving method was used at the Climax mine.

Only 15 mines produced as much as 1,000 units during the year. The 5 largest mines supplied 75 percent of the total domestic output; the next 5 in size produced 21 percent; and the 15 largest mines together produced 99 percent. Mine production in the first half of 1957 was about double that in the second half.

Tungsten was produced in 11 States in 1957, but over 88 percent came from California, North Carolina, Nevada, and Colorado, in that order. Scheelite comprised 60 percent of production, and wolframite-type ores 40 percent.

CONSUMPTION AND USES

Although consumption of tungsten concentrate in 1957 was 6 percent lower than in 1956, it exceeded the 1949–56 yearly average by 11 percent.

Concentrate was consumed in manufacturing hydrogen-reduced metal powder, carbon-reduced metal powder, chemicals, and ferrotungsten and by direct addition of scheelite to steel.

Hydrogen-reduced metal powder was consumed principally for cemented carbides and pure metal uses, and in alloys. Carbon-reduced metal powder was used in carbides and in alloys. Carbides were also manufactured directly from concentrate by one or more processes. Ferrotungsten was used as a means of introducing tungsten into high-speed and other alloy steels; scheelite, scrap, and certain other compositions also served the same purpose. Chemicals were used chiefly in pigments and dyes.

TABLE 5.—Distribution of tungsten concentrate consumed in 1957

	Tungsten content (pounds)	Short tons (60 percent WO_3)	Percent of total
Manufacturers of steel ingots and ferrotungsten	2,110,000	2,217	25
Manufacturers of hydrogen-reduced metal powder	3,760,000	3,951	44
Manufacturers of carbon-reduced metal powder and tungsten chemicals and consumption by firms making several products	2,674,000	2,810	31
Total	8,544,000	8,978	100

High-Speed and other tungsten-alloy steels, as well as cemented tungsten carbide, were used in tools, blanks, and dies for shaping and machining metal. Tungsten alloys and carbides also were variously employed as machine parts. Alloys or pure tungsten continued to be used as lamp and heating elements, contact points and switches, electronic valves, hard facing, welding rods, and electrodes. Tungsten was the principal constituent in "heavy metal" [7] that was used for counterweights, vibration damping, and radiation shielding and in dies and cutting tools. Carbides, in addition to their use for shaping metals, were used in rock bits, hard facing, flame plating,[8] matrix

[7] Dun's Review and Modern Industry, How You Can Use Industry's Heavyweight Champ; Heavy Metal: Vol. 69, No. 7, May 1957, pp. 92–93.

[8] Carbide Engineering, Flame Plating for Wear Resistance: Vol. 9, No. 9, September 1957, pp. 20–21.

material for diamond drill bits, and abrasives and for shaping of various materials.[9] Chemicals were used principally in manufacture of pigments and fluorescent powders.

TABLE 6.—Consumption of tungsten products in the United States, and stocks at plants of consumers in 1957

(Thousand pounds of contained tungsten)

Product	Consumption	Stocks Dec. 31	Product	Consumption	Stocks Dec. 31
Tungsten-metal powder: [1]			Scheelite (including synthetic)	1,194	4
Hydrogen reduced	1,781	110	Scrap	717	253
Carbon reduced	77	50	Other [2]	1,208	283
Tungsten carbide powder	2,819	72			
Chemicals	334	18	Total	8,130	790

[1] Does not include quantities consumed in manufacturing tungsten carbides.
[2] Includes ferrotungsten, cobalt-chromium-tungsten, melting base, and tungsten-alloy powder.

TABLE 7.—Consumption of tungsten by class of manufacture in 1956–57

(Thousand pounds of contained tungsten)

Uses	1956	1957	Uses	1956	1957
Steel:			Chemicals:		
High Speed	2,893	2,128	Fluorescent powders	54	27
Other tool steel	522	419	Pigments	93	92
Alloy steel (other than tool)	531	298	Other	6	--------
High-temperature nonferrous alloys	342	295	Miscellaneous [1]	557	312
Other nonferrous alloys	56	175	Total	9,722	8,130
Metal (wire, rod, and sheet)	1,242	1,106			
Carbides:					
Cemented or sintered	3,426	2,113			
Other		1,165			

[1] Includes uses (not classified by reporting firms) in diamond-drill bits, electrical contact points, welding rods, etc.

Most carbides were used as small inserts at points of wear, but a survey indicated that the use of solid tungsten carbide rotary cutting tools had increased more than 500 percent since 1954.[10]

Consumption of tungsten in steel declined 28 percent, compared with 1956. Consumption in metal (wire, rod, and sheet) declined 11 percent and in carbides 4 percent.

Consumption of concentrate centered in 2 general areas—72 percent in New Jersey, New York, and Pennsylvania and most of the remainder in Illinois, Indiana, and Ohio.

STOCKS

Stocks of tungsten concentrate held in the National Stockpile exceeded minimum and long-term objectives. Stocks held by industry on December 31 were nearly twice as large as those on January 1 and virtually equal to total consumption during 1957.

[9] Segal, Arthur R., Why Use Carbide Tools on Woodworking Operations?: Carbide Eng., vol. 9, No. 8, August 1957, pp. 18–20.
[10] Carbide Engineering, Solid Carbide Tools: Vol. 9, No. 11, November 1957, p. 26.

PRICES AND SPECIFICATIONS

The price of concentrate declined steadily throughout 1957. The Government made no purchases from domestic sources and none from foreign sources beyond the quantities delivered under existing long-term contracts. Prices paid under these contracts were considerably higher than those quoted on the open market.

London prices declined throughout the year following a brief flurry in late 1956 after the Suez Canal was seized by the Egyptian Government.

A paper on tungsten specifications for high-purity applications was delivered.[11] Specifications for the Government stockpile were quoted in the Tungsten chapter of Minerals Yearbook, 1956.

TABLE 8.—Prices of tungsten concentrate in 1957 [1]

	Open market, per short-ton unit of WO_3, c. i. f. U. S. ports, duty extra [2]		London market, per long-ton unit of WO_3, wolfram
	Wolfram	Scheelite	
Jan. 3	$27.25 @ $27.75	$27.25 @ $27.75	220s, bid, 225s. asked.
Feb. 7	25.75 @ 26.00	25.75 @ 26.00	200s. bid, 206s. asked.
Mar. 7	20.25 @ 20.75	20.25 @ 20.75	147s. 6d. bid, 152s. 6d. asked.
Apr. 11	20.00 @ 20.75	20.00 @ 20.75	160s. bid, 165s. asked.
May 2	19.25 @ 19.75	19.25 @ 19.75	155s. bid, 160s. asked.
June 6	18.50 @ 18.75	17.50 @ 17.75	145s. bid, 150s. asked.
July 4	17.00 @ 17.50	15.75 @ 16.25	130s. bid, 135s. asked.
Aug. 1	14.00 @ 15.00	13.00 @ 13.50	110s. bid, 117s. 6d. asked.
Sept. 5	13.50 @ 14.25	12.75 @ 13.25	112½s. bid, 117½s. asked.
Oct. 3	13.50 @ 14.25	12.75 @ 13.25	113½s. bid, 118½s. asked.
Nov. 7	13.00 @ 14.00	12.00 @ 13.00	106s. bid, 111s. asked.
Dec. 5	12.75 @ 13.25	11.50 @ 12.00	103s. bid, 108s. asked.
Average	18.20	17.57	
Duty	7.93	7.93	
Average price duty paid	26.13	25.50	

[1] Published price quotations (from E&MJ Metal and Mineral Markets).
[2] Known good analysis.

FOREIGN TRADE [12]

General imports of tungsten concentrate declined 35 percent compared with 1956. Bolivia and Brazil each supplied more than 2 million pounds tungsten content and 5 other nations—Argentina, Canada, Republic of Korea, Australia, and Peru—in that order, each supplied more than 1.5 million pounds.

Exports and reexports of tungsten concentrate were 163 and 572 tons, respectively, gross weight, in 1957 compared with 117 and 349 tons, respectively, in 1956.

Imports for consumption of ferrotungsten were less than half the quantity imported in the preceding year and less than those in any year since 1949. The reported value was less than a third the value in 1956.

[11] Nelson, Russell C., Tungsten Utilization for High Purity Applications: (Pres. Nat. Western Min. Cong. Feb. 7-9, 1957, Denver, Colo.) Mines Magazine, vol. 67, No. 3, March 1957, pp. 68-72.
[12] Figures on imports and exports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.

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Exports of ferrotungsten totaling 4,390 pounds, gross weight, and valued at $10,092 went to Canada, Colombia, and Uruguay. There were no reexports of ferrotungsten.

Imports of tungsten metal, tungsten carbide, and combinations containing tungsten or tungsten carbide in lumps, grains, or powder were 82,617 pounds, tungsten content, and value was listed at $238,663.

Exports of tungsten powder were 142,293 pounds, valued at $893,061.

Imports for consumption of ferrochromium tungsten, chromium tungsten, chromium-cobalt tungsten, tungsten nickel, and other alloys of tungsten, not specifically provided for, were 66,955 pounds, tungsten content, valued at $112,099.

Tungstic acid and other compounds of tungsten, not specifically provided for, were imported amounting to 11,433 pounds, tungsten content, valued at $34,005.

Exports of tungsten metal and alloys in crude form and scrap were 252,008 pounds, gross weight, valued at $476,164; and reexports were 74,401 pounds, valued at $42,320.

Semifabricated forms exported were 32,691 pounds, gross weight, valued at $748,232. More than 70 percent of the total went to Canada.

TABLE 9.—Tungsten ore and concentrate imported into the United States, 1956–57, by countries

[Bureau of the Census]

Country	General imports [1]		Imports for consumption [2]		
	Gross weight (pounds)	Tungsten content (pounds)	Gross weight (pounds)	Tungsten content (pounds)	Value
1956					
North America:					
Canada	3,166,125	1,703,941	3,165,989	1,703,782	$6,040,528
Mexico	1,611,302	779,540	1,379,353	667,104	1,451,738
Total	4,777,427	2,483,481	4,545,342	2,370,886	7,492,266
South America:					
Argentina	4,112,086	2,163,714	4,112,086	2,163,714	6,069,456
Bolivia [3]	8,754,756	4,320,349	8,098,536	4,146,450	13,628,069
Brazil	3,807,621	2,081,089	3,853,697	2,106,809	5,720,993
Chile [3]	491,930	271,019	491,930	271,019	1,016,386
Peru [3]	1,570,734	912,754	1,570,734	912,754	3,019,897
Total	18,737,127	9,748,925	18,126,983	9,600,746	29,454,801
Europe:					
Finland	55,115	28,410	110,994	59,669	106,176
France	30,945	16,468	30,945	16,468	33,873
Netherlands	77,452	42,995	56,516	32,658	62,930
Portugal	2,437,697	1,395,016	2,356,024	1,341,304	3,180,672
Spain	854,357	458,617	798,184	445,612	1,109,524
Total	3,455,566	1,941,506	3,352,663	1,895,711	4,493,175
Asia:					
Burma	574,957	313,318	543,475	294,660	546,958
Japan	89,531	51,418	44,519	25,220	46,652
Korea, Republic of	6,526,027	3,632,180	5,477,129	3,081,077	5,493,269
Malaya	478,528	260,968	444,236	242,964	447,476
Thailand	871,766	490,895	809,064	450,393	874,701
Total	8,540,809	4,748,779	7,318,423	4,094,314	7,409,056

See footnotes at end of table.

TABLE 9.—Tungsten ore and concentrate imported into the United States, 1956–57, by countries—Continued

Country	General imports [1]		Imports for consumption [2]		
	Gross weight (pounds)	Tungsten content (pounds)	Gross weight (pounds)	Tungsten content (pounds)	Value
1956—Continued					
Africa:					
Belgian Congo	1,056,986	586,902	1,045,846	573,888	$1,314,236
Egypt			15,665	5,895	16,250
Rhodesia and Nyasaland, Federation of	8,977	4,445	16,031	8,412	17,435
Union of South Africa	840,277	443,415	865,300	455,352	1,753,339
Total	1,906,240	1,034,762	1,942,842	1,043,547	3,101,260
Oceania:					
Australia	3,619,771	1,895,590	3,540,953	1,850,407	6,052,022
New Zealand	7,994	4,121	7,994	4,542	8,131
Total	3,627,765	1,899,711	3,548,947	1,854,949	6,060,153
Grand total	41,044,934	21,857,164	38,835,200	20,860,153	[4] 58,010,711
1957					
North America:					
Canada	3,187,880	1,623,897	3,187,880	1,623,897	5,629,670
Mexico	388,045	199,426	244,758	124,745	145,743
Total	3,575,925	1,823,323	3,432,638	1,748,642	5,775,413
South America:					
Argentina	3,643,569	1,910,521	3,643,569	1,910,521	5,150,110
Bolivia [3]	4,740,358	2,335,576	5,037,267	2,440,917	5,980,339
Brazil	3,667,568	2,051,665	3,612,453	2,011,321	3,980,387
Chile [3]	153,535	83,564	153,535	83,564	310,891
Peru [3]	3,410,637	1,561,583	1,991,960	1,149,333	3,436,664
Total	15,615,667	7,942,909	14,438,784	7,595,656	18,858,391
Europe:					
Finland	22,046	12,313			
Netherlands	61,931	36,505	44,481	24,578	28,994
Portugal	1,152,192	652,984	1,269,801	721,692	1,655,056
Spain	154,324	79,548	263,996	149,950	318,981
United Kingdom	22,400	16,494			
Total	1,412,893	797,844	1,578,278	896,220	2,003,031
Asia:					
Burma	312,592	177,092	267,792	149,111	201,879
Japan			23,081	13,037	26,419
Korea, Republic of	2,825,155	1,566,265	3,209,687	1,726,991	2,554,381
Malaya	112,038	63,955	235,258	129,466	207,127
Thailand	50,386	27,726	94,921	52,585	99,482
Total	3,300,171	1,835,038	3,830,739	2,071,190	3,089,288
Africa: Belgian Congo	349,303	204,596	297,373	163,854	310,828
Oceania: Australia	2,958,539	1,582,069	2,874,601	1,542,578	4,488,495
Grand total	27,212,498	14,185,779	26,452,413	14,018,140	[4] 34,525,446

[1] Comprises ore and concentrate received in the United States; part went into consumption during year, and the remainder entered bonded warehouses.
[2] Comprises ore and concentrate withdrawn from bonded warehouses during year and receipts for consumption.
[3] Imports shown from Chile probably were mined in Bolivia or Peru and shipped from a port in Chile.
[4] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.

TABLE 10.—Ferrotungsten imported for consumption in the United States, 1956–57, by countries

[Bureau of the Census]

Country	1956			1957		
	Gross weight (pounds)	Tungsten content (pounds)	Value	Gross weight (pounds)	Tungsten content (pounds)	Value
Europe:						
Austria	266,355	213,251	$482,229	81,137	65,257	$123,046
Belgium-Luxembourg	22,000	17,311	42,705	22,046	17,637	25,600
Germany, West	42,121	33,558	77,948	70,136	55,427	94,221
Italy	11,020	9,258	21,065			
Netherlands	10,582	8,466	19,895			
Portugal	315,817	262,340	531,514	146,837	120,002	151,541
Sweden	99,218	84,620	210,339	132,277	113,688	202,207
United Kingdom	113,097	93,837	221,743	51,930	42,866	77,749
Total	880,210	722,641	1,607,438	504,363	414,877	674,364
Asia: Japan	193,019	147,980	337,157			
Grand total	1,073,229	870,621	1,944,595	504,363	414,877	674,364

WORLD REVIEW

Free World production of tungsten concentrate (not including the United States) decreased about 10 percent in 1957 compared with 1956, chiefly because of lowered demand and prices. Major factors in the decline were United States Government curtailment of stockpile purchasing from foreign sources and suspension of purchasing from domestic sources.

An increasing tendency to process concentrate in the areas of origin was due in large part to the widespread surplus and search for new markets. New plants to process tungsten or plans for their construction were reported in several nations. The synthetic scheelite plant in the Republic of Korea, scheduled for completion in June of 1958, will represent a substantially increased foreign processing facility.

NORTH AMERICA

Canada.—Concentrate was produced in 1957 at the Salmo, British Columbia, operation of Canadian Exploration, Ltd. Output was sold to the United States Government under a contract requiring completion of deliveries early in 1958.

The Burnt Hill wolframite deposit was described.[13]

Atlas Steels, Ltd., was by far the leading consumer of tungsten in Canada. Other consumers were Canadian General Electric Company, Ltd.; Shawinigan Chemicals, Ltd.; A. C. Wickman (Canada), Ltd.; Kennametal of Canada, Ltd.; Deloro Smelting and Refining Company, Ltd.; Wheel Trueing Tool Company of Canada, Ltd.; Boyles Bros. Drilling Company, Ltd.; Johnson, Matthey and Mallory, Ltd.; Canadian Westinghouse Company, Ltd.; and Dominion Colour Corporation, Ltd.

[13] Victor, Iris, Burnt Hill Wolframite Deposit, New Brunswick, Canada: Econ. Geol., vol. 52, No. 2, March–April 1957, pp. 149–168.

TABLE 11. — World production of tungsten ore and concentrate (60 percent WO_3 basis), by countries, 1948–52 (average) and 1953–57, in short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	514	2,037	1,809	1,618	1,893	1,661
Mexico	228	752	601	626	628	294
United States (shipments)	5,101	9,591	13,691	16,412	14,737	[2] 5,520
Total	5,843	12,380	16,101	18,656	17,258	7,475
South America:						
Argentina	220	661	873	1,213	1,293	1,435
Bolivia (exports)	3,072	4,216	4,900	5,935	5,255	4,809
Brazil	[3] 1,253	[3] 2,146	[3] 1,513	[3] 1,410	[3] 2,017	[4] 2,156
Peru	524	1,001	849	893	1,242	1,257
Total	5,069	8,024	8,135	9,451	9,807	9,657
Europe:						
Austria	----------	----------	----------	----------	----------	138
Finland	29	24	139	146	74	----------
France	790	1,443	1,129	1,520	1,229	1,034
Italy	6	30	36	30	26	22
Norway	2	9	----------	----------	----------	----------
Portugal	4,095	5,581	5,076	5,122	5,506	4,641
Spain	2,347	3,252	2,827	1,728	1,584	1,132
Sweden	411	485	504	510	504	534
U. S. S. R. [5]	7,400	8,300	8,300	8,300	8,300	8,300
United Kingdom	71	67	101	80	68	[5] 110
Yugoslavia	----------	132	[5] 110	[5] 110	[5] 110	[5] 110
Total [5]	15,150	19,300	18,200	17,500	17,400	16,000
Asia:						
Burma [6]	1,618	2,205	1,323	2,927	2,982	2,873
China [5]	15,200	18,700	19,800	19,800	19,800	22,000
Hong Kong	[7] 71	165	33	28	30	42
India	6	17	1	----------	2	2
Japan	154	805	860	990	1,200	1,121
Korea:						
North [5]	1,190	1,650	1,650	1,650	1,650	2,200
Republic of	2,037	8,929	4,575	3,757	4,472	4,580
Malaya	69	162	127	138	117	63
Thailand	1,334	1,929	1,323	1,367	1,411	1,080
Total [5]	21,700	34,600	29,700	30,700	31,700	34,000
Africa:						
Algeria	[7] 40	33	----------	----------	----------	----------
Belgian Congo [8]	622	1,403	1,687	1,733	2,142	1,914
Egypt	10	15	4	21	----------	----------
Morocco: Southern Zone	14	13	14	----------	3	----------
Nigeria	13	20	1	3	4	----------
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	181	419	281	245	287	180
South-West Africa [6]	55	163	294	282	388	278
Tanganyika (exports)	19	13	6	10	7	----------
Uganda (exports)	180	197	204	180	193	224
Union of South Africa	246	425	675	708	330	295
Total	1,380	2,701	3,166	3,182	3,354	2,891
Oceania:						
Australia	1,744	2,660	2,563	2,765	2,954	2,605
New Zealand	40	44	33	[5] 33	33	36
Total	1,784	2,704	2,596	2,798	2,987	2,641
World total (estimate)	50,900	79,700	77,900	82,300	82,500	72,700

[1] This table incorporates a number of revisions of data published in previous Tungsten chapters. Data o not add to totals shown owing to rounding where estimated figures are included in the detail.
[2] Mine production was 8,439 short tons.
[3] Exports.
[4] United States imports.
[5] Estimate.
[6] Including WO_3 in tin-tungsten concentrates.
[7] Average for 1951–52.
[8] Including Ruanda-Urundi.

SOUTH AMERICA

Argentina.—Tungsten-ore purchases during 1957 by Instituto Argentino para la Promocion de Intercambio (IAPI) were 716 short tons of wolframite and 606 tons of scheelite, compared with 606 and 529 tons, respectively, in 1956. The grade ranged between 65 and 70 percent WO_3. Completion of deliveries specified by the United States Government purchase contract was expected by mid-1958, at which time Argentine tungsten (and beryllium) will be released for unrestricted sale. IAPI, a Government buying monopoly, has been in liquidation since October 1955.

Bolivia.—The last United States Government purchase contract for Bolivian concentrate was virtually fulfilled in 1957. This factor and lack of demand from other world markets resulted in decreased production, compared with 1956 output.

The most important tungsten mines of the Bolivian Mining Corporation (COMIBOL) included Viloco, Chorolque, Tasna, Bolsa Negra, Caracoles, and Kami and, to a smaller extent, Huanuni, Amimas, Cerro de Potosi, and San Jose.

W. R. Grace and Company continued to produce at its Chojlla tungsten mine.

Certain operations were permitted to reduce working forces in the interest of greater efficiency and lowered costs. It was reported that Bolsa Negra was to be closed as uneconomic and that Kami will discontinue its output of tungsten and will produce tin only.

Brazil.—Scheelite production from the Barro Verde mine in Rio Grande do Norte was begun in April 1957 by Mineracão Wah Chang. A 300-ton-per-day concentrating plant employed gravity methods, flotation, roasting, and magnetic separation. A second concentrating unit of equivalent capacity was being installed. Wah Chang continued operating at its Inhanjara mine near Jundiai, São Paulo.

Most tungsten producers in northeastern Brazil curtailed output because of decline in world prices.

Peru.—The United States Government purchase contract for Peruvian concentrate was scheduled to end with completion of deliveries in 1958. Fermin Málaga Santolalla in the Pasto Bueno district was the principal supplier of the 893 short tons of 60 percent WO_3 equivalent concentrate exported in 1957; 886 short tons was destined for the United States.

EUROPE

Austria.—In 1957, the Österreichisch-Amerikanisch Magnesit A. G. began mining tungsten ore in Austria. Output was 122 short tons of concentrate containing 84 tons of WO_3.

France.—Although 4 mines were closed in late 1956 and in 1957 owing to declining prices, increased production at Montredon and Montmins provided about half the Nation's requirements.

Portugal.—Production in 1957 was curtailed 15 to 20 percent in quantity, and the value of concentrate declined about 50 percent compared with 1956.

Major underground mining continued throughout the year (working only the higher grade sections) because of the high cost of closing, but output was greatly curtailed in the last quarter.

U. S. S. R.—According to a Soviet publication,[14] large reserves of tungsten ore have been "explored" in the U. S. S. R.

ASIA

Burma.—Agreement was reported late in 1957 between Mawchi Mines, Ld., and the President of the Union of Burma, on formation of a joint venture company to produce and market tin and wolfram concentrates.

The Government-financed Mineral Resources Development Corporation opened an ore-buying depot at Tavoy and also continued to work the Yadana Pone wolframite mine in the Mergui district.

China.—Statistics are not available, but the productive capacity and ore reserves of Chinese tungsten mines are considered by far the largest in the world. According to a report issued by the Geological Bureau of the Chinese Ministry for Metallurgical Industry, a large new area of tungsten mineralization in eastern Kwangtung Province has been discovered.

Korea.—Because of limited demand, only 6 tungsten mines (compared with 120 in 1953) were active at end of the year, and production for the year decreased to less than one-third of capacity.

A chemical plant installed at the Sangdong mine to improve the grade and increase the recovery of concentrate was expected to begin operating in June 1958. Utah Construction Company was acting as engineering consultant. A contract under negotiation at year end between the Korea Tungsten Mining Company, operator of the Sangdong and Dalsung mines, and Continental Ore Corp. of New York called for sales of 386 short tons of concentrate per month at a price of $11 per short-ton unit of WO_3.

Thailand.—Production declined about 46 percent, although, in March 1957, the Government reduced the export royalty from 15 percent to 10 percent as partial compensation for lowered prices.

AFRICA

Tungsten production from Africa was about 7 percent of the Free World total; in most areas output declined because of low prices. Exports to the United States were 84 percent lower than in 1956 and comprised only 6 percent of the total African production. A contract under which the United Kingdom absorbed Uganda's output of wolfram expired in September, and production in the last quarter was greatly curtailed. Tungsten-ore reserves in Uganda were believed to be substantial.

OCEANIA

Australia.—The United States Government contract for purchase of concentrate from King Island Scheelite, Ltd., on King Island, Tasmania, was scheduled for completion early in 1958. This company, the major Australian producer, mined by open-pit methods a deposit with reserves estimated by the company at 2,723,000 tons

[14] Achievements in 40 years of Soviet Power, in Figures, a statistical handbook, was published in Moscow in late 1957 by the Central Statistical Administration of the U. S. S. R. Counsel of Ministers. A translation of the article on Natural Resources of the handbook was published in Mineral Trade Notes, vol. 45, No. 6, December 1957, pp. 115–117.

averaging 0.48 percent WO_3. Total Australian production in 1957 was 12 percent below that in 1956, and exports to the United States declined 17 percent.

TECHNOLOGY

A primary aim of tungsten research in 1957 was developing alloys resistant to stress and oxidation for use at temperatures far above those currently feasible.[15] Tungsten has been employed in high-temperature applications, such as high-speed cutting tools, lamp filaments, and high-temperature alloys, because its melting point is higher than that of any other metal. The possibility of extending its use to more rigorous operating conditions was studied.

A prediction was made [16] that within 12 to 15 years alloy development may increase "* * * the maximum temperature for strength from the 35 to 45 percent of melting point, for a pure metal, up to the 70- to 80-percent level * * * for alloys based on that metal." Thus the use of tungsten-based alloys at temperatures above 4,100° F., compared with the 1957 temperature limitation of about 2,600° F. under the same conditions, was foreseen. Achievement of extreme purity and the resulting perfect crystals might increase strength; another possibility was believed to lie in dispersion of minute, hard particles in the crystals to prevent movement along grain boundaries. A discussion of heat-resistant alloys [17] cited the development several decades ago of a thoriated tungsten alloy possessing exceptionally high strength. This alloy has a very fine grain microstructure with finely dispersed particles of relatively insoluble thorium oxide (ThO_3) at the grain boundaries.

The effect of special impurity additions in tungsten was studied,[18] and certain additions were found capable of raising the recrystallization temperature several hundred degrees.

In 1957 the Federal Bureau of Mines began research on the production and evaluation of ultrapure tungsten. Studies of the processing technology were in preliminary stages at the end of the calendar year; they included review and pioneering investigations of electrolysis, using fused salts and other electrolytes, preparation and reduction of tungsten halides, bomb reduction, purification of tungsten-bearing solutions, precipitation of salts, and hydrogen reduction. Techniques for preventing contamination during processing received special attention.

Improved analytical procedures for determining trace impurities in ultrapure tungsten were sought for evaluating research results. Chemical, vacuum-fusion, spectrographic, polarographic, and radio-

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[15] Hiester, N. K., Ferguson, F. A., Fishman, N., Todays Frontiers in High Temperature Technology: Chem. Eng., vol. 64, No. 3, March 1957, pp. 237–251.
Thielemann, R. H., Are We Overlooking Tungsten?: Pres. at AIME convention, Feb. 26, 1957, New Orleans, La., 11 pp.

[16] Jahnke, L. P., The Future of High-Temperature Metallurgy: Metal Prog., vol. 72, No. 4, October 1957, pp. 113–118.

[17] Pugh, J. W., Refractory Metals, Tungsten, Tantalum, Columbium, and Rhenium: (AIME Paper pres. in Cleveland at Regional Conference on High-Temperature Materials, Apr. 17, 1957, 8 pp.)

[18] Swalin, R. A., and Geisler, A. H., The Recrystallization Process in Tungsten as Influenced by Impurities: Jour. Inst. Metals, vol. 86, 1957–58, pp. 129–134.

activation methods of analysis were being investigated. Descriptions of a number of reports on analytical procedures were published.[19]

Two methods of purification were described—a zone-refining technique [20] and the iodide process.[21]

A paper on the properties of tungsten was presented.[22] The preparation of polycrystalline tungsten samples to show both large- and small-angle grain boundaries [23] was described, and the structure of metal surfaces was studied.[24]

A process for coating heat-resistant alloys as protection against oxidation by a multiple-phase diffusion process and a metallographic study were published.[25]

Various characteristics of tungsten alloys were described.[26]

A report on certain high-temperature properties of tungsten was published.[27]

The manufacture, characteristics, and uses of cemented carbides [28] and the selection of carbide grades were described.[29] The development of heavy metal as a die material for extrusion of titanium shapes[30] was reported. An electric resistance-type furnace, capable of melting samples of tungsten in 5 minutes was reported.[31]

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20 Calverley, A., Davis, M., and Lever, R. F., The Floating-Zone Melting of Refractory Metals by Electron Bombardment: Jour. Sci. Instruments, vol. 34, April 1957, pp. 142–147.

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23 Brock, E. G., Grain Boundaries for Field-Emission Microscopy: Jour. Appl Phys., vol. 28, No. 2, February 1957, pp. 241–244.

24 Mueller, E. W., Study of Atomic Structure of Metal Surfaces in Field Ion Microscope: Jour. Appl. Phys., vol. 28, No. 1, January 1957, pp. 1–6.

25 Buckle, H., Protection contre l'oxydation des alliages refractaires par le procédé de diffusion en phases multiples: Rev. métallurgie, vol. 54, No. 1, January 1957, pp. 16–22. Etude micrographique des alliages riches en Mo-Cr et en W-Cr des systems Mo-Cr-Fe et W-Cr-Ni: Rev. métallurgie, vol. 54, No. 1, January 1957, pp. 9–15.

26 Cadek, J., Perliticka a Eutektoidni Reakce v Legovanych Ocelich (Effect of Tungsten on Isothermal Austenite Decomposition in Hypoutectoid Carbon Steel): Hutnicke Listy, vol. 12, No. 9, September 1957, pp. 777–788.

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29 Hummer, Julius, and Pond, James B., Vacuum Sintering and the Selection of Carbide Grades: Carbide Eng., vol. 9, No. 7, July 1957, pp. 7–10.

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Beneficiation and analysis of tungsten ores at Canadian Exploration, Ltd., Salmo, British Columbia,[32] and a description of high-voltage and magnetic-separation methods were published.[33]

French gravitational washing plants and the mines [34] where they are installed and the deposits and treatment of ore in Belgian Congo and Ruanda-Urundi were described.[35]

The tungsten industry of California, including geology, localities, history, beneficiation, metallurgy, and utilization, was reviewed.[36]

Strip-mining steeply dipping hillside deposits in Nevada was reported.[37]

Two Federal Bureau of Mines reports related to tungsten.[38]

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[32] Kipp, H. H., Development of Tungsten Ore-Dressing Practice: Canadian Min, and Met. Bull., vol. 50, No. 539, March 1957, pp. 134–136.
McLeod, R. J., Tungsten Milling and Current Metallurgy at Canadian Exploration Ltd.: Canadian Min. and Met. Bull., vol. 50, No. 539, March 1957, pp. 137–142.
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Uranium

By James Paone[1]

URANIUM-ORE production from domestic sources reached a new peak in 1957. At the end of the year plans in effect were expected to result in a record growth in industry capacity in 1958. The domestic-ore reserve was increased from 60 to 76 million tons during 1957.

The first full-scale power reactor, the 60,000-kilowatt Pressurized-Water Reactor at Shippingport, Pa., was completed. Four other civilian power reactors produced electrical power in the United States during the year. Three nuclear-powered submarines were in operation, an Army package power reactor was operating successfully, and 16 additional nuclear submarines, an aircraft carrier, and a guided-missile cruiser were authorized.

Uranium-concentrate production from the Free World during the year was estimated at about 24,000 tons, produced chiefly by the United States, Canada, Union of South Africa, Belgian Congo, Australia, France, and Rhodesia. Production for 1959 was estimated at about 40,000 tons. Ore reserves continued to rise, and milling facilities were expanded in almost every uranium-producing country.

The market for uranium remained essentially military, but some material was used for peaceful applications.

About 50 nations had organized special Government agencies to promote its use. The International Atomic Energy Agency came into existence during the latter part of 1957 and by the end of the year had a membership of 65 countries. The Agency's basic objective was to accelerate and enlarge the contribution of atomic energy to the well-being of the world.

Two important multilateral organizations were established to further peaceful objectives of the atom—the European Atomic Energy Community (Euratom) and the European Nuclear Energy Agency of the Organization of European Economic Cooperation (OEEC).

In November the Inter-American Nuclear Energy Commission, an organ within the framework of the Organization of American States (OAS) was formed to survey the needs of members for research and training in atomic energy.

Nuclear-research reactors were operating in or were being planned by most countries in the world; at least five nations had or were soon to have power reactors in operation.

GOVERNMENT REGULATIONS

Contracts for uranium exploration under the Defense Minerals Exploration Administration (DMEA) program totaled $1 million during

[1] Commodity specialist.

1957 compared with $2 million in 1956; 34 contracts were executed. The Government has spent $6 million on uranium exploration since the program began.

The Government regulated the prices of uranium ores and concentrates throughout 1957.

Legislation, which permitted holders of uraniferous lignite mining claims to delay assessment work on their claims until July 1, 1958, was passed. The bill was designed to protect claim holders while the AEC

TABLE 1.—Defense Minerals Exploration Administration contracts involving uranium executed or amended during 1957, by States

State and contractor	County	Total amount of contract [1]
ALASKA		
Southeastern Mining & Exploration Co., Inc	Juneau	$18,000
COLORADO		
Uranium Enterprises	Jefferson	11,700
Universal Metals Co	Saguache	29,475
Lisbon Uranium Corp	Mesa	45,572
New Idria Mining & Chemical Co	do	53,444
D. & J. Uranium Exploration Co	Saguache	44,800
Yellow Queen Uranium Co	Jefferson	44,192
Cervi, Arthur A	do	17,536
Haynes, Caleb V., Jr	do	20,256
Climax Uranium Co	San Miguel	248,380
MONTANA		
Midland Mining Co	Carbon	27,008
NEW MEXICO		
New Jersey Zinc Co	McKinley	90,890
Mid-Continent Uranium Corp	do	113,244
Treasure Uranium & Resources	do	25,832
OREGON		
Timber Beast Mining Co	Harney	24,772
SOUTH DAKOTA		
Anderson, Wesley, and others	Harding	6,700
McAlester Fuel Co	Fall River	72,136
TEXAS		
Briscoe County Uranium Co	Briscoe	11,116
UTAH		
Bleak Uranium Co., Inc	San Juan	73,603
Walter Duncan Mining Co	do	46,608
Dalmid Oil & Uranium, Inc	do	25,441
Strategic Minerals Exploration Co	do	13,500
Vanadium Queen Uranium Corp	do	53,872
Four Corners Uranium Corp	Emery	102,592
Daubert Chemical Co	San Juan	26,808
Maxim Exploration Co	do	103,700
WASHINGTON		
Geo-Resource Corp	Stevens	45,960
Mudhole Exploration, Inc	Spokane	9,520
North Star Uranium, Inc	do	2,772
WYOMING		
Gaddis, W. H., and others	Fremont	64,784
Metals, Inc. (U & S)	Natrona	31,732
Modern Mines Development Co	Big Horn	40,870
P-C Mining Corp	Fremont	81,200
Little Mo Mining Co	do	21,120
Total		1,655,135

[1] Government participation, 75 percent.

conducted studies on the extraction of uranium from lignite to determine the economic possibilities.

The AEC and Bureau of Land Management under a new regulation (10 CFR 60) would cooperate in issuing uranium-prospecting permits and mining leases on Government lands, where other Federal agencies lack authority. The regulation provided for a maximum area of 1,920 acres, a permit period of 2 years, a 2-year renewal on expiration, an annual rental fee of $1.50 per acre, and a Government royalty of 10 percent of the gross; mining leases were for 5 years, with a 3-year extension.

Regulations developed by the AEC and in effect in 1957 were:

10 CFR Part 20—Standards for Protection Against Radiation, effective February 28, 1957.

10 CFR Part 30—Licensing of Byproduct Material, effective February 10, 1956.

10 CFR Part 40—Control of Source Material, effective March 31, 1947, with amendments from time to time.

10 CFR Part 50—Licensing of Production and Utilization Facilities, effective February 18, 1956.

10 CFR Part 55—Operators' Licenses, effective February 3, 1956.

10 CFR Part 70—Special Nuclear Materials Regulations, effective March 4, 1956.

10 CFR Part 140—Financial Protection Requirements and Indemnity Agreements, effective September 11, 1957.

The two regulations issued in 1957 provided for (1) indemnification of persons found liable for nuclear accidents when the losses exceed the amount of private insurance available and for (2) standards for protection against radiation.

During 1957, the 44 applications for licenses to construct and operate research and test reactors and 1 power reactor were approved.

A new office to direct development of nuclear power for aircraft and guided missiles was created by the Department of Defense and the AEC.

DOMESTIC PRODUCTION

Mine Production.—The United States remained the world's leading producer of uranium. The annual rate of production by the end of the year was about 10,000 tons of uranium oxide (U_3O_8) and was expected to increase to 12,500 in 1958.

Uranium-ore receipts at all private plants and Government purchase depots totaled 3,676,000 dry short tons; ore fed to processing installations totaled 3,575,000 tons, with an average grade of 0.27 percent U_3O_8.

Uranium ore was mined by 727 operators on 1,300 properties in Arizona, California, Colorado, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. Production totaled 2 million tons during the latter half of 1957, as compared with about 1.7 million tons for the first half of 1957 and 1.66 million tons for the latter half of 1956. Anticipated mine production for 1958 was 5.5 million tons and for 1959, 7.2 million tons.

Exploration drilling for uranium by private industry totaled about 5.78 million feet as compared with 4.8 million in 1956 and 5.75 million in 1955.

About 5,500 persons were estimated as engaged directly in uranium mining and about 3,000 persons in processing plants.

TABLE 2.—Uranium mine production in 1957, by States

State	Short tons	Average grade percent U_3O_8	U_3O_8 pounds	Total value
Arizona	286,042	0.26	1,510,647	$6,207,111
Colorado	740,168	.26	3,830,386	16,061,646
Montana	879	.43	7,644	33,270
New Mexico	1,187,878	.22	5,169,221	21,263,016
South Dakota	69,632	.17	231,215	804,946
Utah	1,075,789	.35	7,510,665	32,542,617
Wyoming	275,518	.22	1,192,005	4,931,772
Undistributed [1]	59,572		224,692	782,741
Total	3,695,478	.27	19,676,475	82,627,119

[1] Includes Alaska, California, Idaho, Nevada, Oregon, Texas, and Washington.

Almost 90 percent of the 727 producers in 1957 shipped uranium ore from mines producing less than 50 tons up to 5,000 tons a year; over 40 percent of the operators each shipped less than 50 tons annually; and 91.2 percent of the production was delivered by about 10 percent of the 727 producers. Further development of the large deposits in the Ambrosia Lake and Gas Hills areas will increase the percentage of output by the leading producers. The number of mine operators in 1957 was 727, compared with 843 in 1956, 748 in 1955, and 700 in 1954.

Mill Production.—Uranium-concentrate production (chiefly from 16 mills in operation by the end of the year) had reached 8,640 tons of U_3O_8 and represented an increase of about 30 percent over production in 1956. This total included 146 tons, produced as a byproduct in the chemical processing of phosphate rock in Florida and Illinois, from treating Idaho euxenite at the St. Louis plant of Mallinckrodt Chemical Company, and from reprocessing refinery residues at the Vitro Corp. plant, Canonsburg, Pa.

There were 12 mills active in the Western United States at the beginning of 1957, and 4 others came into production during the year.

Domestic-uranium-concentrate purchases by the Commission were about $171 million in 1957 compared with $134 million in 1956. Purchases for 1958 are estimated at $247 million and for 1959 at $322 million, almost double those in 1957.[2]

In October the AEC announced that uranium output would be limited to mill contracts under negotiation because the point had been reached where it no longer was to the interest of the Government to expand production of uranium concentrate. The way was left open for extending limited expansion in areas having no present milling facilities.[3]

The aggregate capacity of the 16 mills in operation at the end of the year was over 11,000 tons per day. All of the mills had sulfuric-acid leaching facilities; the acid leach was used only as a scavenger at two of the mills, which primarily used a sodium carbonate leach for recovering uranium and vanadium. Two other mills had both acid and carbonate circuits for processing a variety of ores, especially high-lime-content ores.

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TABLE 3.—Exploration drilling for uranium by industry in the United States and Alaska

State or Territory	January through June, 1955		July through December, 1955		January through June, 1956		July through December, 1956		January through June, 1957		July through December, 1957	
	Number of operators	Feet	Number of operators	Feet	Number of operators	Feet	Number of operators	Feet	Number of operators	Feet	Number of operators	Feet
Alaska	5		17	1,750	8	2,870					3	2,146
Arizona	21	408,998	27	544,695	26	89,049	16	100,883	18	814,665	20	363,519
California	18	5,145	20	17,103	24	2,135	26	850	30	4,935	49	2,008
Colorado	95	405,080	177	645,133	178	595,569	146	471,908	154	567,555	135	668,378
Idaho	8	600	8	4,194	7	690	5	600	5	1,555	5	657
Montana	10	805	8	6,835	7	6,035	5	5,500	6	822	3	(1)
Nevada	22	13,700	20	7,920	31	4,740	38	13,319	33	3,230	45	13,956
New Mexico	19	499,308	30	751,739	16	752,778	12	547,688	15	897,570	25	494,072
New York					1	(1)	1	(1)				
North Dakota	1		3	5,000	2	(1)						
Ohio									1	(1)		
Oklahoma					3		3					
Oregon			3	4,625	5	25,225	4	20,000	2	(1)	4	
Pennsylvania					1	(1)	1	(1)				
Rhode Island					1	(1)	1	(1)				
South Dakota	6	1,334	15	87,178	10	143,880	9	84,569	7	65,244	5	188,760
Texas	14	221,331			12	21,280	12	5,771	1	(1)	1	(1)
Utah	183	822,708	169	853,538	113	356,472	84	190,071	97	378,206	75	147,130
Washington	18	4,626	10	30,728	29	34,179	25	30,000	5	21,204	5	11,899
Wyoming	22	74,791	69	331,742	41	597,297	28	637,561	35	610,162	32	522,529
Undistributed [1]						65,677		500		1,332		1,009
Total	442	2,458,426	576	3,292,207	515	2,697,876	416	2,109,220	409	3,366,480	407	2,416,063

[1] Figure withheld to avoid disclosing individual company confidential data, included with "Undistributed."

TABLE 4.—Uranium mills in operation or under construction during 1957

Company	Location	Capacity (tons of ore per day)	Estimated cost of mill (thousand dollars)
OPERATING			
The Anaconda Co	Bluewater, N. Mex	3,000	19,358
Climax Uranium Co	Grand Junction, Colo	350	3,088
Dawn Mining Co	Ford, Wash	400	3,100
Kerr-McGee Oil Industries, Inc	Shiprock, N. Mex	500	3,161
Mines Development, Inc	Edgemont, S. Dak	300	1,900
National Lead Co., Inc	Monticello, Utah	600	5,000
Rare Metals Corp. of America	Tuba City, Ariz	250	3,600
Texas-Zinc Minerals Co	Mexican Hat, Utah	775	7,000
Trace Elements Corp	Maybell, Colo	300	2,208
Union Carbide Nuclear Co	Uravan, Colo	1,100	5,000
Union Carbide Nuclear Co	Rifle, Colo	280	1,600
Uranium Reduction Co	Moab, Utah	1,500	8,250
Vanadium Corp. of America	Durango, Colo	430	813
Vanadium Corp. of America	Naturita, Colo	350	1,000
Vitro Uranium Co	Salt Lake City, Utah	550	5,500
Western Nuclear Corp	Split Rock, Wyo	400	3,600
UNDER CONSTRUCTION			
Fremont Minerals, Inc	Riverton, Wyo	500	3,500
Gunnison Mining Co	Gunnison, Colo	200	2,025
Homestake-New Mexico Partners	Grants, N. Mex	750	5,325
Homestake-Sapin Partners	do	1,500	9,000
Kermac Nuclear Fuels Corp	do	3,300	16,000
Lakeview Mining Co	Lakeview, Oreg	210	2,600
Phillips Petroleum Co	Grants, N. Mex	1,725	9,500
Union Carbide Nuclear Co	Rifle, Colo	1,000	8,500
Total		21,020	137,528

Based on information available to the Commission, current direct and indirect costs of milling uranium, exclusive of major replacements and amortization, range from $8 to $15 per ton for the smaller mills and $7 to $10 for the larger. Overall processing cost per ton would be increased $5 to $8 for mills recovering vanadium.

Acid consumption in leaching ranged from 40 to 400 pounds per ton and averaged about 180 pounds. Chemical costs for leach circuits ranged from $2 to as high as $7 per ton of ore treated and for a regenerative sodium-carbonate circuit normally ranged from $1.50 to $2.50 per ton of ore treated.

Uranium-ore-processing facilities in the United States ranged in cost from $5,000 to $10,000 for each ton of daily capacity, depending on the size of the operation. Amortization charge, based on a 5-year period, would be $2.80 to $5.50 per ton. Mills wholly or partly amortized under contracts executed with the AEC before March 31, 1962, could be required to reserve a reasonable percentage of mill capacity for treating purchased or custom ores. The total mill capacity available for custom ore in operating mills and those under construction would be about 4,300 tons per day, or 1,540,000 tons a year. In 1957 approximately 39 percent of all the ore milled was custom ore.

By the end of the year average processing costs were about half those in 1953. Average uranium recovery in 1957 exceeded 90 percent, compared with about 88 percent in 1956.

Refinery Production.—Uranium was refined and converted at three AEC Feed Materials Production Facilities. The refineries operated by private industry for the Commission in 1957 were:

Mallinckrodt Chemical Works, St. Louis, Mo.
Mallinckrodt Chemical Works, Weldon Springs, Mo.
National Lead Co. of Ohio, Fernald, Ohio.

The Weldon Springs, Mo., plant completed in 1957 and the St. Louis, Mo., plant produced high-purity uranium metal from uranium concentrates. In addition to producing metal, the Fernald, Ohio, facility rolled and machined fuels for production reactors. The three plants were operated under cost-plus-fixed-fee contracts. Feed materials were also recovered and processed at the AEC Hanford facilities at Richland, Wash., and at the Savannah River facilities at Aiken, S. C. Uranium hexafluoride was produced from high-purity uranium oxide at Commission plants at Oak Ridge, Tenn., and Paducah, Ky., both operated by Union Carbide Nuclear Co. A third plant, under construction at Portsmouth, Ohio, and scheduled for completion in early 1958, also was to convert high-grade oxide to hexafluoride.

General Chemical Division of Allied Chemicals & Dye Corp., New York, N. Y., continued constructing its facility at Metropolis, Ill., for producing uranium hexafluoride from concentrates. Uranium concentrate for the General Chemical conversion process can be either purchased from the AEC at $10 per pound of U_3O_8 or leased at an annual charge of 4 percent of the $10 value. Conversion of 5,000 tons of U_3O_8 to purified UF would add about $10 million to the value of the material. The project was issued a certificate of necessity by ODM. The estimated cost of the installation was $11 million.

Mallinckrodt Chemical plant at Hematite, Mo., continued producing uranium dioxide enriched in U–235. The plant maintains processes for making other forms of uranium compounds suitable for use in atomic reactors.

During the year many tons of uranium was recovered from underground waste-storage tanks by General Electric Co., operator of the AEC Hanford plant. The man-made deposit, which represented one of the largest concentrations of uranium in the world, resulted from accumulations of irradiated uranium, from which the plutonium had been extracted.

The first batch of unirradiated commercial-enriched uranium scrap was processed in 1957 by Baker & Co., Newark, N. J. Other firms licensed to recover uranium scrap generated from manufacturing fuel elements include Nuclear Materials and Equipment Corp. and Davison Chemical Co.

Production of Fissionable Material.—Enriched uranium (U–235) was produced in gaseous diffusion plants owned by the Commission. The Government-owned plants operated by private industry were:

Union Carbide Nuclear Corp., Oak Ridge, Tenn.
Union Carbide Nuclear Corp., Paducah, Ky.
Goodyear Atomic Corp., Portsmouth, Ohio.

Capital investment in the three plants was about $3 billion. Although the principal function of the plants was to provide material for national defense, they also supplied enriched uranium for research and power reactors.

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Plutonium and other reactor products intended primarily for weapons use were produced by General Electric Co. at the Hanford Works, and by E. I. du Pont de Nemours & Co., Inc., at the Savannah River plant.

