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MINERALS YEARBOOK

1958

Volume I of Three Volumes

METALS AND MINERALS

(EXCEPT FUELS)

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

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FOREWORD

MINERALS YEARBOOK, 1958, 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. When the results of the 1958 Census of Mineral Industries (or Manufactures in some instances such as cement and coke) conducted by the Bureau of the Census become available, comparisons will be shown between Mines and Census data in order to indicate relationships in definitions and coverage.

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 50 States, plus chapters on 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 indispensible cooperation given by industry. Information obtained from individuals by means of confidential surveys has been grouped to provide statistical aggregates. Data on individual producers are presented only if available from published or other nonconfidential sources, or when permission of the individuals concerned has been granted.

MARLING J. ANKENY, *Director.*

ACKNOWLEDGMENTS

The Bureau of Mines has been assisted in collecting mine-production data and the supporting information appearing in this volume of the Minerals Yearbook by the following cooperating organizations:

Alabama: Geological Survey of Alabama.
Alaska: Department of Mines.
Arkansas: Division of Geology.
California: Division of Mines.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey.
Georgia: Department of Mines, Mining, and Geology.
Idaho: Bureau of Mines and Geology.
Illinois: State Geological Survey Division.
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: Division of Mineral Resources.
North Dakota: North Dakota Geological Survey.
Oklahoma: Oklahoma Geological Survey.
Oregon: State Department of Geology and Mineral Industries.
Pennsylvania: Bureau of Topographic and Geological Survey.
Puerto Rico: Mineralogy and Geology Section, Economic Development Administration, Commonwealth of Puerto Rico.
South Carolina: Department of Geology, Mineralogy and Geography.
South Dakota: State Geological Survey.
Tennessee: Tennessee Department of Conservation.
Texas: Bureau of Economic Geology, The University of Texas.
Utah: Utah Geological and Mineralogical Survey.
Virginia: 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 Ferralloys; 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 Thomas E. Howard, 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, Helen E. Tice, Anita C. Going, Dorothy Allen, and Joseph Spann.

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]

Contents

RECOVERY of the nonfuel minerals industry from recession marked the last third of 1958, but overall the year was one of depressed activity. Consumption and production were substantially lower than in 1957 and, as expected, recovery in the mineral industries lagged behind that in industrial production and the economy as a whole. The lagging of the recession-recovery cycle in the nonfuel minerals industry behind the cycle in the economy as a whole in 1957–58 was similar to the behavior in the two previous postwar recessions.

Domestic production of metals declined sharply in 1958, but nonmetals (except fuels) held steady. Ferrous metal mine production was down 35 percent and nonferrous, 15 percent, but nonmetals were up slightly, less than 1 percent. Employment moved upward after the first half of the year, however, and by yearend recovery had definitely begun. The large accumulation of stocks, which overhung the market at the close of 1957, was slightly reduced during 1958; the index of consumer stocks remaining stable and mine stocks down 3 percent, but stocks were still high at yearend. The production decreases were reflected in decreases in value of mineral production, and drops in prices caused the nonmetal value to fall. The percentage share of supply from imports increased in some commodities—notably iron, lead, and zinc—but dropped in copper and fluorspar among others.

The nondefense minerals programs continued to support domestic mining during 1958. Purchases continued until the end of the year un-

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

[2] Assistant chief economist.

der Public Law 733. A minerals stabilization plan was submitted to the Congress in April by the Administration calling for payments to the domestic producers of lead, zinc, Acid-grade fluorspar, and tungsten of the difference between prices received in the market and an established stabilization price. A 1-year purchase program for copper was also part of this plan. The plan passed the Senate but was defeated in the House of Representatives. The President then acted under the Trade Agreements Act to relieve the injury found to exist to the unmanufactured lead-zinc industries by imposing import quotas, effective October 1, 1958. The effect upon the lead-zinc industries was felt very quickly, and conditions were definitely improved at yearend. The Defense Mobilization activities continued to decline as these programs reached their end. However, there were investigations of the fluorspar, cobalt, and tungsten industries pending under the national security clause of the Trade Agreements Act at the end of the year.