CONSUMPTION AND USES

Most of the uranium metal and compounds produced during the year were used in AEC programs. Demand for the material by private industry was growing. Uranium purchased by the Commission was distributed in one of the following ways:

1. "In-process" inventories.
2. Plutonium, which is delivered to the weapons stockpile.
3. Highly enriched U–235 produced in gaseous diffusion plants; also delivered to the weapons stockpile.
4. Uranium of various enrichments of U–235, but generally less than 20 percent U–235, withdrawn from gaseous diffusion plants for research, for Government and private reactor fuel, and for distribution to foreign Governments under the atoms-for-peace program.
5. Depleted uranium, or tailings from gaseous diffusion, plants, of low U–235 assay, but quantitatively by far the greatest fraction of the total imput tonnage.

In-process inventories included the uranium in the 13 AEC production reactors at the Savannah River plant and at the Hanford Works. A loading for one of the production reactors is several thousand fuel elements, each element containing several pounds of uranium. Another significant factor in the in-process inventory was the uranium undergoing treatment in the gaseous diffusion plants at Oak Ridge, Paducah, and Portsmouth. Each gaseous diffusion plant involves about 300,000 miles of piping, which is filled largely with gaseous uranium hexafluoride at all times.

Nuclear reactors active in the United States during the year included 14 high-temperature, power-producing reactors; 56 low-temperature, power-producing reactors; 56 low-temperature reactors, usually not useful for power generation and used principally for research, training, production of special nuclear materials, or testing; and 44 critical experiment facilities. In addition to the 114 reactors operated, 89 reactors were being built in this country, and 67 were planned.

Production Reactors.—Production rates of special nuclear materials equaled or exceeded goals established by the AEC. Scheduled requirements for the military and civilian programs were met by production facilities. Plutonium from 8 production reactors at Hanford, Wash., and 5 production reactors at the Savannah River, Aiken, S. C., plant, was delivered to the weapons stockpile.

Power Reactors.—Developments on nuclear-produced power during the year advanced significantly. The first full-scale nuclear powerplant in the United States went critical on December 2, 1957, at Shippingport, Pa. The Pressurized-Water Reactor (PWR) delivered, on a test basis, 60,000 kw. of electricity (the expected initial capacity of the plant) to the Duquesne Light Co. system serving the Pittsburgh area. At 60,000 kw. of output the PWR was producing more electricity than any other individual reactor in existence. This PWR was the world's first full-scale plant designed exclusively for producing civilian electric power.

In addition to the PWR, 7 experimental civilian power reactors of

6 different types operating for the AEC and the Army reactor operating at Fort Belvoir, Va., had direct civilian applications. The Vallecito Boiling-Water Reactor, Pleasanton, Calif., was the first privately financed nuclear reactor to produce electrical power in the United States. The plant, built primarily to develop operational data applicable to the 180,000-kw. Dresden reactor, was producing 5,000 kw. of electricity for distribution over the Pacific Gas & Electric System. The Experimental Boiling-Water Reactor, Argonne National Laboratory, operated successfully throughout the year and was tested at 2½ times its design capacity (20 thermal megawatts). The first nonmilitary reactor to produce heat for power generation by a private utility was the Sodium Reactor Experiment, Santa Susana, Calif. At the National Reactor Testing Station, Idaho, the Organic Moderated-Reactor Experiment was operated, and at the Oak Ridge National Laboratory, Tenn., Homogeneous Reactor Experiment 2, producing 300 electrical kilowatts, became critical in the latter part of December.

Four full-scale power reactors were under construction. The firms and their proposed reactor locations included: Commonwealth Edison Co., Dresden plant, near Joliet, Ill.; Consolidated Edison Co. of New York, Indian Point, N. Y.; Power Reactor Development Company, Enrico Fermi plant, Monroe, Mich.; and Yankee Atomic Electric Co., Rowe, Mass. (table 5).

Negotiations between AEC and Foster Wheeler Corp. to build a 100,000-kw. power reactor for Wolvering Electric Cooperative, Big Rapids, Mich., were deferred. Formal proposals under the Commission's Power Demonstration Reactor program were made by: Carolina-Virginia Nuclear Power Associates, Inc., Parr Shoals, S. C., for development, design, construction, and operation of a 17,000-electrical kilowatt, heavy water-cooled and -moderated reactor fueled with slightly enriched uranium; East Central and Florida West Coast Nuclear Groups for development, design, construction, and operation of a 50,000-electrical kilowatt, gas-cooled, heavy water-moderated reactor; and Pennsylvania Power & Light Co. for a 150,000-electrical kilowatt aqueous slurry homogeneous reactor.

Operation of power reactors during the year contributed toward identification of basic problems that affect the advent of economic nuclear power, such as reduction of capital, fuel, operating, and maintenance costs.

Military Reactors.—The nuclear-powered submarines U. S. S. *Nautilus* and U. S. S. *Seawolf* traveled thousands of miles, more than half while fully submerged, and the U. S. S. *Skate* successfully completed sea trials. Sixteen additional nuclear submarines, an aircraft carrier, and a guided-missile cruiser were authorized through the fiscal year ending June 30, 1958. Three land-based naval prototype reactors were under construction. One package power reactor had been completed. Under the aircraft-reactors program, nuclear propulsion systems for manned aircraft, as well as reactors for nuclear-missile propulsion and auxiliary nuclear powerplants, would be studied.

Nuclear reactors were found to be suitable as a powerplant for military use because of various favorable characteristics, such as high heat production per unit rate of fuel consumption, production of heat without oxygen, and infrequent fueling.

TABLE 5.—Power reactors in operation, under construction, contracted for, or under negotiation in 1957

Designation and operator	Date critical	Type	Capacity (electrical kw.)	Location
OPERATING				
Pressurized-Water Reactor—AEC & Duquesne Light Co.	December 1957	Pressurized water	60,000	Shippingport, Pa.
Experimental Boiling-Water Reactor—AEC.	December 1956	Boiling water	5,000	Lemont, Ill.
Boiling Reactor Experiment No. 4—AEC.	December 1956	do	2,400	National Reactor Testing Station, Idaho.
Sodium Reactor Experiment, AEC & North American Aviation.	April 1957	Sodium graphite	6,500	Santa Susana, Calif.
Experimental Breeder Reactor No. 1—AEC.	November 1957	Fast breeder	200	ARCO.
Organic Moderated Reactor Experiment—AEC.	September 1957	Organic moderated	none	National Reactor Testing Station, Idaho
Homogeneous Reactor Experiment No. 2—AEC.	December 1957	Aqueous homogeneous.	300	Oak Ridge, Tenn.
Army Package Power Reactor—AEC.	April 1957	Pressurized water	1,855	Fort Belvoir, Va.
Vallecitos Boiling-Water Reactor—General Electric.	October 1957	Boiling water	5,000	Pleasanton, Calif.
UNDER CONSTRUCTION				
Power reactor—Commonwealth Edison Co.	1960	do	180,000	Joliet, Ill.
Do	1960	Pressurized	163,000	Indian Point, N. Y.
Power reactor—Power Reactor Development Co.	1960	Fast breeder	100,000	Monroe, Mich.
Power reactor—Yankee Atomic Electric Co.	1960	Pressurized	134,000	Rowe, Mass.
CONTRACTED FOR				
Power reactor—Consumers Public Power District.	1962	Sodium graphite	75,000	Hillam, Nebr.
Northern States Power Company.	1962	Boiling water	66,000	Sioux City, S. Dak.
UNDER NEGOTIATION				
Chugach Electric Association & Nuclear Development Corp. of America.	1962	Sodium, heavy water.	10,000	Anchorage, Alaska.
City of Piqua	1961	Organic moderated	12,500	Piqua, Ohio.
Rural Cooperation Power Assoc.		Boiling water	22,000	Elk River, Minn.

Research and Test Reactors.—Twenty-eight research and training reactors were operating in the United States on December 31, 1957; 20 were under construction; and 29 were planned. Two test reactors operated, 1 was being built, and 2 were planned during the year.

Radioisotopes.—Use of radioisotopes was estimated to have resulted in an annual saving of $500 million to industrial concerns by accelerating manufacturing processes, improving products, and promoting savings through uniform quality. More than 100 commercial firms were supplying such items as radioactive phamaceuticals, labeled radioisotope compounds, and sealed sources of radioactivity to licensed purchasers for industrial and research purposes. The principal source of domestically produced radioisotopes was the Oak Ridge National Laboratory, Oak Ridge, Tenn. Some radioisotopes were produced in the Brookhaven Research Reactor, in the Materials

TABLE 6.—Military reactors [1]

Designation and operator	Function	Type	Location
OPERATING			
Army Package Power Reactor (Army).	Power generation	Pressurized	Fort Belvoir.
Submarine Thermal Reactor (S1W) (Navy).	Propulsion prototype	Gas-cooled	National Reactor Testing Station, Idaho.
Submarine Thermal Reactor (S2W) (Navy).	Propulsion	Pressurized	U. S. S. *Nautilus*.
Submarine Thermal Reactor (Navy).	do	do	U. S. S. *Skate*.
Submarine Intermediate Reactor (Navy).	do	Sodium	U. S. S. *Seawolf*.
Heat-Transfer Reactor Exp. 1 (USAF).	Testing	Direct air cycle	National Reactor Testing Station, Idaho.
UNDER CONSTRUCTION			
Argonne Low-Power Reactor (Army).	Prototype	Pressurized	National Reactor Testing Station, Idaho.
Submarine Advanced Reactor (S3G) (Navy).	Propulsion prototype	do	West Milton, N. Y.
Small Submarine Reactor (S1C) (Navy).	Propulsion	do	Windsor, Conn.
Large Ship Reactor (A1N) (Navy).	do	do	National Reactor Testing Station, Idaho.
Guided-Missile Cruiser Project (Navy).	do		
Low-Power Test Facility (USAF).	Testing	Critical experiment.	National Reactor Testing Station, Idaho.
Aircraft Reactor Experiment (USAF).	do	Fused salt	Oak Ridge, Tenn.
CANEL (USAF)	do	Critical facility	Middletown, Conn.
PLANNED			
Gas-Cooled Reactor Experiment (Army)	Power prototype	Gas-cooled	National Reactor Testing Station, Idaho.
High-Speed Submarine Project (Navy).	Propulsion		
Destroyer Reactor (D1G) (Navy).	do	Pressurized	
Nuclear-powered rockets and ramjet engines (USAF).	do	Nuclear power	Los Alamos and Livermore, Calif.

[1] Does not include the 18 nuclear-powered ships being built for the Navy.

Testing Reactor in Idaho, in the Savannah River Reactors, and in the Hanford Reactors.

The rate of use of isotopes continued to grow rapidly. The total amount of radioactivity shipped during the year was almost twice the amount shipped in the previous year. The gross income from sales of radioisotopes was $2.7 million in 1957, compared with $2.2 million in 1956 and $1.2 million in 1954.

In addition to approximately 14,000 domestic shipments of radioisotopes, a total of 5,963 shipments had been distributed to 56 foreign countries.

Cobalt–60, produced by the AEC, was manufactured at a rate of 300,000 curies a year. The Commission licensed about 60 industrial and research firms to receive a total of 300 or more curies each of cobalt–60 for radiation research and development. Two private firms announced that they would engage in preparing sealed sources of large amounts of radioactivity. Nuclear Systems, a division of Budd Co., Philadelphia, Pa., would encapsulate Co–60 sources up to 50,000 curies, and Picker X-ray Co., Cleveland, Ohio, was designing a hot cell to handle Co–60 sources up to 1 million curies.

TABLE 7.—Research and test reactors operating, under construction, or being planned in 1957

Operator and designation	Type	Startup	Location
OPERATING			
Oak Ridge X–10 Area Reactor (AEC) X10–100.	Graphite	1943	Oak Ridge, Tenn.
Brookhaven Research Reactor (AEC)	do	1950	Upton, N. Y.
Low-Intensity Test Reactor (AEC) LITR	Tank	1950	Oak Ridge, Tenn.
Super Power Water Boiler (AEC)	Homogeneous	1951	Los Alamos, N. Mex.
North American Aviation Water Boiler Neutron Source (AEC).	do	1952	Van Nuys, Calif.
Livermore Water Boiler (AEC)	do	1953	Livermore, Calif.
North Carolina State College (Raleigh Research-Reactor).	do	1957	Raleigh, N. C.
Argonne Research Reactor (AEC) CP–5	Heavy water	1954	Lemont, Ill.
Pennsylvania State University	Pool	1955	University Park, Pa.
Armour Research Foundation	Homogeneous	1956	Chicago, Ill.
Battelle Memorial Institute	Pool	1956	West Jefferson, Ohio.
Naval Research Reactor (USN)	do	1956	Washington, D. C.
Omega West Reactor (AEC)	Tank	1957	Los Alamos, N. Mex.
U. S. Naval Post Graduate School AGN–201–100.	Homogeneous solid	1956	Monterey, Calif.
Catholic University of America AGN–201–101.	do	1957	Washington, D. C.
Oklahoma A&M College AGN–201–102	do	1957	Stillwater, Okla.
Aerojet-General Nucleonics AGN–201M–103.	do	1957	San Ramon, Calif.
University of Akron ANG–201–104	do	1957	Akron, Ohio.
National Naval Medical Center AGN–201M–105.	do	1957	Bethesda, Md.
Texas A&M College AGN–201–106	do	1957	College Station, Tex.
University of Utah ANG–201–107	do	1957	Salt Lake City, Utah.
Aerojet-General Nucleonics AGN–201–108	do	1957	Lemont, Ill.
Colorado State University AGN–201–109	do	1957	Fort Collins, Colo.
University of California AGN–201–112	do	1957	Berkeley, Calif.
Argonne Naught Power Reactor (Argonaut)	Graphite/water	1957	Lemont, Ill.
Atomics International L–47	Homogeneous	1957	Canoga Park, Calif.
University of Michigan	Pool	1957	Ann Arbor, Mich.
Livermore Pool-Type Reactor (AEC)	do	1958	Livermore, Calif.
UNDER CONSTRUCTION			
Oak Ridge Research Reactor (AEC)	Tank	1958	Oak Ridge, Tenn.
Brookhaven Medical Reactor (AEC)	do	1958	Upton, N. Y.
Massachusetts Institute of Technology MITR.	Heavy water	1958	Cambridge, Mass.
Industrial Research Laboratories, Inc	Pool	1958	Plainsboro, N. J.
Curtiss-Wright Corp	do	1958	Quehanna, Pa.
Aerojet-General Nucleonics AGN201(113–120) 8 reactors.	Homogeneous solid	1958	San Ramon, Calif.
University of Wyoming AGN201–111	do	1958	Laramie, Wyo.
University of Virginia	Pool	1958	Charlottesville, Va.
Watertown Arsenal	do	1958	Watertown, Mass.
Union Carbide Nuclear Co	do	1958	Sterling Forest, N. Y.
American Radiator & Standard Sanitary Corp. UTR–1.	Graphite/water	1958	Mountain View, Calif.
Neutron Source Reactor (AEC)	Tank	1958	Upton, N. Y.
University of Florida	Graphite/water	1958	Gainesville, Fla.
PLANNED			
University of California, Los Angeles Medical Reactor.	Homogeneous		Los Angeles, Calif.
State College of Washington	Pool	1958	Pullman, Wash.
University of Buffalo	do	1958	Buffalo, N. Y.
University of Oklahoma L–47	Homogeneous		Norman, Okla.
Rice Institute L–47	do	1958	Houston, Texas.
Puerto Rico Nuclear Center AGN211 (100)	Pool	1960	Mayaguez.
General Atomic Division of General Dynamics.	Homogeneous solid	1958	San Diego, Calif.
Aerojet-General Nucleonics AGN–211–100	Homogeneous solid pool.	1958	San Ramon, Calif.
Isotope Production Reactor IRGA	Homogeneous solid	1958	San Diego, Calif.
Aerojet-General Nucleonics AGN–201M–(121–125).	do	1958–59	San Ramon, Calif.
Aerojet-General Nucleonics AGN–201(126–140).	do	1958–59	Do.

Weapons.—Production of atomic weapons continued and tests were conducted. Programs were directed toward developing small weapons for defensive purposes and designing weapons to reduce the radioactivity after detonation.

TABLE 8.—Radioisotopes shipped from Oak Ridge National Laboratory, by years, 1947–57

Period from July 1 to June 30	Number of shipments	Curies	Period from July 1 to June 30	Number of shipments	Curies
1947 [1]	1,070	21	1954	12,426	12,341
1948	2,743	73	1955	12,775	40,056
1949	4,665	153	1956	13,035	83,003
1950	6,860	776	1957	13,754	149,185
1951	8,935	2,972			
1952	10,187	9,679	Total	97,604	303,648
1953	11,150	5,389			

[1] First shipment made Aug. 2, 1946.

A series of nuclear weapons tests designated as Operation Plumb Bob resulted in detonation of 24 nuclear devices and the conducting of 6 safety experiments. One of the tests, detonated underground, was believed to have potential peaceful uses in construction and mining.

Preparations were underway for a possible series of tests at the Eniwetok Proving Ground in the Pacific in 1958.

Weapons-production facilities at the Rocky Flats plant near Denver, Colo., at the Iowa Ordnance plant at Burlington, Iowa, and at the Pantex Ordnance plant near Amarillo, Tex., had been expanded and were in operation. The Buffalo, N. Y., plant was closed.

Nonenergy Uses.—One firm supplied uranium on a commercial basis for nonenergy uses. During the year about 4,000 pounds of uranium concentrate was used for nonenergy purposes, primarily by the glass, ceramic, and chemical industries.

PRICES AND SPECIFICATIONS

Uranium Ore.—Purchase prices for uranium ore, guaranteed by the AEC, remained in effect during 1957. Prices are given in AEC Domestic Uranium Program Circulars 2, 5 (revised), and 6, and published in Part 60, Title 10, of the Code of Federal Regulations and in the Uranium and Radium chapter of the 1954 Minerals Yearbook. Circular 5 (revised) which covers minimum price guarantees for the more common domestic ores is effective until March 31, 1962. Circular 6, which covers production bonuses, was extended from February 28, 1957, to March 31, 1962.

The new plan, which becomes effective in 1962, establishes a base price of $8.00 per pound of U_3O_8 contained in concentrates meeting specifications. Under the new purchase plan, uranium concentrates or precipitates would be purchased from domestic mills.

Plutonium.—Prices paid by the Commission for plutonium produced by licensed power and research reactors in the United States were announced in May. Until July 1, 1962, prices would range from $30 to $45 per gram, depending on the plutonium–240 content of the material. For the year July 1, 1962, to June 30, 1963, a single price of $30 per gram would be in effect. Prices for plutonium metal remained at $12 per gram.

Domestic uranium concentrates were purchased in the fiscal year 1956 at an average price of $11.60 per pound of U_3O_8 and in 1957, $10.50. The estimated average purchase price in the fiscal year 1958 is $9.60 and for 1959, $9.30. The prices include a factor of amortization on a 5-year basis and were based upon an estimated normal grade of millfeed. Comparative prices paid by the Commission for foreign concentrates were $10.90 per pound of U_3O_8 in the fiscal year 1956, and $11.15 in 1957; the estimate for 1958 is $11.15 and for 1959, $10.70.

Cobalt-60.—The AEC encouraged more widespread distribution and use of cobalt-60 in industrial, medical, and research applications by reducing its prices $2 to $5 per curie based on the specific activity (number of curies per gram of material) and the quantity purchased. Previous prices for Co-60 were $50 per curie for the first 2 curies or fraction thereof and ranged from $2 to $10 per curie for larger purchases.

Special Nuclear Materials.—Prices for uranium metal, uranium-235, uranium hexafluoride (UF_6), uranium-233, described in the uranium chapter of Minerals Yearbook for 1956, remained in effect.

Specifications.—A set of approved measurement methods was being developed for source and special nuclear materials. Plans for providing uranium isotopic standards through the joint efforts of the AEC and the National Bureau of Standards, United States Department of Commerce, progressed satisfactorily.

FOREIGN TRADE

Uranium from foreign sources continued to supply a substantial part of the Nation's requirements for the atomic-energy program. The Combined Development Agency, comprised of members from the USAEC, Atomic Energy of Canada, Ltd., and the Atomic Energy Authority of England, continued to receive uranium at scheduled rates under contract from the Union of South Africa, Belgian Congo, Portugal, and Australia for delivery to the United States and the United Kingdom. The United States continued to receive uranium from Canadian production.

Increased quantities of uranium and other radioactive materials were shipped to foreign countries in 1957.

TABLE 9.—Shipments of nuclear materials to foreign countries in 1957 [1]

Country	Uranium		Other materials	Type of transaction	Purpose and remarks
	Kg U-235	Percent U-235			
Argentina	6.00	20		Lease	Argentina Argonaut.
Australia			Heavy water, 11 tons.	Sale	Research.
Belgium			Heavy water, 500 pounds.	do	Do.
Do	.085	(2)	Plutonium, 6.6 gm.	do	Contained in 12 irradiated slugs for chemical research.
Do	.45	90		do	Research uses by CEAN.
Do	(3)		Uranium oxide	do	Research.
Do	(3)	90		Gift	Plated on Belgium gold foils for World Fair demonstration.
Do	(3)	90		Sale	Uranyl sulfate crystals for gas loop experiment in Br.-1.
Do	(3)	.4		do	1 kg. metal for research.

See footnotes at end of table.

TABLE 9.—Shipments of nuclear materials to foreign countries in 1957 [1]—Con.

Country	Uranium		Other materials	Type of transaction	Purpose and remarks
	Kg U-235	Percent U-235			
Brazil	5.86	20		Lease	Fuel elements in Sao Paulo reactor.
Canada			Heavy water, 50 tons.	Sale	Reactor.
Do	3.3	20		do	Fuel element research.
Do	(3)	90		Gift	Research quantity.
Do	5.72	90		Lease	PTR Chalk River research reactor fuel (total 6.357 kg. U235).
Do	.008	90		do	Do.
Do	.63	90		do	Do.
Do			Heavy water, 5 tons.	Sale	NRU reactor.
Do			Heavy water, 3.5 tons.	do	University of Toronto research reactor (subcritical assembly).
Do	(3)		Plutonium, 2 gm	Exchange	Exchange for Canadian plutonium.
Do			Heavy water, 5 tons.	Sale	NRU reactor.
Denmark	1.4	20		Lease	Danish water boiler research reactor fuel.
Do	(3)	20		Sale	Fission counters.
Do	.001	90		do	For use in exploration in Greenland.
Do	.003	90		do	Contained in 2 fission counters for use in reactor.
France	(3)	(2).4		Gift	Highly depleted uranium for research.
Do			Heavy water, 5.5 tons.	Sale	EL-series reactors at Saclay.
Do	(3)		Highly depleted laboratory material.	Gift	For fission counter research.
Do	(3)	(2).4		Sale	2 kg. for research use.
Do			Plutonium, 10 gm	do	For metallurgical research.
Do			Heavy water, 5.5 tons.	do	El-series reactors at Saclay.
Germany	1.8	20		Lease	For Frankfurt water boiler and fission tub.
Do	5.93	20		do	Fuel elements in Munich research reactor.
Japan	1.98	20		do	Tokai-Mura water boiler research reactor fuel.
Do	(3)	20		do	Fission counters.
Malaya	(3)	Normal		Gift	For research at University of Malaya.
Netherlands	4.69	20		Lease	Amsterdam Fair reactor fuel.
Do	(3)		Plutonium, 2 mg	Loan	Spectrographic research.
Norway			Heavy water, 17.6 tons.	Sale	Halden reactor.
Switzerland			Heavy water, 9 tons.	do	"Reactor, Ltd." research reactor at Wuerenlingen.
Sweden			Heavy water, 28.5 tons.	do	R-3 space heat reactor, Stockholm.
Spain	4.04	20		Lease	Research reactor Espanola.
United Kingdom	(3)	(2).4		Exchange	Depleted uranium exchanged for columbium.
Do			Plutonium, 1 mg	Gift	Research discharge tube for spectrographic research.
Do		101	Plutonium, 101 gm.	Exchange	Metallurgical research.
Do	(3)	(2).4		do	High-purity U trade for U. K. niobium.
Do	(2)		Depleted uranium metal 0.01.	Loan	Single crystal research.
Do	(2)		Depleted uranium metal, 250 gr.	do	Do.
Do	(2)	90 mg.		Gift	Glass-wool research.
Do			Heavy water, 11 tons.	Sale	Civilian power program.

[1] USAEC, Progress in Peaceful Uses of Atomic Energy, July–December 1957, 461 pp.
[2] Depleted uranium, containing less than 0.71 percent of U-235.
[3] Less than 10 grams contained U-235.

WORLD REVIEW

The International Atomic Energy Agency, proposed by President Eisenhower in 1953 before the United Nations General Assembly, became a reality in 1957. Fifty-nine nations, including the United States, became charter members of the Agency during the year in an effort to accelerate and enlarge the contribution of atomic energy to the peace, health, and prosperity of the world. The Agency would (1) encourage and assist research, development, and the practical application of atomic energy, (2) make provision for materials (including nuclear materials), services, and related equipment for atomic energy programs, (3) foster exchange of scientific and technical information, (4) encourage exchange and training of scientists, and (5) establish and administer necessary safeguards to material and personnel.

Nine new agreements for cooperation between the United States and other nations in developing and advancing peaceful uses of atomic energy went into force in 1957, bringing the total to 39 in effect with 37 different nations and with West Germany.

On July 3, 1957, President Eisenhower announced that an additional 59,800 kilograms of uranium–235 would be made available, raising to 100,000 kilograms the total quantity for peaceful purposes; half was to be used in the United States and half for the Atoms-for-Peace program. By the end of the year 16 export licenses for research reactors valued at $7.5 million were issued.

Foreign trade in the atomic-energy program was supported and assisted by the International Cooperation Administration, the Export-Import Bank, and the United States Information Agency.

South African, United States, and Canadian authorities discussed means of protecting the uranium-producing industry against price undercutting. A committee was to be set up to study the situation.[4]

NORTH AMERICA

Canada.—Uranium production in Canada totaled 6,687 tons of U_3O_8 valued at $135,985,000, compared with 2,290 tons of U_3O_8 valued at $45,732,145 in 1956. By the end of 1958 the production rate was expected to reach $400 million. Some 13 new mines came into production, and 9 mills began processing, adding a total of 23,500 tons per day capacity to the industry.[5] Total designed daily mill capacity at the end of the year reached 43,650 tons of ore.

Uranium held in fifth place the value of Canada's mineral production during the year. Last year uranium was eighth among metals produced in Canada, and by 1959 is expected to be the leading metal produced.

New mines and mills began producing in the Northwest Territories, Lake Athabasca, Blind River, and Bancroft areas. Additional production facilities were scheduled for operation in 1958.

The rate of production was largest in the Blind River area in Ontario, followed by the Beaverlodge area in northern Saskatchewan, the Bancroft area in southeastern Ontario, and the Northwest Territory.

[4] Metal Bulletin (London), No. 4253, Dec. 13, 1957, p. 22.
[5] Simpson, R. A., Uranium in Canada—1957: Canadian Min. Jour., vol. 79, No. 2, February 1958, pp. 146–147.

The United States continued to be the major market for Canadian uranium, but agreements were concluded to supply uranium to the United Kingdom, beginning in 1958. The United Kingdom agreed to buy uranium valued at $115 million from Canada during the next 5 years. Japan purchased 10 tons of unprocessed uranium for experimental purposes. A bilateral agreement was concluded between Canada and West Germany under which the West German Government is to buy 500 tons of Canadian uranium over a 5-year period. A similar agreement was being firmed up between Canada and Switzerland.

The NRU reactor was completed and began operation in November. The Atomic Energy of Canada, Ltd., $57 million reactor was to be used for research, to produce significant quantities of plutonium, to assist in developing electricity-producing nuclear power stations, and to manufacture a wide variety of radioisotopes.[6]

Construction was temporarily suspended on the first atomic-power plant in Canada to permit incorporation of new technological advances in its design. Inclusion of major design changes in the plant was expected to increase the original cost estimate of $14.5 million and to delay completion until 1960.[7]

Scientists of the Saskatchewan Research Council were developing a new process for recovering uranium that may make the mining of the vast resources of low-grade uranium ore an economic proposition within the next few years. The council installed a pilot plant for processing low-grade ore by the new "flotation method."

Official estimate of Canadian reserves remained at 320 million tons with a uranium content of 384,000 tons, but firms in the Blind River area maintained that the Blind River reserve alone exceeded 500 million tons of ore.

British Columbia.—British Columbia's first uranium-producing mine was scheduled to be Rexspar Uranium and Metals Mining Co. Crown-owned Eldorado Mining & Refining, Ltd., signed a $21,557,812 contract with Rexspar for purchasing uranium concentrates to be delivered from March 31, 1958, to March 31, 1963. Construction of a 750-ton-per-day mill was underway. The ore reserve was estimated at 1.5 million tons at 0.09 percent U_3O_8.

Northwest Territories.—Mining and milling continued at the Eldorado Mining and Refining, Ltd., Port Radium branch. The small but rich deposit, sometimes called the birthplace of the uranium industry in Canada, appeared to remain economically attractive. One-half of the millfeed came from mine production and one-half from a nearby old tailings dump. Rayrock Mines, Ltd., became the second uranium producer in the Northwest Territory during the year. By October all the feed for the 150-ton-per-day mill came from underground.

Ontario.—The Blind River area of northern Ontario was the largest uranium-producing area in Canada in 1957. Six new producers with a total rated daily capacity of 22,000 tons began treating ore. The producers and their daily milling capacities were: (1) Algom Uranium Mines, Ltd., Nordic mine, 3,000 tons; (2) Stanleigh Uranium Mining Corp., Ltd., 3,000 tons; (3) Consolidated Denison Mines, Ltd., 6,000

[6] Chemical Age (London), vol. 78, No. 2002, Nov. 23, 1957, p. 853.
[7] American Metal Market, vol. 64, No. 78, Apr. 24, 1957, p. 1.

tons; (4) Northspan Uranium Mines, Ltd., Nordic mine, 4,000 tons; (5) Northspan Uranium Mines, Ltd., Panel mine, 3,000 tons; and (6) Can-Met Explorations, Ltd., 3,000 tons.

Algom Uranium Mines, Ltd., Nordic mine reached design capacity in 1957, and the five remaining firms did not begin producing until late in the year. All of the mines in the Blind River area are expected to be in full production in 1958. Pronto Uranium Mines, Ltd., the first mine in the area to begin production, stepped up its yield to 1,500 tons of ore per day. The Algom Uranium Mines, Ltd., Quirke mine produced at the rate of 3,000 tons of ore per day. By the end of the year the rated capacity for all mines in production in the Blind River area reached 26,500 tons per day. When uranium oxide content was 2 pounds per ton, the area could produce some 53,000 pounds per day of U_3O_8. In addition several new mines are expected to begin producing in 1958.

TABLE 10.—Canadian uranium-ore-processing plants and uranium-ore-purchase contracts [1]

Company	Purchase contracts (thousand Can$)	Production rate		Estimated capital expenditure (thousand Can$)	Estimated total operating costs per ton of ore	Approximate district grade pounds U_3O_8 per ton
		Tons per day	Thousand Can$[2]			
Blind River:						
Algom: Nordic, & Quirke	206,910	6,000	49,300	47,800		
Can-Met Explorations, Ltd	90,000	2,500	20,500	20,000		
Consolidation Denison	201,895	6,000	49,300	40,000	$8.50	
Milliken	94,000	3,000	24,600	26,000		
Northspan (Spanish, Buckles, Panel, Lake Nordic)	275,000	9,000	73,900	75,000		2 to 2.5
Pronto	55,000	1,500	12,300	6,000		
Stanleigh	90,405	3,000	24,600	26,000	10.00	
Stanrock	95,000	3,300	27,100	24,500		
Total	1,108,210	34,300	281,600	265,300		
Beaverlodge:						
Eldorado	168,500	2,000	31,000	35,000		
Gunnar	76,950	1,650	24,000	19,500	12.00	
Lorado [3]	64,480	500	7,300	9,250		3.5 to 5
Total	309,930	4,150	62,300	63,750		
Bicroft:						
Bicroft	35,805	1,000	9,100	12,000		
Cavendish	24,192	750	6,800	6,000		
Dyno	31,750	1,000	9,100	7,500	10.00	
Faraday	29,754	750	6,800	8,500		2 to 3
Greyhawk	20,350	600	4,900	5,500		
Total	141,851	4,100	36,700	39,500		
Northwest Territories:						
Rayrock (Marian Lake)	15,792	150	3,800	3,400	35.00	[5]7
Eldorado (Port Radium)	33,500	200	3,000	------------		([4])
Total	49,292	350	6,800	3.400		
British Columbia:						
Rexspar	21,557	750	5,500	6,850	------------	2
Grand total	1,630,842	43,650	392,900	[5]378,800		

[1] Source: South African Mining and Engineering Journal, Mar. 29, 1957, p. 565.
[2] Production rate in Can$ per year is calculated on daily mill capacity and rounded to the nearest $100,000.
[3] Lorado will treat ore shipped to it by Cayzor Athabaska (200,000 tons reserves 33 percent); Black Bay (100,000 tons reserves 0.22 percent); Lake Cinch (reserves not reported).
[4] Not reported.
[5] This estimated grand total for capital expenditure does not include Eldorado Port Radium project.

Blind River area companies that continued development activities but had not reached production included Northspan Uranium's Spanish American mine, Stanrock Uranium Mines, Ltd., and Milliken Lake Uranium Mines, Ltd.

The 11 large mines of the Blind River area will reach full production in 1958 and will probably produce about 70 percent of Canada's uranium in the following 5 years, at a value of over $1.1 billion.

The Bancroft area of southeastern Ontario had a total rated daily production capacity of 2,700 tons of uranium ore. Faraday Uranium Mines, Ltd., began producing in April and was treating about 1,000 tons of ore per day from its mine and 200 tons per day from the adjacent mine of Greyhawk Uranium Mines, Ltd. Bicroft Uranium Mines, Ltd., increased production from 1,000 to 1,500 tons per day. Canadian Dyno Mines, Ltd., was expected to reach production soon at a rate of about 1,000 tons of ore per day.

Saskatchewan.—The Lorado Uranium Mines, Ltd., custom mill in the Uranium City area of northern Saskatchewan was officially opened in August, although the mine and mill began production in May. The mill was processing about 400 tons daily in August. In addition to Lorado's mine production (150 tons of ore per day) the mill received 75 tons per day from the Lake Cinch Mines, Ltd., 150 tons per day from Cayzor Athabaska Mines, Ltd., and 25 tons per day from National Explorations, Ltd. The three private companies were delivering ore at a rate of about one-half their production ability. Lorado installed additional equipment for processing greater quantities of ore. The nature of the ore caused a shortage of acid thereby reducing throughput of the mill. The firm planned to install flotation equipment to separate the high-carbonate ore for a different type of treatment than that given to low-carbonate material. St. Michaels Uranium Mines, Ltd., and Black Bay Uranium, Ltd., holding contracts with Lorado, had not shipped ore during the year.

Processing capacities were increased at Gunnar Mines, Ltd., and at Eldorado Mining & Refining, Ltd. All production from Gunnar Mines came from its open pits, but preparations for underground mining continued. In 1958 underground production was expected to supplement that from the open pits. The company completed installing additional milling equipment and a second sulfuric-acid plant; this expansion allowed Gunnar to increase daily production from 1,250 tons to 1,650. Expanded plant facilities at Eldorado enabled the firm to handle over 2,000 tons of ore daily. Eldorado maintained the only carbonate leach process in Canada and also has a sulfuric-acid circuit to treat sulfide ores.

Milling facilities in the Uranium City area could process about 4,100 tons of ore per day.[8]

A paper describing beneficiation of low-grade pegmatite ores from northern Saskatchewan was published.[9]

Mexico.—Exploration for uranium in Mexico continued during the year. Under the National Nuclear Energy Commission, exploration for radioactive materials was conducted in the arid mountains of the States of Chihuahua and Sonora and in the mountainous jungles of

[8] Work cited in footnote 5.

[9] Crawford, L. W., Gunn, Brad, Cavers, S. D., and Van Cleave, A. B., Beneficiation of Low-Grade Saskatchewan Uranium Ores, IV: Canadian Jour. Chem. Eng., vol. 35, October 1957, pp. 99-104.

the State of Oaxaca. By the end of the year no commercial deposits had been found.

The director of Mexico's Nuclear Energy Commission indicated that exploration for radioactive minerals by private individuals would be encouraged, production would be controlled by the Government, and private prospectors locating deposits would be compensated.

SOUTH AMERICA

Argentina.—Concentration plants of the National Committee on Atomic Energy in Córdoba and Mendoza were processing uranium production from at least a dozen mines. Higher grade ore came from deposits in Santa Brigida and San Victorio, near Sanogasta in La Rioja Province, and lower grade ore was found in the large deposits of Papagayos Cerro Huemul, and Agua Batada in Mendoza.

The Government decree offering awards to prospectors for discovering uranium deposits resulted in a rush for uranium in Argentina. About 200 geiger counters owned by the Argentine Atomic Energy Commission were made available to prospectors.[10]

Argentina received the first United States shipment of uranium oxide, consisting of an 80-pound lot of uranium that contained 20-percent U-235, on December 12. The uranium was scheduled for use by the Argentine Atomic Energy Commission in fabricating fuel elements for the Argonaut-type reactor that was under construction and expected to go critical early in 1958.

On October 14 the Argentine Atomic Energy Commission signed an agreement with the Government of Chubut authorizing the Commission to explore for and exploit nuclear minerals in Chubut Territory. Similar agreements were made with La Rioja Province and Santa Cruz Territory, since under the constitution mineral rights belong to the province rather than the nation.[11]

Brazil.—The 5-thermal-megawatt, pool-type reactor of the University of São Paulo was the first reactor constructed in South America under the Atoms-For-Peace program. The United States supplied fuel for the reactor under a lease agreement and a grant for $350,000. The reactor became critical September 16.

A cooperative agreement between the United States and Brazil for uranium prospecting in Brazil was approved by both Governments in December and replaced an earlier one of August 3, 1955. The new agreement provided for a 2-year program for the continued cooperation of United States geologists with the Brazilian Government for discovering, appraising, and evaluating uranium resources in Brazil.[12]

Early in the year the São Paulo Technological Institute reported discovery of high-grade deposits in the Aguas da Prata region of the State of São Paulo near São João da Boa Vista. Metallurgical studies were made by the Departmente Producão Mineral on the gold-bearing ores of mines in the region of Canaviers de Dentro and Itapicuru to determine the uranium content of the gold-bearing ores.

The Brazilian Atomic Energy Commission was reported to have signed a contract with a French group for uranium from two treatment plants processing ore from Pocos de Caldas.

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[10] Mining World, vol. 19, No. 4, April 1957, p. 90.
[11] U. S. Embassy, Buenos Aires, Argentina, Foreign Service Dispatch 549; Oct. 16, 1957, 1 p.
[12] U. S. Embassy, Rio de Janeiro, Brazil, State Department Telegram: Priority 719, Dec. 26, 1957, 1 p.

The State Government of São Paulo announced that an atomic-power station with 2 reactors producing 10,000 kw. each is to be installed in the vicinity of the hydro-electric station of Jurumirim on the Paranapanema River. The new source of energy would be connected with the transmission line that links the Paranapanema system with that of the São Paulo grid. Reports indicated that the plant is to be built by private enterprise, the State participating with a minority holding.[13]

British Guiana.—It was announced in Georgetown that two representatives from the United Kingdom Atomic Energy Authority were scheduled to visit British Guiana late in the year to determine whether it would be advisable to encourage prospecting for uranium in the colony. Surveys made to date have not revealed the presence of uranium ores in commercial quantities.[14]

Chile.—The Joint Uranium Prospecting Agreement between Chile and the United States was ratified by the Chilean Government. A new Institute of Geological Research, to be the equivalent of a geological survey service, was being organized, and it appeared likely that the two United States geologists to be assigned in Chile under the uranium prospecting program would be under the institute.

A fiscal corporation was formed by three Government agencies (the Mining Credit Bank, the Chilean RFC, and the Smelters Corporation) to exploit the few uranium deposits that had been found in Chile. Deposits were found at Carrizal Alto, Las Animas, Los Azules, Pampa Larga, Cabeza de Vaca, and Romeral. The grade of ore varies from 0.2 to 0.3 percent U_3O_8.[15]

Colombia.—Reports from Bogotá indicate that an organization, the Compania Minera de Uranio, had been formed to exploit uranium fields in the area of California in the Department of Santander and Cucutilla, Pamplonita, and Bochalena in the Department of Norte de Santander. Initial production was expected to be about 50 tons per month.

A report, RME–87, Preliminary Reconnaissance for Uranium in Colombia, was delivered by the USAEC to the Colombian authorities in August. The report describes work done by Commission geologists in Colombia early in 1956 and probably would be used as a base for study by ICAN to determine the feasibility of suggesting an arrangement with the United States for a complete and comprehensive survey of Colombia's mineral resources, especially of radioactive minerals.[16]

Cuba.—No discoveries of commercial ore bodies or favorable indications of radioactive minerals were reported in Cuba during the year, although several news sources carried stories implying that significant discoveries had been made.[17]

Cuban Standolind Oil Company, subsidiary of Standard Oil Company of Indiana, was prospecting for uranium on 25,000 acres in Camaguey Province.

Ecuador.—An agreement with the United States for cooperation regarding the peaceful uses of nuclear energy was approved by the President of Ecuador.

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[13] U. S. Embassy, São Paulo, Brazil, State Department Dispatch 300: May 31, 1957, 1 p.
[14] U. S. Embassy, Georgetown, British Guiana, State Department Dispatch 47: Sept. 13, 1957, 1 p.
[15] Engineering and Mining Journal, vol. 158, No. 7, July 1957, p. 192.
[16] U. S. Embassy, Bogotá, Colombia, State Department Dispatch 853: May 28, 1957, p. 13.
[17] U. S. Embassy, Havana, Cuba, State Department Dispatch 10: July 2, 1957, 2 pp.

Peru.—USAEC geologists reported no significant findings of radioactive material in Peru in 1956 or preceding years.

Venezuela.—Geologists reported discoveries of deposits of uranium near Los Teques. The Institute for Neurology and Brain Research was constructing a 3- to 5-thermal-megawatt pool reactor near Caracas. The project would receive a $350,000 grant from the United States, and the reactor was scheduled to begin operation in 1958.

EUROPE

Euratom, the Community of six Western European countries, was established upon ratification of a treaty by Belgium, France, Republic of Germany, Italy, Luxembourg, and the Netherlands. Some 50 leading industrialists from Euratom countries visited the United States in July to study atomic-energy facilities that may be applicable in the Euratom program for nuclear power.

A Euratom program providing for 15 million electrical kilowatts of nuclear-produced power within the next 10 years was proposed during the year. Euratom would pool its scientific and industrial resources, and the United States and Great Britain would be expected to supply fuel for the first nuclear plants and to process the spent fuel. Estimated total expenditure on nuclear fuels in the 10-year period approximates $2 billion.

Austria.—Proposals submitted early in 1957 by the Austrian Study Company for Atomic Energy, calling for a research reactor with associated laboratory facilities and a training reactor, were formally adopted by the Austrian Government in November.[18]

Belgium.—The Belgian Government contracted for an 11,500-electrical-kilowatt, pressurized-water, power reactor, planned for exhibition at the Brussels Fair in 1958; later the plan of construction was changed to Mol, the Belgian Government research center of Centre d'Études pour les Applications de l'Energie Nucleaire (CEAN). Also planned at Mol was erection of a high-flux materials-testing reactor and installation of a medical reactor to be used especially for research in radiobiology. A nuclear-fuel-reprocessing plant was to be constructed at Mol by Eurochemic, a joint company set up by 12 member countries of the Organization for European Economic Cooperation; the $12 million plant is expected to produce plutonium from an annual charge of 100 tons of uranium by 1961. Countries taking part in the venture included West Germany, Austria, Belgium, Denmark, France, the Netherlands, Norway, Portugal, Sweden, Switzerland, Italy, and Turkey.

A metallurgical firm (Société Générale Métallurgique de Hoboken) in Hoboken began production of uranium oxide from concentrates from the Congo. Its production was expected to reach 1,600 tons annually.[19] A month-long international conference on protection against atomic radiation, sponsored by World Health Organization, met in October at the Belgian atomic-energy center at Mol. An international conference on the industrial uses of atomic energy was scheduled for Brussels in May 1958. The conference was organized

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[18] Foreign Commerce Weekly, vol. 58, No. 23, Dec. 2, 1957, p. 26.
[19] U. S. Embassy, Brussels, Belgium, State Department Dispatch 302: Sept. 12, 1957, p. 1.

by the International Forum of New York in collaboration with CEAN.[20]

Czechoslovakia.—Geological research revealed uranium deposits in Slovakia. Uranium was a main export to the Soviet Union. Construction was begun on a nuclear reactor; the U. S. S. R. assisted.[21] The first phase in erecting Czechoslovakia's Institute of Nuclear Physics was completed in August. Work was being concentrated on installing a cyclotron and other equipment for starting up the reactor early in 1958.

Denmark.—The Danish Government planned an extensive search for uranium deposits in Greenland in mid-1958. Results of previous exploration were promising enough to warrant the expedition. Twenty tons of uranium-bearing ore mined in Greenland indicated that processing methods used in the United States could not be used to recover the uranium on a commercially profitable basis. A laboratory was being set up near the ore field at Narssaq to continue experimental extraction work.[22]

Denmark's first reactor, a zero-energy reactor for atomic research, arrived from the United States. A heavy water-moderated Pluto-type research reactor, similar to the Pluto-type reactors being built at the British Atomic Energy centers at Harwell and Dounreay, was ordered by Denmark. It was to be erected at the Rico Atomic Research Center in Denmark.

Finland.—An Atomic Energy law for Finland passed its second reading in the Diet in October. The bill provided for regulation by the Ministry of Trade and Industry of production, sale, possession, and use and for the import or export of materials suitable for generating atomic energy. The law was not concerned with prospecting for and exploitation of deposits of uranium and thorium ores, inasmuch as such materials are covered under existing mining laws. The atomic-energy law also included establishing a commission to follow developments in atomic energy, to plan training, and to maintain relations with corresponding agencies abroad.[23]

The building of a graphite reactor for experimental purposes was being considered by a Finnish association, Voimayhoistys Ydin. The organization, formed by industry to study nuclear-energy problems, was negotiating with several countries about the purchase of about 3,300 pounds of uranium.[24]

France.—Estimated uranium production in France in 1957 was about 300 tons of metal. Production capacity between 1959 and 1961 was expected to reach 1,000 tons a year. With a uranium reserve of 100,000 tons at 0.2 percent U_3O_8, France continued its exploration for nuclear raw materials. The French Atomic Energy Authority was methodically prospecting all potential uranium-bearing Hercyian granitic terrains that cover half of France's total area. Major uranium-bearing districts in France were (1) the Puy-de-Dôme district, in Lachaux Province, (2) the Upper Vienne district, in La Crouzelle Province, (3) the Saône-et-Loire district in Grury Province, and (4) in Vendée Province. Promising uranium areas also included

[20] U. S. Embassy, Brussels, Belgium, State Department Dispatch 514: Nov. 8, 1957.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 3, September 1957, p. 19.
[22] U. S. Embassy, Copenhagen, Denmark, State Department Dispatch 449: Dec. 30, 1957, 2 pp.
[23] U. S. Embassy, Helsinki, Finland, State Department Dispatch 193: Oct. 10, 1957, p. 3.
[24] Chemical Age (London), vol. 78, No. 2005, Dec. 14, 1957, p. 980.

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the Morbihan district in Brittany, the Beaujolais, Aller, Creuse, and Lozère districts. Discovery of three new uranium deposits were reported in Trou-au-Diable, Schaentzed, and Tannenkirch in the Saint Hippolyte region, Alsace.

Intensive exploration for uranium continued in French territories overseas.

Plants for concentrating uranium ore at Gueugnon in Grury Province and at Lachaux were shipping concentrates to the Bouchet plant in the Greater Paris area. Plants for processing uranium were under construction at L'Escarpeire, at Malvezy, and at Bessines. Methods of recovery at uranium-processing plants were described.[25]

France planned to expand its electric-power industries by establishing plants using atomic energy through a 5-year program at an estimated cost of $1.1 billion.

A ceremony at Saclay on July 4 marked the starting up of pile EL_3, the fourth pile to come into operation. The moderator employed is heavy water, but the fuel is uranium slightly enriched with uranium–235. The reactor was designed to produce a high neutron flux of about 10^{14}n/cm.^{2}/sec., which is 10 times greater than that of the previous pile EL_2. Pile EL_3 was to be used for investigating the resistance to radiation of materials intended for constructing industrial reactors, for producing radioisotopes, such as ^{60}Co and ^{14}C, and for extending research on neutron irradiation.

At Marcoule, in the Gard, between Pont-Saint-Esprit and Avignon, a representative of the press was invited to inspect reactors, G_2 and G_3, and the factory for extracting plutonium, which were under construction.