World mineral markets were not as depressed as the domestic during 1958. World-mining production did not drop as severely as in the United States, and showed definite increases during the last half of the year. Ocean freight rates continued to decline and contributed to the declines in the world price indexes for minerals.

NONDEFENSE MINERALS PROGRAM

Public Law 733.—Purchases under Public Law 733 ceased on December 31, 1958, as the law expired under its own terms. There were purchases of asbestos, columbium-tantalum, and fluorspar during the year but none of tungsten. Total purchases under this act from inception, with the final limitations are presented in table 1.

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

Commodity	Total limitation	Quantity purchased to Dec. 31, 1958 [2]	Base price
Asbestos, chrysotile, nonferrous: [3]			
Crude Nos. 1 and 2 ... short tons	1,975	1,741	$1,500 / 900
Crude No. 3, when offered with No. 1 and/or No. 2 ... do	1,199	1,047	400
Columbium-tantalum bearing ores: [3] Contained combined pentoxides ... pounds	62,310	59,104	[4] 1.40–3.00
Fluorspar, Acid grade, 97 percent calcium fluoride, f.o.b. milling point ... short tons	175,815	139,886	53
Tungsten trioxide, f.o.b. milling point [5] ... short-ton units	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, 1958: Federal Register, Feb. 26, 1959, p. 1433.
[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.

Minerals Stabilization Program.—The Secretary of the Interior, Fred A. Seaton, presented a minerals stabilization program to the Senate Subcommittee on Interior and Insular Affairs on April 28, 1958.

This program was designed to stabilize production of lead, zinc, Acid-grade fluorspar, and tungsten from domestic mines by establishing a system of stabilization payments to sustain constant receipts from mined ore. In addition, a one year copper purchase plan was suggested to tide the domestic producers over a period of oversupply. During the hearings on the Seaton proposal, many changes were made in the plan. The major ones were upward revisions in the stabilization price of lead and zinc by 0.75 cents per pound to 15.5 and 13.5 cents per pound, respectively, and of fluorspar by $5 a ton to $53. The maximum stabilization payments to producers of lead, zinc, and fluorspar were increased from 3.37 cents to 3.9 cents per pound, 2.5 cents to 2.9 cents per pound, and $8 to $13 per ton, respectively; tungsten remained unchanged at $18 per short ton unit. Higher payments were established for the first 500 tons of lead and zinc ores produced in each quarter by each producer; the stabilization price for this tonnage being set at 17 cents and 14.5 cents per pound, respectively. The cost of the amended program was approximately $350 million over the 5-year period the program was to be in effect.

The plan that was embodied in Senate Bill 4036 was presented to the Senate on July 3, 1958. Amendments to exclude tungsten and fluorspar from the measure were defeated, and the bill passed the Senate on July 14 by a vote of 70 to 12, with 14 not voting. In the House Committee on Interior and Insular Affairs proposals for production bonuses for producers of beryl, chromite, and columbium-tantalum were incorporated in the bill, raising the cost to $650 million. The legislation was introduced in the House on August 18; amendments to exclude the provisions on tungsten and fluorspar were passed by a vote of 174 to 171, with 84 not voting, and the entire bill was defeated on August 21, by a vote of 182 to 159, with 87 not voting.[3]

The President had suspended consideration of the escape-clause finding of the Tariff Commission on lead and zinc, pending congressional consideration of the minerals stabilization plan. After that plan was rejected, the President imposed import quotas on lead and zinc at 80 percent of the commercial imports over the 5-year period, 1953–57.[4] These quotas had an immediate effect upon the domestic industry: Noticeable improvement in employment, production, and prices occurred by the end of the year. Perhaps the most immediate result was a decline in the labor separation rate in lead-zinc mining from a 3-month average of 7.1 per hundred employees in the third quarter to 1.4 in the last quarter of the year and an increase in the accession rate from 1.0 per hundred employees in the third quarter to 5.1 in the last quarter of the year. Details of the quota program are given in the lead and zinc commodity chapters, this volume.