Reactor G_1 has been in operation since January 1956. Reactors G_2 and G_3 will be similar to G_1 in using natural uranium as fuel and graphite as moderator. The heat produced by G_1 is removed by means of air at a pressure not much greater than atmospheric; G_2 and G_3 will be cooled by means of carbon dioxide at a pressure of 15 kg. By 1958 the entire installation should be completed, including the plutonium-producing factory, which was mainly designed by the Compagnie de Saint-Gobain. The power output of the electrical-generating stations that operated in connection with reactors G_1, G_2, and G_3 was about 50,000 kw.

The Second French Atomic Plan also provides for constructing a factory to separate isotopes. The factory may be built in the Lacq district; or, if it is constructed under the Euratom plan, in the Rhine Valley or northern Italy.[26]

Construction of a prototype atomic-powered tanker of about 40,000 dead weight tons was being planned by the French AEC. Reactor types under study for the project included pressurized water, boiling water, and gas; all would use enriched uranium fuel.

France was reported beginning to manufacture atomic weapons from plutonium produced from French reactors.[27]

Germany, East.—East Germany claimed to be the leading uranium producer in Europe. The most important deposits were in the Ore Mountains (Ave), Thüringian Forest, and Harz Mountains. Uranium

[25] Moyal, Maurice, The Uranium Industry in France: Canadian Min. Jour., vol. 3, No. 78, March 1957, pp. 76–79.
[26] Prax, Yvonne, Atomic Energy: French Newsletter, Chem. and Ind., No. 35, Aug. 31, 1957, p. 1176.
[27] Northern Miner (Toronto), vol. 43, No. 38, Dec. 12, 1957, p. 23.

deposits were exploited by the Wismut Company, jointly owned by East Germany and U. S. S. R.; the output was exported to the U. S. S. R. Two reactors were under construction during the year. A 2-megawatt pool-type research reactor, built by the U. S. S. R. at the Central Institute for Nuclear Physics in Rossendorf near Dresden, was scheduled to begin operating late in 1957. The second reactor, a 70-megawatt (electrical) power reactor believed to be near the Stechlinsee in the Neubrandenburg district about 45 miles north of Berlin was to be in operation in 1961; the slightly enriched, heavy-water power reactor would receive its fuel from U. S. S. R. The Warnow shipyard (at Warnemünde on the Baltic) was preparing to construct a nuclear-powered vessel.[28]

Germany, West.—The Federal Republic of Germany purchased four United States research reactors. The pool reactor at Technische Hochschule München, Munich, went critical in October. By early 1958 a homogeneous reactor built for Farbwerke Höchst, A. G., Frankfurt, and a pool reactor for the Society for the Utilization of Nuclear Energy in Shipbuilding and Navigation, Inc., Hamburg, were scheduled to be in operation. A homogeneous reactor was under construction at the Institute for Nuclear Research in West Berlin. Several German companies had designs for projected large-scale, nuclear-power projects under active study. West Germany's most important uranium mine, operating since 1950 in Weissenstadt, shut down because of high production costs.

Exploration for uranium in Bavaria continued. A German firm in Schwandorf was given a second Government license for prospecting in the area of Schwandorf. Uranium deposits in Bavaria included deposits (1) between the cities of Regensburg and Hof along the Czechoslovak border, (2) in Weissenstadt and Leupoldsdorf, (3) in Flossenburg, and (4) in the Wackersdorf coalfields. The West German Atomics Ministry set aside almost $1 million for prospecting and processing uranium deposits.

Greece.—Greece and Yugoslavia laid the groundwork for future cooperation in the peaceful uses of atomic energy. A three-man delegation from the Yugoslav Atomic Energy Commission visited Greece in November to discuss mutual assistance, especially in education and technology.

The Minister of Commerce and Industry in Greece was drafting a bill providing for uranium prospecting and for remunerating persons discovering uranium deposits.

A nuclear research center was being established near Athens, and the Greek AEC had ordered a United States-built, pool-type reactor that was scheduled for completion in 1958.

Hungary.—Uranium mines near Pécs were under study by more than 100 U. S. S. R. experts. Samples of the ore averaged 0.7 percent U_3O_8; the richest averaged about 3.0 percent U_3O_8. Some 25 tons of ore was estimated as being mined daily. Prerevolt agreements provided for a joint Hungarian-Soviet Union company; the U. S. S. R. was to pay Hungary the operational costs, plus 10 percent.[29]

Italy.—Italy had no uranium-production facilities during 1957 but ore reserves in the Alps were estimated at 3 million tons at 0.2 percent

[28] U. S. Mission, Berlin, Germany, State Department Dispatch 283: Oct. 28, 1957, 3 pp.
[29] Mining World, vol. 19, No. 3, March 1957, p. 107.

U_3O_8. Italy's most promising uranium discovery was being developed in the Preit district of Cuneo Province, Northern Italy, by SOMIREN, subsidiary of the Italian State Oil Agency, ENI. Results from exploration at Trentino (Val Daone and Val Redina) and Calabria were encouraging.

Edisonvolta Co. of Milan planned to build a 134,000-electric-kilowatt, pressurized-water reactor and Societa Italiana Meridionale Energia Atomica was considering a pressurized-water reactor of 125,000- to 150,000-electric-kilowatt capacity near Rome. In southern Italy the Societa Electro-nucleare Nazionale (SENN), subsidiary of Finnelettrica, was planning to construct a large-scale nuclear-power plant. In northern Italy, at Ispra, the National Committee for Nuclear Research was expected to have a heavy-water-moderated research reactor in operation in 1958. The Societa Ricerche Impeanti Nucleari and the Enrico Fermi Nuclear Study Center of Politechnico, both in Milan, had contracted for research reactors. The Italian and British Governments were negotiating for uranium to supply a natural-uranium, graphite-moderated, gas-cooled reactor that the Italian Government had ordered from Great Britain. The 200-megawatt plant will cost about $75 million.

Operation of one of Italy's proposed powerplants will require more than 2 tons of uranium, which would be supplied by the United States at a cost of about $80 million.

In Rome on December 28 the Italian Government and Great Britain signed an agreement that provides for extensive cooperation between the two countries in the field of nuclear research; under the agreement the United Kingdom would furnish enough fuel to keep British-supplied reactors in operation.

Luxembourg.—A study of the possibility of uranium deposits in Luxembourg revealed that the substratum of that country does not comprise rocks containing radioactive elements of practical significance.[30]

Netherlands.—A pool reactor went into operation in June at the Amsterdam International Atomic Exhibition, where it operated at a power level of 10 kilowatts. Upon permanent relocation at the University of Delft it will operate at 100 kilowatts. The Netherlands Government ordered a 20-megawatt, high-flux pool research reactor to be built at Petten near The Hague. The United States approved a $350,000 grant toward the cost of the project.

Norway.—Norway and the United States signed an agreement on February 25 for cooperation in the peaceful uses of atomic energy. The agreement provided for an exchange of unclassified information on research and power reactors and authorized the sale by the United States to Norway of uranium for reactor fuel. The terms permit the sale to Norway of up to 500 kilograms of contained uranium–235 in uranium enriched up to a maximum of 20 percent of uranium–235. The uranium was expected to be used as fuel for a 20-megawatt-power demonstration reactor under construction at Halden, where nuclear steam production and nuclear ship propulsion are to be studied, and for two prototype power reactors. Also, under the agreement the United States AEC could sell up to 6 kilograms of uranium–235 enriched up to 90 percent for use in a material-testing reactor.

[30] U. S. Embassy, Luxembourg, Luxembourg, State Department Dispatch 206: Mar. 1, 1957, 1 p.

The United Kingdom AEA and the Norwegian Institute for Atomic Energy completed an agreement for cooperation in establishing the Norwegian Halden Reactor project. The United Kingdom would supply the initial fuel charge and cooperate in research to develop suitable fuel elements for later charges for the reactor.[31]

The Norwegian Atom Insurance Pool was formed in October for protection against damage or loss occurring in or caused by atomic-energy plants.

Poland.—Construction continued on Poland's first atomic reactor at the nuclear-research center at Swierk near Warsaw. The 2-megawatt reactor is scheduled for operation in 1958.

As Poland lacked processing facilities for uranium, all ore mineral was sold to the U. S. S. R.; however, plans were made for developing uranium-treatment plants.

Portugal.—Uranium ore mined at the Urgeicera mine was shipped to the United States and Great Britain through the Combined Development Agency. Many thousand square miles of dry, rocky hills in southeast Portugal were being explored by more than 300 prospectors to determine the extent of what is believed to be one of the largest uranium deposits in Western Europe.

The Junta da Energia Nuclear was negotiating with AMF Atomics, New York, N. Y., for the purchase of a swimming-pool-type reactor for research and instruction purposes. The United States would contribute $350,000 toward the cost of the project, which was due to be completed near Lisbon in 1959.

Rumania.—U. S. S. R. sold its half ownership of Rumania's extensive uranium mines back to Rumania. The deposits are in the Baita district, Transylvania, and in the Derna-Tatros district. Ore was first shipped to the Soviet Union and later processed in Rumania. Apparently the processed uranium will continue to be exported to Russia.

Spain.—A 3-megawatt pool-type research reactor, under construction for the Spanish AEC near Madrid, was Spain's first nuclear project. The United States was to contribute $350,000 toward the reactor project.

TECNATOM, a newly formed company engaged in the study, development, and application of nuclear energy in Spain, was created by seven prominent Spanish companies. The company was interested in exploring power-reactor potentialities, radioisotope applications, and nuclear raw-material processing.

Sweden.—The nuclear plant under construction in Farsta, suburb of Stockholm, and a similar plant in Vasteras about 60 miles northwest of Stockholm were expected to begin operating in 1960.

The Aktiebolaget Atomenergi planned to install a United States tank-type reactor at Studsvik.

Uranium was extracted from the shale deposits of central Sweden. Two plants were built to handle uranium ores. The first plant, in central Sweden, produced a concentrate with a uranium content of 10 percent; the second, in Stockholm, reprocessed the concentrate and recovered pure uranium. Sweden's uranium requirements were

31 Chemical Trade Journal and Chemical Engineer (London), vol. 141, No. 3664, Aug. 23, 1957, p. 436.

estimated at 20 tons a year by 1960, rising to more than 200 tons by 1970.[32]

Atomic experts in Sweden were studying the technical aspects of plutonium production for use in nuclear weapons.[33]

Switzerland.—The Swiss Government was negotiating a contract to purchase about 5 tons of uranium from the Canadian Government.

Nine tons of heavy water, shipped from the United States, arrived at the Reaktor A. G. plant at Würenlingen in November. Construction of a second nuclear-research installation at Würenlingen was expected to begin in 1958.

A Swiss firm was formed to erect an atomic-power reactor having an electric-power capacity of 5,000 kw.

U. S. S. R.—Soviet Russia's major sources of uranium were (1) the Satellite countries, (2) the Ferghana region of the Central Asian Republics, (3) Northern Siberia, (4) Southern Siberia, and (5) Central Kamchatka. The most important source during the year was the Ferghana field, where the carnotite deposits closely resemble those of the Colorado Plateau in the United States. At least half of the current Soviet production is believed to be from Ferghana.

The fields in Northern and Southern Siberia and Central Kamchatka are less known to the western world, although much can be inferred from the geology. Main occurrences of uranium are in two geological regions in belts of ancient Precambrian rocks and in widespread areas of permeable sediments (such as the Ferghana field). Such rocks indicate either the existence or potential source of uranium. Two vast areas of Precambrian rocks exist in the U. S. S. R.—the Angara shield of Northern Siberia, and the whole of Southern Siberia and the Mongolian Peoples' Republic. Scientists of the Free World are convinced that considerable mining is being done in these areas and consider that by 1960 the Angara shield deposits and the Ukhta reserves of North Russian might well be producing 2,000 tons of metal a year.

Another 2,000 tons of metal a year may be mined in Southern Siberia by 1960; in addition to 1,000 tons from the Mongolian-North China field. Mining was most intensive in the Lake Baikal area of Southern Siberia. At Slyudyanka, at the southern end of the lake, betafite deposits, containing uranium, calcium, columbium, and tantalum were mined. East of the lake uranium deposits were worked at Ulan Ude and at Vitim, 300 miles farther northeast on the Lena river. On the Yenisei River and about 1,000 miles west of Lake Baikal, 2 other fields are known—Yeniseisk and Minusinsk.

Within the next 2 years possibly, the extensive Kamchatka area, northeast Soviet Russian, may be yielding some 1,000 tons annually. Another 800 tons may come from the Satellite countries—half from East Germany and Czechoslovakia and the remainder from Rumania, Bulgaria, and Hungary.

East Germany was the principal producer among the Satellite countries.

Increased interest in atomic energy brought about appeals from the Soviet Government for amateur prospectors to boost the Soviet output of atomic fuel.

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[32] Mining Journal (London), vol. 249, No. 6373, Oct. 11, 1957, p. 423.
[33] Washington Post and Times Herald, Dec. 29, 1957, p. A5.

The U. S. S. R. planned to build six nuclear plants, having a total capacity of 995,000 kilowatts. One experimental atomic 5,000-kilowatt powerplant was operating near Moscow.

The Soviet Union offered to give 50 kilograms of uranium–235 to the Atoms-for-Peace pool of the new International Atomic Energy Agency.

The first USAEC-approved shipment of radioisotopes to the Soviet Union for use in cancer research was made in March.

Atomic weapons continued during the year to be produced and developed.

United Kingdom.—Uranium was imported from South Africa, Australia, and Belgian Congo. An order was placed by the United Kingdom for $115 million of uranium from Canada to be delivered before 1962. The United Kingdom Atomic Energy Authority also planned to buy 500 short tons of uranium oxide annually from existing or future mines in Kenya, Uganda, Tanganyika, Swaziland, and British Guiana.[34]

The uranium refinery at Springfields continued to make nuclear fuel for the atomic reactors at Calder Hall, Chapel Cross, Windscale, and other places. The plant also recovered plutonium and other byproducts of irradiated fuel. A new and larger plant at Springfields was being built adjoining the existing one. The new plant would use more continuous unit operations to cope with the increasing nuclear-power program, and magnesium instead of calcium reduction would be employed.[35]

Atomic power being fed into the national grid by October was about 70,000 kilowatts. In addition to the British reactors listed in the Uranium chapter, Minerals Yearbook 1956, a 500-megawatt electrical-output nuclear-power station was announced. The plant, at Hinkley Point, Somerset, will have two reactors of the gas-cooled, graphite-moderated type, and its cost is estimated at between $168 and $196 million. Operation was scheduled for late 1959 or early 1960.

In October the Windscale plutonium plant had the world's worst nuclear reactor accident to date. An overheated fuel element permitted the escape of volatile fission products, mainly radioiodine, through the plant's chimney filters, contaminating large areas of the surrounding countryside.[36]

The chemistry of the Dounreay experimental fast breeder reactor was described.[37] Two plants process irradiated fuel elements from the fast reactor and the materials-testing reactor, separating uranium and plutonium from waste fission products; a third plant prepares uranium metal from the nitrate. In addition, an evaporation plant concentrates highly radioactive wastes from the separation plants.

At Harwell research was continuing on methods of obtaining power from controlled thermonuclear or fusion reactions. The object was to heat isotopes of hydrogen to temperatures of about 100 million° C., at which the nuclei fuse to form heavier nuclei, releasing energy in the process. Many problems remained to be solved, including heating

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[34] Chemical Age, vol. 78, No. 1992, Sept. 14, 1957, p. 402.
[35] Chemical Age, vol. 78, No. 1987, Aug. 10, 1957, p. 221.
[36] Chemical Age (London), Windscale Post-Mortem: Vol. 78, No. 2001, Nov. 16, 1957, pp. 799–800.
[37] Chemical Age (London), Chemical Operations at Dounreay: Vol. 77, No. 1975, May 18, 1957, pp. 831–833.

the hydrogen to the required temperature, isolating the hot gas from the walls of its container, and maintaining it at a temperature long enough for the heat energy released in fusion to exceed that needed to heat the fuel.

An atomic power station in Northern Ireland, probably in the Lough Neagh vicinity of Ulster, was being planned. The plant, estimated to cost $70 million, would be established and operated by the Northern Ireland Electricity Boar, and was expected to have a generating capacity of 150,000 kilowatts; operation was expected by 1963–64.[38]

Construction of a 320-megawatt nuclear-power station at Hunterston, Ayrshire, Scotland, was announced by the Secretary of State for Scotland.

ASIA

Burma.—Plans were underway for developing a nuclear-energy program, including a research reactor at an early date and a power reactor by 1965.[39]

China.—Reports indicated that uranium was being mined in an unspecified region in China and that the Chinese Academy of Science had obtained satisfactory results on extracting uranium from domestic ore.[40]

India.—Deposits of radioactive minerals, claimed to be the world's largest, were found in northeast India near Ranchi, Bihar. Reports said that the deposits contained over 3.3 million tons of ore; comprising 300,000 tons of thorium concentrate (10 percent thoria) and 10,000 tons of uranium at a concentration of 0.13 to 0.4 percent U_3O_8. Further exploration was expected to lead to doubling present estimates.[41]

The plant at Alwaye continued to refine thorium- and uranium-containing monazite sands of the Kerala coast. A new uranium-processing plant was to be built at Trombay, suburb of Bombay. A plant to produce uranium metal, under construction near Bombay, was scheduled to be completed by mid-1958.

The Indian Atomic Energy Commission indicated that plans for a power-generating atomic reactor would be ready by the end of 1958; and, if finances permitted and the plan was approved, the reactor could be ready by 1962. By the end of 1958 India expected to have two additional swimming-pool-type reactors. During the year India's atomic reactor had been used for research in neutron physics, irradiating biological and agricultural materials, and producing isotopes.

Iraq.—Iraq was scheduled to get up to 13.2 pounds of U–235 for reactor fuel from the United States Atomic Energy Commission. Under a cooperative agreement between the two countries Iraq could also receive limited quantities of highly enriched U–235, plutonium, and U–233 for research.

Israel.—Production of uranium from the phosphate rocks of the Negev was reported to be starting. Equipment was assembled, and technologists reported a feasible extraction method; the uranium

[38] Foreign Commerce Weekly, vol. 57, No. 14, Apr. 8, 1957, p. 34.
[39] U. S. Embassy, Rangoon, Burma, State Department Dispatch 151: Aug. 22, 1957, 14 pp.
[40] Metal Bulletin (London), No. 4206, June 28, 1957, p. 23.
[41] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, p. 18.

would be recovered as a byproduct in manufacturing superphosphates and phosphoric acids in the Haifa plant of Fertilisers & Chemicals, Ltd.[42]

Japan.—Several new uranium discoveries were reported in Tottori, Okayama, and Fukuoka Prefectures. The Tottori find joins the known uranium deposits of the Kurayoshi mine. The Fukuoka discoveries in the Shimomazaki area in Kawasaki were reported to contain deposits estimated at 117,000 tons at a maximum grade of 0.8 percent U_3O_8. A high-grade deposit was reported in the southeastern part of Iwate Prefecture.

Japan's first nuclear reactor was started during the year. Situated at Japan's new nuclear research center, some 70 miles from Tokyo, the 50-kilowatt, solution-type reactor would be used in nuclear engineering and physics studies, to make radioisotopes, and for varied research. Fuel for the reactor was supplied by Mallinckrodt Chemical Works. The AEC announced plans to issue a license for the export of a 10,000-thermal-kilowatt research reactor to Japan.

The Atomic Fuel Public Corp. was expected to begin experimental production of uranium metal.

Jordan.—First concessions for uranium mining were reported to be granted by the Jordan Government. The concession was said to cover a 300-square-mile area in the Araba region in the southern part of the country.

Korea.—Assistance from the United States in building an atomic powerplant was requested by the South Korean Government.

Pakistan.—An extensive exploration for radioactive minerals was planned. A research reactor was planned for fundamental research education and production of radioisotopes for West Pakistan; a power reactor was to be installed in East Pakistan.

Thailand.—The ban on exporting radioactive ores continued, but indications were that Japan would be permitted to mine uranium for the Thai Government.

AFRICA

Belgian Congo.—Union Minière du Haut-Katanga continued to mine and to concentrate rich uranium ores for shipment to the United States and Great Britain. Belgian Congo production figures were not available, but it was known that Congo milling facilities had a capacity of 25,000 tons of ore a month and could produce 1,000 to 3,000 tons of concentrate a year.

Mozambique.—A plan of the Portuguese Government to encourage prospecting for radioactive minerals in Mozambique was announced.[43] Uranium production in 1956 was about 42 tons of davidite, which was probably shipped to France.

Rhodesia and Nyasaland, Federation of.—A 5-year plan to boost the mining of uranium in the Federation was announced by the United Kingdom Atomic Energy Authority. A special "Bonsella" price of 55s. per pound of uranium oxide will be paid by the Authority until March 31, 1962, for the first 5 tons of uranium oxide contained in acceptable ore delivered from each new mine. A substantial refund of rail charges also will be made.

[42] Metal Bulletin (London), No. 4181, Mar. 26, 1957, p. 26.
[43] U. S. Embassy, Lourenco Marques, Mozambique, State Department Dispatch 242; May 31, 1957, 1 p.

Apart from the special offer the Authority will be prepared to purchase until March 31, 1964, in any 1 year, suitable ores containing up to 100 tons of uranium oxide and will accept small consignments not less than a quarter of a ton of oxide. The offer is primarily directed to stimulate the small miner and prospector. The Authority offered to set up a uranium-processing plant if large deposits are found.

Survey maps of parts of Southern Rhodesia indicating areas of radioactivity were published.[44]

Federation of Rhodesia and Nyasaland exported uranium oxide for the first time. Production of calcined uranium oxide began in May 1957, when a recovery plant for treating uranium-bearing ore from Northern Rhodesia's Nkana mine came into operation. For the period ended June 30, 1957, Nkana produced 9,703 pounds of uranium oxide containing 7,257 pounds of U_3O_8.

South-West Africa.—Anglo American Corp. of South Africa, Ltd., was reported to have discovered uranium in the Namib Desert.[45]

Tanganyika.—The United Kingdom Atomic Energy Authority established an office in Dodoma, Tanganyika, to encourage exploration for radioactive minerals. Apparently radioactive minerals could be licensed for export from Tanganyika to the United States under certain conditions.

Anglo American Corp. of South Africa and Newmont Mining Corp. were cooperatively exploring for uranium in Tanganyika.

Union of South Africa.—Uranium was being produced from 29 gold-uranium mines with 17 mills at a rate of about 20 million tons of ore per year. Concentrate production in 1957 was estimated at 5,500 tons and was sold to the United States and Great Britain through the Combined Development Agency. Ore reserves remained at 1.1 million tons, with a content of 0.03 percent U_3O_8.[46]

Chemical concentration methods and techniques were published during the year.[47]

OCEANIA

Australia.—Uranium was produced by the Government-owned mill at Rum Jungle and the South Australia State mill at Radium Hill. The Rio Tinto mill at Mary Kathleen was scheduled for operation in 1958.

The Rum Jungle mill capacity was 10,000 tons per month; it produced an estimated 595,000 pounds of concentrate. The Radium Hill mill, with a capacity of 37,500 tons of ore per month, produced about 450,000 pounds of concentrate. Total production from Australia was about 522 tons of uranium concentrate. Annual production was expected to increase to 1,000 tons when the Mary Kathleen mill begins.

The reserve of the Rum Jungle area was 335,000 tons at 0.3 percent U_3O_8.

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[44] U. S. Embassy, Salisbury, Southern Rhodesia, State Department Dispatch 91: Sept. 6, 1957, 3 pp.
[45] Mining World, vol. 20, No. 1, Jan. 1958, p. 93.
[46] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 1, January 1957, p. 15.
[47] Mining Engineering, South Africa as a Leading Uranium Producer: Vol. 9, No. 11, November 1957, pp. 1211, 1213.
Waspe, L. A., South African Uranium Leach Plants: Min. Mag. (London), vol. 95, No. 6, December 1956, pp. 332–341.
Mining Magazine (London), Uranium Precipitation at Randfontein: Vol. 96, No. 6, June 1957, pp. 373–374.
Holz, Peter, South Africa in the Nuclear Age: Canadian Min. Jour., vol. 78, No. 8, August 1957, pp 87–92.

Geologists of Mount Isa Mines investigated what appeared to be an important new uranium field, 200 miles northeast of Mount Isa, Queensland. Economic aspects of the Mount Isa Mines proposal for an atomic-power reactor to supply power and light for the company mining and processing activities were being studied by the Commonwealth Atomic Energy Commission. The South Australian Government was considering installing an atomic powerplant at Mount Gambier in southeast South Australia near the border of Victoria.[48]

A major symposium on the Peaceful Uses of Atomic Energy, with specific reference to research and applications in Australia, was scheduled to be held in Sydney on June 2–6, 1958.[49]

New Zealand.—Exploration for radioactive minerals continued in New Zealand, particularly in Buller Gorge area. The Geological Survey Branch of the Department of Scientific and Industrial Research carried out mineralogical studies of the area.

A bill to encourage exploration for uranium was introduced in the House of Representatives of New Zealand. It provided for grants to persons discovering materials related to atomic-energy production.[50]

WORLD RESERVES

Free World reserves of developed or partly developed commercial uranium ore contain over 1 million tons of uranium. Further development of known occurrences and adjacent areas was expected to result in a Free World reserve of 2 million tons of uranium. The domestic known and inferred reserve at the end of 1957 was estimated at nearly 76 million tons, averaging about 5 pounds of uranium oxide per ton. In 1956 the reserve had been about 60 million tons; in 1955, 25 million; in 1954, 10 million; and in 1953, 5 million. Most of the domestic reserve was in deposits ranging from several hundred thousand to several million tons.

Ore reserves by countries of the Free World at the end of 1957 were as follows:

Country	Thousand tons (ore)	Grade (percent U_3O_8)	Tons U_3O_8
United States	75, 800	0. 27	205, 500
Canada	320, 000	. 12	380, 000
South Africa	1, 100, 000	. 034	370, 000
Australia (Rum Jungle area only)	335	. 30	1, 000
France			500, 000–100, 000
Total Free World, estimated			1, 000, 000

Data on reserves from Portugal, other areas in Australia, the Soviet Bloc, and other countries were not available.

The basis for estimating reserves in foreign countries was not defined; the domestic reserves were calculated from engineering and geologic data in compliance with definitions for measured, indicated, and inferred ore used by the Bureau of Mines and the Geological Survey.

[48] Foreign Commerce Weekly, vol. 57, No. 14, Apr. 8, 1957, p. 35.
[49] Chemistry and Industry, No. 52, Dec. 28, 1957, p. 1675.
[50] U. S. Embassy, Wellington, New Zealand, State Department Dispatch 23: July 12, 1957, 2 pp.

TECHNOLOGY

Exploration.—In the United States, small contractors used from 1 to 3 combination rigs for exploration drilling of uranium; they supplemented the large, heavy drills with smaller rigs for core-drilling and for hole maintenance. Drillers usually specialized in one type of drilling and subcontracted for other types of drilling when necessary.

The major types of drills used were the rotary rock, wagon, and churn drill. Truck-mounted rotary drills equipped with mud pumps and air compressors probably supplied over 75 percent of the drilling for uranium on the Colorado Plateau. The mud supported the walls of the hole, removed the cuttings as they were made, and cooled the cutting edges of the drill bit. Compressed air was the simplest method of cleaning the hole and was generally used until such depths were reached as to require use of drilling mud to remove the restrictions in the hole that could not be removed with air. Wagon drills usually consisted of a multiple-axle-drive army-surplus truck, upon which were mounted both a compressor and a mast to support a long-change feed pneumatic drifter machine, a heavy-duty hoist, and a dust sampler. Generally the wagon drill was limited to areas in which the drilling depth was less than 200 feet and the ground fairly stable and relatively dry. The churn drill commonly used to drill water wells was used in plug drilling when the ground was loose, caving, or too hard for rotary or core drills to function economically. Churn drills were used principally to drill ventilation holes.

Mining.—Mining costs from five of the largest uranium-mining districts prepared by the AEC are shown in table 11. The Uravan Mineral Belt, with reserves estimated at 3.5 million tons at an average grade of mined ore of 0.28 percent U_3O_8 and 1.00 to 1.25 percent V_2O_5, contains thin, discontinuous deposits averaging about 3 feet thick. Mining was done at depths ranging from a few feet to as much as 600.

The White Canyon Monument Valley deposits, containing 1.9 million tons of ore at 0.32 percent U_3O_8 content, average 4 feet in thickness, are more continuous than the Uravan deposits, and require only occasional ground support. Mining depth varied from a few feet to 200. Estimated grade of ore mined was 0.25 percent U_3O_8. The Big Indian Wash, with reserves estimated at 3.8 million tons of 0.43 percent uranium, has deposits ranging from 4 to 20 feet in thickness and averaging 6 feet. The depth of mining averaged 550 feet. The estimated average grade of mined ore was 0.35 percent U_3O_8. The

TABLE 11.—Uranium mining costs in 1957

	Uravan Mineral Belt, Utah-Colorado	White Canyon Monument Valley, Utah-Colorado	Big Indian Wash, Utah	Greater Grants area, New Mexico	Gas Hills, Wyo.—Open-pit-stripping ratios		
					5-1	8-1	12-1
Exploration	$2.00	$2.00	$1.00	$0.50	$0.30	$0.50	$0.70
Development	3.00	1.50	1.00	1.50	2.00	3.20	4.80
Depreciation (plant and equipment)	2.00	2.00	1.00	1.00	.50	.50	.50
Direct mining	11.00	8.50	6.00	7.50	1.25	1.25	1.25
Indirect mining	2.00	2.00	2.00	1.50	.75	.75	.75
Total	20.00	16.00	11.00	12.00	4.80	6.20	8.00

Ambrosia Lake area in the Greater Grants district in northwest New Mexico was the most important uranium area developed.

Reserves in the Greater Grants area were estimated to total 51.4 million tons, with an average grade of 0.26 percent U_3O_8. Ambrosia Lake deposits average about 8 feet in thickness, varying locally up to 100 feet. Mining depths varied from 350 to 800 feet. Workings above the water table required only occasional supports, but those below the water table presented problems of rock stability and required considerable ground support. The average grade of mined ore was estimated at 0.25 percent U_3O_8. The Gas Hills area contains some 7.2 million tons of ore averaging 0.26 percent U_3O_8. Ore was mined principally from open pits; it ranged from surface outcrops to 300 feet in depth. The thickness of deposits averages 6 feet. Unconsolidated ground can be broken by rippers, keeping blasting operations at a minimum. The estimated average grade of ore mined was 0.225 percent U_3O_8.

Mining expenses, presented in table 11, include exploration and development costs, direct and indirect operating costs, and depreciation.[51]

Basic systems used in mining uranium included (1) open stoping, (2) room-and-pillar, and (3) retreat mining with induced caving. Open stoping was used where the individual ore pods and lenses were small and back conditions were good. Room-and-pillar methods were employed in the larger, continuous ore bodies. Production per man-shift increased when large trackless equipment was used in room-and-pillar systems. Some miners found that retreat mining systems were successful where back conditions were poor. The trend toward better understanding and study of mining methods was apparent.[52]

Ventilation in underground workings received increased attention over previous years as uranium miners learned more about the radiation hazard in uranium mines.

The Ambrosia Lake district of New Mexico probably will have the largest domestic underground mines. The ore will be mined from shafts ranging from 350 to 1,000 feet or more in depth. Plans indicate a daily mine-production rate of about 8,000 tons, and individual units will produce about 500 to 1,000 tons daily. The Ambrosia Lake mines were in the development stage, and certain mining problems had not been fully evaluated.

Three Bureau of Mines reports on uranium mining methods and costs were published.[53]

Milling.—All domestic uranium mills operating in 1957 had sulfuric-acid leaching facilities for uranium recovery. Two mills used sodium carbonate as the principal leaching medium and the acid leach as a scavenger operation. Two mills had both acid and carbonate as separate operations to process a variety of ores, especially the high-lime-content ore. Two mills used a fusion step for purification;

[51] Youngbery, Elton A., Uranium-Ore Reserves and Ore Production: Address at the Future Markets for Uranium Symposium, Denver, Colo., Dec. 16–17, 1957.
[52] Delicate, Donald T., Underground Uranium-Mining Methods: Min. Cong. Jour., vol. 43, No. 5, May 1957, pp. 36–40.
[53] Dare, W. L., Mining Methods and Costs, Continental Uranium, Inc., Continental No. 1 Mine, San Juan County, Utah: Bureau of Mines Inf. Circ. 7801, 1957, 20 pp.
Dare, W. L., and Delicate, D. T., Mining Methods and Costs—La Sal Mining & Development Co., La Sal Uranium Mine, San Juan County, Utah: Bureau of Mines Inf. Circ. 7803, 1957, 48 pp.
Dare, W. L., Mining Methods and Costs, Calyx Nos. 3 and 8 Uranium Mines, Temple Mountain District, Emery County, Utah: Bureau of Mines Inf. Circ. 7811, 1957, 36 pp.

3 mills used column ion exchange; 6 had basket-type resin-in-pulp ion-exchange circuits, and 3 employed liquid-liquid solvent extraction.

Milling costs, based on current direct and indirect milling costs, exclusive of major replacements and amortization, ranged from $8.00 to $15.00 per ton for the smaller mills and $7.00 to $10.00 for the larger. Overall processing costs per ton were increased an additional $5.00 to $8.00 if vanadium was recovered.

Uranium recovery by ion exchange furnished 73 percent of the Free World production of uranium. In the United States production processes were primarily by ion exchange; 48 percent used the resin-in-pulp process and 13 percent, the column ion exchange. Twenty-one percent of the production was by acid-chemical precipitation, 10 percent by carbonate leach, and 8 percent by solvent extraction.[54] The solvent-extraction process for uranium recovery, developed principally by the Bureau of Mines at its Salt Lake City laboratories, will supply about 50 percent of domestic production when mills under construction begin operations in 1958.

Milling in the Ambrosia Lake area, New Mexico was described.[55] The paper detailed processing methods and presented flowsheets of Anaconda's Bluewater mill and of the mills being built by the Homestake New Mexico Partners, the Homestake-Sapin Partners, the Phillips Petroleum Co., and the Kermac Nuclear Fuels, Inc.

Solvent extraction as a unit operation in metallurgy was defined nd evaluated during the year.[56]

Uranium-concentrate specifications were reviewed by the AEC. Specifications depend upon: (1) Impurities that complex with the uranium and prevent it from being extracted by the solvent in the refining process, (2) impurities that carry through the solvent-extraction process and contaminate the final product, and (3) impurities that do not affect the chemistry of the process but do create other operating problems, such as foaming, corrosion, and scaling. These specifications were adopted for uranium concentrate: (1) A minimum U_3O_8 content of 75.0 percent; (2) a maximum V_2O_5 content of 2.0 percent of the U_3O_8 content; (3) a maximum phosphate (PO_4) content not to exceed the sum of 1.31 times the iron (Fe) content plus 2.0 percent of the U_3O_8 content, provided the total phosphate content shall not exceed 6.0 percent of the U_3O_8 content; (4) a maximum molybdenum content of 0.60 percent of the U_3O_8 content; (5) a maximum boron content of 0.030 percent of the U_3O_8 content, (6) a maximum halogen (Cl, Br, and I, expressed as Cl) content of 0.10 percent of the U_3O_8 content; (7) a maximum fluorine (F) content of 0.10 percent of the U_3O_8 content; (8) a maximum copper (Cu) content of 1.70 percent of the U_3O_8 content; (9) a maximum arsenic (As) content of 0.80 percent of the U_3O_8 content; (10) a maximum carbonate (CO_3) content of 1 percent of the U_3O_8 content; (11) a maximum sulfate (SO_4) content of 15 percent of the U_3O_8 content; (12) a maximum moisture content of 10 percent; (13) all uranium concentrates passing through a ¼-inch screen; (14) a maximum thorium content of 2.00 percent of the U_3O_8 content; (15) a maximum rare-earth content of

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54 Kennedy, R. H., Uranium Ore Processing: Mines Mag., vol. 47, No. 9, September 1957, pp. 22–25.
55 Osborn, C. E., Milling Uranium Ores of the Ambrosia Lake Area, New Mexico, Present and Future: Address at the annual meeting of the New Mexico Mining Association, El Paso, Tex., Nov. 8, 1957.
56 Rosenbaum, J. B., and Clemmer, J. B., Metallurgical Applications of Solvent Extraction: Paper presented at Sixtieth National Western Mining Conference, Denver, Colo., Feb. 7, 8, and 9, 1957.

0.2 percent of the U_3O_8 content; and (16) a maximum organic content of 0.10 percent of the U_3O_8 content.[57]

A new solvent-extraction process for making UF_6, announced at the American Mining Congress at Salt Lake City in September 1957 and developed by Dow Chemical Company, extracts uranium chloride anion complex from high-chloride liquors; hydrofluoric acid is added to the solvent phase to precipitate UF_4 or green salt.

A 5-day international symposium at Amsterdam was conducted in April 1957. The various methods of separating isotopes were debated, with Netherlands and German scientists favoring the ultracentrifuge over the diffusion process.

Research at the Reactor Centrum Nederland, the Netherlands Institute for the Development of Nuclear Science for Peaceful Purposes, indicated that an ultracentrifuge operating at very high speeds could be used to separate uranium–235 from natural uranium. Preliminary experiments suggested that this may be a considerably cheaper method of concentrating uranium–235, present in the proportion of 1 part in each 140 parts in natural uranium, than the gaseous diffusion process used in the United Kingdom and the United States. In the gaseous diffusion process considerable power is required in pumping uranium (as gaseous uranium hexafluoride) through a series of thousands of permeable plastic membranes through which the light uranium–235 atoms pass more easily than the heavier uranium–238 atoms, which are present in greater quantity. In the ultracentrifuge process the heavier uranium–238 atoms are stated to be thrown outward more readily than the lighter uranium–235 atoms. The latter can be collected as a residue after prolonged centrifuging. As relatively few centrifuge units are required, considerably less power is required.[58]

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[57] Lennemann W. L., Uranium Concentrate Specifications: Paper presented at the National Western Mining Conference of the Colorado Mining Association, Denver, Colo., Feb. 8, 1958.

[58] Chemical Age (London), vol. 78, No. 2005, pp. 979–980, Dec. 14, 1957.

Vanadium

By Phillip M. Busch[1] and Kathleen W. McNulty[2]

THE DOMESTIC vanadium industry in 1957 was characterized by an increase in the output of vanadium in ore and concentrate, decreases in the production of vanadium pentoxide and ferrovanadium, and reductions in consumption and exports. World production of vanadium in 1957 reached a new high, with increased production in Finland and Africa.

The Vanadium Corp. of America and the Electro Metallurgical Co., a division of Union Carbide & Carbon Corp., were acquitted by a United States District Court on a charge of conspiring to monopolize the vanadium industry and to fix prices between 1933 and 1946.[3]

TABLE 1.—Salient statistics of the vanadium industry in the United States, 1948–52 (average) and 1953–57, pounds of contained vanadium

	1948–52 (average)	1953	1954	1955	1956	1957
Production (domestic):						
Ore and concentrate processed	5,189,746	7,890,000	9,609,000	11,312,000	11,402,582	14,613,797
Recoverable vanadium in ore and concentrate [1]	3,261,536	6,114,851	6,051,784	6,571,655	7,735,088	7,382,638
Vanadium pentoxide	3,324,252	5,012,448	6,302,912	7,338,668	7,876,398	7,218,841
Imports:						
Ore and concentrate	1,017,339	716,977	395,287	184,737		
Vanadium-bearing flue dust	349	1,010				
Exports:						
Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium (gross weight)	[2] 186,287	156,952	140,510	439,457	[3] 278,674	267,988
Vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates [4]	30,091	12,319	42,935	1,729,103	[3] 1,856,594	1,000,340

[1] Measured by receipts at mills.
[2] Classified as ferrovanadium, 1948–52.
[3] Revised figure.
[4] Classified as "Ore and concentrate," 1948–52, but probably included vanadium pentoxide.

On June 5, 1957, the Atomic Energy Commission (AEC) invited bids on 4¼ million pounds of fused vanadium pentoxide (V_2O_5), which was determined to be surplus to the Government needs. As originally planned, the vanadium pentoxide was to be sold in 6 offerings. Bids on the first offerings were received at Grand Junction, Colo., July 5, 1957. The AEC, in cooperation with the Defense Services Administration and the United States Department of Commerce, determined the quantity of V_2O_5 to be sold periodically, making such adjustments in sales as might be in the best interest of the Government and create the minimum impact on industry.

[1] Commodity specialist.
[2] Statistical clerk.
[3] Metal Bulletin (London), Vanadium: No. 4207, July 2, 1957, p. 28.

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DOMESTIC PRODUCTION

ORE

Southwestern Colorado, northwestern New Mexico, northeastern Arizona, and southeastern Utah—the "Four Corners" area of the Colorado Plateau—continued to be the center of vanadium-ore mining in the United States; a small quantity of ore was also produced in Wyoming and Montana. Vanadium from these six States was a byproduct or coproduct of uranium production.

Production of vanadium in ore and concentrate increased about 29 percent over 1956.

TABLE 2.—Recoverable vanadium in ore and concentrate produced in the United States, 1948–52 (average) and 1953–57, by States, pounds of contained vanadium

State	1948–52 (average)	1953	1954	1955	1956	1957
Colorado	2,424,237	4,530,612	4,528,472	4,595,359	5,582,484	6,264,012
Utah	215,442	385,038	575,884	995,873	1,098,802	1,016,851
Arizona and other States [1]	621,856	1,199,201	947,428	980,423	1,053,802	101,775
Total	3,261,535	6,114,851	6,051,784	6,571,655	7,735,088	7,382,638

[1] Includes Idaho, 1948–54; Montana, 1957; New Mexico, 1948, 1950–54, 1956–57; South Dakota, 1954; and Wyoming, 1954, 1956–57.

TABLE 3.—Vanadium and recoverable vanadium in ore and concentrate produced in the United States, 1948–52 (average) and 1953–57, in pounds

Year	Mine production [1]	Recoverable vanadium	Year	Mine production [1]	Recoverable vanadium
1948–52 (average)	4,560,434	3,261,536	1955	9,965,205	6,571,655
1953	9,285,898	6,114,851	1956	11,270,919	7,735,088
1954	9,860,028	6,051,784	1957	14,588,088	7,382,638

[1] Measured by receipts at mills.

Colorado continued to be the leading vanadium-ore-producing State, and its output of recoverable vanadium was 12 percent larger than in 1956. In 1957 ore-processing mills were operated by Climax Uranium Corp. at Grand Junction, Union Carbide Nuclear Co. at Rifle and Uravan, and Vanadium Corp. of America at Durango and Naturita.

Production of recoverable vanadium in ore and concentrate in Utah decreased about 7 percent over 1956.

OXIDE

Vanadium pentoxide, containing 85 to 92 percent V_2O_5, is the first vanadium product from mills processing uranium-vanadium-bearing ore. The vanadium oxide output in 1957 was consumed largely in manufacturing ferrovanadium, which averages 53 to 55 percent vanadium. Production of vanadium pentoxide decreased about 8 percent in 1957 from the record high of 1956. Vanadium pentoxide from domestic ores was produced at 6 plants in 1957 and 5 plants in 1956. The figures in table 4 include the vanadium pentoxide produced as a byproduct of foreign chromite ores, 1948–57; vanadium pentoxide produced from Peruvian concentrate, 1948–55; and vanadium oxide recovered as a byproduct of domestic phosphate rock, 1948–54.

TABLE 4.—Production of vanadium pentoxide in the United States, 1948–52 (average) and 1953–57, in pounds [1]

Year	Gross weight	V_2O_5 content	Year	Gross weight	V_2O_5 content
1948–52 (average)	6,694,400	5,936,200	1955	14,851,000	13,104,800
1953	10,140,900	8,950,800	1956	15,925,900	14,060,000
1954	12,735,000	11,255,200	1957	14,431,800	12,886,200

[1] Includes a relatively small quantity recovered as a byproduct of Peruvian concentrate and foreign chrome ore.

FERROVANADIUM

Ferrovanadium was produced in the United States in 1957 by two companies—Vanadium Corp. of America and Electro Metallurgical Co. Production was about 35 percent smaller in 1957 than in 1956.

CONSUMPTION AND USES

ORE AND CONCENTRATE

The quantity of domestic and foreign ore and concentrate consumed at domestic plants in making vanadium pentoxide and ferrovanadium again established a new record of over 14 million pounds (vanadium content), about a 28-percent increase over 1956.

VANADIUM PRODUCTS

Of the total consumption reported in 1957, approximately 77 percent was in the form of ferrovanadium. Consumption of vanadium by uses indicates that about 79 percent was used in high-speed and other alloy steel.

TABLE 5.—Vanadium consumed and in stock in the United States in 1957, by forms, in pounds of vanadium

Form	Stocks at consumers' plants Dec. 31, 1956	Consumption	Stocks at consumers' plants Dec. 31, 1957
Ferrovanadium	534,012	2,748,012	435,343
Oxide	34,482	264,158	23,663
Ammonium metavanadate	30,570	199,807	26,578
Other	133,232	367,912	141,316
Total	732,296	[1] 3,579,889	626,900

[1] Represents approximately 90 percent of total consumption of 3.9 million pounds.

TABLE 6.—Vanadium consumed in the United States in 1957, by uses

Use	Vanadium, pounds	Use	Vanadium, pounds
High-speed steel	790,894	Chemicals	205,336
Other alloy steels	2,045,374	Other	121,555
Alloy cast iron	49,184		
Nonferrous alloys	367,546	Total	[1] 3,579,889

[1] Represents approximately 90 percent of total consumption (3.9 million pounds).

Ferrovanadium was used in making tool steels, high-strength structural steels, high-temperature alloys, and wear-resistant cast irons. Ferrovanadium was also used as a deoxidizer for low-carbon steel and in permanent-magnet alloys. Vanadium oxide was used as an additive to steel under special conditions and for coating welding-rod electrodes. Ammonium metavanadate and vanadium oxide were used as catalysts, in ceramics, and in research. Vanadium metal, excluding the high-purity product, was used for remelting or alloying purposes. The high-purity product was employed primarily for research purposes.

Vanadium was used primarily for its grain-refining and alloying effects in steel and to increase the strength of cast iron. For these purposes, only small quantities are needed. The vanadium content of high-speed steels ranged from approximately 0.50 to 2.50 percent, but higher percentages were occasionally employed. In tool steels other than high-speed, the vanadium content varied from 0.20 to 1.00 percent. The vanadium content of engineering steel was 0.01 to 0.25 percent. Most steels containing over 0.50 percent vanadium were for special applications. Vanadium, with chromium, nickel, tungsten, manganese, and boron, was used in a variety of engineering and structural steels. Aluminum alloyed with 2.5 to 40 percent vanadium controlled thermal expansion, electrical resistivity, and grain size of aluminum alloys. An alloy containing 80 to 85 percent vanadium with 13 to 17 percent aluminum was employed in producing titanium metal alloys. Another alloy containing aluminum, titanium, and boron, with 25 percent vanadium, was employed to increase the hardenability and improve the physical properties of steels. This alloy improved the hot-working characteristics of wrought stainless and heat-resisting steels and reduced heat checking of castings composed of these steels.

STOCKS

Stocks of various forms of vanadium held at consumers' plants December 31, 1957, decreased about 14 percent from those on December 31, 1956.

PRICES

From March 8, 1951, through 1957 vanadium oxide (V_2O_5) contained in ore has been quoted at 31 cents per pound. This quotation, however, disregards penalties based on the grade of ore or the presence of objectionable impurities, such as lime, which are important to the refiners, since impurities vitally affect recoveries.

Quoted prices on vanadium pentoxide (Technical grade) varied from $1.28 to $1.38 a pound of V_2O_5; the price of ferrovanadium ranged from $3.20 to $3.40 a pound of contained vanadium (depending upon the grade of alloy). Vanadium metal, in 100-pound lots, advanced 20 cents a pound from $3.45 to $3.65 in July 1957.

FOREIGN TRADE [4]

No vanadium ore or concentrate was imported in 1957. During the year 7 pounds (gross weight) of vanadium carbide valued at $280 was imported from West Germany. In addition, 20,406 pounds (gross weight) of vanadic acid, anhydride, salts and compounds and mixtures of vanadium valued at $22,523 was imported from Switzerland, and 400 pounds (gross weight) of chromium nickel and chromium-vanadium valued at $1,692 was imported from West Germany.

Exports of vanadium in various forms in 1957 were about 36 percent less than in 1956. Exports of vanadium ore, concentrate, vanadic acid, vanadium oxide, and vanadates were about 46 percent less than in 1956; those of ferrovanadium and other vanadium alloying materials declined about 4 percent; and exports of vanadium-bearing flue dust and other waste materials were about 4.1 times greater in 1957 than in 1956. Eight countries (Japan, France, West Germany, Austria, Sweden, Italy, the Netherlands, and Switzerland) were the main foreign markets for vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates in 1957, taking 98 percent of the total exports for these commodities. Canada and West Germany were the main markets for ferrovanadium and other alloying material containing over 6 percent vanadium, taking a total of 99 percent. Exports of vanadium-bearing flue dust went to the Netherlands, Italy, and West Germany.

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

TABLE 7.—Vanadium ores or concentrate, vanadium-bearing flue dust, and ferrovanadium[1] imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Vanadium ores and concentrate			Vanadium-bearing flue dust			Ferrovanadium	
	Pounds		Value	Pounds		Value	Pounds (gross weight)	Value
	Gross weight	Vanadium content		Gross weight	Vanadium content			
1948–52 (average)	3,881,290	1,017,339	$528,290	4,372	349	$980	54,894	$42,717
1953	2,959,600	716,977	421,091	9,822	1,010	2,237	17,364	12,584
1954	1,183,961	395,287	238,222					
1955	[2] 582,536	[2] 184,737	[2] 104,230					
1956–57								

[1] In addition to data shown "vanadic acid, anhydride, salts and compounds, and mixtures of vanadium" imported as follows: 1953, 3,090 pounds (gross weight), $2,368; 1954, 4,000 pounds (gross weight), $2,934; 1957, 20,406 pounds (gross weight), $22,523. Vanadium carbide imported 1957, 7 pounds (gross weight), $280. Chromium nickel and chromium vanadium imported 1957, 400 pounds (gross weight), $1,692.

[2] Includes 92,594 pounds of concentrates containing 29,804 pounds of vanadium, valued at $16,811, received but not reported by the Bureau of the Census until 1956.

TABLE 8.—Exports of vanadium from the United States, 1948–52 (average) and 1953–57, by classes

[Bureau of the Census]

Year	Vanadium ore, concentrates, vanadic oxide, vanadium oxide, and vanadates (except chemically pure grades).		Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium.[1]		Vanadium metal, alloys, and scrap		Vanadium-bearing flue dust and other waste materials	
	Pounds (vanadium content)	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value	Pounds (vanadium content)	Value
1948–52 (average)	30,091	$69,588	186,287	$328,800	22,842	$10,238	(2)	(2)
1953	12,319	32,141	156,952	296,157	(3)	(3)	54,211	$31,285
1954	42,935	120,311	140,510	237,333	(3)	(3)	23,953	13,609
1955	1,729,103	3,768,358	439,457	991,955	(3)	(3)	86,519	66,472
1956	[4] 1,856,594	[4] 4,046,100	[4] 278,674	[4] 650,955	(3)	(3)	28,545	27,185
1957	1,000,340	2,114,700	267,988	519,955	(3)	(3)	116,160	118,894

[1] Classified as ferrovanadium, 1948–52.
[2] Not separately classified before Jan. 1, 1953.
[3] Beginning Jan. 1, 1953, not separately classified.
[4] Revised figure.

TABLE 9.—Exports of vanadium from the United States, 1956–57, by countries, in pounds

[Bureau of the Census]

Country	Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium (gross weight)		Vanadium ore, concentrates, pentoxide, vanadic oxide, vanadium oxide and vanadates (except chemically pure grade) (vanadium content)		Vanadium flue dust and other vanadium waste materials (vanadium content)	
	1956	1957	1956	1957	1956	1957
North America:						
Canada	159,018	204,878	3,360	4,846		
Mexico			1,680	1,214		
Total	159,018	204,878	5,040	6,060		
South America:						
Argentina			700	568		
Bolivia				896		
Brazil	2,205			2.122		
Uruguay		880				
Total	2,205	880	700	3,586		
Europe:						
Austria	(1)		[2] 609,749	96,343		
Belgium-Luxembourg		1,000	2,105	3,333		
France			265,376	158,524	2,895	
Germany, West	79,725	59,570	456,617	135,927	16,276	24,690
Italy			78,620	48,522		39,528
Netherlands	22,059		49,694	33,486	9,374	51,942
Norway				632		
Spain	13,400					
Sweden			65,019	62,974		
Switzerland			1,232	11,089		
United Kingdom	112	560		5,765		
Yugoslavia	1,655					
Total	[2] 116,951	61,130	[2] 1,528,412	556,595	28,545	116,160
Asia:						
India				283		
Japan		1,100	322,442	433,816		
Total		1,100	322,442	434,099		
Africa: Union of South Africa	500					
Grand total	[2] 278,674	267,988	[2] 1,856,594	1,000,340	28,545	116,160

[1] Revised to none.
[2] Revised figure.

WORLD REVIEW

EUROPE

United Kingdom.—A Key Industry Duty on fused vanadium pentoxide for non-Commonwealth material placed special steel and ferroalloy producers in England at a disadvantage in respect to this commodity compared with certain Continental nations.[5] Radical alteration of this situation may be anticipated when supplies from a newly developed source in the Transvaal of the Union of South Africa become available. New supplies from the Transvaal may well compete with United States material, which was exported in considerable quantity since 1955.

[5] Metal Bulletin (London), Vanadium, Supplies Improving: No. 4213, July 23, 1957, p. 29.

Sweden.—Vanadium was reported present in the oil shale at Skåne, Västergötland, Närke, and Östergötland and in deposits of apatite in Grängesberg and Norrbotten.[6] Since the vanadium content of these deposits is small, it is retrieved as a byproduct. Production figures have not been available, but it was thought that vanadium was produced by Domnarvets Järnverk from apatite ore from Grängesberg and possibly by the Norrbottens Järnverk from Kiruna and Luossavaara ores. Vanadium may also be produced by the Kvarntorps Skifferoljeverk (Kvarntorp oil-shale plant) in Närke.

AFRICA

South-West Africa.—Control of the South-West Africa Co., Ltd., was acquired by a British mining group consisting of New Consolidated Goldfields, Anglo American Corp. of South Africa, and the British South Africa Co.[7] The Abenab West mine controlled by this group has been the sole source of vanadium from South-West Africa.

Union of South Africa.—Two United States companies—Minerals Engineering Co. and Rockefeller Center, Inc.—and an English concern—High Speed Steel Alloys, Ltd., of Lancashire, England—undertook a joint venture to construct a vanadium mill in the Transvaal, Union of South Africa.[8] Vanadium is contained in titaniferous magnetite. The annual capacity of the mill was reported as 3 million pounds of vanadium concentrate. Open-pit mining of the new company, called the Minerals Engineering Co. of South Africa, Ltd., will supply ore for the new mill. Production from the new mill, situated

TABLE 10.—World production of vanadium in ores and concentrates, 1948–57, in short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
North America: United States (recoverable vanadium)	[2] 670	[2] 1,188	[2] 1,598	[2] 2,126	[2] 2,571	[2] 3,057	[2] 3,026	3,286	3,868	3,691
South America:										
Argentina	(3)	(3)	1	(3)	(3)	(3)	(3)	------	(3)	(3)
Peru (content of concentrate)	563	503	481	495	482	349	195	78	------	------
Europe: Finland	------	------	------	------	------	------	------	------	43	290
Africa:										
Angola	------	------	------	------	------	------	------	------	11	1
Rhodesia and Nyasaland, Federation of: Northern Rhodesia (recovered vanadium)	191	169	------	96	47	------	------	------	------	------
South-West Africa (recoverable vanadium)	206	180	325	583	688	596	633	632	308	[4] 330
World total (estimate)[5]	1,630	2,040	2,405	3,300	3,788	4,002	3,854	3,996	4,230	4,312

[1] This table incorporates a number of revisions of data published in previous Vanadium chapters.
[2] Includes vanadium recovered as a byproduct of phosphate-rock mining, 1948–54.
[3] Negligible.
[4] Estimate.
[5] Total represents data only for countries shown in table and excludes vanadium in ores produced in Belgian Congo, Morocco, Spain, Union of South Africa (Transvaal), and U. S. S. R., for which figures are not available; the table also excludes quantities of vanadium recovered as byproducts from other ores and raw materials.

[6] U. S. Embassy, Stockholm, Sweden, State Department Dispatch 251: Aug. 28, 1957.
[7] Mining Journal (London), Vanadium: Annual Review, 1957, May 1957, p. 43.
[8] Wall Street Journal, Three Concerns Plan to Build South African Vanadium Mill: Vol. 149, No. 105, May 29, 1957, p. 13.

near Pretoria, was scheduled for September.[9] Vanadium-ore deposits available for development reportedly contain over 50 million pounds of recoverable V_2O_5.[10]

TECHNOLOGY

Research on vanadium was centered primarily upon development of methods to produce a high-purity metal and the development of vanadium alloys. Substantial effort continued on determining the effect of vanadium in special steels and in new applications, and in the chemical and related industries.

The Bureau of Mines vanadium-research program was concerned with developing methods of making a ductile metal of consistent purity and properties, developing vanadium alloys, and testing and determining the properties of vanadium metal and alloys.

Vanadium metal was indicated to resist attack by aerated salt water, as well as dilute HCl and H_2SO_4.[11] It cannot withstand dilute or concentrated nitric acid. Against certain liquid metals it has good resistance to corrosion.

For vanadium alloys three possible applications were suggested, including: A formable, weldable high-hot-strength sheet alloy for airframe service up to 1,200° F.; a fuel-element cladding for fast reactors in which hot strength, thermal conductivity, and interdiffusion are important considerations; and a diffusion barrier between titanium and steel.

According to researchers of a major automobile firm, vanadium pentoxide catalyst eliminated about four-fifths of the unused hydrocarbons in exhaust gases of single-cylinder engine.[12] Tests indicated that vanadium pentoxide for this purpose does not have as long a life as desired. Future refinements may provide a curb on smog produced by automobile exhaust gases.

Studies on the use of vanadium salts capable of preventing heart attacks were conducted by research teams at the University of Kansas Medical School.[13] According to the theory advanced, vanadium salts tend to reduce deposits of cholesterol (which blocks arteries) and discourages its production in the body.

Patents were issued for uranium-vanadium recovery and separation by phosphate precipitation [14] and recovery from carbonate solutions by reduction-precipitation.[15]

Other patents were issued for a vanadium-carbon-iron alloy,[16] for high-strength vanadium alloys, [17] and for the electrocleaning of vanadium.[18]

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[9] Mining World, vol. 19, No. 8, July 1957, p. 43.

[10] Chemical Week, Vanadium/South Africa: Vol. 80, No. 8, Feb. 23, 1957, p. 25.

[11] Mining Journal (London), Gleaning From the Reactive Metals Conference: Vol. 248, No. 6357, June 21, 1957, p. 793.

[12] Northern Miner (Toronto), Fight Smog With Vanadium: Vol. 43, No. 24, Sept. 5, 1957, p. 10.

[13] Vanadium Corp. of America, Vancoram Vista, Vanadium Salts: Summer 1957, p. 3.

[14] Arendalo, William F., and Colemann, Charles F. (assigned to the United States of America by the United States Atomic Energy Commission), Uranium-Vanadium Recovery and Separation by Phosphate Precipitation: U. S. Patent 2,797,143, June 25, 1957.

[15] Ellis, David A., and Lindblom, Robert O. (assigned to the United States of America by the United States Atomic Energy Commission), Process for Recovery of Uranium and Vanadium From Carbonate Solutions by Reduction-Precipitation: U. S. Patent 2,807,518, Sept. 24, 1957.

[16] Brennan, Joseph H. (assigned to the Union Carbide & Carbon Corp.), Vanadium-Carbon-Iron Alloy: U. S. Patent 2,791,501, May 7, 1957.

[17] Rostoker, William (assigned to the Armour Research Foundation of Illinois Institute of Technology), High Tensile Vanadium Alloys: U. S. Patent 2,805,153, Sept. 3, 1957.

[18] Brown, Charles M. (assigned to the Union Carbide Corp.), Electro-Cleaning of Vanadium: U. S. Patent 2,803,596. Aug. 20, 1957.

Vermiculite

By L. M. Otis[1], Nan C. Jensen[2]

VERMICULITE consumption remained fairly constant in 1957, conforming to the pattern prevalent since 1950. The Union of South Africa continued to be an important factor in the market, as about 4 percent of the vermiculite sold or used in the United States was imported from that source.

DOMESTIC PRODUCTION

Crude Vermiculite.—Four domestic operators mined vermiculite in 1957, producing a total of 184,000 short tons valued at $2.6 million. Montana and South Carolina were the only producing States; most of the output came from Montana.

TABLE 1.—Salient statistics of vermiculite production, 1948–52 (average) and 1953–57, in thousand short tons

	1948–52 (average)	1953	1954	1955	1956	1957
United States:						
Crude	187	190	196	204	193	184
Average value per ton	$11.28	$12.90	$12.98	$13.24	$13.20	$14.15
Exfoliated	(1)	(1)	145	158	159	161
Average value per ton	(1)	(1)	$74.55	$63.31	$60.93	$61.47
World: Crude	218	224	242	263	255	249

[1] Data not available.

TABLE 2.—Screened and cleaned domestic crude vermiculite sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	186,693	$2,106,611	1955	204,040	$2,702,225
1953	189,535	2,445,381	1956	192,628	2,542,467
1954	195,538	2,537,577	1957	183,987	2,602,548

Exfoliated Vermiculite.—In 1957, 24 companies operated 54 exfoliating plants in 34 States and Hawaii, compared with 25 companies with 55 plants in 32 States and Hawaii in 1956. Texas had 4 exfoliating plants; 7 States each had 3; 2 States each had 2; and all other States with vermiculite-exfoliating facilities had 1 plant each.

Total production in 1957 was 161,000 short tons valued at $9.9 million, a 2-percent increase in both quantity and value compared with 1956.

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

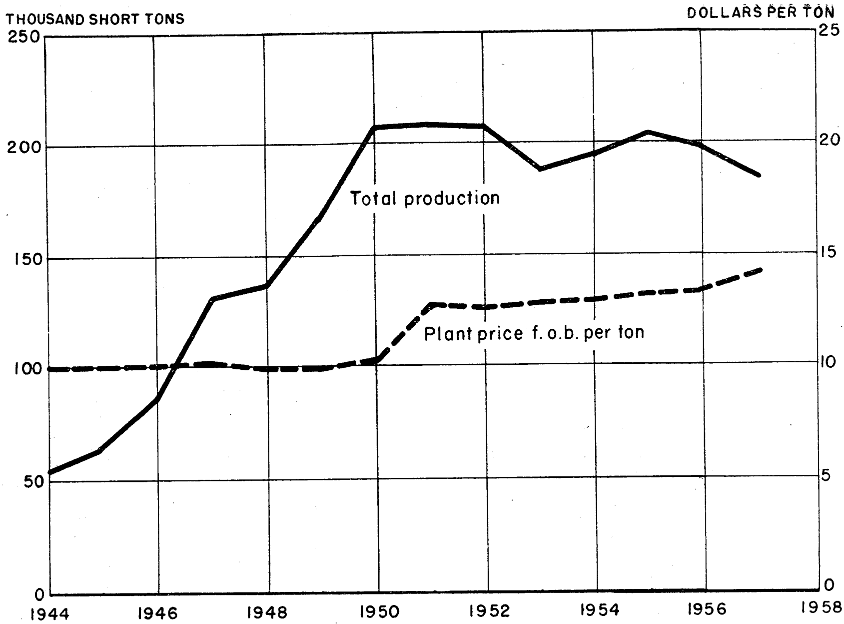

FIGURE 1.—Screened and cleaned crude vermiculite sold or used by producers in the United States and average value per ton, at their plants, 1944–57.

TABLE 3.—Exfoliated vermiculite sold or used by producers in the United States,[1] 1954–57

Year	Operators	Plants	Short tons	Value	
				Total	Average per ton
1954	27	50	144,964	$10,807,023	$74.55
1955	24	54	157,952	9,999,634	63.31
1956	25	55	158,787	9,674,350	60.93
1957	24	54	161,200	9,909,509	61.47

[1] Includes Hawaii.

CONSUMPTION AND USES

The building-plaster, lightweight-concrete, and loose-fill-insulation markets continued to consume most of the exfoliated vermiculite. Development of machine application of vermiculite plasters has widened its use.

The Vermiculite Institute reported that, of the production by its members, the quantity of vermiculite used as aggregates for precast products increased 71 percent from 1953 to 1957 and that sales for all vermiculite-aggregate uses increased 50 percent in the same period.

A recent survey disclosed a growing use was insulation of hollow-core concrete blocks. The Vermiculite Institute claimed that this doubles the insulating value of a wall, regardless of the type of aggregate used in making the block.

Other uses of vermiculite included soil conditioning, carriers for herbicides, insecticides, fungicides and fumigants, hatchery litter, seed propagation, transportation of hot steel ingots, and refractory fire brick.

PRICES

The E&MJ Metal and Mineral Markets in November 1957 quoted crude vermiculite: Per short ton, f. o. b. mines, Montana, $9.50 to $18; South African, $30 to $32, c. i. f. Atlantic ports.

The average mine value of all crude reported to the Bureau of Mines as having been sold or used in 1957 was $14.15 per short ton, compared with $13.20 in 1956.

The exfoliated material so reported, f. o. b. processors' plants, was $61.47 per ton, 1 percent higher than in 1956.

FOREIGN TRADE

Crude vermiculite is imported into the United States duty free. The Union of South Africa continued to be the only substantial source of imports.

Official data on exports are not maintained. Due to the bulky nature of exfoliated vermiculite, exports in this form were insignificant. Canadian-industry statistics show that 78 percent of the dollar value of crude vermiculite exfoliated there in 1956 came from the United States and was valued at Can$291,198. At the same unit price as the United States average value for 1956, this would amount to 22,000 short tons. Crude is also exported to Cuba and Venezuela in substantial quantities.

WORLD REVIEW

NORTH AMERICA

Canada.[3]—Canadian imports of crude vermiculite during the first half of 1957 were valued at Can$146,215.

Starting in 1938 Canada used imported vermiculite for exfoliating and from 1938 to 1957 has shown a continuous increase in volume of output. In 1956 mining of crude vermiculite was begun by Northern Vermiculite, Ltd., near Stanleyville, 8 miles southwest of Perth, Lanark County, Ontario, for local exfoliation. Production figures have not been published.

All other Canadian exfoliators use crude from the United States or Union of South Africa.

Crude vermiculite imports and exfoliated production, 1955–56

	1956		1955
	Cubic feet	*Can$*	*Can$*
Imports, crude:			
United States	------------	291,198	284,152
Union of South Africa	------------	82,609	71,259
United Kingdom	------------	109	------------
Products produced	5,721,000	1,154,000	1,369,000

[3] Canada Department of Mines and Technical Surveys, Ottawa, Vermiculite in Canada: Bull. 57, 1956, 2 pp.

Five companies exfoliated vermiculite in 10 Canadian plants during 1956.

Canada reported a price range in 1956 for exfoliated vermiculite, f. o. b. plant, of Can$0.20 to $0.35 per cubic foot, packed in 4-cubic-foot bags.

TABLE 4.—World production of crude vermiculite, by countries,[1] 1948–52 (average) and 1953–57, in short tons [2]

[Compiled by Helen L. Hunt and Berenice B. Mitchell]

Country [1]	1948–52 (average)	1953	1954	1955	1956	1957
Argentina				551	1,323	[3] 1,100
Australia	123	32			1	
Egypt	[4] 385	[3] 100				
India	[5] 115		3	138	1,038	[3] 1,100
Kenya	2	82	807	380	497	33
Morocco						147
Rhodesia and Nyasaland, Federation of:						
Southern Rhodesia	483				305	460
Union of South Africa	30,174	33,844	45,633	57,482	58,717	62,619
United States (sold or used by producers)	186,693	189,535	195,538	204,040	192,628	183,987
World total [1] [2]	217,975	223,593	241,981	262,591	254,509	249,446

[1] In addition to countries listed, vermiculite is produced in Brazil and U. S. S. R., but data are not available and no estimates of their production 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 1951–52.
[5] Average for 1950–52.

ASIA

India.—Substantial reserves of vermiculite have been reported in Mysore State and prospected by the Mysore Government Geological Department at Bageshpura in Bangalore district and Chennarayapatna in Hassan district.

AFRICA

Rhodesia and Nyasaland, Federation of.—The production of crude vermiculite in 1956 was 305 short tons, valued at $1,980. Bell Asbestos and Engineering (Rhodesia), Ltd., acquired the Industrial Corp. of Rhodesia (Pvt.), Ltd., of Bulawayo. Among the latter's interests was the production of exfoliated vermiculite in Africa, Australia, and England. Insulation products and acoustical plaster were made in a new plant in Bulawayo opened in March 1957.

Union of South Africa.—The output of crude vermiculite in 1956 increased 2 percent over 1955.

Output, local sales, and exports of crude vermiculite from Union of South Africa, 1955–56

Year	Output	Local sales		Exports	
	Short tons	Short tons	Value	Short tons	Value
1955	57,482	3,064	$57,000	44,840	$786,000
1956	58,717	2,847	56,800	52,775	971,000

TABLE 5.—Exports of crude vermiculite from Union of South Africa, 1953–57, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1953	1954	1955	1956	1957 [2]
North America:					
Canada	2,820	4,873	3,168	4,440	3,192
Cuba	----------	----------	349	----------	491
United States	6,615	7,553	10,637	8,083	6,483
South America:					
Chile	----------	48	19	----------	----------
Uruguay	120	----------	181	358	54
Venezuela	----------	130	197	251	----------
Europe:					
Belgium	274	391	280	286	619
Denmark	2,218	2,832	1,439	3,181	1,395
Finland	5	----------	88	110	82
France	3,167	5,209	4,341	5,162	6,889
Germany, West	1,273	2,668	2,926	5,703	3,154
Italy	3,169	5,036	5,748	5,715	3,170
Netherlands	1,482	1,163	1,024	2,260	1,638
Norway	214	----------	50	56	----------
Sweden	353	756	366	230	173
Switzerland	----------	116	55	357	----------
United Kingdom	9,381	8,710	11,711	11,879	8,889
Asia:					
Iraq	----------	----------	197	165	----------
Israel	----------	----------	----------	134	396
Japan	293	186	88	632	282
Lebanon	60	101	----------	89	----------
Malaya	29	56	59	188	----------
Saudi Arabia	167	52	28	419	10
Africa:					
Egypt	----------	70	130	171	----------
French West Africa	139	54	159	----------	149
Morocco	112	114	382	----------	56
Rhodesia and Nyasaland, Federation of	437	354	304	349	373
Oceania:					
Australia	436	578	685	1,951	869
New Zealand	123	204	57	125	76
Other countries	----------	----------	172	481	366
Total	32,887	41,254	44,840	52,775	38,806
Total value [3]	$556,405	$712,570	$785,651	$970,804	$758,082
Average value	$16.92	$17.27	$17.52	$18.40	$19.54

[1] Compiled from Customs Returns of Union of South Africa.
[2] January through September, inclusive.
[3] Converted to U. S. currency at the rate of SA£—US$2.8021 (1953); US$2.7982 (1954); US$2.7809 (1955); US$2.7852 (1956); and US$2.7828 (1957).

TECHNOLOGY

At the annual meeting of the Vermiculite Institute progress in developing some possible large-volume new uses was reviewed. Tests were conducted to demonstrate the adequacy of vermiculite concrete as a horizontal safety diaphragm for buildings in earthquake zones. Procedures were developed for sampling and testing poured vermiculite concrete for roof fills, roof decks, and floors; precast insulating roof slabs and fill; insulation for underground heating conduit in military structures; and built-up roofing over vermiculite roof decks. This research was sponsored by the institute and tests were carried out by industry and the National Bureau of Standards.[4]

Four years of plant research and 2 years of commercial application of nutriculture and mist propagation, using vermiculite, were reported.[5] Polyethylene bags with holes in the bottom were filled with

[4] Rock Products, Vermiculite Institute Explores New Markets at Annual Meeting: Vol. 60, No. 6, June 1957, pp. 184–186.
[5] Vanderbrook, Clarence, Mist Spray Growing and Nutriculture: American Nurseryman (rept. from Terra Lite Division, Zonolite Co., 135 South LaSalle St., Chicago 3, Ill.), Nov. 1, 1955.

exfoliated, sized, vermiculite; plant cuttings were inserted and placed in gravel beds to secure proper drainage. Water with nutrients was then forced under pressure through pipes with many small holes to produce a spray mist. This system reportedly gives a high percentage of rooting, high-quality plants, decreased nursery costs, and increased production and speeds plant maturity.

A 1-inch thickness of vermiculite plaster was applied to the underside of a reinforced-concrete slab for a fire-rating test sponsored by industry and conducted by the Fire Research Station of the British Department of Scientific and Industrial Research. Without the vermiculite plaster the slab fire rating was ½ hour, but the plaster increased the rating performance to 4 hours.[6]

Patents.—Ground peat moss and exfoliated vermiculite are used to retain moisture in a patented plant receptacle.[7]

A patented growth medium for propagating plants consists of a mixture of exfoliated vermiculite, a water insoluble phosphate, and ammonium nitrate.[8]

A patented method for reducing sprouting time and improving the flowering of plants utilizes soaking of the seeds in solution before bedding them in moist, exfoliated vermiculite at low temperature.[9]

A patented exhaust silencer for internal-combustion engines uses exfoliated vermiculite to deaden the sound and absorb heat from the exhaust.[10]

An oil-well concrete was patented having relatively high permeability to liquids. It is made from a slurry of portland cement, a pozzolan, and a mixture of lightweight aggregate, such as vermiculite, having a range of particle sizes.[11]

Artificial, fire-resistant, fireplace logs made of magnesium oxide, asbestos fiber, silex, and exfoliated vermiculite were patented.[12]

A machine was patented for blending and mixing fibrous and ground materials, such as exfoliated vermiculite, for thermal and acoustical insulation and fireproofing.[13]

Exfoliated vermiculite was impregnated with fertilizing agents to produce a patented combination soil conditioner and fertilizer carrier.[14]

A unitary seed-carrying package was patented, consisting of exfoliated vermiculite and pumice mixed with plant foods and an organic water-soluble binder. The seeds are placed in indentations in the package, covered with another layer of the mixture, embedded in soil, and allowed to germinate.[15]

A fire-retardant roofing and shingle material was patented, using a conventional, asphalt-saturated felt base, coated on 1 side with 2 layers of an asphalt-asbestos mixture. The two layers were separated by a layer of unexfoliated vermiculite granules. In case of fire, the

[6] Engineering News-Record, Vermiculite-Treated Slab Gets 4-Hour Fire Rating: Vol. 158, No. 12, Mar. 21, 1957, pp. 89–90.
[7] Hawkins, W. L., Plant Receptacle: U. S. Patent 2,814,161, Nov. 26, 1957.
[8] Schmitz, G. W., and Rothfelder, R. E. (assigned to Zonolite Co., Chicago, Ill.), Plant-Propagating Medium: U. S. Patent 2,816,825, Dec. 17, 1957.
[9] Leopold, A. C., and Guernsey, F. S. (assigned to Research Corp., New York, N. Y.), Method of Accelerating and Increasing Flowering and Fruitfulness in Plants: U. S. Patent 2,802,306, Aug. 13, 1957.
[10] Fischer, J. C., Jr., Exhaust Silencer: U. S. Patent 2,798,569, July 9, 1957.
[11] Mangold, G. B., Dyer, J. A., and Hart, J. T. (assigned to Petroleum Engineering Associates, Inc., Pasadena, Calif.), Permeable Concrete: U. S. Patent 2,793,957, May 28, 1957.
[12] Nielsen, H., Simulated-Log Fireplace Heater: U. S. Patent 2,762,362, Sept. 11, 1956.
[13] Fisher, E. J., Blending and Mixing Machine: U. S. Patent 2,764,392, Sept. 25, 1956.
[14] Rice, R. W., Method of Impregnating Exfoliated Vermiculite: U. S. Patent 2,791,496, May 7, 1957.
[15] Clawson, C. D. (assigned to Ferro Corp., Cleveland, Ohio), Seed Planting Package: U. S. Patent 2,785,969, Mar. 19, 1957.

vermiculite particles exfoliate to form a nonflammable porous mass.[16]

A deodorant using vermiculite as a carrier was patented. A vaporizable deodorant was adsorbed into exfoliated vermiculite particles and placed where odors are to be neutralized.[17]

A cigarette filter tip was patented which uses exfoliated vermiculite granules loosely packed between the smoking section of the tobacco and a shorter section of tobacco held in the smoker's lips.[18]

A method and apparatus for the continuous, large-scale manufacture of lightweight, reinforced, insulating concrete roof and floor slabs were patented. Exfoliated vermiculite may be used as one of the suitable lightweight aggregates.[19]

An insulating wall structure was patented and formed by applying to a metal or plastic screen a composition of sodium silicate, aluminum powder, and an insulating mineral aggregate, such as exfoliated vermiculite. The composition foams after emplacement, leaving air spaces.[20]

A patented formula for producing a permeable concrete for cementing oil wells specifies exfoliated vermiculite as a suitable aggregate. This is mixed with a calcined, ground, oil-impregnated diatomite as a pozzolan, together with a hydraulic cement.[21]

A method of impregnating exfoliated vermiculite with various substances was patented. While exfoliated vermiculite granules were heated to between 350° and 600° F., they were exposed to a fine mist containing the ingredients to be adsorbed in the cells of the vermiculite, such as soil conditioners and fertilizers.[22]

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16 Donegan, J. W. (assigned to Allied Chemical and Dye Corp., New York, N. Y.), Fire-Retardant Coated Roofing Sheet and Process for Preparing: U. S. Patent 2,782,129, Feb. 19, 1957.

17 Buslik, D., Granular Vermiculite Deodorants: U. S. Patent 2,778,774, Jan. 22, 1957.

18 Graybeal, K. W., Cigarettes: U. S. Patent 2,786,471, Mar. 26, 1957.

19 Sterrett, R. W. (assigned to Southern Zonolite Co., Atlanta, Ga.), Manufacture of Roofing Slabs and the Like: U. S. Patent 2,778,088, Jan. 22, 1957.

20 Rasmussen, P. D. (assigned to Invention Development Corp., a corporation of Illinois), Insulating Structure: U. S. Patent 2,780,090, Feb. 5, 1957.

21 Mangold, G. B., Dyer, J. A., and Hart, J. T. (assigned to Petroleum Engineering Associates, Inc., Pasadena, Calif.), Well Completion With Permeable Concrete: U. S. Patent 2,786,531, Mar. 26, 1957.

22 Rice, R. W., Encampment, Wyo., Method of Impregnating Exfoliated Vermiculite: U. S. Patent 2,791,496, May 7, 1957.

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Water

By Robert T. MacMillan [1]

WATER PROBLEMS in many areas were eased by drought-breaking rains in 1957; but long-range supply problems, resulting from population growth, higher per capita consumption, and pollution, received increasing attention from both industry [2] and Government.[3]

DOMESTIC SUPPLY

The water supply of the Nation is related directly to precipitation, which is reflected in the flow of water in streams and rivers. In 1957 stream runoff was in the median range for three-quarters of the Nation; the remaining quarter was divided about equally between excessive and deficient runoff. Water supply was more favorable than for any year since 1938; only one-eighth of the Nation was deficient.

Most of the area of deficiency was in New England and parts of the Southeastern and Southwestern States. Precipitation was above normal in the central and southern Great Plains, where drought had persisted since 1952.[4]

The flows of the Mississippi River at Vicksburg, Miss., and the Ohio River at Metropolis, Ill., were 102 and 108 percent of median, respectively, in 1957, a substantial increase for the former compared with the 3 years, 1954–56. At Herman, Mo., the Missouri River flowed at 67 percent of median, also an increase compared with 1956. In the West, the Colorado River flowed at 130 percent of median and the Columbia at 111 percent. The annual flow of the St. Lawrence below Lake Ontario was 105 percent of median and was the lowest in 15 years.[5]

The quantity of water stored in the major power, municipal, and industrial reservoirs in the Northeast was below average at the year's end due to drought in that area. Most water storage facilities in other parts of the Nation were above or well above average. Lakes Mead and Mohave on the Colorado River were up to 116 percent of average, and Shasta Reservoir in northern California was 130 percent of average. Owing to the continued drought in Southern California, municipal reservoirs of San Diego, which are not supplied by Colorado River water, held only about 3 percent of normal capacity and were lower than in 1956.

Ground water levels had been below average in many areas, particularly in the southern half of the Nation, but rose because of the combination of excessive rainfall and decreased pumping; the result

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1 Commodity specialist.
2 Engineering News Record, Three More States Study Water: Vol. 158, No. 5, Jan. 31, 1957, p. 26.
3 Chemical Week, New Water Measures: Vol. 80, No. 7, Feb. 16, 1957, pp. 24, 25.
4 U. S. Department of Commerce, Climatological Data: National Summary, vol. 8, No. 13, Annual 1957, 138 pp.
5 Geological Survey (in collaboration with Canada Department of Northern Affairs and Natural Resources), Water Resources Review: Ann. Summary, Water Year 1957, Oct. 17, 1957, 16 pp.

was that deficiencies of several years were either replenished or substantially improved in 1957. Many exceptions were noted owing to extremely irregular precipitation and increased pumping in certain areas. In many areas of New England and the Northern Middle Atlantic States, the summer drought caused ground water levels to fall well below average. Several observation wells in Rhode Island were dry, and others in surrounding States were at record low levels.

Owing to previous droughts ground water in parts of the north central plains continued below average, despite more than average precipitation. Of the total water used in the United States, about one-fourth is ground water.

CONSUMPTION AND USES

Water uses that require withdrawal from streams, lakes, or aquifers may be classified under the following headings: Irrigation, self-supplied industrial, public supplies, and rural. Water for generating hydroelectric power is not included because this use of water seldom affects its properties and permits reuse without treatment. Nonwithdrawal uses include navigation, recreation, waste disposal, and conservation of wildlife.

The leading uses of water were for irrigation and industry; it was estimated that more than 90 percent of the total water withdrawn in 1957 was for these purposes.

Withdrawal use, exclusive of water used for hydroelectric power, has increased enormously since the turn of the century. From about 40 billion gallons per day (bgd.) in 1900, total water use in the United States had climbed to an estimated 240 bgd. in 1955.[6] By extrapolating this growth curve a total of 280 bgd. was estimated for 1957 and 597 bgd. in 1980.[7] The latter figure includes some saline water used by industry for cooling and is not strictly comparable with the 1955 estimate, which covers fresh water only.

Use of industrial water has grown most rapidly, nearly equaling that used for irrigation, historically the leading user. It was estimated that by 1980 industry will take two-thirds of all water used.

Although usually not appearing in the finished product, water is used in virtually all processing. Table 1 shows the quantity of water used by various industry groups in 1954. Specific information was obtained only from the groups requiring 20 million or more gallons; estimates were made for the smaller users.

Another method of expressing water use by industry was in gallons per unit of product. Table 2 shows the average quantity of water used in producing a unit, usually 1 ton, of various commodities. The minimum water required is also shown in some instances and indicates the large differences that exist between the average use and the minimum. For example, the average use per ton of steel is 50 times greater than the minimum required.

The mineral industry was a principal user of water in mining and processing ores and minerals. Both the quality and quantity of water required for certain metallurgical processes were being studied by

[6] MacKichan, K. A., Estimated Use of Water in the United States, 1955: Geol. Survey Circ. 398, 1957, 18 pp.

[7] Woodward, D. R., Availability of Water in the United States, With Special Reference to Industrial Needs by 1980: Ind. College of the Armed Forces Thesis 143, Apr. 10, 1957, 74 pp.

TABLE 1.—Industrial water use by industry groups, 1954, in billion gallons [1]

Industry group	Intake of larger users [2]	Total intake
Food and kindred products	590	677
Tobacco manufacturers	2	3
Textile and mill products	273	287
Apparel and related products		16
Lumber and wood products	133	166
Furniture and fixtures	7	16
Pulp, paper, and products	1,607	1,613
Printing and publishing	13	36
Chemicals and products	2,810	2,827
Petroleum and coal products	1,516	1,519
Rubber products	113	115
Leather and leather goods	20	25
Stone, clay, and glass products	267	282
Primary metal industries	3,641	3,651
Fabricated-metal products	196	220
Machinery, except electrical	120	143
Electrical machinery	118	126
Transportation equipment	253	259
Instruments and related products	19	22
Miscellaneous manufactures	59	74
Total	11,757	12,077

[1] U. S. Department of Commerce, Industrial Water Use: 1954 Census of Manufactures, Bull. MC-209, 1957, p. 52.
[2] 20 million gallons and over.

TABLE 2.—Water used per unit of product in certain typical industries

Industry	Unit	Typical use (gallons)	Minimum required (gallons)
Steel	Ton	65,000	1,300
Paper from wood	do	38,000 184,000	
Explosives	do	200,000	
Alumina	do	2,200	560
Aluminum from alumina	do	32,000	2,500
Thermoelectricity	1,000 kw.-hrs	80,000	10,000
Rayon fiber	Ton	220,000	
Carbon black:			
Contact process	do	2,000	
Furnace process	do	6,900	
Coal hydrogenation	100 bbl	730,000	
Glycerin	Ton	1,100	
Oxygen	do	2,000	

Bureau of Mines engineers. Preliminary results indicated that certain flotation separations required water of relatively high purity.

In 1957 the quantity of water used in the secondary recovery of oil by waterflooding was estimated to be 105 billion gallons. This was a 25-percent increase over the quantity used in 1956. Oil recovered by injecting water into the oil-bearing strata was estimated to be 180 million barrels—a 15-percent increase over that recovered the previous year. Most of the water injected was brine; only 25 percent was fresh water. These figures do not include pressure maintenance.

PRICES

The prices paid for water ranged widely, depending on the availability of suitable water and the treatment required. For small quantities of municipal water delivered at the tap a median price of 35 cents per thousand gallons was estimated for 1957. Larger quantities usually were sold at lower rates.

Water used by industry was mostly self-supplied, and costs depended upon the quality required and the expense of development, treatment, and distribution. The cost was usually considerably below municipal rates.

Irrigation water was usually less expensive than that used by industry, ranged up to 13 cents per thousand gallons. The median cost was under 2 cents per thousand gallons.

Heavy water, D_2O, was available from the Atomic Energy Commission at $28 per pound in 125- and 500-pound stainless-steel drums.

In many instances municipal water rates were too low to provide for adequate expansion and maintenance of facilities. Several factors aggravated this situation: Unprecedented growth of urban and suburban population; larger lots resulting in greater lawn area and less revenue per mile of distribution system; higher per capita use of water; growth and decentralization of industry, small units of which may obtain water from public waterworks, necessity of providing for high peak loads that may be many times the average load; and widespread use of air conditioning without providing for conservation of the cooling water. These increasing demands created a need for enlarged facilities; but revenues from existing water rates were often inadequate to finance the required improvements.[8]

TECHNOLOGY

The technical problems of water were related largely to its quality. Dissolved and suspended substances, both mineral and organic, make water unfit for many uses. Much research work was directed toward removing or neutralizing these substances.

Because streams are used both for waste disposal and water supply, the pollution problem has become acute in many areas. Industry, a leading user of water, was a leading waste producer. Pollution abatement received increasing attention, not only from the standpoint of aesthetics and public health but also as a means of recovering important values from the waste material. Phosphate miners in Florida developed a subsidiary industry from the uranium found in small quantities in their ore. A fertilizer industry was based on waste sulfur recovered from gas scrubbers. Anthracite fines were successfully recovered from culm, a coal-mine-waste material and stream contaminant.

In combating stream pollution, industry was urged to minimize waste volume, to search for recoverable values in its wastes, and to select proper predisposal treatment.[9]

Liquid cyclones were used to solve the water problem of several sand processors in California. By recirculating process water through the cyclones, the water was desilted, potential stream pollution was eliminated, fine sand production was increased, and water requirements were reduced.[10]

The conversion of salt water to fresh water was viewed as a potentially large industry, providing costs are reduced. Sea-water-conversion costs in 1957 ranged from $100 to $1,000 per acre-foot

[8] Learned, A. P., Determination of Municipal Water Rates: Jour. Am. Water Works Assoc., vol. 49, No. 2, February 1957, pp. 165–173.

[9] Berk, A. A., Utilizing and Disposing of Waterborne Industrial Wastes: Min. Eng., vol. 9, No. 7, July 1957, pp. 780–783.

[10] Rock Products, Water Scarcity Can't Halt Production: Vol. 60, No. 11, November 1957, pp. 116, 118.

and were too high for large-scale, economic conversion. If costs were lowered to $40 per acre-foot, the water-deficient areas of California and Texas could use 10 million acre-feet per year to replace present usage and 11 million of additional supply.[11]

The Office of Saline Water continued to study and evaluate a number of processes for producing fresh, potable water from salt-water sources.[12] Through laboratory and economic studies the Office consolidated 20 or more possible processes for saline water conversion into 5 broad groups: (1) Distillation through artificial heat, (2) solar heat distillation, (3) membrane processes of 2 or more kinds, (4) freezing processes, and (5) other chemical or electrical methods, including solvent extraction. Several projects were being studied by contractors in each of these fields.

Sudden dramatic advances in technology that would bring about substantially lowered conversion costs are improbable but reduction of cost through improved efficiency of known processes, and smaller capital outlay, and reduced operating expenses is more likely.

Two modified distillation processes were tested on pilot-plant scale in 1957. One based on the vapor compression principle was designed to produce 25,000 gallons of fresh water per day from sea water, using an unconventional rotary-evaporator design. A second distillation unit employed long-tube vertical evaporators of conventional design, with improvements to gain maximum heat transfer and minimum scale formation. The tests were being evaluated at the end of 1957

Solar distillation studies were concerned largely with cost studies and the development of tough, strong, wettable plastic films for use in constructing solar stills. Cost surveys indicated that in the United States solar stills were not likely to compete with conversion processes using fuel. In areas of the world, notably Australia, where fuel was more expensive and the climate was favorable, solar stills were finding increasing application for producing small quantities of potable water from saline sources.

Membrane processes became more feasible as more durable membrane became available at lower costs. Membrane processes have an advantage in that the salt is removed from the brine instead of removing the water from the brine as in distillation processes. In electrodialysis positive and negative salt ions under the influence of an electric current are caused to migrate through membranes that are permeable only to ions of similar charge. Thus, anions flowed toward the anode and cations toward the cathode leaving desalted water behind. Brackish water, containing less salt than sea water, required less energy and was therefore, less expensive to convert

Other membrane processes using ionic, osmotic, and mechanical forces to replace the electric current were in the development stage.

Freezing processes require less energy than distillation, but the resulting ice and brine are difficult to separate. Improvements in ice-washing techniques and the development of a combination freezing and evaporation process were notable achievements in 1957.

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[11] Chemical Engineering, What Price Fresh Water From the Sea?: Vol. 45, No. 1, January 1957, pp. 215–216.
[12] Secretary of the Interior, Saline-Water Conversion: Annual Report, 1957, 128 pp.

A symposium on Saline Water Conversion was sponsored jointly by the National Academy of Sciences—National Research Council and the Office of Saline Water. Scientists and engineers from the United States and many foreign countries met in Washington in November 1957, presented technical papers, and discussed saline-water conversion. In addition to projects classifiable under the five groups previously mentioned, other subjects discussed included the role of nuclear energy in conversion processes, the use of salt-accumulating algae, and the thermodynamic properties of saline water. Of the 39 papers presented, 32 were written in the United States. Other papers included work done in Australia, the Union of South Africa, Algeria, the Netherlands, France, and England.

The use of water in oil production was discussed in an article in the technical press.[13] In the secondary-recovery and pressure-maintenance operations in Texas oilfields it was estimated that between 10 and 15 volumes of water was required for each volume of oil produced. Special treatment of the injected water was usually required to prevent clogging the pores in the oil-bearing strata. This treatment included precipitation, coagulation, and settling to remove certain suspended and dissolved substances and chlorination to control bacterial growth. Highly acidic brines were found to inhibit swelling of clay particles but also caused corrosion of metal structures. Chemical inhibitors and protective coatings were used to control corrosion.

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[13] Torrey, P. D., Needs and Uses of Water in Oil Production: Mines Magazine, vol. 47, No. 1, January 1957, pp. 23–25, 54.

Zinc

By O. M. Bishop[1] and Esther B. Miller[2]

WORLD mine production and smelter output of zinc attained record levels in 1957 despite falling demand. In the United States the zinc industry was characterized by peak smelter output of slab zinc, an alltime high in zinc imports, a substantial increase in stocks, a moderate decline in consumption, and sharp reductions in price. Slab zinc imported or smelted in the United States from foreign ores totaled 715,000 tons, and that smelted from domestic ores and scrap totaled 612,000 tons—a grand total of 1,327,000 tons. Of that quantity, 936,000 tons was consumed domestically, 11,000 tons was exported, and 380,000 tons was added to industry and Government stocks.

Prime Western grade zinc was quoted at 13.5 cents a pound, East St. Louis, throughout the early part of the year. Late in April the Commodity Credit Corporation announced its decision to modify the barter program under which large quantities of foreign metals (185,000 tons of zinc in the first 4 months of 1957) had been obtained. Other Government announcements indicated that strategic stocks of zinc were nearing objective levels and that buying for the long-term stockpile would soon cease. These announcements, coupled with excess supplies, caused the price to drop from 13.5 to 10.0 cents a pound between May 6 and July 1 and to remain 10 cents through the remainder of the year.

Domestic mines, which had produced at an annual rate of 591,000 tons in the first quarter of the year, reduced output by 22 percent in the last quarter and produced a total of 532,000 tons of recoverable zinc in the year. Numerous zinc and zinc-lead mines closed, and

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

others curtailed output. By October 1957 virtually all mines in the Tri-State district, about 30 percent of those in the Western States, and a few of those in States east of the Mississippi River were inactive. Employees at domestic lead and zinc mines and mills in October 1957 totaled 12,800, compared with an average 16,800 in 1956 and 24,300 in 1952.

Smelter output of 1,058,000 tons of slab zinc comprised 986,000 tons of primary zinc (45 percent from imported ores) and 72,000 tons of redistilled or secondary zinc. In addition to slab zinc, primary and secondary smelters and chemical plants processed ore and scrap to produce zinc oxide, lithopone, zinc dust, chemicals, and various alloys containing about 192,000 tons of zinc.

Imports of 269,000 tons of slab zinc and 526,000 tons of zinc in ores and concentrates totaled 795,000 tons, exceeding by 25,000 tons the record established in 1956.

Consumption of zinc totaled 1,232,000 tons—936,000 tons of slab zinc, 110,000 tons of ore for pigments and salts, and 186,000 tons of secondary zinc for various products.

Despite falling prices and minor cutbacks, foreign mine and smelter production of zinc rose to record levels in 1957, greatly exceeding commercial requirements. Much of the excess was shipped to the United States for sale on the open market and under barter contracts

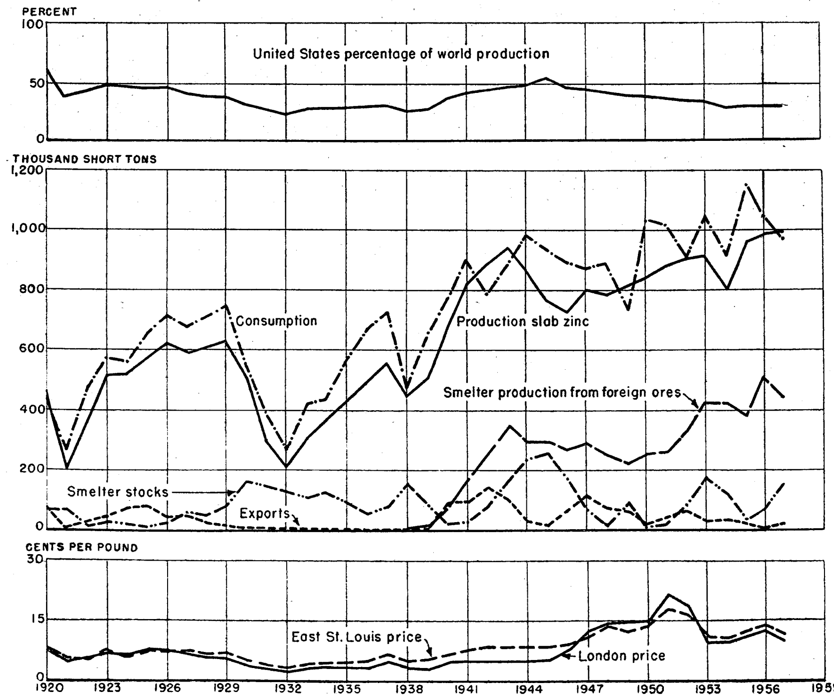

FIGURE 1.—Trends in the zinc industry in the United States, 1920–57. Consumption figures represent primary slab zinc plus zinc contained in pigments made directly from ore.

in which payment was in agricultural commodities. Deliveries under these contracts totaled 194,000 tons in 1957.

An interesting event in 1957 was the export of about 50,000 tons of Soviet and Polish zinc to western European markets.

TABLE 1.—Salient statistics of the zinc industry in the United States, 1948–52 (average) and 1953–57

	1948–52 (average)	1953	1954	1955	1956	1957
Production of slab zinc:						
By sources:						
From domestic ores short tons	583,073	495,436	380,312	582,913	470,093	539,692
From foreign ores do	263,352	420,669	422,113	380,591	513,517	446,104
Total primary do	846,425	916,105	802,425	963,504	983,610	985,796
From scrap do	57,620	52,875	68,013	66,042	72,127	72,481
Total production do	904,045	968,980	870,438	1,029,546	1,055,737	1,058,277
Stocks on hand at producers' plants:						
At primary plants short tons	44,105	176,725	121,847	37,322	64,794	153,338
At secondary plants do	2,086	3,268	1,549	1,942	2,081	2,495
Total	46,191	179,993	123,396	39,264	66,875	155,833
Imports (general):						
Ores (zinc content) short tons	307,274	513,724	455,427	478,044	525,350	525,730
Slab zinc do	115,976	234,576	156,858	195,696	244,978	269,034
Mine production of recoverable zinc short tons	638,749	547,430	473,471	514,671	542,340	531,735
Consumption:						
Slab zinc short tons	856,693	985,927	884,299	1,119,812	1,008,790	935,620
Ores (recoverable zinc content) short tons	119,669	118,244	99,247	118,135	113,388	[1] 110,311
Zinc-base scrap [2] (recoverable zinc content) short tons	84,243	73,936	62,166	74,547	70,871	72,084
Copper-base scrap (recoverable zinc content) short tons	151,509	160,499	132,051	149,630	125,535	108,832
Aluminum and magnesium-base scrap (recoverable zinc content) short tons	897	3,783	2,929	6,956	4,438	4,746
Total do	1,213,011	1,342,389	1,180,692	1,469,080	1,323,022	1,231,593
Exports: Slab zinc do	46,277	17,969	24,994	18,069	8,813	10,785
Price, Prime Western grade:						
East St. Louis cents per pound	14.76	10.86	10.69	12.30	13.49	11.40
London do	16.73	9.47	9.78	11.30	12.19	10.18
World mine production short tons	2,410,000	2,940,000	2,930,000	3,180,000	[3] 3,360,000	3,420,000
World smelter production do	2,188,000	2,600,000	2,700,000	2,970,000	[3] 3,120,000	3,230,000

[1] Includes ore used directly in galvanizing.
[2] Excludes redistilled slab and zinc produced by remelting.
[3] Revised figure.

LEGISLATION AND GOVERNMENT PROGRAMS

Provisions of the Defense Production Act of 1950, as amended, with respect to exploration continued to be carried out by the Defense Minerals Exploration Administration (DMEA) and those with respect to procurement by the General Services Administration (GSA). The Office of Minerals Mobilization in the United States Department of the Interior was responsible for evaluating metal and mineral supply requirements and developing mobilization programs based on them.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

The Defense Minerals Exploration Administration (DMEA) continued its program to encourage exploration and increase domestic reserves of strategic and critical minerals and metals. On exploration contracts for zinc and lead DMEA provided 50 percent of the approved cost of the projects. During 1957, 15 new contracts were executed for lead and zinc exploration. From the beginning of the program in 1951 through December 1957, 257 contracts involving lead and zinc authorized Government participation of $12 million and combined total expenditures (Government and private capital) of $25 million. Of the 257 exploration projects undertaken, 78 were certified as ore discoveries that ranged from several hundred tons of ore to 35 million tons or more at the project in eastern Tennessee.

TABLE 2.—Defense Minerals Exploration Administration contracts involving lead and zinc executed in 1957, by States

State and contractor	Property	County	Date approved	Total amount [1]
COLORADO				
General Minerals Corp	Summitville	Rio Grande	July 15	$149, 380
Leadville Lead & Uranium Corp	Hilltop	Park	Aug. 21	99, 418
IDAHO				
American Smelting & Refining Co	East Page mine	Shoshone	Sept. 18	660, 206
Clayton Silver Mines	Clayton mines	Custer	July 19	130, 840
MISSOURI				
St. Joseph Lead Co	Czar Knob Project	Crawford	Feb. 26	119, 950
Do	Courtois area	Washington	Mar. 18	258, 560
Do	Viburnum area	Iron	Apr. 3	277, 860
NEVADA				
John H. Uhalde	Aladdin mine	Elko	Apr. 29	62, 610
TENNESSEE				
National Lead Co	Puncheon Camp Creek.	Grainger	May 20	170, 125
New Jersey Zinc Co	Cedar Springs area, Copper Ridge Belt.	do	Mar. 29	105, 950
UTAH				
Western Resources, Inc	Sunbeam mine	Juab	Apr. 25	33, 268
VIRGINIA				
New Jersey Zinc Co	Bondurant area	Buckingham	June 27	8, 370
Do	Williams property	Wythe	June 26	42, 200
Do	Valzinco mine	Spottsylvania	July 19	12, 770
Do	Hunter area	Louisa	July 22	18, 680
				2, 150, 187
Net increases by amendment executed during 1957.				1, 094, 657
Total contracts plus amendments, 1957.				3, 244, 844

[1] Government participation was 50 percent in exploration projects for lead and zinc in 1957.

GOVERNMENT BARTER PROGRAM

Under authority of Public Law 480 (1954) and the Office of Defense Mobilization authorization of May 1956, the Department of Agriculture, through its agent, the Commodity Credit Corporation (CCC), continued to trade perishable surplus agricultural products for zinc and other commodities of foreign origin. In 1957 the CCC contracted for 109,584 tons of zinc (147,182 tons in 1956) to be added to the

Government's supplemental stockpile. On April 30 the Department of Agriculture ceased making new barter agreements pending an evaluation of the program. On May 28 the program was resumed with restrictions providing that agricultural commodities traded were in addition to marketings that otherwise would have taken place. Relatively few barter contracts were made after April 30 under the modified program.

GENERAL SERVICES ADMINISTRATION

The General Services Administration (GSA) continued to be responsible for stockpile procurement and administration, procurement under foreign-aid programs as agent of the International Cooperation Administration and administration of Defense Production Act programs, including domestic purchase programs. Purchases of zinc produced from domestic ores were made against the long-term stockpile objective for this metal throughout 1957. Such purchases are included in the 179,500 tons reported by the American Zinc Institute as shipped by domestic producers.

Foreign zinc received at GSA warehouses under barter agreements during the year totaled 193,929 tons (60,162 in 1956). Such zinc was placed in the supplemental stockpile and cannot be removed except by consent of Congress.

DOMESTIC PRODUCTION

Statistics on domestic production of zinc are compiled for both mine and smelter output. Mine output is the sum of the zinc recovered from all domestic primary ores, ore residues, mill tailings, and slags; the recovery at each smelter or other processing plant is the ratio of total zinc content of the products to total zinc input. Recovery at plants processing primary materials approximated 91.5 percent in 1957. Smelter production of slab zinc from domestic ores differs from mine recovery because there is a time lag in smelting and because more than 100,000 tons of zinc in ore and concentrate form are used annually in the direct manufacture of zinc pigments and chemicals and in galvanizing (Bethanizing). Secondary zinc recovered at smelters treating zinc-bearing scrap metals constitutes a large part of the domestic production of zinc in all forms.

MINE PRODUCTION

Mines in the United States produced 532,000 tons of recoverable zinc in 1957 compared with 542,000 tons in 1956. Under the stimulus of the 13.5-cent Prime Western price that was in effect until May 6, 1957, mine production increased, and the rate of output for the first 4 months of the year was 13 percent above the average rate for 1956. Thereafter, zinc prices fell, and mine production in the last quarter of 1957 was 19 percent below that in the last quarter of 1956. Table 4 shows ore production by States and the recoverable zinc and lead by major ore groups.

TABLE 3.—Mine production of recoverable zinc in the United States, 1948–52 (average) and 1953–57, by States, in short tons

State	1948–52 (average)	1953	1954	1955	1956	1957
Western States and Alaska:						
Alaska	6					
Arizona	57,152	27,530	21,461	22,684	25,580	33,905
California	7,821	5,358	1,415	6,836	8,049	2,969
Colorado	49,512	37,809	35,150	35,350	40,246	47,000
Idaho	80,630	72,153	61,528	53,314	49,561	57,831
Montana	69,741	80,271	60,952	68,588	70,520	50,520
Nevada	19,027	5,812	1,035	2,670	7,488	5,292
New Mexico	39,301	13,373	6	15,277	35,010	32,680
Oregon	6					
South Dakota	6					
Texas	5					
Utah	36,221	29,184	34,031	43,556	42,374	40,846
Washington	15,295	32,786	22,304	29,536	25,609	24,000
Total	374,723	304,276	237,882	277,811	304,437	295,043
West Central States:						
Arkansas	23					
Kansas	29,314	15,515	19,110	27,611	28,665	15,859
Missouri	9,205	9,981	5,210	4,476	4,380	2,951
Oklahoma	48,592	33,413	43,171	41,543	27,515	14,951
Total	87,134	58,909	67,491	73,630	60,560	33,761
States east of the Mississippi River:						
Illinois	19,742	14,556	14,427	21,700	24,039	22,185
Kentucky	1,808	489	458		417	837
New Jersey	60,891	45,700	37,416	11,643	4,667	12,530
New York	36,710	51,529	53,199	53,016	59,111	64,659
North Carolina						2
Tennessee	34,259	38,465	30,326	40,216	46,023	58,063
Virginia	12,437	16,676	16,738	18,329	19,196	23,080
Wisconsin	11,045	16,830	15,534	18,326	23,890	21,575
Total	176,892	184,245	168,098	163,230	177,343	202,931
Grand total	638,749	547,430	473,471	514,671	542,340	531,735

Western States.—Mines in the Western States yielded 55 percent of the total domestic mine output of zinc—essentially the same proportion as in 1956; however, the 295,000 tons produced in 1957 was 9,000 tons less than the output in 1956. Sharp declines in Montana, California, and New Mexico and small decreases in several other States more than offset substantial increases in Arizona, Colorado, and Idaho.

Idaho was the largest producer in the Western States and third largest in the Nation. Total mine production of zinc in Idaho in 1957 was 57,800 tons, nearly 17 percent more than in 1956. In order of output, the three largest producers were Star mine of The Bunker Hill Co., Bunker Hill mine of The Bunker Hill Co., and Page mine of American Smelting & Refining Co., all in Shoshone County. In May the 1,000-ton concentrator of the Morning mine of American Smelting & Refining Co. was destroyed by fire; thereafter the ore, exclusively from development headings, was processed at the Golconda mill.

Montana was the second largest zinc-producing State in the West and fourth largest in the United States. Although the State ranked first in the Nation in 1956, zinc production decreased 28 percent in 1957 owing to sharp curtailment of output from The Anaconda Co. units at Butte. The Anaconda Co. Lexington mine, usually a large zinc producer, was closed in 1957. Much of the zinc mined at Butte

TABLE 4.—Ores yielding lead and zinc in the United States in 1957, in short tons [1]

State	Zinc ore			Lead ore			Lead-zinc ore			Copper-lead, copper-zinc, and copper-lead-zinc ores			Total		
	Gross weight	Lead	Zinc	Gross weight	Lead	Zinc	Gross weight	Lead	Zinc	Gross weight	Lead	Zinc	Gross weight of ore	Lead	Zinc
Alaska				55	9								55	9	
Arizona	7,072		1,464	9,762	1,722	132	371,412	10,497	23,542	91,059	195	8,754	479,305	12,414	33,892
California				1,609	396	2	68,153	3,042	2,961				69,762	3,438	2,963
Colorado	785	9	62	25,935	1,259	47	422,610	10,914	33,637	499,562	8,525	13,254	948,892	20,707	47,000
Idaho				55,897	2,825	148	1,157,206	61,978	48,441	22	4		1,213,125	64,807	48,589
Illinois	491,239	1,021	15,905	1,538	674	1	478	96	9				493,255	1,791	15,915
Kansas	531,008	1,522	10,012	2,607	49	2	399,954	2,686	5,845				933,569	4,257	15,859
Missouri	2,900		85	[3] 7,265,023	107,276	2,006	523,005	12,236	860	[4] 354,764	6,751		8,145,692	126,263	2,951
Montana	632,397	9,706	43,574	7,003	926	114	32,964	1,841	1,641				672,364	12,473	45,329
Nevada	1,003	12	104	23,055	3,666	303	60,438	1,281	4,754	33	2		84,529	4,961	5,161
New Mexico	327,591	1,655	22,705	902	102	12	82,582	3,076	9,962				411,075	4,833	32,679
Oklahoma	238,587	722	5,246	92,607	1,480	422	568,779	4,981	9,283				899,973	7,183	14,951
Tennessee	1,714,582		54,662							1,394,020		3,401	3,108,602		58,063
Utah	20	1	5	34,680	2,897	259	543,577	39,844	38,845	44		8	578,321	42,742	39,117
Washington				110	72		1,189,578	12,658	23,453				1,189,688	12,730	23,453
Wisconsin	719,324	1,808	21,382				8,518	92	193				727,842	1,900	21,575
New York			11,689					1,667	52,970					1,667	64,659
New Jersey	343,852		12,530				1,261,424						1,605,276		12,530
Virginia [2]			3,809					3,143	19,271					3,143	23,080
Total	5,010,360	16,456	203,234	7,520,783	123,353	3,448	6,690,678	170,032	275,667	2,339,504	15,477	25,417	21,561,325	325,318	507,766

[1] Does not include lead or zinc recovered from other ores, tailings, slags, dumps, etc., except where exclusion was impossible.
[2] Data partly combined to avoid disclosing individual company confidential data.
[3] Includes 1,271,684 tons of tailings containing 7,247 tons of recoverable lead and 788 tons of recoverable zinc.
[4] Includes some copper concentrate yielding 38 tons of recoverable lead.

came from the manganese-rich ores of the Anselmo and Emma mines. Unfavorable demand caused Anaconda to postpone its Northwest project, which was scheduled to develop high-zinc deposits in the northwestern Butte area. Smaller producing mines in other areas included the Trout-Algonquin and Scratch Awl mines in Granite County and the Jack Waite mine in Sanders County.

Mine production in Colorado rose to 47,000 tons of recoverable zinc in 1957, a 17-percent gain over 1956. Increased output by larger producers more than offset shutdowns due to depressed zinc prices during the second half of 1957. Mines that closed included American Smelting & Refining Co. Keystone unit, the Rico Argentine Mining Co. Rico group, and the Resurrection Mining Co. Leadville properties. The Eagle unit of New Jersey Zinc Co. and the mines of Idarado Mining Co. continued to be the largest zinc producers in Colorado.

Utah mines produced 4 percent less zinc in 1957 than in 1956 owing to the closing of the Eagle-Blue Bell, Chief No. 1, and Plutus mines in June and the Mayflower-Park Galena (New Park) mine in September. The United States & Lark mine continued to be the largest zinc producer in the State.

A 33-percent increase in zinc output was reported by Arizona mines in 1957 despite the closing of several mines. The San Xavier mine suspended operations in June, the Athletic mine in July, the Coronado Copper-Zinc Co. Johnson Camp unit in August, and the Trench group in October. The Iron King mine of the Shattuck Denn Corp., the principal producer in the State, operated throughout the year.

Mines in New Mexico yielded 7 percent less zinc in 1957 than in 1956. The decrease was due mainly to closing of the Kearney mine of the Peru Mining Co. in April, the Ground Hog mine of American Smelting & Refining Co. in July, and their custom mills at Deming.

Zinc output in Washington declined 6 percent in 1957. The Van Stone open pit of American Smelting & Refining Co. closed July 15. Other large zinc producers in the State were the Grandview and Pend Oreille mines.

Mine production in California and Nevada declined sharply in 1957. The Anaconda Co. closed its Darwin and Shoshone mine groups in California about midyear, and Combined Metals Reduction Co. shut down its mines at Pioche, Nev., in August.

West Central States.—Mine production of recoverable zinc from Kansas, Missouri, and Oklahoma dropped from 60,600 tons in 1956 to 33,800 tons in 1957—a 44-percent decline. In the Tri-State district, The Eagle-Picher Co. operated its mines and Central custom mill intermittently. Largest single mine producer in the Tri-State district was the Ballard mine of National Lead Co. Mine output from the district was the lowest since the 1880's.

The southeast Missouri lead belt produced zinc concentrates as a byproduct from lead ores and old tailings treated at mills of the St. Joseph Lead Co. Recoverable zinc produced in 1957 was approximately 3,000 tons.

States East of the Mississippi River.—Eight States east of the Mississippi mined zinc ore in 1957. Output totaled 203,000 tons of recoverable zinc. Substantial increases in New Jersey, New York, Tennessee, and Virginia were only slightly offset by declines in Illinois and Wisconsin. The net result was a 14-percent increase in 1957.

A 9-percent increase in zinc production from the Balmat and Edwards mines of the St. Joseph Lead Co. in St. Lawrence County raised New York's output to a record high of 64,700 tons in 1957. New York became the leading mine producer of zinc in the United States, and the Balmat became the principal zinc-producing mine. St. Joseph Lead Co. was deepening the Balmat No. 2 shaft below the 1,900-foot level in 1957, and at the end of the year the shaft was 2,100 feet deep.

Mines of Tennessee yielded 58,100 tons of zinc in 1957, 26 percent more than in 1956. The State ranked second only to New York in total mine output. The increased output came partly from ore bodies discovered or delineated with the assistance of the Defense Minerals Exploration Administration. The New Jefferson City mine of New Jersey Zinc Co. in Jefferson County operated throughout 1957. The company's announced results were excellent, and increased ore reserves permitted plans to double the mining rate. Development of New Jersey Zinc Co. Flat Gap mine near Treadway neared completion in 1957, but the company anticipated no production from the 1,000-ton-per-day unit until zinc prices increased. American Zinc Co. Mascot No. 2, North Friends Station, and Young mines were operated at capacity during 1957. Its Grasselli mine was shut down the end of December pending higher zinc prices. The Coy mine, the newly developed American Zinc Co. mine in Tennessee, was under development in 1957, and small tonnages of development ore were milled at Mascot. Tennessee Coal and Iron Division of United States Steel reduced its Davis-Bible mine at Jefferson City to a 4-day week in mid-July. In Polk County zinc concentrate was recovered by the Tennessee Copper Co. from iron-copper-zinc sulfide ores. Exploration for new zinc ore bodies continued at a high level in the carbonate rocks of the East Tennessee Valley.

Ore mined in Virginia in 1957 yielded 23,100 tons of zinc. The major producer was the Austinville mine, in Wythe County, owned by New Jersey Zinc Co. The company announced that production of ore from the recently developed Ivanhoe mine began late in September; the ore was transported through the 13,000-foot tunnel to the Austinville shaft. Ore from the Ivanhoe mine was milled at the Austinville plant. New Jersey Zinc Co. continued exploration at the Arminius mine in Louisa County to establish the economics of its anticipated operation. Tri-State Zinc, Inc., began production from its newly developed Timberville mine in April.

Mines of northern Illinois and Wisconsin produced approximately 1,000 tons less zinc in 1957. Among other mine shutdowns during the year were Eagle-Picher Co. Linden-Wisconsin mine and mill unit and the mines and mill of Vinegar Hill Division of American Zinc, Lead & Smelting Co. The major producers in 1957 were the Eagle-Picher Co. and Tri-State Zinc, Inc.

Although zinc production in New Jersey was considerably higher in 1957 than in 1956, it remained lower than normal because of the shutdown of the Sterling mine of the New Jersey Zinc Co. in Sussex County on August 16.

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Kentucky's zinc output comes from concentrates produced in milling fluorspar-zinc-lead ores of western Kentucky.

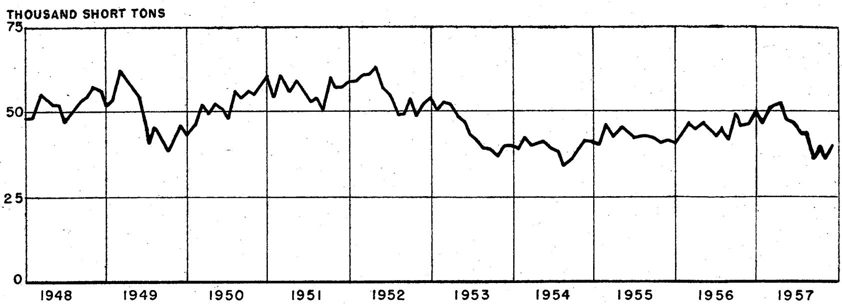

FIGURE 2.—Mine production of recoverable zinc in the United States, 1948–57 by months.

TABLE 5.—Mine production of recoverable zinc in the United States, 1956–57, by months

Month	1956	1957	Month	1956	1957
January	41,082	50,406	August	45,532	43,090
February	42,703	46,344	September	42,513	35,514
March	47,745	51,040	October	49,600	39,746
April	44,971	52,367	November	46,170	36,043
May	47,286	47,791	December	46,445	39,895
June	45,141	46,154			
July	43,152	43,345	Total	542,340	531,735

The 25 leading zinc-producing mines in the United States in 1956, listed in table 6, yielded 71 percent of the total domestic output of zinc. The 3 leading mines supplied 23 percent, and the first 6 mines contributed 34 percent.

TABLE 6.—Twenty-five leading zinc-producing mines [1] in the United States in 1956, in order of output

Rank	Mine	District	State	Operator	Type of ore
1	Balmat	St. Lawrence County.	New York	St. Joseph Lead Co	Lead-zinc.
2	Butte Mines	Summit Valley	Montana	The Anaconda Co	Zinc.
3	The United States & Lark.	West Mountain (Bingham).	Utah	United States Smelting, Refining & Mining Co.	Lead-zinc.
4	Eagle	Red Cliff (Battle Mountain).	Colorado	The New Jersey Zinc Co	Do.
5	Austinville	Austinville	Virginia	do	Do.
6	Iron King	Big Bug	Arizona	Shattuck Denn Mining Co.	Do.
7	Star	Coeur d'Alene	Idaho	The Bunker Hill Co	Do.
8	Davis-Bible Group.	Eastern Tennessee.	Tennessee	United States Steel Corp., Tennessee Coal & Iron Division.	Zinc.
9	Sterling Hill	New Jersey	New Jersey	The New Jersey Zinc Co	Do.
10	Jefferson City	Eastern Tennessee.	Tennessee	do	Do.
11	Mascot No. 2	do	do	American Zinc Co. of Tennessee.	Do.
12	Edwards	St. Lawrence County.	New York	St. Joseph Lead Co	Do.

See footnote at end of table.

TABLE 6.—Twenty-five leading zinc-producing mines [1] in the United States in 1956, in order of output—Continued

Rank	Mine	District	State	Operator	Type of ore
13	Treasury Tunnel-Black Bear-Smuggler Union.	Upper San Miguel.	Colorado	Idarado Mining Co	Copper-lead-zinc.
14	Bunker Hill	Coeur d'Alene	Idaho	The Bunker Hill Co	Lead-zinc.
15	Hanover	Central	New Mexico	The New Jersey Zinc Co	Zinc.
16	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co.	Lead-zinc.
17	Page	Coeur d'Alene	Idaho	American Smelting & Refining Co.	Do.
18	Bayard	Central	New Mexico	United Smelting, Refining & Mining Co.	Zinc.
19	Gray	Upper Mississippi Valley.	Illinois	Tri-State Zinc Co., Inc	Do.
20	Young	Eastern Tennessee.	Tennessee	American Zinc Co. of Tennessee.	Do.
21	Shullsburg	Upper Mississippi Valley.	Wisconsin	The Eagle-Picher Co	Do.
22	Ground Hog Unit	Central	New Mexico	American Smelting & Refining Co.	Lead-zinc.
23	United Park City Mines.	Park City Region.	Utah	United Park City Mines Co.	Do.
24	Graham-Snyder-Spillane-Feehan.	Upper Mississippi Valley.	Illinois	The Eagle-Picher Co	Zinc.
25	Grandview	Metaline	Washington	American Zinc, Lead & Smelting Co.	Lead-zinc.

[1] Excludes old slag dump of the Bunker Hill Co., Kellogg, Idaho.

TABLE 7.—Mine production of zinc in the principal districts [1] of the United States, 1948–52 (average) and 1953–57, in terms of recoverable zinc, in short tons

District	State	1948–52 (average)	1953	1954	1955	1956	1957
St. Lawrence County	New York	36,709	51,529	53,199	53,016	59,111	64,659
Eastern Tennessee [2]	Tennessee	34,259	38,465	30,326	40,216	46,023	58,063
Coeur d'Alene	Idaho	77,916	68,650	58,736	50,527	46,738	54,825
Summit Valley (Butte)	Montana	64,117	75,170	53,527	62,588	63,375	43,169
Upper Mississippi Valley	Northern Illinois, Iowa,[3] Wisconsin.	24,964	26,286	25,441	31,411	38,498	37,490
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	85,218	55,729	64,322	69,696	57,215	30,895
Central	New Mexico	35,668	12,743		15,104	33,631	30,623
West Mountain (Bingham).	Utah	19,838	19,669	20,489	21,864	24,310	24,953
Red Cliff (Battle Mountain).	Colorado	21,792	16,850	18,604	21,322	19,766	24,105
Metaline	Washington	10,135	(4)	(4)	(4)	(4)	17,244
New Jersey	New Jersey	60,890	45,700	37,416	11,643	4,667	12,530
Park City region	Utah	8,812	4,848	6,650	12,295	10,983	12,322
Upper San Miguel	Colorado	7,482	10,414	7,899	6,532	(4)	11,571
Kentucky-Southern Illinois	Kentucky-Southern Illinois.	7,631	5,589	4,978	8,615	9,848	7,107
California (Leadville)	Colorado	7,241	3,945	2,437	1,621	2,128	6,568
Northport	Washington	2,826	14,944	13,296	17,667	12,725	6,181
Eureka (Bagdad)	Arizona	2,425	2.594	1,126	444	3	5,924
Cochise	do	2,634	3,893	3,566	3,295	2,795	2,510
Magdalena	New Mexico	2,639	512		98	1,031	1,991
Creede	Colorado	709	858	1,111	745	927	1,819
Flint Creek	Montana	326	(4)	1,290	1,400	2,046	1,619
Silver Bell	Arizona	89	1,324	441	93	328	1,454
Pima (Sierritas, Papago, Twin Buttes).	do	5,525	11		1,310	2,786	1,288
Warm Springs	Idaho	1,684	3,026	2,584	1,833	1,388	1,208
Ophir	Arizona	635	692	753	734	671	1,043
Aravaipa	do	1,104	1,732	1,366	1,670	1,185	696
Bayhorse	Idaho	372	264	(4)	790	1,203	630
Tintic	Utah	4,431	2,433	4,335	4,018	1,119	481
Rush Valley and Smelter (Tooele County).	do	1,897	1,528	1,738	1,434	1,622	396
Breckinridge	Colorado	389	1,200	1,186	615	830	383

See footnotes at end of table.

TABLE 7.—Mine production of zinc in the principal districts [1] of the United States, 1948–52 (average) and 1953–57, in terms of recoverable zinc, in short tons—Continued

District	State	1948–52 (average)	1953	1954	1955	1956	1957
Yellow Pine (Goodsprings)	Nevada	864	-------	-------	716	1,603	107
Pioneer (Rico)	Colorado	2,232	2,634	2,896	(4)	(4)	-------
Warren (Bisbee)	Arizona	18,614	1,182	-------	-------	-------	-------
Austinville [5]	Virginia	12,437	16,676	16,738	18,329	19,156	(4)
Big Bug [5]	Arizona	9,119	10,476	10,453	11,234	13,934	(4)
Coso [5]	California	4,799	(4)	(4)	(4)	(4)	(4)
Elk Mountain [5]	Colorado	126	(4)	(4)	(4)	(4)	(4)
Harshaw [5]	Arizona	3.603	4,186	4,193	(4)	(4)	(4)
Pioche [5]	Nevada	16,752	(4)	(4)	(4)	(4)	(4)
Smelter (Lewis and Clark County).[5]	Montana	2,495	2,924	5,301	4,077	4,361	(4)
Smelter (Salt Lake County).	Utah	20	-------	-------	3,148	(4)	(4)

[1] Districts producing 1,000 short tons or more in any year of the period 1953–57.
[2] Includes zinc recovered from copper-zinc-pyrite ore in Polk County.
[3] No production in Iowa since 1917.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] This district not listed in order of 1957 output.

SMELTER AND REFINERY PRODUCTION

The zinc smelting and refining industry in 1957 comprised 19 primary and 11 secondary plants producing slab zinc, zinc pigments, zinc dust, zinc salts, and zinc alloys for consuming industries. Manufacturers of chemicals, pigments, die-casting alloys, rolled zinc, and brass also produced secondary zinc.

Primary Smelters and Electrolytic Plants.—The primary reduction plants processed zinc ore and concentrate, zinc fume from Waelz and slag-fuming plants, other primary zinc-bearing materials, and about a third of all zinc-base scrap.

Collectively, primary zinc plants reported production of 1,021,000 tons of slab zinc, of which 35,200 tons was redistilled secondary zinc. Some of the primary plants also produced zinc oxide, zinc dust, and lithopone.

Primary Capacity.—Primary-plant capacity for slab zinc at the end of 1957 was reported to be 1,162,600 tons. The 5 electrolytic plants reported 3,178 of their 4,072 electrolytic cells in use at the end of the year and an output of 409,500 tons or 85 percent of the reported 479,500 tons of capacity. The 9 horizontal-retort plants reported 41,828 of their 54,640 retorts in use at the end of the year. One plant, that of the United States Steel Corp. at Donora, Pa., was closed November 23, 1957. The 5 remaining primary smelters were the continuous-distilling vertical-retort plants at Meadowbrook, W. Va., Depue, Ill., Palmerton, Pa., Josephtown, Pa., and Herculaneum, Mo.; the first 3 used New Jersey Zinc Co. externally gas-fired vertical retorts, and the last 2 used electrothermic distillation retorts developed by St. Joseph Lead Co. The Herculaneum plant recovers zinc directly from Herculaneum lead smelter slags and differs from slag-fuming plants in the Western States in that the zinc is condensed and tapped as Prime Western metal rather than being produced as a densified fume containing about 70 percent zinc. Combined horizontal- and vertical-retort production of 576,300 tons was only 84 percent of the reported capacity of 683,100 tons.

TABLE 8.—United States primary zinc smelters, their location and group capacity for slab zinc in 1957

Type of plant	Plant location	Slab-zinc capacity (short tons)
Primary plants:		
Electrolytic plants:		
American Smelting & Refining Co	Corpus Christi, Tex	479,500
American Zinc Co. of Illinois	Monsanto, Ill	
The Anaconda Co	Anaconda, Mont	
Do	Great Falls, Mont	
The Bunker Hill Co	Kellogg, Idaho	
Horizontal-retort plants:		
American Smelting & Refining Co	Amarillo, Tex	683,001
American Zinc Co. of Illinois	Dumas, Tex	
Do [1]	Fairmont City, Ill	
Athletic Mining & Smelting Co	Fort Smith, Ark	
Blackwell Zinc Co	Blackwell, Okla	
The Eagle-Picher Co	Henryetta, Okla	
Matthiessen & Hegeler Zinc Co	LaSalle, Ill	
National Zinc Co	Bartlesville, Okla	
United States Steel Corp.[2]	Donora, Pa	
Vertical-retort plants:		
Matthiessen & Hegeler Zinc Co	Meadowbrook, W. Va	
The New Jersey Zinc Co	Depue, Ill	
The New Jersey Zinc Co. (of Pennsylvania)	Palmerton, Pa	
St. Joseph Lead Co	Josephtown, Pa	
Do	Herculaneum, Mo	

[1] Furnaces idle entire year.
[2] Plant closed November 23, 1957—to be dismantled.

Waelz Kilns.—Six Waelz kilns in 1957 processed and concentrated the zinc content of horizontal-retort residues and similar plant scrap. One Waelz plant, that of Zinc Nacional at Monterrey, Mexico, was used for pyrometallurgical concentration of oxidized zinc ores for shipment to the United States. Plants operated in the United States were as follows:

Illinois:
- Fairmont City—American Zinc Co. of Illinois.[3]
- LaSalle—Matthiessen & Hegeler Zinc Co.

Kansas: Cherryvale—National Zinc Co., Inc.[3]
Oklahoma: Henryetta—The Eagle-Picher Co.
Pennsylvania:
- Donora—United States Steel Corp., American Steel and Wire Division.
- Palmerton—The New Jersey Zinc Co.

West Virginia: Moundsville—St. Joseph Lead Co.[4]

Slag-Fuming Plants.—Many lead ores and concentrates smelted throughout the world contain considerable zinc that accumulates in lead blast-furnace slags. Such slags, commonly containing 7½ to 12½ percent zinc, were treated to extract zinc and remaining lead at the following plants in 1957:

California: Selby—American Smelting & Refining Co.
Idaho: Kellogg—The Bunker Hill Co.
Montana: East Helena—The Anaconda Co.
Texas: El Paso—American Smelting & Refining Co.
Utah: Tooele—International Smelting & Refining Co

These 5 plants treated 867,100 tons of hot and cold slag (including some crude ore at the Tooele plant), which yielded 159,300 tons of oxide fume containing 105,200 tons of recoverable zinc. Corre-

[3] Plant idle entire year.
[4] Plant closed in second quarter 1957.

sponding figures for 1956 were 799,000, 145,900, and 97,100 tons, respectively.

Secondary Zinc Smelters.—Zinc-base scrap—a term that includes skimmings and drosses, die-cast alloys, old zinc, engravers' plates, new clippings, and chemical residues—was smelted chiefly at 11 secondary smelters, although about a third usually is reduced at primary smelters and much of the sal ammoniac skimmings is processed at chemical plants. Secondary smelters depend mostly on the galvanizers and dealers for their supply of the various types of scrap materials.

TABLE 9.—United States secondary zinc smelters, their location and capacity for slab zinc in 1957

Type of plant	Plant location	Slab zinc capacity (short tons)
Secondary plants:		
American Smelting & Refining Co	Beckemeyer, Ill	61,100
American Smelting & Refining Co., Federated Metals Division.	Los Angeles, Calif	
American Zinc Co. of Illinois	Hillsboro, Ill	
Arco Die Cast Metals Co	Detroit, Mich	
W. J. Bullock, Inc	Fairfield, Ala	
General Smelting Co	Bristol, Pa	
Gulf Reduction Co	Houston, Tex	
Pacific Smelting Co	Torrance, Calif	
Sandoval Zinc Co	Sandoval, Ill	
Superior Zinc Corp	Bristol, Pa	
Wheeling Steel Corp	Martins Ferry, Ohio	

Primary and secondary smelting plants that treated zinc-base scrap in 1957 produced 72,500 tons of redistilled zinc, 6,400 tons of remelt zinc, and 26,700 tons of zinc dust. The zinc content of these products totaled 104,700 tons.

Details of consumption and stocks of zinc-base scrap, output of secondary zinc and zinc-alloy products, and zinc recovered from scrap by kind of scrap are given in tables 10, 11, and 12.

Additional details on 108,800 tons of zinc recovered in processing copper-base scrap (table 12) may be obtained in the Secondary section of the Copper chapter of this volume.

SLAB ZINC

Domestic smelters produced a record output of 1,058,300 tons of slab zinc in 1957, about 2,500 tons more than in 1956, the previous record year. Of the output, 985,800 tons or 93 percent was primary metal and 72,500 tons was redistilled secondary zinc. The primary production was 55 percent domestic and 45 percent foreign, and 58 percent was distilled and 42 percent electrolytic slab zinc as in 1956. The output of redistilled secondary zinc at primary plants increased again and accounted for 35,200 of the 72,500 tons of redistilled secondary zinc.

Prime Western zinc, which comprised 41 percent of the total (38 percent in 1956), was the principal grade produced in 1957. Special

TABLE 10.—Stocks and consumption of new and old zinc scrap in the United States in 1957, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and distillers:						
New clippings	219	2,232	2,309		2,309	142
Old zinc	519	3,642		3,789	3,789	372
Engravers' plates	870	2,672		3,085	3,085	457
Skimmings and ashes	6,494	28,449	31,582		31,582	3,361
Sal skimmings	497	196	264		264	429
Die-cast skimmings	1,809	11,848	11,403		11,403	2,254
Galvanizers' dross	8,755	55,141	59,542		59,542	4,354
Die castings	4,742	36,053		36,767	36,767	4,028
Rod and die scrap	954	8,892		8,268	8,268	1,578
Flue dust	155	7,088	7,057		7,057	186
Chemical residues	1,326	7,743	8,667		8,667	402
Total	26,340	163,956	120,824	51,909	172,733	17,563
Chemical plants, foundries, and other manufacturers:						
New clippings	36	400	423		423	13
Old zinc	16	67		69	69	14
Engravers' plates		135		135	135	
Skimmings and ashes	2,070	2,447	2,281		2,281	2,236
Sal skimmings	10,982	18,340	21,768		21,768	7,554
Galvanizers' dross	18	117	53		53	82
Die castings	48	1,029	832	213	1,045	32
Rod and die scrap	36	36		66	66	6
Flue dust	270	170	340		340	100
Chemical residues	1,346	14,314	14,268		14,268	1,392
Total	14,822	37,055	39,965	483	40,448	11,429
Grand total:						
New clippings	255	2,632	2,732		2,732	155
Old zinc	535	3,709		3,858	3,858	386
Engravers' plates	870	2,807		3,220	3,220	457
Skimmings and ashes	8,564	30,896	33,863		33,863	5,597
Sal skimmings	11,479	18,536	22,032		22,032	7,983
Die-cast skimmings	1,809	11,848	11,403		11,403	2,254
Galvanizers' dross	8,773	55,258	59,595		59,595	4,436
Die castings	4,790	37,082	832	36,980	37,812	4,060
Rod and die scrap	990	8,928		8,334	8,334	1,584
Flue dust	425	7,258	7,397		7,397	286
Chemical residues	2,672	22,057	22,935		22,935	1,794
Total	41,162	201,011	160,789	52,392	213,181	28,992

TABLE 11.—Production of secondary zinc and zinc-alloy products in the United States, 1948–52 (average) and 1953–57, gross weight in short tons

Products	1948–52 (average)	1953	1954	1955	1956	1957
Redistilled slab zinc	57,620	52,875	[1] 68,013	[1] 66,042	[1] 72,127	[1] 72,481
Zinc dust [2]	28,145	25,297	26,714	30,118	28,048	26,715
Remelt spelter	5,747	2,938	4,456	5,019	7,900	6,404
Remelt die-cast slab	8,830	5,695	9,418	12,729	12,900	10,328
Zinc-die and die-casting alloys	4,160	3,411	4,037	6,377	4,306	6,440
Galvanizing stocks	348	107	186	325	369	240
Rolled zinc	3,113	3,132	2,701	2,915	2,179	185
Secondary zinc in chemical products	40,415	34,680	26,078	28,917	30,675	33,361

[1] Includes redistilled slab made from remelt die-cast slab.
[2] Includes zinc dust produced from other than scrap.

TABLE 12.—Zinc recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1956–57, in short tons

Kind of scrap	1956	1957	Form of recovery	1956	1957
New scrap:			As metal:		
Zinc-base	116,198	108,319	By distillation:		
Copper-base	88,623	75,933	Slab zinc [1]	71,420	71,737
Aluminum-base	2,728	3,004	Zinc dust [2]	27,415	26,255
Magnesium-base	60	59	By remelting	9,091	6,705
Total	207,609	187,315	Total	107,926	104,697
Old scrap:			In zinc-base alloys	15,972	15,640
Zinc-base	35,184	42,207	In brass and bronze	122,204	105,437
Copper-base	36,912	32,899	In aluminum-base alloys	4,413	4,758
Aluminum-base	1,545	1,585	In magnesium-base alloys	165	157
Magnesium-base	105	98	In chemical products:		
			Zinc oxide (lead-free)	10,076	15,729
Total	73,746	76,789	Zinc sulfate	4,780	5,322
			Zinc chloride	11,139	11,407
Grand total	281,355	264,104	Lithopone	4,034	(3)
			Miscellaneous	646	957
			Total	173,429	159,407
			Grand total	281,355	264,104

[1] Includes zinc content of redistilled slab made from remelt die-cast slab.
[2] Includes zinc content of dust made from other than scrap.
[3] Included under "Miscellaneous."

High Grade constituted 34 percent of all grades (34 percent in 1956), High Grade 14 percent (15 percent in 1956), Brass Special 8 percent (9), Intermediate 3 percent (4), and Select a small fraction of 1 percent in both 1957 and 1956.

In 1957 Pennsylvania ranked first among the States in production of primary slab zinc; Montana ranked second and Texas third. The slab-zinc output of Pennsylvania, West Virginia, Oklahoma, and Arkansas was distilled, that of Montana and Idaho was electrolytic, and part of that of Illinois and Texas was distilled and part electrolytic.

TABLE 13.—Primary and redistilled secondary slab zinc produced in the United States, 1948–52 (average) and 1953–57 in short tons

Year	Primary			Redistilled secondary	Total (excludes zinc recovered by remelting)
	From domestic ores	From foreign ores	Total		
1948–52 (average)	583,073	263,352	846,425	57,620	904,045
1953	[1] 495,436	[1] 420,669	916,105	52,875	968,980
1954	[1] 380,312	[1] 422,113	802,425	68,013	870,438
1955	582,913	[1] 380,591	963,504	66,042	1,029,546
1956	[1] 470,093	[1] 513,517	983,610	72,127	1,055,737
1957	539,692	446,104	985,796	72,481	1,058,277

[1] Includes a small tonnage of slab zinc further refined into high-grade metal.

TABLE 14.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1948–52 (average) and 1953–57, in short tons

CLASSIFIED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled	Redistilled secondary		Total
			At primary smelters	At secondary smelters	
1948–52 (average)	333,581	512,844	22,875	34,745	904,045
1953	370,870	545,235	17,645	35,230	968,980
1954	311,237	491,188	31,658	36,355	870,438
1955	389,891	573,613	24,747	41,295	1,029,546
1956	410,417	573,193	30,221	41,906	1,055,737
1957	409,483	576,313	35,215	37,266	1,058,277

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		
1948–52 (average)	265,595	190,566	24,123	51,678	7,682	364,401	904,045
1953	312,810	180,188	14,720	56,219	1,930	403,113	968,980
1954	270,159	132,980	19,284	52,662	1,233	394,120	870,438
1955	378,215	138,597	23,792	80,209	3,904	404,829	1,029,546
1956	356,756	162,467	37,691	96,291	2,400	400,132	1,055,737
1957	354,042	152,317	32,262	84,291	1,150	434,215	1,058,277

TABLE 15.—Primary slab zinc produced in the United States, by States where smelted, 1948–52 (average) and 1953–57, in short tons

Year	Arkansas	Idaho	Illinois	Montana	Oklahoma	Pennsylvania	Texas and West Virginia [1]	Total	
								Short tons	Value
1948–52 (average)	19,362	49,330	102,446	212,772	152,620	174,744	135,151	846,425	$254,950,464
1953	20,379	54,037	129,904	222,354	134,918	192,279	162,234	916,105	210,154,487
1954	8,576	47,404	92,262	154,024	153,846	180,706	165,607	802,425	173,805,255
1955	21,481	56,625	102,808	207,366	160,961	218,469	195,794	963,504	236,829,283
1956	27,651	57,799	101,826	214,755	166,173	198,968	216,438	983,610	270,099,306
1957	23,080	68,831	[2] 107,294	198,036	157,633	[3] 247,836	[4] 183,086	985,796	229,493,309

[1] Includes Missouri, 1948–53, 1955, 1956.
[2] Includes Missouri.
[3] Includes West Virginia.
[4] Texas only.

BYPRODUCT SULFURIC ACID

Sulfuric acid was made from sulfur dioxide gases produced in roasting zinc sulfide concentrate at zinc smelters, where demand for sulfuric acid warranted the plant investment and operation. At several such plants elemental sulfur also was burned to increase acid-making capacity.

TABLE 16.—Sulfuric acid (basis, 100 percent) made at zinc sulfide roasting plants in the United States, 1948–52 (average) and 1953–57

Year	Made from zinc sulfide [1]		Made from native sulfur		Total [1]		
	Short tons	Value [2]	Short tons	Value [2]	Short tons	Value [2]	
						Total	Average per ton
1948–52 (average)	583,329	$8,966,777	218,642	$3,347,842	801,971	$12,314,619	$11.89
1953	636,864	11,397,458	229,951	4,115,262	866,815	15,512,720	13.90
1954	612,250	11,642,763	156,984	2,985,268	769,234	14,628,031	14.77
1955	782,938	14,687,012	153,622	2,881,771	936,560	17,568,783	14.57
1956	807,477	15,272,091	136,749	2,586,380	944,226	17,858,471	14.69
1957	855,357	15,450,832	135,843	2,453,805	991,200	17,904,637	14.03

[1] Includes acid from foreign zinc sulfide.
[2] At average of sales of 60° B. acid.

ZINC DUST

The zinc dust included in data shown in tables 11, 12, and 17 is restricted to commercial grades that comply with close specifications as to percentage of unoxidized metal, evenness of grading, and fineness of particles and does not include zinc powder and blue powder. The zinc content of the dust produced in 1957 ranged from 95 to 99.8 percent and averaged 98.3 percent. Shipments of zinc dust totaled 26,200 tons, of which 500 tons was shipped abroad. Producers' stocks of dust rose from 2,100 tons on January 1 to 2,300 tons on December 31.

The bulk of the production of dust was from zinc scrap (mostly galvanizers' dross), but some was recovered from zinc ore and as a byproduct of zinc refining.

TABLE 17.—Zinc dust [1] produced in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per pound			Total	Average per pound
1948–52 (average)	28,145	$9,816,326	$0.174	1955	30,118	$9,216,108	$0.153
1953	25,297	6,729,002	.133	1956	28,048	9,368,032	.167
1954	26,714	7,266,208	.136	1957	26,715	7,859,553	.147

[1] All produced by distillation.

ZINC PIGMENTS AND SALTS

The principal zinc pigments were zinc oxide and lithopone, and the principal salts were zinc chloride and zinc sulfate. These products were manufactured from various zinc-bearing materials, including ore, metal, scrap, and residues. In 1957, 164,000 tons of zinc was consumed in producing 152,700 tons of zinc oxide, 26,400 tons of leaded zinc oxide, 61,200 tons of zinc chloride (50° B.), 33,800 tons of zinc sulfate, and an undisclosed quantity of lithopone. The recoverable zinc content of raw material consumed in making these products (excluding lithopone and zinc sulfate) was 96,600 tons of ore, 19,400 tons of slab zinc, and 36,000 tons of zinc scrap. Details on production and shipments of zinc pigments and salts are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

Consumption of slab zinc in 1957, as reported by approximately 750 consumers, totaled 936,000 tons. Consumption was the fifth highest on record but was 16 percent below the peak consumption of 1955 and 7 percent below that of 1956.

Zinc used in zinc-base alloys increased 4 percent over 1956 and for the first year exceeded slab zinc used in galvanizing. Zinc consumed in galvanizing declined about 16 percent, largely owing to decreased demand and sales of galvanized steel products.

TABLE 18.—Consumption of slab zinc in the United States, 1948–52 (average) and 1953–57, by industries, in short tons [1]

Industry and product	1948–52 (average)	1953	1954	1955	1956	1957
Galvanizing: [2]						
Sheet and strip	149,178	164,601	181,558	200,403	203,713	168,221
Wire and wire rope	47,378	44,100	44,882	48,171	42,937	36,468
Tubes and pipe	82,609	88,428	76,891	98,206	86,277	70,463
Fittings	14,605	10,330	10,513	10,586	10,652	9,965
Other	94,530	99,529	89,619	93,775	[3] 95,567	[3] 82,640
Total galvanizing	388,300	406,988	403,463	451,141	439,146	367,757
Brass products:						
Sheet, strip, and plate	60,645	94,826	52,284	67,550	56,207	52,873
Rod and wire	39,005	47,312	30,899	46,830	39,413	33,711
Tube	15,815	18,136	12,097	15,363	13,666	11,915
Castings and billets	5,076	8,145	5,499	7,518	6,337	5,818
Copper-base ingots	4,859	7,659	6,594	8,062	7,197	7,286
Other copper-base products	1,189	2,104	895	920	1,184	787
Total brass products	126,589	178,182	108,268	146,243	124,004	112,390
Zinc-base alloy:						
Die castings	244,874	297,280	279,676	417,333	349,200	363,830
Alloy dies and rod	5,699	7,140	8,857	11,754	9,322	10,149
Slush and sand castings	1,319	3,025	2,313	1,720	1,985	2,060
Total zinc-base alloy	251,892	307,445	290,846	430,807	360,507	376,039
Rolled zinc	63,144	54,649	47,486	51,589	47,359	41,269
Zinc oxide	15,913	20,675	18,701	22,433	19,160	20,428
Other uses:						
Wet batteries	1,480	1,417	1,264	1,420	1,345	1,336
Desilverizing lead	2,521	2,425	2,740	2,676	2,939	2,808
Light-metal alloys	1,988	5,939	3,526	3,484	5,830	4,958
Other [4]	4,866	8,207	8,005	10,019	8,500	8,635
Total other uses	10,855	17,988	15,535	17,599	18,614	17,737
Total consumption [5]	856,693	985,927	884,299	1,119,812	1,008,790	935,620

[1] Excludes some small consumers.
[2] Includes zinc used in electrogalvanizing and electroplating, but excludes sherardizing.
[3] Includes 27,760 tons used in job galvanizing in 1956 and 28,286 tons in 1957.
[4] Includes zinc used in making zinc dust, bronze powder, alloys, chemicals, castings, and miscellaneous uses not elsewhere mentioned.
[5] Includes 3,710 tons of remelt zinc in 1953, 3,589 tons in 1954, 2,997 tons in 1955, 5,230 tons in 1956, and 6,805 tons in 1957.

Increased use of zinc die castings in automobiles and electrical appliances brought the total so used to 376,000 tons, or 40 percent of the total consumption of slab zinc. Galvanizing used 39 percent and brass products 12 percent. The major consuming industries accounted for 91 percent in 1957, compared with 92 percent in 1956. In addition to slab zinc, the brassmaking industry used 108,800 tons of secondary zinc in copper-base scrap for making brass and bronze ingots at secondary smelters.

Rolling mills used 41,300 tons of slab zinc in 1957 and remelted and rerolled 12,700 tons of metallic scrap produced in fabricating plants operated in connection with the rolling mills. In addition, 400 tons of purchased scrap (new clippings and old zinc) were melted and rolled.

Total output of rolled zinc declined 17 percent to 39,700 tons. Stocks of rolled zinc increased from 2,200 tons on January 1 to 2,400 tons on December 31, 1957. In addition to shipments of 24,900 tons of rolled zinc, the rolling mills consumed 27,400 tons of rolled zinc in manufacturing 12,200 tons of semifabricated and finished products.

TABLE 19.—Rolled zinc produced and quantity available for consumption in the United States, 1956–57

	1956			1957		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Production:						
Sheet zinc not over 0.1 inch thick	11,929	$7,302,484	$0.306	11,317	$7,077,606	$0.313
Boiler plate and sheets over 0.1 inch thick	1,205	567,170	.235	614	265,022	.216
Strip and ribbon zinc [1]	32,780	12,640,543	.193	25,904	9,568,389	.185
Foil, rod, and wire	2,024	1,152,748	.285	1,897	1,091,456	.288
Total rolled zinc	47,938	21,662,945	.226	39,732	18,002,473	.227
Imports	454	171,960	.189	732	244,722	.167
Exports	3,043	1,718,187	.282	2,677	1,534,800	.287
Available for consumption	45,173			38,388		
Value of slab zinc (all grades)			.137			.116
Value added by rolling			.089			.111

[1] Figures represent net production. In addition, 7,906 tons of strip and ribbon zinc in 1956 and 12,686 tons in 1957 were rerolled from scrap originating in fabricating plants operating in connection with zinc rolling mills.

TABLE 20.—Consumption of slab zinc in the United States in 1957, by grades and industries, in short tons

	Special High Grade	High Grade	Intermediate	Brass Special	Select	Prime Western	Remelt	Total
Galvanizers	15,414	12,546	5,306	54,147	36	276,866	3,442	367,757
Brass mills [1]	25,442	59,872	1,393	7,304	1,381	15,817	1,181	112,390
Die casters [2]	373,157	451	33		1	820	1,577	376,039
Zinc rolling mills	7,555	7,962	9,834	14,164	1,725	29		41,269
Oxide plants	179	1,718		306		18,225		20,428
Other	6,136	1,177	375	407		9,037	605	17,737
Total	427,883	83,726	16,941	76,328	3,143	320,794	6,805	935,620

[1] Includes brass mills, brass ingotmakers, and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.

Of the commercial grades of slab zinc used, Special High Grade comprised 46 percent of the total, Prime Western 34 percent, High Grade 9, Brass Special 8, Intermediate 2 and Select and Remelt combined 1 percent. All grades of slab zinc were used in galvanizing and in brass products. Consumption of Special High Grade zinc increased slightly, owing mainly to greater use of zinc in die castings in automobiles and appliances.

CONSUMPTION OF SLAB ZINC BY GEOGRAPHIC AREAS

Table 21 shows the distribution of slab-zinc consumption by geographic areas.

TABLE 21.—Consumption of slab zinc in the United States in 1957, by industries and States, in short tons

	Galvanizers	Brass mills [1]	Die casters [2]	Other [3]	Total
Alabama	23,543	(4)	----	(4)	24,756
Arizona	(4)	----	----	(4)	(4)
Arkansas	----	----	----	(4)	(4)
California	20,875	1,763	19,803	930	43,371
Colorado	(4)	(4)	----	----	(4)
Connecticut	2,794	37,253	(4)	(4)	43,566
Delaware	----	(4)	(4)	----	(4)
District of Columbia	----	(4)	----	----	(4)
Florida	(4)	----	----	----	(4)
Georgia	(4)	(4)	----	----	(4)
Idaho	----	----	----	(4)	(4)
Illinois	46,312	15,039	68,539	21,028	150,918
Indiana	39,510	(4)	21,537	(4)	77,658
Iowa	482	----	----	(4)	3,402
Kansas	----	(4)	----	(4)	(4)
Kentucky	(4)	(4)	(4)	----	(4)
Louisiana	(4)	----	----	(4)	991
Maine	(4)	(4)	----	----	(4)
Maryland	29,707	(4)	----	(4)	30,105
Massachusetts	4,075	(4)	----	(4)	7,489
Michigan	4,436	10,489	87,284	81	102,290
Minnesota	2,054	(4)	----	(4)	2,106
Mississippi	(4)	----	----	----	(4)
Missouri	2,928	(4)	8,686	(4)	12,764
Montana	----	----	----	(4)	(4)
Nebraska	(4)	----	(4)	(4)	2,035
New Hampshire	----	(4)	----	----	(4)
New Jersey	4,608	5,490	16,189	1,107	27,394
New York	(4)	8,796	48,592	(4)	69,303
North Carolina	(4)	----	(4)	----	(4)
Ohio	70,077	8,516	73,246	995	152,834
Oklahoma	(4)	----	----	(4)	2,152
Oregon	456	(4)	(4)	(4)	1,860
Pennsylvania	63,352	6,647	16,353	29,950	116,302
Rhode Island	517	(4)	(4)	(4)	603
South Carolina	(4)	----	----	----	(4)
Tennessee	959	----	(4)	(4)	1,729
Texas	9,370	(4)	(4)	(4)	11,698
Utah	(4)	9	----	(4)	(4)
Virginia	(4)	(4)	----	----	463
Washington	1,272	----	(4)	(4)	1,910
West Virginia	(4)	(4)	----	----	11,571
Wisconsin	1,990	5,383	4,483	----	11,856
Total [5]	364,315	111,209	374,462	78,829	928,815

[1] Includes brass mills, brass ingotmakers and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] Includes slab zinc used in rolled-zinc products and in zinc oxide.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] Includes States not individually shown.

Consumption of Slab Zinc for Galvanizing.—Among the 36 States consuming zinc for galvanizing, Ohio, Pennsylvania, Illinois, and Indiana were again the leading States. These 4 States used 60 percent of the total in 1957. The iron and steel industry used zinc to galvanize steel sheets, wire, tube, pipe, cable, chain, bolts, railway-signal equipment, building and poleline hardware, and many other items. Shipments of galvanized steel sheets in 1957, as reported by the Iron and Steel Institute, totaled 2,393,000 tons, a decline of 19 percent from the 1956 record of 2,958,000 tons. Zinc consumed in galvanizing steel sheet and strip averaged 1 ton per 14.2 tons of these products shipped in 1957. The ratios for 1955 and 1956 were, respectively, 1 to 14.3 and 1 to 14.5 tons.

Consumption of Slab Zinc for Brass Products.—Connecticut, with 33 percent of the total, again ranked first in the use of zinc in brass-making. Of the other 28 States that alloy zinc with copper to produce brass, Illinois, Michigan, New York, and Ohio ranked second, third, fourth, and fifth, respectively.

Consumption of Slab Zinc for Zinc-Base Alloys.—Increased use of zinc die castings in the automobile industry and in manufacturing home appliances, office machines, builders' hardware, and scientific, communications, and photographic equipment contributed to the 4-percent increase in slab zinc used in alloys. Michigan, Ohio, Illinois, New York, and Indiana, in order of use, accounted for 80 percent of the total slab zinc used in zinc-base alloys.

Consumption of Slab Zinc for Rolled Zinc.—Slab zinc used by rolling mills to make sheet, strip, ribbon, foil, plate, rod, and wire totaled 41,300 tons, 13 percent less than in 1956. Rolled zinc has many uses. The major American use is for dry-cell battery cases and similar extruded cases for radio condensers and tube shields. Weather stripping, roof flashing, photoengraving plates, and household electric fuses are other uses. Illinois ranked first in production of rolled zinc in 1957, followed in order by Indiana, Pennsylvania, and New York.

Consumption of Slab Zinc for Other Uses.—Other uses included 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.

STOCKS

National Stockpile.[5]—Under authority of the Strategic and Critical Materials Stockpiling Act of 1946 and supplemental legislation and in accordance with directives of the Office of Defense Mobilization, monthly purchases of domestic zinc and lead continued throughout 1957. As the minimum stockpile objective for zinc was virtually fulfilled by mid-1954 and as inventories in 1957 equaled or exceeded the minimum objective, all acquisitions of domestic zinc were directed toward the long-term objective. By May industry offers of zinc exceeded quantities for which General Services Administration had Office of Defense Mobilization directives. In July ODM announced the long-term objectives for zinc were nearing completion, but monthly acquisitions were continued through December. Deliveries of both zinc and lead also were made to the stockpile to repay International Cooperation Administration (ICA) advances under several contracts.

[5] Office of Defense Mobilization, Stockpile Report to the Congress, Jan.-June 1957 and July-Dec. 1957, 16 pp.

GSA[6] received 193,929 tons of foreign zinc in 1957 (60,162 tons in 1956), which was acquired under barter contracts authorized under the Agricultural Trade Development and Assistance Act of 1954 and amendments. All strategic materials acquired under this program were placed in the supplemental stockpile and were in addition to the minimum and long-term objectives.

Producers' Stocks.—Smelter stocks of slab zinc were at a low of 66,900 tons on January 1, 1957. During the year inventories rose constantly; by the end of June producers' stocks of slab zinc were about 133,500 tons, and by the end of the year 155,800 tons.

TABLE 22.—Stocks of zinc at zinc-reduction plants in the United States at end of year, 1953–57, in short tons

	1953	1954	1955	1956	1957
At primary reduction plants	176,725	121,847	37,322	64,794	153,338
At secondary distilling plants	3,268	1,549	1,942	2,081	2,495
Total	179,993	123,396	39,264	66,875	155,833

Consumers' Stocks.—Stocks of slab zinc at consumers' plants declined nearly 16,000 tons during 1957. At the average monthly rate of consumption in 1957, stocks on hand at the end of the year plus 6,200 tons of metal in transit to consumers' plants represented about a 5-week supply.

TABLE 23.—Consumers' stocks of slab zinc at plants at the beginning and end of 1956, by industries, in short tons

	Galvanizers	Brass mills [1]	Zinc die casters [2]	Zinc rollmills	Oxide plants	Other	Total
Dec. 31, 1956 [3]	55,932	12,425	29,393	4,195	388	1,761	[4] 104,094
Dec. 31, 1957	40,462	12,117	29,664	4,062	231	1,652	[4] 88,188

[1] Includes brass mills, brass ingotmakers, and foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] Revised figures.
[4] Stocks on Dec. 31, 1956 and 1957, exclude 578 tons (revised figure) and 488 tons, respectively, of remelt spelter.

PRICES

The average quoted price for Prime Western slab zinc, East St. Louis, was 13.50 cents per pound at the beginning of 1957. On May 6 the price dropped to 12.00 cents, on May 13 to 11.50 cents, on June 4 to 11.00 cents, and on June 19 to 10.50 cents. On July 1 another ½-cent decline brought the price to 10.00 cents, where it remained for the rest of the year.

Average monthly zinc quotations [7] on the London Metal Exchange in 1957 ranged from £103.256 per long ton in January (equivalent to 12.91 cents a pound computed at the exchange rate recorded by the Federal Reserve Board) to a low of £62.794 per long ton (7.85 cents

[6] United States Tariff Commission, Lead and Zinc—Report to the President on Escape-Clause Investigation No. 65 Under the Provisions of Section 7 of the Trade Agreements Extension Act of 1951 as Amended: April 1958, table 9.
[7] Monthly mean of buyers' and sellers' quotations at the close of morning sessions.

per pound) in December. The average for 1957 was £81.62 (10.18 cents a pound).

Prices for zinc scrap varied with market quotations for slab zinc. Sales of clean new zinc clippings and trimmings and engravers' or lithographers' plates averaged 7.11 cents a pound in January, when the price of Prime Western was 13.50 cents; in the last half of the year sales averaged 4.25 cents a pound. Sales of old zinc scrap and new die-cast scrap in the same periods averaged 4.75 cents and 3.12 cents a pound.

TABLE 24.—Price of zinc concentrate and zinc, 1953–57

	1953	1954	1955	1956	1957
Joplin 60-percent zinc concentrate:[1] Price per short ton..dollars..	64.65	65.72	77.50	[2] 83.89	76.94
Average price common zinc at—					
St. Louis (spot) [2]..............cents per pound..	10.86	10.69	12.30	13.49	11.40
New York [2]..............do....	11.53	11.19	12.80	13.99	11.90
London [3]..............do....	9.47	9.78	11.30	12.19	10.18
Price indexes (1947–49 average=100):					
Zinc (New York)	91	88	101	111	94
Lead (New York)	84	88	94	100	91
Copper (New York)	138	142	177	199	144
Straits tin (New York)	103	100	103	110	105
Nonferrous metals [4]	125	124	143	156	137
All commodities [4]	110	110	111	114	118

[1] Metal Statistics, 1958.
[2] Corrected figure.
[3] E&MJ Metal and Mineral Markets English quotations converted into American money on basis of average rates of exchange recorded by Federal Reserve Board.
[4] Based upon price indexes of U. S. Department of Labor.

TABLE 25.—Average monthly quoted prices of 60-percent zinc concentrate at Joplin, and of common zinc (prompt delivery or spot), St. Louis and London, 1956–57 [1]

Month	1956			1957		
	60-percent zinc concentrates in the Joplin region (dollars per ton)	Metallic zinc (cents per pound)		60-percent zinc concentrates in the Joplin region (dollars per ton)	Metallic zinc (cents per pound)	
		St. Louis	London [2 3]		St. Louis	London [2 3]
January	82.62	13.44	12.60	84.00	13.50	12.91
February	84.00	13.50	12.55	84.00	13.50	12.43
March	84.00	13.50	12.70	84.00	13.50	12.08
April	84.00	13.50	12.28	84.00	13.50	12.30
May	84.00	13.50	11.85	71.90	11.92	10.72
June	84.00	13.50	11.75	63.04	10.84	9.29
July	84.00	13.50	11.69	56.00	10.00	9.32
August	84.00	13.50	11.95	56.00	10.00	9.16
September	84.00	13.50	11.95	56.00	10.00	9.06
October	84.00	13.50	11.87	56.00	10.00	8.65
November	84.00	13.50	12.50	56.00	10.00	8.44
December	84.00	13.50	12.57	56.00	10.00	7.85
Average for year	83.89	13.49	12.19	76.94	11.40	10.18

[1] Joplin: Metal Statistics, 1958, p. 585. St. Louis: Metal Statistics, 1958, p. 583. London: E&MJ Metal and Mineral Markets.
[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.
[3] Average of daily mean of bid and asked quotations at morning session of London Metal Exchange.

TABLE 26.—Average price received by producers of zinc, 1953–57, by grades, in cents per pound

Grade	1953	1954	1955	1956	1957
Grade A:					
Special High Grade	11.81	11.46	12.79	14.26	12.13
High Grade	11.40	11.05	12.59	13.98	11.70
Grade B: Intermediate	11.38	11.36	12.30	14.06	11.69
Grades C and D:					
Brass Special	11.72	10.93	12.21	13.71	11.31
Select	11.59	10.02	11.13	13.41	10.56
Grade E: Prime Western	11.21	10.39	11.74	13.13	11.24
All grades	11.47	10.83	12.29	13.73	11.64
Prime Western; spot quotation at St. Louis [1]	10.86	10.69	12.30	13.49	11.40

[1] Metal Statistics, 1958, p. 583.

FOREIGN TRADE [8]

Imports.—General imports of zinc rose 25,000 tons above the previous record in 1956 to 795,000 tons in 1957. Imports of zinc in ore and concentrate (zinc content) were 525,700 tons, essentially the same figure as in 1956, but imports of slab zinc increased 10 percent to 269,000 tons. Of the zinc in ores, Mexico supplied 37 percent, Canada 30 percent, Peru 22 percent, other Latin American countries 4 percent, Union of South Africa 4 percent, and other countries the remainder.

Of the slab-zinc imports, 39 percent came from Canada, 13 percent from Belgium-Luxembourg, 12 percent from Belgian Congo, 9 percent from Mexico, and 9 percent from Peru; Yugoslavia, Italy, Australia, and Germany each supplied about 4 percent.

TABLE 27.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1948–52 (average) and 1953–57, in short tons [1]

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
Ores (zinc content):						
North America:						
Canada-Newfoundland-Labrador	90,007	165,910	156,830	173,157	177,087	158,220
Cuba	46			3,704	1,155	1,209
Guatemala	3,257	6,477	3,755	8,353	11,433	9,262
Honduras	164	637	792	1,433	2,288	2,589
Mexico	157,187	169,124	175,692	186,461	193,007	192,519
Other North America	12	(2)	(2)		4	(2)
Total	250,673	342,148	337,069	373,108	384,974	363,799
South America:						
Argentina	1,247				2	165
Bolivia	6,860	22,528	11,440	1,833	7,294	7,633
Chile	232	3,247	1,797	4,858	346	1,400
Peru	25,559	84,365	93,216	83,915	98,541	118,771
Other South America	266	389	31	142	212	8
Total	34,164	110,529	106,484	90,748	106,395	127,977

See footnotes at end of table.

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

TABLE 27.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1948–52 (average) and 1953–57, in short tons [1]—Continued

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
Europe:						
Belgium-Luxembourg				1,546	861	
Italy	2,258	8,738				
Malta, Gozo, and Cyprus					1,062	1,116
Netherlands		3,009				
Spain	10,552	8,617				
United Kingdom				1,497		191
Yugoslavia	854	10,820	4,871			
Other Europe		1	15			91
Total	13,664	31,185	4,886	3,043	1,923	1,398
Asia:						
Korea, Republic of	414				66	25
Philippines	358	2,104	444	465	828	777
Other Asia	1,359	778				54
Total	2,131	2,882	444	465	894	856
Africa:						
Algeria		2,804				
Union of South Africa	3,994	13,356	4,183	5,050	13,400	21,048
Other Africa	40					1,896
Total	4,034	16,160	4,183	5,050	13,400	22,944
Oceania: Australia	2,608	10,820	2,361	5,630	17,764	8,756
Grand total: Ores	307,274	513,724	455,427	478,044	525,350	525,730
Blocks, pigs, or slabs:						
North America:						
Canada	90,229	107,925	105,154	113,402	116,875	103,964
Mexico	13,134	33,878	9,726	19,480	17,153	23,536
Total	103,363	141,803	114,880	132,882	134,028	127,500
South America: Peru	566	8,406	6,757	9,767	6,590	22,947
Europe:						
Austria					2,296	1,020
Belgium-Luxembourg	2,832	21,549	7,540	17,748	32,353	34,191
Germany [3]	1,851	13,906	3,109	6,642	15,285	8,772
Italy	1,664	23,972	5,285	6,190	13,486	10,010
Netherlands	1,247	4,338	1,461	1,079	5,965	2,504
Norway	2,426	6,323	717	504		
United Kingdom	111	6,317	22	79	611	1,790
Yugoslavia	655	1,900			500	10,909
Other Europe	149	165			110	
Total	10,935	78,470	18,134	32,242	70,606	69,196
Asia:						
Japan	982				4,883	2,887
Other Asia	6					
Total	988				4,883	2,887
Africa:						
Belgian Congo		882	13,895	15,228	17,782	33,007
Morocco	88			1,264		
Mozambique			112		(4)	1,230
Rhodesia and Nyasaland, Federation of		[5] 1,064		280	[6] 3,808	2,744
Union of South Africa					(4)	
Total	88	1,946	14,007	16,772	21,590	36,981
Oceania: Australia	36	3,951	3,080	4,033	7,281	9,523
Grand total: Blocks, pigs, or slabs	115,976	234,576	156,858	195,696	244,978	269,034

1 Data include zinc imported for immediate consumption plus material entering country under bond.
2 Less than 1 ton.
3 West Germany, 1952–57.
4 Revised to none.
5 Northern Rhodesia.
6 **Revised figure.**

TABLE 28.—Zinc imported for consumption in the United States, 1948–52 (average) and 1953–57, by classes [1]

[Bureau of the Census]

Year	Ore (zinc content)		Blocks, pigs, slabs		Sheets	
	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)	244,244	$36,054,350	114,897	$32,068,081	112	$48,296
1953	449,732	47,918,150	227,654	50,281,745	196	76,507
1954	480,918	[4] 52,481,723	160,138	[4] 33,714,309	259	88,010
1955	384,648	36,810,856	195,059	46,452,269	431	[4] 148,389
1956	462,379	49,230,965	244,726	65,053,834	454	171,960
1957	679,322	88,491,227	268,852	[4] 64,056,938	732	244,722

Year	Old, dross, and skimmings [2]		Zinc dust		Total value [3]
	Short tons	Value	Short tons	Value	
1948–52 (average)	7,899	$928,592	163	$40,725	$69,140,044
1953	5,915	556,592	1,045	161,612	98,994,606
1954	1,087	103,486			[4] 86,387,528
1955	284	31,529	72	17,994	[4] 83,461,037
1956	602	97,360	72	[4] 17,709	[4] 114,551,828
1957	590	89,030	112	[4] 28,236	[4] 152,910,153

[1] Excludes imports for manufacture in bond and export, which are classified as "imports for consumption" by Bureau of the Census.
[2] Includes dross and skimmings as follows: 1948–52 (average)—4,402 tons ($405,498); 1953—2,925 tons ($250,544); 1954—316 tons ($33,181); 1955—108 tons ($3,060); 1956—417 tons ($61,264); 1957—363 tons ($57,061).
[3] In addition, manufactures of zinc were imported as follows: 1948–52 (average)—$44,885; 1953—$5,855; 1954—[4] $41,454; 1955—[4] $190,076; 1956—[4] $287,361; 1957—[4] $264,348.
[4] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable with years before 1954.

Exports.—Exports of zinc in ore and concentrate, in scrap, and as metal and dust totaled 20,900 tons valued at $6,520,400 in 1957, compared with 29,400 tons valued at $7,335,300 in 1956. In addition to export items listed in tables 33 and 34, considerable zinc was exported 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 the 11,000 tons of slab zinc exported in 1957, the United Kingdom received 60 percent, Belgium-Luxembourg 10 percent, and the Republic of Korea 8 percent. India, Mexico, Netherlands, and West Germany received most of the remainder.

Tariff.—The duty on slab zinc remained at 0.7 cent per pound, that on zinc contained in ore and concentrate at 0.6 cent per pound, and that on zinc scrap at 0.75 cent per pound throughout 1957. The rates of duty imposed on zinc articles under the Tariff Act of 1930, in specific years, 1930–54, are given in the 1953 Minerals Yearbook zinc chapter. The rates were not changed in 1955–56.

In May Secretary Seaton, United States Department of the Interior, presented to Congress a program for legislation to give long-range support to the domestic mining industry. Recommendations included a graduated excise tax on entries of foreign lead and zinc. The sliding-scale adjustment was designed to discourage excessive

TABLE 29.—Slab and sheet zinc exported from the United States, by destinations, 1954–57, in short tons

[Bureau of the Census]

Destination	Slabs, pigs, and blocks				Sheets, plates, strips, or other forms, n. e. s.			
	1954	1955	1956	1957	1954	1955	1956	1957
North America:								
Canada	9	8	8	13	1,704	2,062	2,596	2,581
Cuba	-------	11	86	31	96	132	105	123
Mexico	517	961	839	513	637	583	716	315
Other North America	-------	4	21	58	58	43	90	40
Total	526	984	954	615	2,495	2,820	3,507	3,059
South America:								
Argentina	2,205	6,062	-------	6	-------	9	-------	-------
Brazil	2,900	35	49	17	952	71	61	69
Chile	230	6	96	40	9	8	7	37
Colombia	-------	2	-------	55	219	270	344	408
Venezuela	1	14	1	-------	70	50	97	72
Other South America	13	-------	7	3	49	26	37	21
Total	5,349	6,119	153	121	1,299	434	546	607
Europe:								
Belgium-Luxembourg	3,136	2,883	1,428	1,064	10	2	-------	5
Denmark	-------	84	-------	-------	-------	-------	34	64
Germany, West	2,777	-------	279	336	-------	30	46	34
Italy	224	-------	-------	-------	-------	12	14	7
Netherlands	560	112	44	476	22	12	9	22
Switzerland	1,064	224	448	-------	17	30	34	26
United Kingdom	10,052	7,504	5,040	6,504	34	50	30	11
Other Europe	169	1	25	(1)	3	72	10	40
Total	17,982	10,808	7,264	8,380	86	208	177	209
Asia:								
India	112	-------	2	672	49	38	68	53
Korea, Republic of	948	132	433	912	6	1	-------	-------
Philippines	16	7	-------	8	67	84	85	53
Other Asia	61	17	7	77	29	29	40	24
Total	1,137	156	442	1,669	151	152	193	130
Africa:								
Union of South Africa	-------	-------	-------	-------	14	38	21	51
Other Africa	-------	2	-------	-------	-------	(1)	-------	-------
Total	-------	2	-------	-------	14	38	21	51
Oceania	-------	-------	-------	-------	-------	5	-------	-------
Grand total	24,994	18,069	8,813	10,785	4,045	3,657	4,444	4,056

[1] Less than 1 ton.

imports but to permit unhampered entry of lead and zinc needed to supplement the domestic supply. Congress adjourned without decisive action on the measure.

In September the Emergency Lead and Zinc Committee, representing domestic mining groups, petitioned the Tariff Commission for regulation of imports, claiming that concessions made by the United States under the Trade Agreements Act had caused serious injury to the domestic industry. Formal hearings were held by the Tariff Commission in November, and a study of the facts was in progress at the end of 1957.

TABLE 30.—Zinc ore and manufactures of zinc exported from the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Zinc, ore, concentrates, and dross (zinc content)		Slabs, pigs, or blocks		Sheets, plates, strips, or other forms, n. e. s.		Zinc scrap (zinc content)		Zinc dust	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948–52 (average)[1]	[2] 2,814	[2] $571,380	46,277	$15,724,207	6,084	$3,286,037	(3)	(3)	(4)	(4)
1953[1]	[2] 2,953	[2] 758,600	17,969	4,620,452	4,628	2,637,240	1,000	$169,517	502	$181,055
1954[1]			24,994	5,393,938	4,045	2,183,170	16,689	2,023,493	509	150,756
1955[1]			18,069	4,175,451	3,657	2,192,882	21,612	2,249,583	445	161,956
1956[1]	854	162,400	8,813	2,465,173	4,444	3,031,215	14,921	1,540,404	372	136,096
1957[1]	7	800	10,785	2,552,770	4,056	2,949,693	5,469	822,009	595	195,170

[1] Effective Jan. 1, 1952, zinc and zinc-alloy semifabricated forms, n. e. s., were exported as follows: 1952—$191,746 (quantity not available); 1953—286 tons ($151,496); 1954—543 tons ($257,316); 1955—651 tons ($295,685); 1956—582 tons ($301,230); 1957—485 tons ($246,527).
[2] Effective Jan. 1, 1949, "dross" included with "scrap."
[3] Classification established Jan. 1, 1949. Not included in 1948-52 averages; 1949—1,570 tons ($224,291); 1950—6,212 tons ($674,235); 1951—4,613 tons ($871,302); 1952—972 tons ($282,816).
[4] Not included in 1948-52 averages; 1948—891 tons ($299,494); 1949—690 tons ($261,484); 1950—506 tons ($186,557); 1951—723 tons ($400,656); 1952 included with "scrap."

WORLD REVIEW

World mine production of zinc in 1957, estimated at 3.42 million short tons (3.36 million in 1956), was at an alltime peak. The output of North and South America declined; that of Africa remained the same; and that of Europe, Asia, and Oceania increased. The United States was again the leading zinc-producing country, exceeding the output of Canada, the second highest producer, by 30 percent. The Western Hemisphere accounted for 43 percent of world output and Iron Curtain areas for approximately 20 percent. Among the principal producing countries gains were reported in the U. S. S. R., Australia, Japan, Italy, and Poland and decreases in the United States, Canada, Mexico, Peru, Belgian Congo, and Spain.

World smelter production of zinc increased in 1957 for the 12th consecutive year, totaling 3.23 million tons, or 4 percent more than in 1956 and 48 percent more than the 1948–52 average. Substantial gains were reported in the U. S. S. R., Peru, France, Belgian Congo, Poland, and Australia and smaller gains in Belgium, the United States, Japan, Bulgaria, and several other countries. No significant declines were reported.

Although figures on world consumption of zinc are not compiled, the growth in known world stocks suggests that mine and smelter production in 1957 exceeded consumer requirements by 350,000 to 450,000 tons.

TABLE 31.—World mine production of zinc (content of ore),[1] by countries,[2] 1948–52 (average) and 1953–57, in short tons [3]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [2]	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada [4]	318,367	401,762	376,491	433,357	422,633	409,528
Cuba	----	----	----	1,134	1,638	752
Greenland [5]	----	----	----	----	6,050	9,350
Guatemala	[6] 5,224	6,700	4,400	10,400	12,000	10,300
Honduras [7]	164	636	791	1,433	2,288	2,589
Mexico	217,905	249,715	246,441	296,961	274,351	267,891
United States [4]	638,749	547,430	473,471	514,671	542,340	531,735
Total	1,180,409	1,206,243	1,101,594	1,257,956	1,261,300	1,232,145
South America:						
Argentina	14,700	17,735	[5] 22,000	23,260	26,100	32,570
Bolivia (exports)	27,451	26,427	22,403	23,509	18,818	21,678
Chile	[6] 1,464	3,500	[5] 1,650	3,200	2,969	[5] 3,300
Peru	98,916	153,334	174,784	183,074	193,037	173,571
Total	142,531	200,996	[5] 220,840	233,043	240,924	[5] 231,120
Europe:						
Austria	1,579	4,826	5,140	5,787	5,868	6,334
Finland	3,770	3,500	5,000	23,300	43,000	47,400
France	12,274	14,600	12,500	12,100	13,800	13,200
Germany, West	71,166	100,581	103,867	101,558	101,803	104,013
Greece	5,025	8,300	7,900	13,500	22,300	[5] 17,600
Ireland	[6] 1,241	1,819	1,719	2,769	2,127	1,792
Italy	98,883	117,102	129,707	131,891	134,912	144,623
Norway	6,543	5,661	5,917	7,411	7,055	7,606
Poland [5]	[8] 119,000	130,000	129,000	139,000	138,000	143,000
Spain	70,800	92,000	97,000	102,000	96,000	87,000
Sweden	40,677	49,706	64,407	64,810	72,796	74,524
U. S. S. R. [5, 8]	157,000	241,000	258,000	300,000	351,000	386,000
United Kingdom	392	3,187	3,905	3,167	1,563	1,085
Yugoslavia	45,879	66,106	63,052	65,800	63,400	64,000
Total [2, 5]	648,900	869,000	931,000	1,017,000	1,103,000	1,170,000
Asia:						
Burma	485	4,300	6,400	9,100	8,000	10,100
India	[6] 1,378	2,900	2,600	2,900	4,200	4,600
Iran [9]	[10] 9,370	6,200	5,800	6,300	5,200	5,000
Japan	62,046	106,507	120,581	119,787	135,585	149,322
Korea, Republic of	159	22	----	----	440	311
Philippines	[10] 965	830	----	----	1,050	330
Thailand	301	2,000	3,000	3,200	2,400	1,820
Turkey [5]	880	4,400	6,100	770	1,090	1,910
Total [2, 5]	78,200	138,800	159,900	160,200	179,500	197,100
Africa:						
Algeria	9,311	20,470	31,538	35,982	33,665	31,483
Angola	[10] 215	110	----	----	3	----
Belgian Congo	80,350	138,661	94,015	74,700	124,125	118,176
Egypt	658	282	262	757	692	[5] 660
French Equatorial Africa	344	----	----	----	----	----
Morocco: Southern zone	14,051	38,895	37,908	47,686	43,567	53,864
Nigeria	107	71	----	----	----	----
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	[8] 25,361	43,353	38,672	38,070	38,134	40,353
South-West Africa	14,330	[4] 17,400	[4] 22,000	19,500	20,458	16,663
Tunisia	3,470	4,020	5,707	6,311	5,200	3,915
Total	148,197	263,262	230,102	223,006	265,844	265,114
Oceania: Australia	214,115	265,481	282,978	287,352	311,452	326,523
World total (estimate)[2]	2,410,000	2,940,000	2,930,000	3,180,000	3,360,000	3,420,000

[1] Data derived in part from the Yearbook of the American Bureau of Metal Statistics, the United Nations Statistical Yearbook, and the Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London).

[2] In addition to countries listed, Bulgaria, Czechoslovakia, East Germany, Rumania, China, and North Korea also produce zinc, but production data are not available; estimates by senior author of chapter included in total.

[3] This table incorporates a number of revisions of data published in previous Zinc chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.

[4] Recoverable.

[5] Estimate.

[6] Average for 1950–52.

[7] United States imports.

[8] Smelter production.

[9] Year ended March 21 of year following that stated.

[10] Average for 1951–52.

TABLE 32.—World smelter production of zinc by countries, 1948–52 (average) and 1953–57, in short tons [1] [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America:						
Canada	209,553	250,961	253,365	256,542	255,564	247,351
Mexico	58,301	[3] 58,481	[3] 60,477	[3] 61,878	[3] 62,136	[3] 62,353
United States	846,425	916,105	802,425	963,504	983,610	985,796
Total	1,114,279	1,225,547	1,116,267	1,281,924	1,301,310	1,295,500
South America:						
Argentina	7,145	12,787	[4] 12,000	14,881	16,200	16,150
Peru	2,221	9,819	16,935	18,801	10,415	32,482
Total	9,366	22,606	[4] 29,000	33,682	26,615	48,632
Europe:						
Austria				1,493	7,932	10,291
Belgium [5]	197,425	213,217	234,897	233,625	254,289	259,755
Bulgaria				1,497	6,435	8,282
Czechoslovakia	[4] 2,930	(6)	(6)	(6)	(6)	(6)
France	75,095	89,219	122,249	123,624	124,106	143,918
Germany, West	118,811	163,430	184,804	197,026	204,964	202,548
Italy	42,590	66,214	74,356	77,761	81,086	81,192
Netherlands	21,487	27,780	28,702	31,347	31,980	33,085
Norway	45,486	42,767	49,010	50,176	53,171	52,789
Poland [4]	119,000	152,600	156,600	172,200	169,000	175,000
Rumania	[4] 3,220	(6)	(6)	(6)	(6)	(6)
Spain	23,087	25,490	25,652	26,291	25,381	21,751
U. S. S. R. [4]	157,000	241,000	258,000	300,000	351,000	386,000
United Kingdom	77,243	81,433	90,989	91,108	91,247	86,111
Yugoslavia	12,177	16,038	15,040	15,176	21,890	32,473
Total [4]	896,000	1,127,000	1,249,000	1,330,000	1,430,000	1,501,000
Asia:						
China [4]	230	400	[5] 13,800	[5] 16,500	[5] 19,800	[5] 20,000
Japan	50,441	87,261	112,296	124,075	150,169	152,835
Total [4]	50,670	87,700	126,100	140,600	170,000	173,000
Africa:						
Belgian Congo		8,599	35,274	37,443	46,390	54,227
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	25,361	28,370	29,736	31,248	32,396	33,040
Total	25,361	36,969	65,010	68,691	78,786	87,267
Oceania: Australia	91,923	100,999	117,066	113,220	117,592	123,589
World total (estimate)	2,188,000	2,600,000	2,700,000	2,970,000	3,120,000	3,230,000

[1] Data derived in part from the Yearbook of the American Bureau of Metal Statistics, the United Nations Monthly Bulletin and Statistical Yearbook, and the Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London).
[2] This table incorporates a number of revisions of data published in previous Zinc chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] In addition, other zinc-bearing materials totaling 30,288 tons in 1953, 18,545 in 1954, 37,442 in 1955, 39,554 in 1956, and 30,504 in 1957.
[4] Estimate.
[5] Includes production from reclaimed scrap.
[6] Data not available; estimate by senior author of chapter included in total.

NORTH AMERICA

Canada.—Mine production of recoverable zinc in Canada was 410,000 tons—3 percent less than in 1956. The zinc-producing provinces were British Columbia, Quebec, Saskatchewan, Manitoba, Newfoundland, New Brunswick, Yukon, Nova Scotia, and Ontario. Smelter output of slab zinc from domestic and foreign ores totaled 247,000 tons compared with 256,000 tons in 1956. All slab zinc was produced by the electrolytic process at Consolidated Mining and

Smelting Co. Trail (British Columbia) plant and Hudson Bay Mining & Smelting Co. Flin Flon (Manitoba) plant.

Consumption of slab zinc in Canada was 50,700 short tons, considerably below the 59,200 consumed in 1956. Exports of refined zinc and zinc in concentrates were 202,000 and 187,000 tons, respectively. Of these quantities, 105,000 tons of slab zinc and 148,000 tons of zinc in concentrates were exported to the United States, or about 40 percent of the total.

The Consolidated Mining and Smelting Co. of Canada, Ltd., continued to be the largest producer in Canada, operating the Sullivan, H. B., Bluebell, and Tulsequah mines in British Columbia and the largest zinc-reduction plant in the world at Trail, British Columbia. In 1957 the company's mills processed 3,274,000 tons of ore (3,661,000 in 1956). The decrease was the result of closing the open-pit unit of the Sullivan mine in May and the Tulsequah mines at the end of August. Zinc and lead concentrates produced at the 4 mills were smelted with purchased ores at the company's zinc and lead smelters at Trail to yield 189,300 tons of electrolytic zinc (193,000 in 1956), 144,000 tons of refined lead (149,300 in 1956), 95,400 ounces of gold (97,400 in 1956), 10,877,500 ounces of silver (11,584,000 in 1956), 900 tons of cadmium (900 in 1956), 73 tons of bismuth (78 in 1956), 800 tons of antimony (1,100 in 1956), and 400 tons of tin (300 in 1956). Other British Columbia producers included Reeves McDonald Mines, Ltd., at Remac; Sheep Creek Mines, Ltd., at Nelson; and Yale Lead & Zinc Mines, Ltd., at Ainsworth.

The second largest zinc producer in Canada was the Hudson Bay Mining & Smelting Co., operating the Flin Flon copper-zinc-gold-silver property on the Manitoba-Saskatchewan boundary and other nearby properties in Manitoba. A total of 1,644,300 tons was mined from 5 mines; 1,377,800 tons came from the Flin Flon mine and the balance from the Schist Lake, North Star, Don Jon, and Birch Lake mines. The milling plant processed 1,644,400 tons of ore in 1957 (1,653,800 in 1956). Concentrate [9] was processed in the company's copper reverberatory furnaces to produce copper matte and a slag containing about 8 percent zinc. The zinc-rich slag was charged to two 8- by 21-foot coal-fired fuming furnaces, and the zinc was recovered as zinc oxide fume in the baghouse. The fume was treated in the electrolytic-zinc plant to recover slab zinc.

During 1957 the copper-zinc plant produced 58,800 tons of zinc (63,300 in 1956), 44,300 tons of copper (46,300 in 1956), 113 tons of cadmium (78 in 1956), 49 tons of selenium (54 in 1956), 97,500 ounces of gold (104,900 in 1956), and 1,528,300 ounces of silver (1,586,900 in 1956). About 88 percent of the zinc content of the slag was recovered, but additional dust-collecting equipment being installed in 1957 will increase recovery of zinc, lead, and other metals.

Geco Mines, Ltd., at Manitouwadge, Ontario, began operating early in September after an investment of $24 million, and by the end of 1957 the plant was treating 3,500 tons of ore daily to produce 280 to 350 tons of copper concentrate and about 70 tons of zinc concentrate. The ore reserve was reported to be 15 million tons containing 1.76 percent of copper, 3.38 percent of zinc, and 1.77 ounces of silver.

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[9] Mast, R. E., and Kent, G. H., How Hudson Bay Fumes Reverb Slags: Eng. and Min. Jour., vol. 158, No. 6, June 1957, pp. 82–88.

Another new mine in the Manitouwadge area—Willroy Mines, Ltd.—began producing in July 1957 at a daily rate of 400 tons, which was increased to more than 800 tons by October, when 25,300 tons of ore containing 1.17 percent of copper, 10.38 percent of zinc, 0.43 percent of lead, and 2.87 ounces of silver was treated. The operating cost was reported to be less than $5.50 per ton, and zinc recovery was 85.7 percent.

Barvue Mines, Ltd., Quebec's major producer of zinc concentrate, which opened November 1952, was shut down in October 1957. Other Quebec producers of zinc concentrate included Normetal Mining Corp., Ltd., which treated 378,000 tons of ore to produce 37,700 tons of 21.60-percent copper concentrate and 31,000 tons of 51.63-percent zinc concentrate; Waite Amulet Mines, Ltd., which milled 290,000 tons of ore to yield 9,939 tons of copper and 8,400 tons of zinc in concentrates; and Quemont Mining Corp., Ltd., which milled 837,000 tons of ore to recover 11,300 tons of copper and 16,200 tons of zinc in concentrates.

In New Brunswick, Heath Steele Mines, Ltd. (subsidiary of American Metal Climax, Inc.) completed installation of mining, milling, and related facilities in 1957, and during the latter part of the year the 22-mile railway spur to the mine was completed. By April the mill began operating on a tuneup basis. Mine development and stope preparation was continued, and a long incline was started at No. 2 shaft to permit trucking ore from the stope faces.

Brunswick Mining and Smelting Corp., Ltd., continued mine development and intensive studies in ore dressing and concentrate treatment. Test results were favorable.

Greenland.—The Mestersvig mine of the Nordic Mining Co., Ltd., which began producing in February 1956, shipped 13,650 tons of zinc concentrate and 8,750 tons of lead concentrate to Belgium and West Germany in the 1957 shipping season. The shipments resulted from treating about 80,000 tons of ore containing 8.4 percent zinc and 8.1 percent lead over the 10-month period July 1956 to July 1957, exclusive of December and January when the mine was closed. Solution to the many problems of mining at a latitude of 72° N. were described in an article.[10]

Guatemala.—Compañía Minera de Guatemala operated its Caquipec mine near Coban throughout 1957, producing zinc and lead concentrates.

Mexico.—Mine production of zinc was 267,900 short tons in 1957, a small decline from the 274,400 tons produced in 1956. Smelter production of slab zinc (62,400 tons) remained at near capacity level. As domestic consumption was about 16,800 tons, most of Mexico's production was exported. The United States, with imports of 23,500 tons of slab zinc and 192,500 tons of zinc in concentrates, was the principal recipient.

American Smelting & Refining Co. Mexican operations were conducted on a normal basis throughout 1957, except for the closing of the leased Aurora-Xichu mine.[11] Mines operated in 1957 by the company included the Charcas unit at Charcas, San Luis Potosi; Nuestra Senora at Cosala, Sinaloa; the Parral, Santa Barbara; and

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[10] Astlind, Bertil, and Fahlstrom, P. H., Greenland Lead-Zinc Mine Beats Elements With Underground Mill: Min. World, vol. 19, No. 12, November 1957, pp. 46–50.
[11] American Smelting & Refining Co., Annual Report, 1957, 32 pp.

Santa Eulalia, units, Chihuahua; and Taxco, Guerrero. Operating mines leased or owned in part and managed by American Smelting were the Aurora-Xichu unit, Guanajuanto; Cía. Metalurgica Mexicana mines; Montezuma Lead Co. mines at Santa Barbara; and Plomosas unit at Picachos, Chihuahua. Smelting and refining plants operated by American Smelting & Refining Co. were the Chihuahua plant (lead smelting and zinc fuming); Monterrey (lead refining); San Luis Potosi (copper smelting and converting, arsenic refining, and lead smelting); and Rosita, Coahuila (zinc retort smelting).

American Metal Climax, Inc. (formerly The American Metal Co.), through its Mexican subsidiary, Cía. Minera de Penoles, S. A., produced 43,300 tons of zinc concentrate and 31,300 tons of lead concentrate from 325,000 tons of company ore and small quantities of custom ore.

The Avalos unit at Avalos (Zacatecas), the Calabaza unit at Etzatlan (Jalisco), and the Topia unit at Topia (Durango) produced both zinc and lead concentrates; the Ocampo unit at Boquillas, Coahuila, produced lead concentrate. The company zinc concentrate was shipped to the Blackwell (Okla.) smelter of the Blackwell Zinc Co. (subsidiary of American Metal Climax Co.), but the lead concentrate was smelted at the company smelter at Torreon, Coahuila, in Mexico.

The San Francisco Mines of Mexico, at San Francisco del Oro, Chihuahua, in which American Metal Climax Co. has an interest, during the year ended September 30, 1957, milled 878,000 short tons to produce concentrate containing 56,900 short tons of zinc, 38,300 tons of lead, about 4,500 tons of copper, and considerable gold and silver.

The El Potosi Mining Co. (subsidiary of Howe Sound Co.) operated its El Potosi mine in the Santa Eulalia district and El Carmen mine at Batophilas, both in Chihuahua, to produce both lead and zinc concentrates.

Fresnillo Co. continued to operate its lead-zinc mines at Fresnillo in Zacatecas and its Naica mine in Chihuahua. In the year ending June 30, 1957, the company mined and milled 1,036,000 tons of ore to produce 39,000 tons of zinc and 36,900 tons of lead in concentrates, as well as values in copper, gold, and silver.

The Minas de Iguala, S. A., subsidiary of the Eagle-Picher Co., operated its zinc-lead-copper mine and concentration mill at Parral, Chihuahua.

SOUTH AMERICA

Argentina.—The Aguilar mine of Cía. Minera Aguilar, S. A., a subsidiary of St. Joseph Lead Co., operating in the Province of Jujuy, produced zinc and lead concentrates containing 26,300 tons each of lead and zinc, or about 80 percent of the national totals. The zinc concentrate was roasted at the plant of Sulfacid, S. A., at Borghi and partly reduced to slab zinc at an electrothermic zinc smelter, Comodoro Rivadavia, owned by Cía. Metalúrgica Austral-Argentine, S. A., of which St. Joseph Lead with its Aguilar subsidiary owned 43.3 percent. The smelter produced about 9,700 short tons of slab zinc. Sulfacid, S. A., operated an electrolytic pilot plant in

1957 and was considering a commercial installation with capacity of 18 metric tons of electrolytic zinc per day.

Bolivia.—Pulcayo & Animas, the nationalized mine-mill zinc units, produced 39,100 short tons of concentrate containing 21,700 tons of zinc. No zinc was produced from privately owned mines in Bolivia in 1957. The entire output was exported mostly to Belgium, the Netherlands, and the United States.

Peru.—Mine output of zinc in 1957 was 173,600 tons—virtually unchanged from 1956. Cerro de Pasco Corp. continued to be the largest producer; its copper-lead-zinc mines at Casapalca, Cerro de Pasco, Morococha, San Cristobal, and Yauricocha produced 2,115,840 tons of crude ore. Smelter production at La Oroya,[12] including company and purchased ores, yielded 32,540 tons of zinc, 45,345 tons of copper, 75,900 tons of lead, 12,735,000 ounces of silver, and 42,000 ounces of gold. Peak production of electrolytic zinc and sales of concentrate permitted a significant reduction in stocks of low-grade zinc concentrate.

Other significant zinc producers in Peru during 1957 were Volcan Mines Co., Cía. Minera Atacocha, Cie des Mines de Huaron, and Northern Peru Mining Co.

Many lead and zinc mines had closed or curtailed production by midyear, owing to declining metal prices. Among them were Volcan, Venturosa, Huaron, Yauli, and Atacocha.[13]

Cía. Minerales Santander was engaged in stripping the ore body in 1957 and building a mill at Chancay River, Peru.[14] Consideration was being given to preparing the mine for production but leaving it on a standby basis, pending higher metal prices.

Of the 166,000 tons of zinc exported from Peru, 75 percent was shipped to the United States, 17 percent to Belgium, and the remaining 8 percent to many European countries and Japan.

EUROPE

Austria.—The lead-zinc mine of Bleiberger Bergwerks Union, a nationalized company, produced about 200,000 tons of lead-zinc ore. The ore was concentrated by flotation to yield lead and zinc concentrates. The electrolytic plant of Bleiberger Bergwerks Union at Gailitz produced 10,287 tons of zinc. Consumption of slab zinc by Austrian industry was 12,700 tons.

Belgium and France.—No zinc mine was operated in Belgium in 1957. French mines produced 13,200 tons of zinc. Belgian and French smelters together produced 404,000 tons of zinc, a 7-percent increase over 1956. Zinc concentrates were imported from Belgian Congo, North Africa, Sweden, Australia, Spain, and Peru. Société Anonyme des Mines and Fonderies de Zinc de la Vielle-Montagne continued to be the largest zinc-producing company. The company's electrolytic plants at Balen, Belgium, and Viviez Aveyron, France, yielded 115,000 tons of zinc. Eleven retort plants in Belgium and France operated at near capacity in 1957.

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[12] Cerro de Pasco Corp., Annual Report, 1957, 24 pp.
[13] American Metal Market, vol. 64, No. 144, July 27, 1957, p. 23, Metal Bulletin (London), No. 4215, July 30, 1957.
[14] St. Joseph Lead Co., Annual Report, 1957, 24 pp.

Bulgaria.—According to Comtel-Reuter reports from Vienna, prospecting in Bulgaria revealed 37 zinc-lead ore bodies having reserves of 15 million tons in Harmanti, Sivilengrad, and Ivailovograd. Annual production of 330,000 tons of ore and 50,000 tons of zinc concentrate was planned and work was begun.

Germany, West.—West German mines produced 104,000 tons of zinc in 1957. Zinc was mined in the Harz Mountains and from Stolberger properties in the Rhineland. Six active zinc smelters produced 202,500 tons of slab zinc. A large volume of imports was necessary to equal West German consumption of approximately 250,000 tons in 1957.

Italy.—Mine output of zinc, mostly from the island of Sardinia, was 144,600 tons, a gain of 7 percent over 1956. The principal producers were the Montevecchio and Monteponi mines. Italy exported 38,300 short tons of zinc in concentrates to European refiners. Most of the remainder was processed in 3 Italian electrolytic plants and 1 retort smelter that together produced 81,192 tons of zinc. Estimated Italian consumption in 1957 was 75,000 tons.

Norway.—Mine production of zinc in 1957 totaled 7,600 tons. Bleikvassli mines in the Rana district of northern Norway began developing a sulfide deposit containing pyrite, lead, and zinc. Ore output was anticipated to be 100,000 tons annually. The ore reserve was reported to be 2 to 3 million tons. Development of the nearby Mofjelletsand zinc and lead mine was nearly finished at the end of 1957. The electrolytic zinc plant of Det Norske Zinkkompani, A. S., reported an output of 52,800 tons of refined zinc. Estimated Norwegian consumption of zinc in 1957 was 15,800 tons.

Poland.—Zinc mines of Upper Silesia have long been mjaor contributors to the Polish economy. In 1957 they produced 2,146,000 tons of ore containing an estimated 143,000 tons of zinc metal. Poland also imported zinc concentrate in 1957. Smelters and refineries produced 175,000 tons of zinc, of which approximately 65,000 tons was electrolytic and 110,000 tons fire-refined zinc.

Spain.—The Real Compañía Asturiana de Minas continued to be the largest producer of zinc concentrate and the only producer of slab zinc in 1957. The company operated the Reocin and Arditurri mines near the north coast and the Arnao zinc-retort smelter near Aviles The output of the Arnao plant was 21,750 tons of slab. The Penarroya zinc smelter in Cordoba Province of southern Spain remained idle. Concentrates in excess of Arnao plant capacity were shipped to other European countries for processing. In 1957 the Spanish Government authorized the Spanish banks, Herrew and Banco Espanol jointly to set up a company for producing electrolytic zinc under the name of Austuriana de Zinc, S. A. The Belgian-owned enterprise Real Compañía Austriana de Minas was participating to a maximum of 40 percent, although foreign participation normally is limited to 25 percent.

Sweden.—Zinc was mined in Sweden at Ammeberg between Narke and Ostergitland and at Kopparbergs Bergslags mines. A small quantity also was mined at Kaveltorp, Ryllshyttan, Saxberger, Garpenberg, and Slollberg. The Swedish subsidiary of Vieille-Montagne Zinc Co. of Belgium celebrated 100 years of ownership of the Ammeberg mines, which produced 34,000 tons of zinc concentrate

(54 percent zinc) in 1957. Boliden Mining Co. mined three large pyrite-copper-lead-zinc bodies in northern Sweden. Boliden reported ore production at Langselegruvan in 1957 totaling 2,240,000 tons of zinciferous pyrite. The ore was transported by standard-gage railway underground to the central works at Boliden. The company's Akulla mine was abandoned owing to exhaustion of ore.[15] Mine production of Boliden Mining Co. in 1957 totaled 40,532 tons of zinc. Sweden's zinc concentrates were shipped to European smelters, and refined zinc was reshipped to Sweden for internal use.

United Kingdom.—Ores mined in England yielded 1,100 tons of zinc in 1957. The National Smelting Co., Ltd., at Avonmouth, operating near capacity on imported concentrates, produced 85,500 tons of refined zinc in 1957. The Imperial Smelting Corp., parent to National Smelting Co., announced the successful development of a blast-furnace process for smelting complex zinc ores.[16] Two furnaces having a combined daily capacity of about 80 tons of zinc were operated in 1957. Experience indicated that the process is applicable to high- or low-grade zinc concentrates or mixed lead-zinc concentrates. Imports by the United Kingdom included 207,244 tons of zinc ore and 148,350 tons of cast shapes. Consumption in 1957 was 316,400 long tons, of which 231,020 was new zinc and 85,386 long tons scrap.[17] In August the British Government announced plans to sell 27,000 long tons of zinc from its stockpile. Accordingly, 3,000 long tons a month were released from September through December. Similar releases were planned in first half of 1958.

U. S. S. R.—Official data on zinc production in the U. S. S. R. in 1957 are not available, but estimates indicate a smelter output of 386,000 tons, all from mines within the Soviet Union. Exploration continued at a high level in 1957. New zinc ore bodies were discovered in regions of Kazakhstan, Ukraine, and Transcaucasus.[18] Pravda announced that lead and zinc production in Kyzl-Ordinskaya furnaces will be 50 percent greater in 1961 than in 1955. The first slag-treating plant in Russia began producing in 1957.

Yugoslavia.—In 1957 Yugoslavian mines produced about 1,750,000 tons of lead-zinc ore containing 64,000 tons of zinc. The leading zinc and lead mining areas are nearby in Serbia, Macedonia, and Slovenia. The Trepca mines in Serbia continued to be the largest producer. New discoveries of lead-zinc deposits were reported in the Sasa-Toranica Basin. Total refined-zinc output was 32,500 tons, of which three-fourths came from the retort smelter at Celje, Slovenia.

ASIA

Burma.—The Burma Corp., Ltd., continued to operate the Bawdwin lead-zinc-silver mine in the Shan States of northern Burma. For the year ended June 30, 1957, output was 131,200 tons of crude ore. The zinc content of Burmese concentrate received by West Germany, the United Kingdom, and Belgium during 1957 was 15,400 short tons.

India.—Mine output of zinc in India in 1957 came from the Zawar lead-zinc mine of the Metal Corp. of India, Ltd., near Udaipur in

[15] Mining Journal (London), Annual Review, May 1958, 328 pp.
[16] Morgan, S. W. K., The Production of Zinc in a Blast Furnace: Bull. Inst. Min. and Met., August 1957, No. 609; Trans., vol. 66, pt. 11, 1956–57, pp. 553–565.
[17] British Bureau of Non-Ferrous Metal Statistics.
[18] Mining Journal (London), Annual Review, May 1958, 328 pp.

Rajasthan. The zinc concentrate produced was sent to Japan for smelting. Estimated output of zinc concentrate in 1957 was 8,800 tons containing 4,600 tons of zinc. Indian internal annual requirements of zinc were estimated to be about 53,000 tons.

Japan.—The principal zinc producers in Japan in 1957 were Mitsui Mining & Smelting Co., Ltd.; Mitsubishi Metal Mining Co., Ltd.; Toho Aen Kogyo, K. K.; Nihon Soda K. K.; and Mikkaichi Smelting Co. Output of electrolytic zinc rose 3 percent to 94,300 short tons in 1957, and production of refined zinc totaled 152,800 tons. Japanese consumption of zinc in 1957 was estimated at 142,500 tons.

AFRICA

Algeria.—Most of Algeria's output of zinc continued to come from deposits near the Moroccan border south of Oudja, Morocco, and adjacent to the Bou Beker lead-zinc mines in Morocco. The larger zinc producers in Algeria included the mines of the Société Nord Africaine du Plomb and Société Algerienne du Zinc.[19] Combined mine output of the two companies was 226,000 short tons of ore containing 13.4 percent zinc and 2.0 percent lead. Operations were suspended from December 11, 1956, to February 14, 1957, owing to political unrest.

Belgian Congo.—The large Prince Leopold copper-zinc mine of the Union Minière du Haut Katanga at Kipushi, near Elisabethville, was the only zinc producer in the Congo. According to the company's annual report, the mine output was 1,117,000 tons of crude ore in 1957. The Kipushi concentrator treated 1,280,000 tons during the year and extracted 207,400 tons of 56.97-percent zinc concentrate and 279,770 tons of 26.62-percent copper concentrate. A large part of the zinc concentrate was roasted in the Sogechem works at Jadotville to produce sulfuric acid. Some calcined concentrate was sold to the Metalkat electrolytic zinc plant at Kolwezi, and some was shipped to Belgium for smelting. Exports of zinc in concentrate in 1957 totaled 71,580 tons and exports of refined metal, 40,766 tons.

Morocco.—In 1957 production of zinc concentrate was 87,000 short tons containing 45,600 tons of metal. Virtually all of the zinc concentrate was exported to France. The Bou Beker mines of the Société des Mines de Zellidja continued to be the largest Moroccan producer of zinc. The Touisitt properties of the Compagnie Royale Asturienne des Mines ranked second. Both mines are in eastern Morocco 25 miles south of Oudja on the Algerian border. A third large producer was the Aouli Mibladen near Midelt.

Rhodesia and Nyasaland, Federation of.—The Rhodesian Broken Hill Development Co., Ltd.,[20] hoisted 182,600 short tons of ore in 1957 (161,400 in 1956), of which 31,700 tons was silicate ore sent directly to the zinc leaching plant. The sulfide flotation plant processed 136,600 short tons of ore containing 19.7 percent lead and 29.1 percent zinc to produce 28,200 tons of lead concentrate assaying 64.4 percent lead and 40,606 tons of zinc concentrate assaying 59.4 percent zinc. Silicate ores and calcined sulfide concentrate were processed in the company's electrolytic plant to yield 36,200 short tons of zinc. Byproduct cadmium totaled 112 tons. The lead smelter produced

[19] Newmont Mining Corp., Annual Report 1957, 20 pp.
[20] Annual Report of December 31, 1957, 20 pp.

16,800 tons of refined lead and retort bullion containing 117,400 ounces of silver. Ore reserves were reported to be 4,160,000 tons containing 28.4 percent zinc and 14.4 percent lead.

South-West Africa.—Tsumeb Corp., Ltd.,[21] mined and milled 638,000 tons of complex lead-copper-zinc ore containing economic quantities of germanium, cadmium, and silver. Assured ore reserves were estimated to total 9,490,000 tons, averaging 14.17 percent lead, 5.38 percent copper, 4.5 percent zinc, and 0.017 percent germanium. Rail transport to the seaport at Walvis Bay remained inadequate and was supplemented by truck haulage, which reduced the accumulation of zinc concentrate at the mine by one-third. The company announced plans to replace the narrow-gage rail section with standard South African gage.

Tunisia.—Tunisian mines produced 6,600 tons of zinc concentrate containing 3,620 tons of zinc. No refined zinc was produced in Tunisia in 1957. The mines also produced lead concentrate containing 26,300 tons of lead.

OCEANIA

Australia.—The Broken Hill district of New South Wales was by far the leading Australian zinc-producing area. Mining companies operating in 1957 were New Broken Hill Consolidated, Ltd.; Zinc Corp., Ltd.; Broken Hill South, Ltd.; and North Broken Hill, Ltd. An estimate of output in the Broken Hill district was 2,220,000 tons of crude ore that yielded zinc and lead concentrates containing about 250,000 short tons of zinc, 280,000 tons of lead, and 10 million ounces of silver.

During the fiscal year ended June 30, 1957, Mount Isa Mines, Ltd., processed 1,573,400 tons of lead-zinc-copper ore from the Cloncurry district in Queensland. The ore yielded 50,600 tons of lead bullion, 32,340 tons of blister copper, and 39,650 tons of zinc concentrate.[22] The company planned to install a new 4,500-hp. hoist made by the British General Electric Co. designed to increase monthly capacity from 100,000 to 180,000 tons of ore per month. Exploration and development increased reserves of both silver-lead-zinc and copper ore substantially.

The Lake George Mining Corp., Ltd., in the year ended June 30, 1957, milled 189,900 tons of ore to produce 29,600 tons of zinc concentrate, 14,900 tons of lead concentrate, and 34,900 tons of copper concentrate from ores mined in the Captain's Flat district of New South Wales.[23] The company expressed disappointment at failure to extend ore reserves significantly in 1957.

For the fiscal year ended June 30, 1957, the mines of the Electrolytic Zinc Company of Australasia, Ltd., in the Read-Rosebery district produced 191,238 tons of ore that yielded 56,279 tons of zinc concentrate, 9,300 tons of lead concentrate, and 6,000 tons of copper concentrate. The zinc concentrate was processed at the company's Risdon electrolytic plant. The Risdon plant again produced a record output of 123,600 short tons of zinc, compared with 117,600 tons in the preceding year. Plans were made to expand capacity to 140,000

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[21] American Metal Climax, Inc., 1957 Annual Report, 52 pp.
[22] American Smelting & Refining Co., Annual Report, 1957, 32 pp.
[23] Lake George Mining Corp., Ltd., Annual Report, 1957, 18 pp.

tons a year. In addition to company concentrates from the Read-Rosebery district mines, the plant treats a large tonnage of zinc concentrates from the Broken Hill district.

The British company, Consolidated Zinc Corp., Ltd., commenced building a new smelter at Cockle Creek, New South Wales. The smelter will be the new blast-furnace type.[24] Production was scheduled to begin in 1960, and capacity output of 52,000 short tons annually was anticipated by 1963.

WORLD RESERVES

The term "zinc reserves" refers only to zinc ores that have been inventoried and are economic at the time of inventory. It does not include material that requires new technologies or more favorable prices; neither does it include estimates for undiscovered ores. Ore reserves listed in table 33 include measured and indicated reserves but not inferred ore. Definitions of these classes of reserves follow:

Measured ore is ore for which tonnage is computed from dimensions revealed in outcrops, trenches, workings, and drill holes and for which the grade is computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are so closely spaced and the geologic character is so well defined that the size, shape, and mineral content are well established. The computed tonnage and grade are judged to be accurate within limits which are stated, and no such limit is judged to differ from the computed tonnage or grade by more than 20 percent.

Indicated ore is ore for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on geologic evidence. The sites available for inspection, measurement, and sampling are too widely or otherwise inappropriately spaced to outline the ore completely or to establish its grade throughout.

Inferred ore is ore for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on an assumed continuity or repetition for which there is geologic evidence; this evidence may include comparison with deposits of similar type. Bodies that are completely concealed may be included if there is specific geologic evidence of their presence. Estimates of inferred ore should include a statement of the spacial limits within which the inferred ore may lie.

TABLE 33.—Estimate of world reserve of zinc in measured and indicated ore, January 1957

	Zinc content, short tons	Percent of total		Zinc content, short tons	Percent of total
North America:			Africa: Algeria, Belgian Congo, Morocco, Northern Rhodesia, Southwest Africa, and Tunisia	4,000,000	4.7
Canada [1]	16,691,000	19.8	Asia: Burma, China, India, Iran, and Japan	4,500,000	5.3
Mexico [2]	6,650,000	7.9	Australia	11,000,000	13.0
United States [3]	13,485,000	16.0	Total	84,501,000	100.0
Other	175,000	.2			
South America: Argentina, Bolivia, Peru, and Chile	6,000,000	7.1			
Europe:					
Eastern Europe	11,000,000	13.0			
Western Europe	11,000,000	13.0			

[1] Source: Canada Department of Mines and Technical Surveys, Mines Branch, Memo. Ser. 137.
[2] Estimate by Bureau of Mines.
[3] Survey made by Bureau of Mines in 1957.

[24] Work sited in footnote 16.

TECHNOLOGY

Numerous technologic advances in the zinc industry in 1957 were reported in trade journals and the reports of private and governmental research units.

The Federal Bureau of Mines [25] and the Federal Geological Survey [26] published results of several investigations relating to zinc.

A significant paper [27] described a process developed by the Imperial Smelting Corp., Ltd., at Swansea, Wales. More than 70,000 long tons of zinc was produced by the process in 2 furnaces, which in 1957 had a combined capacity of 70 long tons per day. The blast furnaces are charged with a mixture of sintered zinc or zinc-lead concentrate and preheated coke. Furnace gases containing 5 to 6 percent zinc as vapor are withdrawn from above the furnace charge at a temperature higher than that required for zinc reoxidation. The gases pass to condensers, where they are shock-cooled by series showers of molten lead to about 450° C. Approximately 95 percent of the zinc condenses in the lead bath before oxidation. Uncondensed zinc leaving the condensers in furnace gas is recovered by scrubbing and filtration and is added to the sinter feed and recycled to the blast furnace.

The lead-zinc metal mix is cooled in a water-cooled launder and passes to a separation bath, whence the zinc overflows to a bath for reheating with sodium to remove arsenic before casting. The zinc produced was Prime Western grade containing 1.2 percent lead, 0.024 percent iron, 0.07 percent cadmium, and 0.001 percent arsenic. When lead is present in the blast-furnace feed, the lead is smelted with the zinc and the bullion tapped periodically from the furnace bottom. Carbon consumption is reported to be about 104 percent of the weight of the volatilized zinc. The zinc content of the slag has been approximately 2 to 3 percent.

An article describing American Smelting & Refining Co.'s new electrolytic zinc plant at Corpus Christi, Tex., appeared in 1957.[28] Zinc is deposited at 82 amperes per square foot per cell in 196 cells arranged 14 cells to a bank in 14 parallel rows. The cells are made of concrete surfaced with asphalt and plastic, and lined with 1.25-inch acidproof brick. Each cell holds 750 gallons of zinc solution and is equipped with 29 silver-lead anodes and 28 aluminum cathodes; the cathodes are stripped of zinc after 16 hours. Each cell uses a closed system of circulation for continuous flow of electrolyte in the cell.

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[25] Peyton, A. L., Examination of Copper-Lead-Zinc Deposits, Cabarrus and Union Counties, N. C.: Bureau of Mines Rept. of Investigation 5313, 1957, 13 pp.
Cole, W. A., Mining and Milling Methods and Costs, Tri-State Zinc, Inc., Jo Daviess County, Ill.: Bureau of Mines Information Circ. 7780, 1957, 19 pp.
Olds, E. B., and Parsons, E. W., Methods and Costs of Deepening the Crescent Shaft, Bunker Hill & Sullivan Mining & Concentrating Co., Shoshone County, Idaho: Bureau of Mines Information Circ. 7783, 1957, 19 pp.
Hardwick, W. R., and Sierakoski, Joe, Mining Methods and Practices at the Johnson Camp Copper-Zinc Mine, Coronado Copper & Zinc Co., Cochise County, Ariz.: Bureau of Mines Information Circ. 7788, June 1957, 27 pp.

[26] Kinkel, A. R., Hall, W. E., and Albers, J. P., Geology and Base-Metal Deposits of West Shasta Copper-Zinc District, Shasta County, Calif.: Geol. Survey Prof. Paper 285, 1956, 156 pp.
McClelland, Dings G., and Robinson, C. S., Geology and Ore Deposits of the Garfield Quadrangle, Colorado: Geol. Survey Prof. Paper 289, 1957, 110 pp.
Bodenlos, A. J., and Straczek, J. A., Base-Metal Deposits of the Cordillera Negra, Departmento de Ancash, Peru: U. S. Geol. Survey Bull. 1040, 1957, 165 pp.
Brown, C. Ervin, Whitlow, J. W., and Corsby, Percy, Geology and Zinc-Lead Deposits in the Catfish Creek Area, Dubuque County, Iowa: Geol. Survey Field Study Map MF-116, 1957.

[27] Work sited in footnote 16, p.37.

[28] Jephson, A. C., and Allen, R. E., Asarco's New Electrolytic Plant at Corpus Christi, Tex.: Jour. Metals, vol. 9, No. 10, October 1957, pp. 1381-1384.

American Zinc Co. of Tennessee drilled a 66-inch-diameter ventilation shaft at its Young mine near New Market, Tenn.[29]

The Dnepropetrovsk Institute of Chemistry and Technology of the U. S. S. R.[30] claimed development of a method for continuous electrolytic production of zinc. The process is said to produce zinc 12 to 15 times faster than the usual method in a continuous ribbon 0.2 to 0.5 mm. thick that is stripped automatically from drum-shaped cathodes.

A solder [31] composed of zinc with a little aluminum and magnesium was developed by Bell Telephone Laboratories to bond aluminum without flux and without the vigorous abrasion usually needed. The solder is said to wet the aluminum even if rolling-mill oils and surface oxide have not been removed.

A new process,[32] involving the use of zinc as the first layer under copper-, nickel-, and chromium-plated bumpers and other plated parts of automobiles, may prevent rusting. The zinc is applied to the base metal in such a manner that it does not blend with a coating of copper applied over the zinc.

A novel use of zinc as galvanic anodes at the Trail plant of Consolidated Mining & Smelting Co. of Canada, Ltd., was described.[33] Zinc bars attached to steel rake arms of leaching-plant thickeners gave the arms 100 percent cathodic protection from corrosion. It was reported that the zinc anodes were consumed by corrosion at the rate of 1 pound per day (for a 40-foot thickener), or about 2 pounds per square foot of protected steel surface per year.

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[29] Mining World, American Zinc Revives Old Art to Drill 66-Inch Hole: Vol. 19, No. 10, September 1957, pp. 60-63.
[30] South African Mining and Engineering Journal, Zinc Refining: Vol. 68, No. 3353, May 17, 1957, p. 959.
[31] Chemical Age (London), New Solder Process for Aluminum: Vol. 78, No. 2005, Dec. 14, 1957, p. 978.
[32] American Metal Market, Plating Process by Wagner Bros. Utilizes Zinc as Initial Layer: Vol. 64, No. 157, Aug. 15, 1957, pp. 1, 7.
[33] Engineering and Mining Journal, How Zinc Anodes Can Reduce Galvanic Corrosion in Zinc Plant Thickneners: Vol. 158, No. 10, October 1957, p. 99.

Zirconium and Hafnium

By F. W. Wessel [1]

THE INCREASED PACE of construction of private nuclear powerplants and power reactors for naval vessels required increasingly large quantities of zirconium. This activity, however, also extended the use of stainless steel in direct competition with zirconium, particularly in reactors using highly enriched fuels.

To provide the Atomic Energy Commission (AEC) with an additional 5,500 tons of Reactor-grade zirconium over a 5-year period, contracts were placed with 3 domestic companies, each of which built a new plant. The new plants have a total capacity in excess of AEC requirements.

All hafnium produced in zirconium plants was assigned to the AEC for allocation. The Commission is interested in constructing a central plant of 75,000 pounds capacity to recover hafnium metal from the refinery wastes of all zirconium producers.

Zircon demand, active at the beginning of the year, had dropped sharply by the end of the year. The decline was ascribed to reduced demand by foundries in the United States. Australian zircon was a coproduct of rutile, which also suffered a depressed market during the year; early in January informed sources warned of overproduction of both minerals. In spite of this warning, the more recently established titanium companies in Western Australia progressed toward the marketing of coproduct zircon; at least one new company was formed to work beach sands in New South Wales, and others began production or expanded output. By midyear the price of zircon had dropped, and many producers suspended operations late in the the year.

Although prices remained constant in the United States, the same decline in demand was apparent. Most producers operated throughout the year, but curtailment was imminent. In the United States, where the bulk of the output comes from captive mines, the decline in demand was expected to have less effect than in Australia. Deposits in Georgia, Nevada, and Tennessee were discovered or examined during the year.

DOMESTIC PRODUCTION

Mine Production.—Florida again was the principal, but not the only, domestic producer of zircon. In 1957, 56,802 tons of concentrate was produced at 3 operations in Florida—an increase of 29 percent over output in 1956. The estimated value, however, decreased 9 percent—from $2,159,540 to $1,975,700. In addition, some

[1] Physical scientist.

zircon was mined and marketed in South Carolina. In Idaho and elsewhere in the West freight costs again prohibited marketing, and no production was recorded. Baddeleyite, which occurs in this country only in Montana, was not mined in 1957.

Metal Production.—Five-year contracts, placed with 3 companies by the AEC in 1956, called for delivery of 1,100 tons of Reactor-grade sponge per year. Carborundum Metals Co., Inc., agreed to deliver 250 tons of metal at $7.72 per pound, U. S. Industrial Chemicals Co. 500 tons at $4.53, and Columbia-National Corp. 350 tons at $6.50. As a result of these contracts, Carborundum Metals Co., Inc., built a second plant at Parkersburg, W. Va., with a capacity of 600 tons annually; U. S. Industrial Chemicals Co. equipped a plant at Ashtabula, Ohio, with an annual capacity of 1,000 tons; and Columbia-National Corp., jointly controlled by Columbia Southern Chemical Co. and National Research Corp., built a plant at Milton, Fla., with an annual capacity of 750 tons.

Carborundum Metals continued to produce zirconium at the full capacity of its plant at Akron, N. Y. The plant at Parkersburg, W. Va., began production by midyear, and at the end of 1957 its annual rate of output was 500,000 pounds.

U. S. Industrial Chemicals Co. (which late in the year became a division of Mallory-Sharon Metals Corp.) remodeled the plant purchased from Lake City Malleable Co. at Ashtabula, Ohio, but reported no shipments in 1957. The plant of the Columbia-National Corp. produced and shipped its first metal late in the year.

The Wah Chang Corp. operated leased facilities at Albany, Oreg., throughout the year at above nominal capacity while constructing its own plant in the same area. The new plant was producing at full capacity by the end of the year, and the total annual production rate of the 2 plants was 900,000 pounds. Construction and testing continued at the Bedford (Ohio) plant of Kennecott Titanium Development Corp., where an electrolytic process was used under license from Horizons Titanium Corp., Princeton, N. J.

Melting capacity for zirconium sponge in the United States was estimated at 5,630,000 pounds annually—far more than the production of sponge. Leaders in the field were Allegheny Ludlum Steel Corp., Firth Sterling, Inc., Oregon Metallurgical Corp., and Reactive Metals, Inc. Firth Sterling, Inc., was awarded a contract to melt and fabricate Zircaloy mill products worth nearly $5 million; this material will be used for fuel-element cladding and structural parts in nuclear reactors. The Oregon Metallurgical Corp. at the end of 1957 had begun to deliver 350,000 pounds of ingot on a $4 million melting contract; Wah Chang Corp. supplied the sponge.

CONSUMPTION AND USES

Consumption of zircon in the United States in 1957 is estimated at 85,000 tons. A preliminary estimate of distribution indicates that 7 percent went into metals and alloys, about 85 percent into refractory and foundry use (refractory use being slightly larger than foundry use), and the remaining 8 percent into ceramics, abrasives, paints, and miscellaneous uses. The small quantity of baddeleyite was consumed in manufacturing alloys and refractories.

Nonnuclear uses of zirconium metal were as valves, valve stems, pipes, and reaction vessels to withstand corrosive conditions, including exposure to sea water. Minor uses of zirconium metal were as a "getter" in vacuum tubes and elsewhere in the electronics industry, in photographic flashbulbs, as surgical plate and mesh for bone repair to replace tantalum, in nonferrous master alloys, and in naval ordnance. Zirconium sulfate began to be used as a paint component, zirconium fluorides were used in preparing metallic coatings, and the acetate was used as a filler in textiles. Zirconia refractories were used extensively by the glass industry, and stabilized-zirconia laboratory ware was marketed. Sintered zircon and zirconia refractories were being studied.

Zirconium tubing for reactor use was made by Superior Tube Co., Wolverine Tube Division of Calumet & Hecla, Inc., and Bridgeport Brass Co. in 1957. Fittings of zirconium were made by National Cylinder Gas Co. for welding use. The Sylvania Electric Products Corp. produced a photographic flashbulb containing zirconium foil instead of magnesium. A new melting furnace, developed by Titanium Metals Corp., Allegheny Ludlum Steel Corp., and McGraw Edison Co., was placed on the market by the last-named firm.

Developments, not yet on commercial scale, indicated possible use of zirconium boride, carbide, and nitride in the high-temperature field. The boride was said to resist temperatures of 3,300° C.

STOCKS

Dealers' stocks of zircon concentrate increased during the year from 3,109 tons (revised figure) to 5,950 tons. In addition, an estimated 12,750 tons was in consumers' stockpiles at the end of 1957. Stocks of baddeleyite decreased sharply and probably did not exceed 350 tons on December 31, 1957.

PRICES AND SPECIFICATIONS

The price of domestic zircon concentrate remained constant in 1957 at $50 (Jacksonville) and $55 (Starke) per short ton, f. o. b. mines. Quotations in E&MJ Metal and Mineral Markets of $64 to $68 per long ton, c. i. f. Atlantic ports, set on September 13, 1956, were reduced to $55 to $60 on July 25, $54 to $57 on August 15, and $50 to $51 on October 3, 1957. The October price was maintained until the end of the year.

AEC specifications for zirconium and hafnium metal delivered by contractors are as follows:

	Maximum limit, p. p. m.	
	Zirconium	*Hafnium*
Iron	1500	1500
Oxygen	1400	1400
Chlorine	1300	600
Magnesium	600	600
Carbon	500	
Chromium	200	
Hafnium	100	
Lead	100	
Phosphorus	100	

	Maximum limit, p. p. m. Zirconium	Hafnium
Silicon	100	
Zinc	100	
Aluminum	75	200
Nickel	70	
Copper	50	
Manganese	50	
Molybdenum	50	
Nitrogen	50	50
Sodium	50	
Titanium	50	200
Tungsten	50	
Vanadium	50	
Calcium	30	
Cobalt	20	
Rare earths (total)	15	
Lithium	1	
Boron	0. 5	
Cadmium	0. 5	

Zirconium sponge is required to be at least 99.6 percent pure, and hafnium must be 95 percent pure, with a minimum of 99.3 percent hafnium plus zirconium.

These standards have been in effect since April 27, 1956.

U. S. Industrial Chemicals Co. quoted Reactor-grade zirconium platelets at $7 to $14 per pound and Commercial-grade platelets at $5 to $10. It is not known whether any metal was sold at these prices. On November 14 Carborundum Metals Co. reduced prices to $7.50 to $10 per pound for Reactor-grade sponge and $5 to $7 for Commercial-grade sponge. The company simultaneously announced prices of $10.50 to $12.50 per pound for Reactor-grade zirconium or Zircaloy–2 ingot and $7.75 to $9.75 for Commercial-grade ingot.

Prices for powder (flash-grade) and mill shapes closed the year at $4 and $25–$35 per pound, respectively.

The Electro Metallurgical Co., in a schedule issued December 1, 1957, quoted the following prices for zirconium-bearing ferroalloys:

		Price per pound of ferroalloy
Zirconium ferrosilicon:		
12–15 percent Zr	cents	9.25 to 13.00
35–40 percent Zr	do	27.25 to 32.75
Nickel-zirconium		$1.80 to $1.90

FOREIGN TRADE [2]

Imports of zircon totaled 41,692 short tons in 1957, an increase of 34 percent over 1956 and about the same proportion of the total supply (imports plus production less exports) as in 1956. Value of imports increased 44 percent to $1.1 million.

Japan shipped to the United States 93,397 pounds of Reactor-grade zirconium sponge, valued at $1,043,504, or $11.17 per pound. This was received by the Commodity Credit Corporation on behalf of AEC.

Exports of zircon in 1957 totaled 3,160 tons; 2,729 tons went to Canada, 265 tons to Mexico, 103 tons to South American countries, and 63 tons to other nations. Total value of these shipments was

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

TABLE 1.—Zirconium ore (concentrate) [1] imported for consumption in the United States, 1948–52 (average) and 1953–57, by countries, in short tons

[Bureau of the Census]

Country	1948–52 (average)	1953	1954	1955	1956	1957
North America: Canada	28	----------	----------	----------	303	14
South America: Brazil	2,060	1,206	1,408	1,549	331	----------
Europe: United Kingdom	----------	----------	----------	----------	155	19
Asia: India	56	----------	----------	----------	----------	----------
Oceania: Australia [2]	19,258	23,461	17,249	27,542	30,351	41,659
Total: Short tons	21,402	24,667	18,657	29,091	31,140	41,692
Value	$586,757	$571,783	[3] $486,555	$813,448	$791,612	$1,142,472

[1] Concentrate from Australia is zircon or mixed zircon-rutile-ilmenite, and that from Brazil is baddeleyite or zircon. All other imports were zircon.
[2] Imports of zircon, rutile, and ilmenite from Australia until early 1948 were largely in the form of mixed concentrate. This mixed concentrate is classified by the Bureau of the Census 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) is estimated as follows: 1949, 14,623 tons; 1950, 15,098 tons; 1951, 24,577 tons; 1952, 21,500 tons; 1953, 22,200 tons; 1954, 16,300 tons; 1955, 27,542 tons; 1956, 30,351 tons; and 1957, 41,659 tons.
[3] Owing to changes in tabulating procedures by the Bureau of the Census, data are not comparable with those of other years.

$315,378, or about $100 per ton, indicating that most of the exported material was ground and sized zircon, probably for foundry and ceramic uses.

Reexports of 3,290 tons of zircon were shipped to Canada.

Exports of approximately 33 tons of crude metal, alloy, and scrap were distributed as follows: To Canada, 30,304 pounds; France, 14,861 pounds; Mexico, 7,173 pounds; the United Kingdom, 7,127 pounds; Japan, 4,410 pounds; and other nations, 1,758 pounds. As values per pound ranged from $0.32 to $12.91, commodities of widely differing zirconium content probably were included. Total value of these exports was $359,204.

Semifabricated forms valued at $24,385 were exported to several countries; shipments totaled 1,151 pounds.

WORLD REVIEW

NORTH AMERICA

Canada.—Dominion Magnesium, Ltd., continued experimental production of zirconium metal.

SOUTH AMERICA

Brazil.—The Brazilian Government's regulation against exporting any material containing over 0.2 percent HfO_2 was still in effect. As most Brazilian zirconium ore exceeds this percentage, little, if any, Brazilian ore entered the United States in 1957.

EUROPE

Sweden.—Experimental quantities of zirconium were produced.

United Kingdom.—Associated Lead Manufacturers, Ltd., expanded its facilities for preparing zirconium compounds. Murex, Ltd., produced some zirconium sponge.

ASIA

India.—Although production of titanium minerals from black sands continued, zircon was no longer recovered.

Japan.—The Toyo Zirconium Co. made barter contracts with the United States Government to deliver 400,000 pounds of Reactor-grade zirconium at an average price of $10.50. To the end of 1957, 93,000 pounds had been delivered. Australian zircon concentrate was used. Late in the year a fire seriously disrupted production and shipments.

Taiwan.—A proposal was made to produce titanium and zirconium tetrachlorides, using available excess chlorine, but action probably will be deferred, pending better market conditions.

TABLE 2.—World production of zirconium ore and concentrate, by countries,[1] 1948–52 (average) and 1953–57, in short tons[2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country[1]	1948–52 (average)	1953	1954	1955	1956	1957
Australia[3]	30,438	30,081	45,830	53,994	80,382	92,000
Brazil[4]	3,709	3,409	4,173	3,312	2,829	[5] 3,000
Egypt	97	263	109	126	402	[5] 400
French West Africa	151	1,047	1,012	----------	1,268	[5] 2,000
Madagascar	[6] 5	----------	----------	----------	----------	----------
Malaya	----------	----------	----------	----------	51	----------
United States	[7] 26,985	23,904	16,322	28,110	44,174	([8])

[1] In addition to the countries listed, zirconium was also produced in India; however, production data are not available for publication.
[2] This table incorporates a number of revisions of data published in previous tables.
[3] Estimated zircon content of all zircon-bearing concentrate.
[4] Chiefly baddeleyite.
[5] Estimate.
[6] One year only, as 1952 was the first year of commercial production.
[7] Average for 1952–53; previous years not available for publication.
[8] Figure withheld to avoid disclosing individual company confidential data.

AFRICA

Egypt.—The Société Egyptienne des Produits du Sable Noir—RAMLAH, S. A. E., and the Société Générale d'Ilmenite, S. A. E. (an Egyptian Government corporation), were formed to exploit black-sand deposits in the Nile Delta.[3]

Nigeria.—Production of zircon concentrate (5 percent HfO_2, 3 percent ThO_2) continued, but shipments were suspended.

Union of South Africa.—Anglo-American Corp. purchased the black-sand property at Umgababa, Natal, and did extensive metallurgical testing. The plant machinery was on order and, when installed, was expected to produce 7,000 tons of zircon annually.[4]

OCEANIA

Australia.—Estimated production of zircon in 1957 exceeded 90,000 tons[5]—all from east coast mines. The mines in Western Australia produced titanium minerals, and at the beginning of the last quarter one mine was reported to be about to produce zircon.[6] All zircon

[3] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 42.
Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, November 1957, p. 17.
[4] United States Consulate, Pretoria, Union of South Africa, State Department Dispatch 127: Oct. 9, 1957, pp. 4, 5.
[5] E&MJ Metal and Mineral Markets, vol. 28, No. 52, Dec. 26, 1957, p. 4.
[6] Mining Magazine (London), vol. 112, No. 2834, May 16, 1957, p. 15.

was exported; about half went to the United States. Most producers shut down during the last half of the year, owing to the reduced overseas demand for rutile and zircon.

WORLD RESERVES

A moderately detailed study gives the estimated reserves as shown in tables 3 and 4.

TABLE 3.—Reserves of zircon in the United States, by States, in short tons of 66 percent ZrO_2 concentrate

State	Thousand short tons	State	Thousand short tons
Florida (operating properties)	5,920	North Carolina, Georgia, and other Florida properties	352
New Jersey	1,520	Idaho	120
California	1,500	Oregon	90
South Carolina	1,275	Total	10,777

Deposits of zircon in Virginia, Washington, Colorado, Montana, and several other States have not yet been quantitatively examined.

TABLE 4.—World reserves of zirconium mineral, by countries, in short tons of concentrate [1]

Country	Concentrate, thousand short tons	Grade, percent ZrO_2	Country	Concentrate, thousand short tons	Grade, percent ZrO_2
United States	10,777	66	Brazil	2,000	70-75
Australia	10,000	65	Africa [2]	365	65
India and Malaya	7,500	65			

[1] Exclusive of the U. S. S. R., data for which are not available.
[2] Includes Union of South Africa, Egypt, Nigeria, and French West Africa.

Zirconium deposits having commercial potential exist in Western Australia, Canada, eastern Africa, Ceylon, Thailand, Norway, and Sweden.

TECHNOLOGY

Carborundum Metals' new plant at Parkersburg, W. Va., used the Kroll process, with modifications suggested by the company's experience at Akron, N. Y. Wah Chang Corp. also used a standard Kroll process at both their plants; purchased raw $ZrCl_4$ was the initial material.

The plant built by the U. S. Industrial Chemical Co. at Ashtabula, Ohio, was planned to use metallic sodium as a reductant rather than magnesium. It was thought that the sponge would be contaminated with sodium chloride rather than magnesium chloride and that the chloride could be removed by an aqueous leach, thus eliminating expensive vacuum distillation. This process has not yet proved satisfactory on a plant scale. A drip-melting process was used at the Ashtabula plant. Molten zirconium was dripped onto a spinning plate, forming disklike platelets, ½ to 1 inch in diameter. Compared with sponge, the platelets are nonpyrophoric, and handling economies are effected thereby; however, it is said that they do not compress into a consumable electrode as well as sponge. During 1957 the company purchased rights to a process developed in Australia by I. E. Newnham, in which hafnium and other impurities are separated from raw $ZrCl_4$ by disproportionation.[7] This process is cyclical, using reactions between various chlorides of zirconium, and gives promise of reducing the cost of purification. The company has been gradually perfecting operations, and at the end of 1957 it was stated that shipment of Reactor-grade metal was not more than 6 months away.

The Columbia-National operation differs from the original Kroll flowsheet in that (1) the zircon concentrate is fused with caustic soda to form soluble sodium zirconate, and (2) after the sodium zirconate is converted to zirconyl nitrate the hafnium is removed by solvent extraction with tributyl phosphate. The purified zirconyl nitrate is then converted to oxide, chlorinated, and reduced by the standard Kroll process.

In January Titanium Alloy Mfg. Division of National Lead Co. announced plans to expand its facilities for ground zircon and zirconium oxide. In March Stauffer Chemical Co. announced plans to expand by 40 percent its facilities for preparing $ZrCl_4$ at Niagara Falls in order to keep pace with demand.

In 1957 research on zirconium and hafnium, based on published papers and patents, centered around alloys. Corrosion, fabrication, improvement of production methods, and analytical chemistry also were studied.

Data on a silver-cadmium-indium alloy indicated that this alloy may partly replace hafnium as a control-rod material.

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[7] Newnham, I. E., Zirconium for Nuclear Reactors: Research, vol. 10, No. 11, November 1957, pp. 424-428.

Minor Metals

By C. T. Baroch,[1] William R. Barton,[2] Donald E. Eilertsen,[2] Frank L. Fisher,[2] James Paone,[2] and H. Austin Tucker[2] [3]

CESIUM AND RUBIDIUM [4]

CESIUM gained attention in 1957 as the ion source for an ion-propulsion rocket motor.

Domestic Production.—Production of pure cesium and rubidium compounds or metals from ore increased severalfold in 1957. Companies reporting production were: American Potash & Chemical Corp., Los Angeles, Calif.; Dow Chemical Co., Midland, Mich.; Fairmont Chemical Co., Inc., Newark, N. J.; Rocky Mountain Research, Inc., Denver, Colo.; and Var-Lac-Oid Chemical Co., New York, N. Y. In addition to metals, the following cesium and rubidium compounds were produced: Acetate, bromide, carbonate, chloride, chromate, dichromate, fluoride, hydroxide, iodide, nitrate, phosphate, sulfate, and disulfate.

A new $750,000 plant was completed in March by San Antonio Chemicals, San Antonio, Tex., to produce mixed potassium-rubidium-cesium carbonates from alkali-rich end liquors from a lithium hydroxide plant. The product, called ALKARB contained several hundred tons of rubidium and cesium. Most of the 1957 output was shipped to glass manufacturers, and minor quantities were converted to pure separated compounds by American Potash & Chemical Corp.

Cesium and rubidium radioisotopes were produced by Union Carbide Nuclear Co. at Oak Ridge National Laboratory, Oak Ridge, Tenn.

Consumption and Uses.—Consumption of cesium and rubidium compounds increased moderately in 1957. Less than 10 tons of pollucite was estimated to have been consumed in manufacturing metals and compounds. Cesium-rubidium-potassium carbonate was consumed in glass manufacture, where the cesium and rubidium served as a

[1] Chief, Branch of Rare and Precious Metals.
[2] Commodity specialist.
[3] Unless otherwise noted, figures on imports compiled by Mae B. Price and Elsie D. Jackson, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce, Bureau of the Census.
[4] Prepared by William R. Barton.

potassium equivalent. Cesium or its compounds were used in photoelectric cells; as scavengers of gases and other undesirable substances in chemical processes; in purifying other metals; in specialty glass, spectrographic instruments, scintillation counters, radio and television tubes, X-ray equipment, microchemical reagents, and catalysts; for medicinal purposes; and in infrared signaling devices. Rubidium closely resembles cesium and was used for similar purposes.

Prices.—Pollucite ore (25 to 30 percent Cs_2O) was quoted at approximately \$0.50–\$0.84 per pound in 1957. Cesium metal was quoted at \$1.95–\$4.00 per gram and rubidium metal at \$3.25–\$6.00 per gram, depending upon quantity and packaging. Cesium and rubidium compounds ranged in price from \$59 to \$136 per pound until December, when American Potash & Chemical Corp. announced prices ranging from \$13 to \$27.50 per pound. Cesium–137 radioisotope was priced at \$0.10 per millicurie for the first curie, \$25 per curie for 1 to 500 curies, and \$10 for each curie over 500.

World Review.—No pollucite was produced in South-West Africa in 1957. The output in 1956 was 147,300 pounds. Shipments in 1957 totaled 23,895 pounds, all to West Germany. In 1956, 22,220 pounds was shipped to the United States and 2,800 pounds to the United Kingdom.

Technology.—Considerable interest was shown in 1957 on the possibilities of ionic propulsion for space ships, using cesium as a propellent. One system, described in detail, would require a propellent mass of 51.2 tons for a 1-year trip.[5] North American Aviation, Inc., was studying the feasibility of ion rocket engines.[6]

The chemistry of the alkali metals, including cesium and rubidium, was discussed in detail in a recent book.[7]

One author reviewed briefly the properties, uses, ores, and metallurgy of cesium.[8]

A report on methods of converting cesium zinc ferrocyanide to cesium chloride included descriptions and flowsheets for several techniques.[9]

Procedures were investigated for recovering cesium–137 from radioactive wastes by leaching.[10]

GALLIUM[11]

Gallium melts in the palm of the hand and remains liquid up to 1,950° C.

Domestic Production.—Three firms produced gallium in 1957: The Aluminum Company of America, East St. Louis, Ill.; The Anaconda Co., Great Falls, Mont.; and the Eagle-Picher Co., Joplin, Mo. Output exceeded that in 1956.

[5] Stuhlinger, Ernst, Design and Performance Data of Space Ships With Ionic Propulsion Systems: Presented under the auspices of Am. Rocket Soc. at 8th Internat. Astronaut. Cong., Barcelona, Spain, Oct. 6–12, 1957.

[6] North American Aviation, Inc., Prelude to Outer Space: Ann. Rept., 1957, p. 17.

[7] Suttle, J. F., The Alkali Metals—Comprehensive Inorganic Chemistry: Vol. 6, pt. I, D. Van Nostrand Co., Inc., Princeton, N. J., 1957, 182 pp.

[8] Strod, Arvid J., Cesium—a New Industrial Metal: Am. Ceram. Soc. Bull., vol. 36, No. 6, June 1957, pp. 212–213.

[9] Hepworth, J. L., McClanahan, E. D. Jr., and Moore, R. L., Cesium Packaging Studies—Conversion of Cesium Zinc Ferrocyanide to a Cesium Chloride Product: AEC Hanford Works Rept. 48832, June 5, 1957, 28 pp.

[10] Abriss, A., Reilly, J. J., and Tutbill, E. J., Separation of Cesium and Strontium from Calcined Metal Oxides as a Process in Disposal of High-Level Wastes: AEC Brookhaven Nat. Lab. Rept. 453, April 1957, 12 pp.

[11] Prepared by Donald E. Eilertsen.

Uses.—Gallium has numerous uses, but they require only small quantities of the metal. The element was used to seal glass joints in vacuum equipment, in backing material for optical mirrors, and in dental and low-melting alloys. Potential uses for gallium arsenide are in high-temperature transistors and in solar batteries.

Prices.—Throughout 1957 E&MJ Metal and Mineral Markets quoted gallium at $3 per gram in 1,000-gram lots and $3.25 per gram in smaller lots.

Technology.—Studies were made on the use of gallium to replace part of the iron in yttrium-iron garnets (YIGS) that are used in place of ferrites in microwave devices.[12]

Gallium arsenide was one of many compounds evaluated for use as a new semiconductor material.[13]

Data were published on the toxicity, fire and explosion hazards, storage, and handling of many gallium materials.[14]

GERMANIUM [15]

Production of germanium diodes, transistors, and power rectifiers reached an alltime peak in 1957, owing to continuing demand for more semiconductor devices by the electronic and electric industries. Domestic production plus imports appeared ample to fulfill requirements. In general, the price of metal and dioxide decreased. Advances in technology, especially in zone refining and single-crystal growth, enabled manufacturers in 1957 to introduce germanium semiconductor devices for wider use.

Domestic Production.—All primary domestic germanium output was a byproduct of zinc production from the Tri-State district of Missouri-Kentucky-Oklahoma and the Illinois-Kentucky zinc-fluorspar district. Producers were the American Zinc Co. of Illinois, Fairmont City, Ill.; The Eagle-Picher Co., Miami, Okla.; and Sylvania Electric Products, Inc., Towanda, Pa.

Consumption and Uses.—Based on an estimated world production of 90,000 pounds and assuming that the United States consumed three-fourths of the available supply, domestic consumption of germanium in 1957 approximated 70,000 pounds. Virtually all of this germanium was used in manufacturing semiconductor devices; about 40 million germanium diodes, transistors, and power rectifiers were manufactured in 1957. The largest advance was in the use of germanium in power rectifiers, as many industrial consumers of power adopted the germanium rectifier for converting alternating to direct current.[16]

The development of tiny germanium transistors as an integral part of printed circuits was announced in November by research scientists of the United States Army.[17]

The use of germanium outside the electronic and electrical industries was negligible in 1957. Germanium has a potential use in special

[12] Chemical Engineering News, YIGS Are Hot: Vol. 35, No. 49, Dec. 9, 1957, p. 62.

[13] Willardson, R. K., New Semiconductor Materials: Battelle Tech. Rev., vol. 6, No. 8, August 1957, pp. 8–14.

[14] Sax, N. Irving, Dangerous Properties of Industrial Materials: Reinhold Pub. Co., New York, N. Y., 1957, pp. 731–734.

[15] Prepared by Frank L. Fisher.

[16] Burton, L. W., and Thurell, J. R., Germanium Rectifiers: The Sky's the Limit: Power, vol. 101, No. 7, July 1957, pp. 73–76.

[17] American Metal Market, Transistors Made by Printed Circuit: Vol. 64, No. 224, Nov. 21, 1957, p. 2.

types of glass. Uses for alloys of germanium have been studied, but the comparative high price of germanium limits its use.

Prices.—Domestic germanium dioxide was quoted at 27½ cents a gram throughout 1957. The quoted price of foreign dioxide ranged from 24 to 30 cents a gram during the year. The price of germanium decreased on January 3, May 16, and June 6. Quoted prices for foreign germanium are on a delivered basis. Domestic germanium is quoted f. o. b. shipping point. The price basing system for germanium metal was changed on June 6; throughout the rest of the year, quotations, in cents per gram, delivered and f. o. b. shipping point, were as follows:

First reduction		Intrinsic quality		Pricing point
1,000-gram lots	10,000-gram lots	1,000-gram lots	10,000-gram lots	
40	38	44½	45½	Delivered.
43½	42½	48½	42½	F. o. b. shipping point.

Foreign Trade.—Germanium import data are not available. Exports were negligible. The three major foreign germanium producers were represented in the United States in 1957 by the African Metals Corp., American Metal Climax, Inc., and Harmon, Lichtenstein & Co., all of New York. Virtually all foreign germanium was produced in Belgium from concentrate from Africa.

World Review.—*Belgian Congo.*—The Prince Leopold mine of the Union Minière du Haut-Katanga continued to be a major source of germanium recovered as a chemical concentrate from flue dust at the Kolwezi smelter.

Belgium.—The Olen plant of the Société Générale Métallurgique de Hoboken produced germanium metal and dioxide from chemical concentrate from the Belgian Congo and South-West Africa (on toll). The plant had a capacity of about 75,000 pounds of dioxide (65 percent Ge).

South-West Africa.—The Tsumeb mine in the northern part of the Otavi Mountains produced a germanium concentrate in conjunction with its base-metal operations. Two studies on the geochemistry of the germanium in the deposit were published during the year.[18]

Technology.—Germanium technology in 1957 centered on zone melting and research and a study of germanium single crystals. Work on the production of germanium from coal in Great Britain was reviewed during the year,[19] and a study was made of the germanium content of coals in Australia.[20]

There were major technological developments in the production of germanium for use in semiconductor devices in 1957. A paper by

[18] Frondel, C., and Ito, J., Geochemistry of Germanium in the Oxidized Zone of the Tsumeb Mine, South-West Africa: Am. Mineral. ,vol. 42, 1957, pp. 743–753.
[19] Sclar, G. B., and Geier, B. H., The Paragenetic Relationships of Germanite and Renierite from Tsumeb, South-West Africa: Econ. Geol., vol. 52, No. 6, September–October 1957, pp. 612–631.
NOTE.—Germanium Research Study Group, Germanium From Coal; a Review: Dept. Sc. and Ind. Res., Charles House, 5–11 Regent St., London S. W. 1, April 1957, 26 pp.
[20] Pilkington, E. S., A Survey of Some Australian Sources of Germanium: Australian Jour. Appl. Sci. (Melbourne), vol. 8, No. 2, June 1957, pp. 98–111.

Pfann reviewed developments in zone melting since he introduced the technique in 1952.[21]

Dacey and Thurmond described the technology and theory of germanium in semiconductors.[22]

Bureau of Mines research continued in 1957 on the recovery of cadmium, germanium, and lead from zinc concentrate by a continuous volatilization treatment. A report on the titanium-germanium alloy system was published.[23]

INDIUM [24]

Indium occurs spasmodically in about 50 minerals; some ores, particularly zinc, contain as much as 0.1 percent indium.

Domestic Production.—The American Smelting & Refining Co., Perth Amboy, N. J. produced indium metal, chloride, and sulfate; and The Anaconda Co., Great Falls, Mont., produced indium metal. More indium was produced in 1957 than in 1956. The Anaconda Co. reported an output of 87,600 troy ounces of indium in 1956.

Uses.—Indium was used to form p-n junctions with germanium in the production of semiconductor devices, such as diodes, transistors, and rectifiers. The element also was used in sleeve bearings in aircraft, diesel, and automobile engines; in low-melting alloys for surgical casts and fusible safety plugs or links; in foundry patterns; in gold dental alloys; and as an additive to gasoline.

Potential uses for indium phosphide are in high-temperature transistors and solar batteries and for indium antimonide and indium arsenide in low-temperature transistors, Hall-effect devices, thermistors, and optical devices.

Prices.—Throughout 1957 E&MJ Metal and Mineral Markets quoted 99.9-percent-pure indium at $2.25 per troy ounce.

World Review.—*Canada*—The Dominion Bureau of Statistics, Ottawa, estimated Canada's indium production in 1957 at 385,000 troy ounces valued at $847,000. Indium production in 1954 had been only 477 troy ounces valued at $1,278.

Germany, East.—Construction was begun on a plant in Muldenhütten near Freiburg to extract rare metals, including indium and germanium.[25]

Technology.—Data were published on toxicity, fire and explosion hazards, storage, and handling of indium materials.[26]

RADIUM [27]

Consumption of radium and radium salts increased in the United States in 1957, and imports were nearly double those in 1956. Important demands for radium came from industry and the medical profession.

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21 Pfann, W. G., Zone Melting, Metallurgical Reviews: Inst. Metals (London), vol. 2, No. 5, 1957, pp. 29–76.

22 Dacey, G. C., and Thurmond, C. D., P-N Junctions in Silicon and Germanium—Principles, Metallurgy, and Applications: Metall. Rev. (London), vol. 2, No. 6, 1957, pp. 157–193.

23 Peterson, V. C., and Huber, R. W., The Titanium-Germanium System From 0 to 30 Percent Germanium: Bureau of Mines Rept. of Investigations 5365, 1957, 20 pp.

24 Prepared by Donald E. Eilertsen.

25 Metal Industry (London), Rare-Metal Plant: Vol. 90, No. 22, May 31, 1957, p. 471.

26 Sax, N. Irving, Dangerous Properties of Industrial Materials: Reinhold Pub. Co., New York, N. Y., 1957, pp. 780–783.

27 Prepared by James Paone.

Domestic Production.—No domestic output of radium was reported in 1957. The Canadian Radium & Uranium Corp. refinery at Mount Kisco, N. Y., was maintained primarily for secondary refining of radium and radium products.

Radium, its derivatives, and related compounds were distributed in the United States by the Canadian Radium & Uranium Corp., New York, N. Y.; Radium Chemical Co., Inc., New York, N. Y., sales representative for Union Minière du Haut Katanga; and United States Radium Corp., Morristown, N. J.

Consumption and Uses.—Radium and radium salts were used primarily by industry generally and by the nuclear-energy industry in the form of a radium-beryllium mixture (a source of neutrons) and by the medical profession in telecurietherapy to treat cancer by radium's radioactive emissive properties. Radium was also used in industrial radiography for nondestructive testing of materials, in zinc sulfide compounds to make self-activated luminescent paint, and in radium foil, which was used as an ionizing agent in static-elimination equipment.

Prices.—Throughout 1957 the price of radium was quoted by E&MJ Metal and Mineral Markets at $16 to $21.50 per milligram of radium content, dependent on quantity.

Foreign Trade.—Radium salts were imported for consumption in the United States from Union Minière du Haut Katanga, Belgium.

World Review.—The principal producer of radium continued to be Union Minière du Haut Katanga, Brussels, Belgium. Union Minière processed high-grade pitchblende and other radium-bearing materials from its uranium mines in Belgium Congo in the refinery at Oolen, Belgium.

TABLE 1.—Radium salts and radioactive substitutes imported for consumption in the United States, 1948–52 (average) and 1953–57

[Bureau of the Census]

Year	Radium salts			Radioactive substitutes (value)
	Radium content, milligrams	Value		
		Total	Average per gram	
1948–52 (average)	103,907	$1,687,951	$16,245	$20,799
1953	85,055	1,474,625	17,337	169,762
1954	57.879	856.822	14,804	149,759
1955	65.545	974,982	14,875	188.729
1956	43,221	633,195	14,650	[1 2] 514,471
1957	76,206	1,060,505	13,916	843,994

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with earlier years.
[2] Revised figure.

RARE-EARTH MINERALS AND METALS [28]

Mine shipments of domestic rare-earth concentrates and ores in 1957 were three-fourths greater than in 1956, reversing a downward trend prevalent since 1953. However, the Union of South Africa continued to be the principal source of supply of monazite concentrate. Demand for thorium (produced from the monazite) to fill Government

[28] Prepared by C. T. Baroch.

contracts and increasing nonenergy uses of thorium resulted in a continuing surplus of the lighter rare-earth elements.

Domestic Production.—Mine shipments of rare-earth concentrates and ores aggregated about 2,900 short tons containing an estimated 1,385 tons of rare-earth oxides (REO), a 76-percent increase over 1956.

Monazite was produced by Heavy Minerals Co., Clearwater, S. C.; Humphreys Gold Corp., Jacksonville, Fla.; and Porter Bros. Corp., Boise, Idaho.[29] Heavy Minerals Co. (a subsidiary of Crane Co., Vitro Corp., and the French Pechiney interests) took over the mining operations of Marine Minerals, Inc., near Aiken, S. C. Porter Bros. Corp. also produced euxenite concentrate.

The Molybdenum Corp. of America continued to mine bastnaesite at its Mountain Pass (Calif.) property and to produce both a flotation concentrate and a higher grade, leached, rare-earth oxide. Small but increasing quantities of euxenite, yttrofluorite, and gadolinite were produced from several properties in Colorado to supply a growing demand for yttrium and the heavy yttrium subgroup of the rare-earth elements.

The principal processors of rare-earth concentrates were Davison Chemical Co., Pompton Plains, N. J.; Heavy Minerals Co., Chattanooga, Tenn.; Lindsay Chemical Co. and Michigan Chemical Co., St. Louis, Mich.; Molybdenum Corp. of America, Pittsburgh, Pa.; and St. Eloi Corp., Newtown, Ohio. Mallinckrodt Chemical Works, St. Louis, Mo., under subcontract from Porter Bros. Corp., continued to process euxenite concentrate from Idaho. Columbium, thorium, and a rare-earth residue were recovered for the General Services Administration for stockpiling, and the associated uranium went to the Atomic Energy Commission (AEC).

Davison Chemical Co., a subsidiary of W. R. Grace & Co., terminated its contract for processing stockpiled monazite for the AEC at its Curtis Bay (Md.) plant. The company stated that the installation was inadequate to handle the wide variation in quality of monazite in the Government stockpile. Production of individual rare-earth oxides was continued at the Davison plant, Pompton Plains, N. J.

Heavy Minerals Co. completed a processing plant at Chattanooga, Tenn., and began producing rare-earth oxides, fluorides, and chlorides, in addition to thorium hydroxide. The company planned to expand operations to separate the rare-earth elements, particularly neodymium, praseodymium, samarium, europium, gadolinium, and yttrium salts. Lindsay Chemical Co. also expanded its ion-exchange facilities for separating the individual rare-earth elements. Michigan Chemical Co. announced the production of gadolinium, dysprosium, erbium, and yttrium metals in commercial quantities—the first such announcement in the industry; previously these metals were available only in gram lots for experimental purposes. St. Eloi Corp. announced that it was ready to supply high-purity rare-earth metals and oxides, processed principally from Colorado ores.

Research Chemicals Inc., Burbank, Calif., a subsidiary of Nuclear Corp. of America, Inc., produced purified rare-earth oxides and salts and experimental quantities of the rare-earth metals.

Rare-earth metals were also produced by Lunex Co., Pleasant Valley, Iowa.

[29] See the Titanium and Thorium chapters in this volume.

Production of misch metal was continued by Cerium Metals Corp., Niagara Falls, N. Y.; Mallinckrodt Chemical Works, St. Louis, Mo.; New Process Metals, Inc., Newark, N. J.; General Cerium Corp., Edgewater, N. J.; and American Metallurgical Products Co., Pittsburgh, Pa.

Consumption and Uses.—It is estimated that about 2,000 short tons of rare-earth oxides was consumed in 1957—about the same quantity as in 1956. A slight increase in demand for new uses was offset by a decreased demand for metallurgical uses, caused by smaller output of iron and steel.

Uses for the unseparated rare-earth elements and those separated only roughly into subgroups accounted for the bulk of the output, but demand for the separated rare-earth materials continued an upward trend. Purified lanthanum and cerium salts were made commercially for many years before 1957, and moderately pure neodymium compounds were available. Until about 1955 other pure rare-earth compounds were produced for experimental use only, and prices were very high. The installation of ion-exchange separation facilities enabled several companies to make pure rare-earth compounds available in reasonable quantities in 1957. Competition resulted in improved techniques, and advertising was beginning to dispell the fallacy that these materials are as scarce as the term "rare earths" would indicate. Production of purified rare-earth metals and compounds probably did not exceed 100,000 pounds, but the value of the output probably was nearly 1 million dollars. Most of the demand was for experimental use, principally by Government agencies (particularly the AEC).

Many new uses were developed in 1957, but none created a demand for large quantities of rare-earth compounds. Among the most important new commercial uses were: (1) Mixed rare-earth compounds for flame-sprayed oxide coatings; (2) samarium, europium, dysprosium, and gadolinium as neutron-control rods in nuclear reactors; and (3) gadolinium, erbium, and yttrium in ferrimagnetic garnets for microwave and other electronic applications.

Late in 1957 a long-range research program at Battelle Memorial Institute was sponsored by seven rare-earth processing companies. The principal objective was to develop uses for rare-earth metals and compounds.

Prices.—Monazite prices were quoted nominally by E&MJ Metal and Mineral Markets throughout 1957 at the same prices as in 1956: Total rare-earth oxides, including thoria, per pound, c. i. f. U. S. ports, 55-percent grade, massive, 13 cents, and sand, 15 cents, and 68-percent grade material, 20 cents. Prices noted elsewhere [30] for monazite delivered in large contract tonnages averaged about $250 per net short ton of concentrate containing 45 percent rare-earth oxides and 6 percent ThO_2. Small lots of monazite sand were sold on the basis of their thoria content for prices as low as $25 per short ton unit of ThO_2 content.

Rare-earth oxide produced from bastnaesite continued to sell at $1 per pound.

Prices of misch metal ranged from $3.50 to $4.00 per pound until May 9, 1957, when Mallinckrodt Chemical Works lowered prices to

[30] Kremers, Howard E., Rare Earths: Eng. and Min. Jour., vol. 159, No. 2, February 1957, pp. 145–146.

$3.15 to $3.50 per pound, depending on the quantity purchased. New Process Metals, Inc., quoted Metallurgical-grade ferrocerium at $3.00 per pound and lighter flints at $7.50 per pound and (together with Cerium Metals Corp.) cerium metal, 98 percent pure, at $25.00 per pound.

In 1957 producers reduced the prices of individual rare-earth and yttrium oxides 40 to 90 percent below 1956 quotations. The lower prices were attributed to decreased production costs caused by increases in demand, efficiency, and scale of operation. Table 2 lists prices of the better grade oxides, usually 99.9 percent pure, as released by Lindsay Chemical Co. on December 1, 1957. Prices of lower grade oxides, usually 99 percent pure, were about 15 percent lower.

TABLE 2.—Small-lot prices, December 1957, of rare-earth and yttrium oxides

Oxide	Purity, percent	Price per gram (100-gram lots)	Price per pound	Oxide	Purity, percent	Price per gram (100-gram lots)	Price per pound
Lanthanum	99.99	----------	$10.50	Erbium	99.9	$1.00	$300.00
Cerium	99.9+	----------	6.75	Holmium	99.9	1.65	480.00
Neodymium	99.9	$0.20	54.00	Ytterbium	99.9	1.00	300.00
Praseodymium	99.9	.25	60.00	Europium	99.8	9.00	2,700.00
Samarium	99.9	.25	60.00	Terbium	99.9	5.00	1,500.00
Yttrium	99.9	.40	120.00	Thulium	99.9	10.00	3,000.00
Gadolinium	99.9	.55	162.00	Lutetium	99.9	10.00	3,000.00
Dysprosium	99.9	.95	275.00				

Foreign Trade.—Imports of cerium metal, ferrocerium, and misch metal totaled 8,057 pounds valued at $27,653. Of this quantity, Austria contributed 56 percent and West Germany 33 percent; Japan, the United Kingdom, and France shipped the balance. Imports of cerium compounds totaled 135,329 pounds valued at $17,164 and came mostly from India; 200 pounds was received from France.

Monazite concentrate was imported from Union of South Africa.

Exports of cerium ores, metals, and alloys totaled 13,270 pounds valued at $32,792, of which 92 percent went to Canada and the balance to Japan. A total of 3,372 pounds of lighter flints valued at $23,862 was exported to Canada, Colombia, Mexico, Philippines, Venezuela, Cuba, and the Canal Zone.

Tariff rates were unchanged. Late in 1957 the London Board of Trade gave notice that it was considering increasing the protective duty on lighter flints imported into the United Kingdom.

World Review.[31]—*Australia.*—The Department of External Affairs advised that exportation of monazite, local production of which was relatively small, has been prohibited. Domestic production will be purchased by the Australian Atomic Energy Commission and stockpiled.

Brazil.—Late in 1957 the Brazilian and United Kingdom Governments were reported to be discussing arrangements for exchanging Brazilian monazite for British atomic-energy instruction and training of Brazilian scientists. Brazil has prohibited exportation of monazite since 1951 because of the possible use of thorium as a nuclear fuel.

[31] See also the Titanium and Thorium chapters in this volume.

Ceylon.—The Ministry of Industries announced expansion and improvement of its beneficiating plant at Kalutara, south of Colombo. In 1957, 134 long tons of monazite was produced. Rutile also was produced, and a new magnetic separator was installed to prepare better grades of both minerals.

Egypt.—The Egyptian Government entered into a participating (20 percent) agreement for the mining, collection, and exploitation of black sands.[32]

India.—A division of the French Pechiney interests, Société de Produits Chemiques des Terres Rares, continued operating a plant at Alwaye, Travancore. In 1946 India placed a strict export embargo on monazite because of its thorium content. The French firm has an agreement to process the monazite, turning the thorium over to the Indian Government and retaining most of the rare-earth compounds for export.

Union of South Africa.—A recent report describes the events that led to the establishment of and geological data on the monazite mine near Van Rhynsdorp.[33] The property began operating in 1953 and by 1954 had become the largest producer of monazite in the world. Furthermore, it was the only known deposit of monazite in place that was rich enough to be mined economically. The ore occurs in a vein ranging from 1 foot to 5 feet in width. Originally some ore was shipped after being prepared only by hand cobbing; however, a mill was erected in 1953 and the monazite recovered by flotation.

Technology.—Studies of catalytic properties at the Illinois Institute of Technology disclosed that neodymium and samarium oxides are useful for dehydrogenating various alcohols, such as cyclohexane which can be dehydrogenated to benzene at 545° C. At 525° C. these rare-earth oxides dehydrogenate paraffins but not cycloparaffins; thus they are selective catalysts for dehydrogenating paraffins in natural hydrocarbon mixtures.[34]

Studies of the fundamental properties of the rare-earth elements continued at the Ames Laboratory, Institute for Atomic Research, Iowa State College. Efforts of one group centered on the electrical resistivities and phase transformations of several rare-earth elements.[35] Another group determined new data on the elastic properties of yttrium and 11 rare-earth elements.[36] Details and specifications were given of a method of separating individual rare-earth elements developed at the Ames Laboratory.[37] The mixed rare-earth elements are absorbed from solution on a cation-exchange resin. Then the loaded resin is contacted with an aqueous solution of ethylenediamine tetraacetic acid (EDTA). By using insufficient EDTA to complex the rare-earth elements, the heavier rare-earth elements are preferentially complexed and removed. This method can be used to separate

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[32] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 42.

[33] MacConachie, H., Mining Rare Metals in the Namaqualand Desert: Optima (Anglo American Corp. of South Africa, Ltd., Johannesburg, Union of South Africa), vol. 7, No. 2, June 1957, pp. 95–100; Min. Mag. (London), vol. 97, No. 1, July 1957, pp. 53–54.

[34] Komarewsky, V. I., Catalytic Properties of Rare Earths: Ind. Eng. Chem., vol. 49, No. 2, February 1957, pp. 264–265.

[35] Spedding, F. H., Doane, A. H., and Hermann, K. W., Electrical Resistivities and Phase Transformations of Lanthanum, Cerium, Praseodymium, and Neodymium: Trans. AIME, Jour. Metals, vol. 9, No. 7, July 1957, pp. 895–897.

[36] Smith, J. F., Carlson, C. E., and Spedding, F. H., Elastic Properties of Yttrium and Eleven of the Rare Earth Elements: Trans. AIME, Jour. Metals, vol. 9, No. 10, October 1957, pp. 1212–1213.

[37] Spedding, Frank H., Wheelwright, Earl J., and Powell, Jack E. (assigned to the United States of America as represented by the Atomic Energy Commission), Method of Separating Rare Earths: U. S. Patent 2,798,789, July 9, 1957.

a mixture of rare-earth elements into fractions that contain virtually only one element.

A patent was issued on the caustic-treatment method of processing monazite, as incorporated in the Heavy Minerals Co. plant at Chattanooga, Tenn.[38] The finely ground monazite is treated with a strong caustic (NaOH) solution above 55° C. to convert the phosphate of the monazite into soluble sodium phosphate, which can be separated from the residue of insoluble hydroxides of the rare-earth elements and thorium. Then hydroxide residue can be dissolved readily in weak acid and treated to separate thorium from the rare-earth elements.

A process was patented for chemically beneficiating bastnaesite concentrate.[39] The ore or concentrate is oxidized above 850° C. in the presence of an alkali reagent, such as soda ash. The rare-earth elements are converted to simple oxides, whereas fluorine and sulfate (from any barite present) are converted to water-soluble alkali compounds that can be removed by leaching. The residue can be beneficated further by acid leaching to remove lime and baryta, yielding a relatively high grade rare-earth oxide product.

An alloy of magnesium containing about 4 percent of rare-earth metals was developed in Switzerland.[40] A master alloy of rare-earth metals, with zirconium, titanium, hafnium, and another compatible metal, was patented.[41]

Research progressed rapidly in 1957 on ferrimagnetic materials made from various rare-earth oxides. These were called ferrites because they contain iron and are magnetic, garnets because they have the typical garnet crystal form, or YIGS for yttrium-iron garnet.[42] Some favorable types have compositions similar to $Y_3Fe_5O_{12}$ and are formed by solid-state reaction between the rare-earth oxide and iron oxide, heated as high as 1,400° C. Ferrites of gadolinium, erbium, and yttrium offered the most promise. The transparency or direction of transparency of a ferrite to microwave energy can be controlled by a magnetic field. This characteristic can be used in microwave modulators or isolators in radar and other signal systems. Ferrites also transfer microwave energy with exceptionally low loss and are excellent for wave guides in the microwave region. As a result, electronic devices are possible that heretofore were considered unattainable. One such application, termed "Maser" (meaning microwave amplification by stimulated emission of radiation), promises to extend the use of radar and television far beyond the horizon.

A rapid and reliable method of analyzing rare earths, using X-ray emission spectrographic methods, was devised by the Federal Bureau of Mines.[43] An oxide sample may be prepared and completely analyzed in 35 minutes, and 2 persons using an X-ray machine can analyze about 40 samples per day for 7 elements each.

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[38] de Rohden, Charles, and Peltier, Maurice (assigned to Société de Produits Chemiques des Terres Rares, Paris, France), Treatment of Monazite: U. S. Patent 2,783,125, Feb. 26, 1957.

[39] Kasey, John Bryant, Process for Recovering Rare-Earth Oxides: U. S. Patent 2,805,928, Sept. 10, 1957.

[40] Lucien, René, and Tetart, Emile (assigned to Société d'Inventions Aeronautiques et Mechaniques S. I. A. M., Fribourg, Switzerland), Alloys of Magnesium and Rare Earths: U. S. Patent 2,801,166, July 30, 1957.

[41] Bolkom, Wilbur T., and Knapp, William E. (assigned to American Metallurgical Products Co., Pittsburgh, Pa.), Master Alloys Containing Rare-Earth Metals: U. S. Patent 2,810,640, Oct. 22, 1957.

[42] Work cited in footnote 12, p. 3.

[43] Lytle, Farrel W., Botsford, James I., and Heller, Henry A., X-Ray Emission Spectrographic Analysis of Bastnaesite Rare Earths: Bureau of Mines Rept. of Investigations 5378, 1957, 16 pp.

Another phase of the Bureau's work, performed under contract for the AEC, Oak Ridge National Laboratory, was described.[44] The report outlined briefly gadolinium metallurgy and its application in reactor control rods, including separation of the metal from its oxide and preparation and fabrication of various gadolinium alloys.

A 2-year research program to find new uses for rare-earth metals and compounds was begun at Battelle Memorial Institute, Columbus, Ohio. The study was initiated by Davison Chemical Co., Electro-Metallurgical Co., Heavy Minerals Co., Lindsay Chemical Co., Mallinckrodt Chemical Works, Michigan Chemical Corp., and Molybdenum Corp. of America.

A bibliography of references to September 1954 on thorium and rare-earth deposits was published as a contribution to the bibliography of mineral resources.[45]

RHENIUM [46]

Rhenium is the second highest melting metal and the third highest melting element.

Domestic Production.—Rhenium was produced by Chase Brass & Copper Co., a subsidiary of Kennecott Copper Corp., Waterbury, Conn., and by the Department of Chemistry, University of Tennessee, Knoxville, Tenn.

Prices.—The University of Tennessee quoted the following prices of rhenium metal: Less than 100 grams, $2.50 per gram; in lots of 100 or 1,000 grams, $1.75 per gram.

Uses.—Little is known about uses for rhenium, but the metal has high potential for electrical contacts, electronics, and other high-temperature applications.

Technology.—The Bureau of Mines continued a project on rhenium sources and recovery methods. Mill and smelter samples were analyzed for rhenium, and methods were explored for extracting the metal.

Data were published on toxicity, fire and explosion hazards, storage, and handling of rhenium materials.[47]

SELENIUM [48]

Selenium production in 1957 exceeded 1 million pounds for the second successive year. The near-record production was accompanied by a sharp drop in consumption, a decline in imports, and a steady increase in producers' stocks to an alltime high.

Legislation and Government Programs.—Selenium was in group I of the national stockpile List of Critical and Strategic Materials throughout the year. The Office of Defense Mobilization included selenium among minerals eligible for Government financial participation up to 75 percent in Defense Minerals Exploration Administration projects.

Domestic Production.—Production of selenium in 1957 totaled

[44] Leitten, C. F., Jr., Trip to the Bureau of Mines, Albany, Oreg., Regarding Rare-Earth Alloy Development: Rept. on Contract W-7405-eng-26, Nov. 5, 1956, 5 pp.; declassified Mar. 13, 1957; photostatic or microfilm copies available from Office of Technical Services.

[45] Buck, Katharine L., Selected Annotated Bibliography of Thorium and Rare-Earth Deposits in the United States, Including Alaska: Geol. Survey Bull. 1019-F, 1957, pp. 517-541.

[46] Prepared by Donald E. Eilertsen.

[47] Sax, N. Irving, Dangerous Properties of Industrial Materials: Reinhold Pub. Co., New York, N. Y., 1957, pp. 1080-1081.

[48] Prepared by Frank L. Fisher.

1,061,000 pounds compared with 1,117,000 pounds in 1956, a decrease of 3.5 percent. The 1957 supply, comprising production plus imports, totaled 1,234,000 pounds—9.3 percent less than in 1956. Approximately 15 percent of the production came from secondary sources, principally burned-out rectifier units and spent catalysts. Most of the primary selenium was produced as a byproduct of electrolytic copper refining. The production data included selenium contained in lead flue dusts from Mexico.

The five major selenium-producing companies in 1957 were: American Metal Climax, Inc., Carteret, N. J.; American Smelting and Refining Co., Baltimore, Md.; International Smelting & Refining Co., Perth Amboy, N. J.; Kawecki Chemical Co., Boyertown, Pa.; and Kennecott Copper Corp., Garfield, Utah. All five companies produced commercial-grade metal in 1957. Only American Smelting and Refining Co., Kawecki Chemical Co., and Kennecott Copper Corp. produced high-purity selenium. American Metal Climax, Inc., American Smelting and Refining Co., and Kawecki Chemical Co. were the only producers of ferroselenium and selenium compounds in 1957.

Consumption and Uses.—Apparent domestic consumption [49] of selenium decreased from 1,243,000 pounds in 1956 to 789,000 pounds in 1957. The 38-percent drop in consumption caused a sharp increase in producers' stocks. The abnormally high price at the beginning of the year and the sharp inroads of competitive materials into the major consumer outlets were partly responsible for the decreased consumption. Germanium and silicon were substituted for selenium in rectifiers. Tellurium replaced some selenium in the rubber industry, in stainless-steel manufacture, and in other metallurgical uses. Mercury and cadmium were substituted for selenium in the glass and pigment industries.

Manufacture of electronic and electrical equipment, mainly rectifiers, consumed nearly half of the available supply. Other users, in order of importance, were the pigment, glass and ceramic, metallurgical, and pharmaceutical industries. Nickel-selenium and chromium-selenium were introduced into the stainless-steel industry in 1957. Self-adjusting movie cameras with a selenium photoelectric cell were placed on the market during the year.

Stocks.—Producers' stocks of selenium metal increased 240 percent—from 191,000 pounds at the beginning of 1957 to 651,000 pounds at the end of the year. The continuing high rate of production of selenium as a byproduct of electrolytically refined copper in 1957 and a sharp drop in demand accounted for the large accumulation of stocks of selenium.

Prices.—Commercial-grade selenium was quoted at $12 a pound effective January 1, 1957. The price decreased to $10.50 a pound on May 28, 1957, and to $7.50 a pound on November 18, 1957, where it remained for the rest of the year. High-purity selenium sold for $3 a pound more than the Commercial grade throughout 1957.

Foreign Trade.—Imports of selenium in 1957 were 172,700 pounds valued at $1,903,700 compared with 235,000 pounds valued at $3,452,000 in 1956, a decrease of 36 percent. Imports from Canada totaled

[49] Producers domestic shipments to consumers plus consumer imports. Exports were negligible.

137,200 pounds in 1957 compared with 227,000 pounds in 1956. Other imports came from Sweden (225 pounds), West Germany (66 pounds), and Japan (10,091 pounds). The Netherlands and Northern Rhodesia exported selenium concentrate to the United States that contained 7,071 pounds of selenium. Imports from Mexico during the last quarter of 1957 totaled 17,211 pounds of selenium contained in selenium-lead flue dust.

World Review.—*Canada.*—Production of selenium in Canada was 353,000 pounds in 1957 compared with 330,000 pounds in 1956. Production of refined selenium, including scrap, totaled 342,700 pounds in 1957, compared with 355,000 pounds in 1956. In 1957 Canadian exports were 228,100 pounds of selenium valued at Can$2,739,000 compared with 409,700 pounds valued at Can$6,343,000 in 1956. Canadian consumption dropped from 31,700 pounds of selenium in 1956 to 15,600 pounds in 1957.[50]

Finland.—Production of selenium in Finland increased from the 8,370 pounds in 1956 to 9,220 pounds in 1957. Selenium was produced as a byproduct of copper from Outokumpu Oy at Pori.

Japan.—Japanese production of selenium dropped from 163,000 pounds in 1956 to 156,100 pounds in 1957. The selenium was produced as a byproduct at several copper refineries, a gold refinery, and two ammonia sulfate plants.

Mexico.—In 1957 Mexico produced 176,000 pounds of selenium-bearing byproducts compared with 203,000 pounds in 1956. Most of the output came from lead flue dusts.

Peru.—Peru produced 6,870 pounds of selenium in 1957.

Rhodesia.—The copper belt of Northern Rhodesia yielded 25,100 pounds of selenium concentrate in 1957, which averaged 48.5 percent selenium.

Technology.—Selenium technology entered a state of transition in 1957. The rapid change from short supply to a sizable surplus resulted in a drop in procurement pressure, and efforts were discontinued to seek selenium from hitherto unobtainable sources. Developments in the search for new outlets for selenium, especially high-purity metal, were insufficient in 1957 to warrant publication of the results.

SILICON [51] [52]

In 1957 the use of high-purity silicon for diodes, rectifiers, transistors, and other solid-state electronic devices continued to expand. It is estimated that twice as much high-purity silicon was made, sold, and used by the electronics industry in 1957 as in 1956. Although germanium and selenium were still the principal commodities employed in semiconductors, increasing quantities of silicon were used.

Domestic Production.—An estimated 20,000 to 30,000 pounds of high-purity silicon was produced in 1957, compared with 10,000 to 20,000 pounds in 1956. In 1957, as in 1956, E. I. duPont de Nemours & Co. Inc., produced at its Newport (Del.) plant most of the high-purity silicon sold to the electronics industry. Three grades of

[50] Jones, R. J., Selenium in Canada, 1957, Review 20: Miner. Res. Div., Dept. Mines and Tech. Surveys, Ottawa, Canada, February 1958, 4 pp.
[51] Data on lower grades of silicon, such as those used for alloying aluminum and copper and producing silicones and silicon tetrachloride, are included in the Ferroalloys chapter.
[52] Prepared by H. Austin Tucker.

high-purity and one grade of slightly lower quality silicon were made. All were supplied in either needle or densified form.

The Eagle-Picher Co., Miami, Okla., and Texas Instruments, Inc., Dallas, Tex., joined E. I. duPont de Nemours & Co., Inc., and Sylvania Electric Products, Inc., Towanda, Pa., in commercial production of high-purity silicon. Merck Chemical Co. began a $5-million addition to its Cherokee plant at Danville, Pa., in 1957; International Metalloids, Inc., controlled by W. R. Grace & Co., began constructing a plant at Toa Alta, Puerto Rico; and duPont nearly completed its new plant at Brevard, N. C. These new plants will add an estimated productive capacity of 110,000 pounds of high-purity silicon to the estimated 1957 capacity of 30,000 pounds.

Sylvania Electric Products, Inc., Texas Instruments, Inc., and Westinghouse Electric Co. produced much of the high-purity silicon they used in fabricating electronic devices for commercial equipment. These companies accounted for an estimated 35 percent of the high-purity silicon produced in 1957.

To illustrate the trend in the trade, duPont introduced three semiconductor grades of high-purity silicon based on boron content in April 1957, and in October it added a resistivity specification to define silicon quality more closely (see table 3).

TABLE 3.—Price and purity data of ultrapure silicon produced commercially in 1957

Producer	Plant location and year started	Price per pound	Boron level (parts per billion)	Resistivity (ohm-cm.) P-type	Resistivity (ohm-cm.) N-type
E. I. duPont de Nemours & Co., Inc.	Newport, Del.; 1951	$360	3	100	25
		250	6	50	15
		160	11	25	5
Sylvania Electric Products, Inc.	Towanda, Pa.; 1956	359	(1)	100	40
		250	(1)	40	15
Texas Instruments, Inc.	Dallas, Tex.; 1957	750	[2] 1	200	--------
		400	[2] 3	100	--------
		240	[2] 5	10	10
Eagle-Picher Co.	Miami, Okla.; 1957	360	2	100	40
		250	6	40	15

[1] Not yet specified.
[2] Total impurities; boron level below 1 part per billion.

Consumption and Uses.—Domestic consumption of high-purity silicon in 1957 was estimated at 25,000 pounds valued at $8 million. Nearly 90 percent[53] of this quantity was lost in purification and fabrication, mostly because of imperfect crystal development. Thus, only 2,500 pounds was fabricated into an estimated 3 million transistors, valued at $40 million, and 13 million diodes and rectifiers, valued at $35 million. Approximately 8 times as many transistors were made of germanium as of silicon in 1957, compared with 12 times as many in 1956.[54] Sales of germanium and silicon transistors in 1957 totaled $69.7 million, compared with $37.4 million in 1956.[55] The value of sales of silicon semi-conductor devices in 1957 was 18.2

[53] Chemical Engineering, vol. 65, No. 5, Mar. 10, 1958, p. 102.
[54] See footnote 53, p. 104.
[55] American Metal Market, vol. 65, No. 101, May 24, 1958, p. 1.

percent of that of vacuum tubes, which was reported to be $384 million for 500 million units.

Prices.—Table 3[56] gives most of the available price and purity data for high-purity silicon.

Technology.—The key to successful production of high-purity silicon is ability to reduce the boron content as low as possible. The methods used by each producer to remove boron and other impurities from silicon are proprietary. The impurity content is measured indirectly in ohm-centimeters, from which the ratio of impurities to silicon can be calculated. Impurities are measured in parts per billion. After silicon is purified as much as possible, specific quantities of particular impurities are added to make it a better conductor for use in electronic devices, such as diodes, rectifiers, transistors, and solar cells.

An improvement in the chemical refining of silicon reported in 1957 was the use of sodium as a reducing agent.[57] Sodium reduced the boron content to 2 parts per billion and gave electrical resistivities as high as 400 to 500 ohm-cm.

The floating-zone method of refining was developed and widely adopted in 1957.[58] Unlike boat refining, no container touches the rod of silicon being refined. The floating zone exists in the molten state with no side support, as a function of the diameter of the rod and the surface tension and specific gravity of the metal.

TELLURIUM[59]

Production of tellurium reached an alltime high in 1957, as demand for the metal continued to increase. The price advantage of tellurium over selenium and the ease with which tellurium can be substituted for selenium accounted for much of the gain in consumption. The use of ferrotellurium in making stainless steels and in the rubber industry were the major outlets.

Domestic Production.—Domestic production of primary tellurium increased 34 percent from 190,700 pounds in 1956 to 254,900 pounds in 1957. Tellurium producers in 1957, as in 1956, were American Smelting & Refining Co., International Smelting & Refining Co., United States Smelting & Refining Co., and American Metal Climax, Inc. Again, most of the tellurium was obtained as a byproduct of lead and copper refining.

Consumption and Uses.—Total shipments of tellurium increased 19 percent—from 143,700 pounds in 1956 to 170,300 in 1957. Consumption by producers totaled an additional 43,400 pounds in 1957. The rubber and metallurgical industries were the major consumers. The growth in use of tellurium in these industries was due partly to the introduction of safeguards to overcome problems arising from the disagreeable odor and toxicity of tellurium. Tellurium's ease of substitution and price advantage over selenium encouraged larger consumption. In the ferrous metallurgical industry in 1957 tellurium was used for degasifying and improving the machinability of stainless steels, in producing ductile cast iron, and to control the depth of chill in hard-

[56] Chemical Week, vol. 82, No. 3, Jan. 18, 1958, p. 58.
[57] American Metal Market, vol. 64, No. 136, July 17, 1957, p. 1.
[58] American Metal Market, vol. 64, No. 149, Aug. 3, 1957, pp. 1-4.
[59] Prepared by Frank L. Fisher.

chilled iron castings. In the nonferrous metal industry tellurium was alloyed with copper to improve machinability without serious effect upon the conductivity and with lead to improve work-hardening and fatigue resistance. Tellurium was used in the rubber industry as a secondary vulcanizing agent to natural and GR–S (synthetic) rubber to increase the rate of vulcanization and resistance to abrasion and heat and to improve the aging and mechanical properties. Tellurium was also used in photography, medicine, glass, and ceramics. In 1957, tellurium rectifiers and other electronic devices were introduced on an experimental scale, using the tellurides of lead, cadmium, bismuth, and mercury.

Stocks.—Stocks of refined tellurium held by producers in 1957 increased 33 percent—from 125,200 pounds in 1956 to 166,400 in 1957.

Raw-material stocks decreased slightly in 1957.

Prices.—The price of refined tellurium increased from $1.50–$1.75 per pound at the beginning of the year to $1.65 on January 17, 1957. On May 16, the price increased to $.165 @ $1.75 and on December 5, 1957, to $.165–$1.75 per pound.[60] Ferrotellurium (50–58 percent tellurium) was quoted at $2.00 per pound of contained tellurium throughout 1957.

Foreign Trade.—Total imports in 1957 were 2,205 pounds of tellurium compounds valued at $2,051, all from West Germany. There were no exports.

World Review.—*Canada.*—Preliminary estimates of Canadian production of tellurium are 34,500 pounds valued at Can$63,980 in 1957, compared with 7,867 pounds valued at Can$13,780 in 1956.[61]

Technology.—The rubber industry was engaged in extensive research on the use of tellurium in rubber products. Other technologic research was done by the glass, electronic, and metallurgical industries.

Research was conducted on the use of tellurium in thermoelectric devices.

THALLIUM [62]

The quoted price of thallium metal was reduced 40 percent.

Domestic Production.—American Smelting and Refining Co., Denver, Colo., was the only domestic producer of thallium. Less thallium and thallium compounds were produced in 1957 than in 1956.

Uses.—Thallium was used as a fungicide and rodent and insect poison. Some special glasses contained thallium, and thallium was used to produce thallium-activated sodium-iodide crystals for electronic purposes.

Prices.—American Metal Market quoted the price of thallium at $12.50 per pound until December 12, 1957, when the price was reduced to $7.50 per pound.

Technology.—Data were published [63] on toxicity, fire and explosion hazards, storage, and handling of many thallium materials.

A 32-pound thallium chloride crystal 6 inches in diameter and 7 feet in length was grown for measuring high-energy electrons for X-rays, and for other experimental uses.[64]

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[60] E&MJ Metal and Mineral Markets, vol. 28, No. 1–52, 1957.

[61] Jones, R. J., Tellurium in Canada, 1957, Review 22: Miner. Res. Div., Dept. Mines and Tech. Surveys, Ottawa, Canada, 1958, 3 pp.

[62] Prepared by Donald E. Eilertsen.

[63] Sax, N. Irving, Dangerous Properties of Industrial Materials: Reinhold Pub. Co., New York, N. Y., 1957, pp. 1173–1178.

[64] Journal of the Franklin Institute, Fort Belvoir Labs Grow 32-Pound Crystal: Vol. 264, No. 1, July 1957, p. 48.

Minor Nonmetals

By D. O. Kennedy,[1] Albert E. Schreck,[2] H. E. Stipp,[2] James M. Foley[3]

GREENSAND

GREENSAND (glauconite) output in 1957 continued to decline. The Kaylorite Corp., Dunkirk, Md., and the Inversand Co., Sewell, N. J., were the only firms that reported production of this mineral commodity. Output came from open pits in Calvert County, Md., and Gloucester County, N. J.

The major part of production was used as a water-softening agent; the remainder was used in soil conditioners as a source of potassium.

Prices for greensand, f. o. b. mine, ranged from $23 to $69 per short ton.

TABLE 1.—Greensand marl sold or used by producers in the United States, 1948–52 (average) and 1953–57

Year	Short tons	Value	Year	Short tons	Value
1948–52 (average)	5, 400	$283, 127	1955	5, 704	$217, 671
1953	6, 821	193, 404	1956–57	(1)	(1)
1954	2, 838	198, 909			

[1] Figures withheld to avoid disclosing individual company confidential data.

MEERSCHAUM

Meerschaum, the mineral sepiolite, is used chiefly in manufacturing smokers' accessories, such as cigar and cigarette holders and pipe bowls. Consumers continued to rely upon foreign sources for their raw-material supplies, as no domestic production of this mineral has been reported since about 1914.

Turkey has been the world's principal supplier of meerschaum for many years; however, production has also been reported in Austria, Italy, Kenya, Tanganyika, and the Union of South Africa.

Meerschaum was produced in Kenya in 1956 for the first full year and totaled 30 short tons.[4]

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Commodity specialist.
[3] Supervisory statistical assistant.
[4] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 1, July 1957, p. 34.

Meerschaum was discovered in Tanganyika in 1953 in the Masai district, Northern Province, near the Kenya border.[5] Production has increased from 2 tons in 1954 to almost 7 short tons in 1956.

Imports into the United States in 1957 decreased when compared with 1956. Turkey was again the major source.

TABLE 2.—Meerschaum imported for consumption in the United States, 1948–52 (average) and 1953–57 [1]

[Bureau of the Census]

Year	Pounds	Value	Year	Pounds	Value
1948–52 (average)	8,047	$13,649	1955	5,102	$15,285
1953	8,568	12,600	1956	13,140	[2] 21,770
1954	12,068	26,357	1957	10,538	20,046

[1] 1948–52: Turkey, 8,039 pounds, $13,617; Italy, 4 pounds, $24; Austria, 4 pounds, $8; 1953: Turkey, 8,168 pounds, $11,911; Union of South Africa, 400 pounds, $689; 1954–56: All from Turkey; 1957: Turkey, 10,426 pounds, $19,649; Union of South Africa, 112 pounds, $397.

[2] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with years before 1954.

MINERAL WOOL

The output of mineral wool produced from rock, slag, and glass in the United States doubled in total value from 1949 to 1955, according to the Bureau of the Census, and remained at about $200 million per year through 1957. Statistics on the use of mineral wool are not available for 1957, but the most recent report of the Bureau of the Census gave the following percentages for the broad classifications of its uses: Structural insulation, 56 percent; equipment insulation, 23; industrial insulation, 17; and unspecified 4.

The average number of people employed in the mineral-wool industry has been about 11,000, and the number of production workers has been about 9,000.

Exports of mineral-wool products from the United States were valued at about $5 million annually for 1955 through 1957.

The American Rock Wool Corp., which operated eight plants in the United States, installed a new bulk-handling system at its Hudson, N. Y., plant. Substantial savings in costs were reported by company officials.[6]

Several patents were issued in 1957 covering types of equipment for manufacturing and cleaning mineral wool.[7]

[5] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 4, October 1957, p. 40.

[6] Peck, Roy L., American Rock Wool Bulk System Pays Off in Lower Handling Costs: Pit and Quarry, vol. 49, No. 8, February 1957, pp. 71, 72, 90.

[7] Barnett, I. (assigned to Johns-Manville Corp.), Fiber Opener and Cleaner: U. S. Patent 2,789,319, Apr. 23, 1957.

Hills, L. H. (assigned to The Garlock Packing Co.), Mineral Wool Depelletizing Apparatus: U. S. Patent 2,789,694, Apr. 23, 1957.

Stalego, C. J. (assigned to Owens-Corning Fiberglass Corp.), Apparatus for Handling and Processing Materials Having High Fusing Temperatures: U. S. Patent 2,790,019, Apr. 23, 1957.

Richardson, C. D. (assigned to Charles Richardson Corp.), Apparatus for Forming Mineral Wool: U. S. Patent 2,793,395, May 28, 1957.

Hedges, L. M. (assigned to Johns-Manville Corp.), Apparatus for Forming Fibers: U. S. Patent 2,807,048, Sept. 24, 1957.

Baldasarre, E. C., and Gennari, A. P., Mineral Wool Spinning Wheel: U. S. Patent 2,808,616, Oct. 8, 1957.

Fisher, E. J., Cleaning Mineral Wool or Rock Wool: U. S. Patent 2,808,929, Oct. 8, 1957.

Smout, W. C. P., Process and Apparatus for the Production of Mineral and Slag Wool: U. S. Patent 2.810,158, Oct. 22, 1957.

STAUROLITE

Production of staurolite has increased steadily since 1953 and established a new high in 1957. Staurolite was recovered as a byproduct of ilmenite and rutile production by two companies in 1957; the Humphreys Gold Corp., which operated the Highland and Trail Ridge plants in Clay County, Florida, for E. I. du Pont de Nemours and Co., Inc., and the Marine Minerals Co. of Clearwater, S. C., also recovered staurolite in 1957. The recovered mineral was used as a raw material in the manufacture of portland cement in Florida and for sand blasting.

WOLLASTONITE

Output of wollastonite increased 41 percent over the preceding year. The Cabot Carbon Co. continued to produce wollastonite from its Fox Knoll mine, Essex County, N. Y.

Several firms shipped wollastonite float from talus deposits near Blythe, Riverside County, Calif. This material was used as an interior and exterior ornamental stone, favored largely because of its resemblance to driftwood.

An article describing the wollastonite occurrences in California was published.[8] The physical properties and uses of this mineral, as well as mining methods and a brief description of the more important California deposits, are discussed. Geologic maps are included in the article.

Oil, Paint and Drug Reporter quoted the following prices on wollastonite: Fine, bags, carlots, works, $39.50 per ton; less than carlots, ex warehouse, $56 per ton; medium, bags, carlots, works, $27 per ton; less than carlots, ex warehouse, $44 per ton. These prices have remained unchanged since December 1954.

Wollastonite has found use in the ceramics industry in floor and wall tiles, porcelain fixtures, electrical insulators and frits; in welding-rod coatings, as a paint extender, and as a filler in asphalt tile.

[8] Troxel, Bennie W., Wollastonite; Mineral Commodities of California: California Dept. of Nat. Resources, Div. of Mines, Bull. 176, 1957, pp. 693–697.

INDEX

The index consists of two parts, a commodity index and a world review index.

Because nearly all commodity chapters in Minerals Yearbook, volume I, follow a standard outline (Introductory Summary, Domestic Production, Consumption and Uses, Prices (and specifications), Foreign Trade, World Review and Technology), references to such data have been omitted under the various headings.

Readers wanting information on mine production for States, Territories, or possessions should refer to tables in the Statistical Summary chapter, starting on page 69. These tables show the commodities produced in each area, thus guiding the reader to the appropriate commodity chapters. The reader should refer to volume III, however, for complete area information.

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