[3] The Congressional Record, July and August, 1958.
[4] Proclamation of the President of the United States, Sept. 22, 1958. Published in the Federal Register, vol. 23, No. 189, Sept. 26, 1958, p. 7475.

DEFENSE MOBILIZATION

Prepared by Gabrielle Sewall [5]

Defense Production Act.—Of the $2.1 billion authorized borrowing authority under the Defense Production Act (DPA) at the end of 1958, $724 thousand was available for further implementation of programs ($501 million was available at the end of 1957); only $234 thousand was unallocated.

Gross transactions certified, as of December 31, 1958, for all programs at $8.4 billions were 1 percent higher than at the end of 1957; gross transactions contracted (or consummated) increased 4 percent to $8.0 billion. An amount of $5.3 billion was contracted for metals and minerals programs, an increase of 2 percent. Of the $5.3 billion for metals and minerals, $5.0 billion was for purchases, $279 million for loans, $26 million for exploration grants, and $14 million for research and development. Purchases of metals and minerals amounted to 66 percent of total purchases, compared with 71 percent in 1957. The probable ultimate net cost of the metals and minerals program as of the end of 1958 was $854 million, an 11-percent increase over 1957.[6]

National Strategic Stockpile Program.[7]—A review of the role of stockpile policy in defense mobilizaton was begun in 1957 when a Special Stockpile Advisory Committee headed by Holman D. Pettibone and composed of leading industrialists and public officials was appointed in October 1957 by the Office of Defense Mobilization. The recommendations of the Committee were released January 28, 1958, together with proposals originating within the Government, and a revised policy became effective June 30, 1958. The new policy called for a 3-year supply of strategic items rather than a 5-year supply as originally specified. Two objectives were established—a "basic" objective, which partly discounted overseas sources of supply, and a "maximum" objective, which assumed no dependence on sources of supply beyond North America and comparably accessible areas. The latest military requirements for a 3-year emergency period were the basis for "maximum" objectives a good deal lower than the former 5-year, long-term targets and for many materials a target even less than the former procurement priority levels. The basic objectives established by this policy had little effect on new procurement because from the middle of 1957 new commitments had been limited generally to meeting the needs of a 3-year emergency. Table 2 summarizes the changes in objectives and gives the total inventory figure.

Deliveries to the strategic stockpile during 1958 amounted to $79 million and consisted principally of amosite asbestos, metallurgical fluorspar, and muscovite block and film mica toward the new basic objectives; lead, zinc, and synthetic manganese dioxide were purchased under the domestic incentive program as an aid in maintain-

[5] General economist, Office of Chief Economist.

[6] Executive Office of the President, Office of Civil and Defense Mobilization, Report on Borrowing Authority: Dec. 31, 1957, pp. 7–49 and 1958, pp. 11–73.

[7] Executive Office of the President, Office of Defense Mobilization, release 638, June 13, 1958, and Stockpile Report to the Congress, January–June pp. 1–12 and July–December, pp. 1–9, 1958.

TABLE 2.—Stockpile objectives and inventory [1]

(Million dollars)

Objectives	Objectives				Inventory
	In effect Dec. 31, 1957	In effect Mar. 31, 1958	Objectives	In effect Dec. 31, 1958	In effect Dec. 31, 1958
Procurement priority	3,000	2,900	Basic	2,900	2,800
Minimum increment	2,600	2,400	Maximum	1,600	900
Long-term increment	3,600	3,200			
Total	9,300	8,500		4,500	3,700
Excess					2,000

[1] Joint Committee on Defense Production, Activities of, 8th Annual Rept., Jan. 9, 1959, 86th Cong., 1st Sess. Rept. 1, p. 58.
Executive Office of the President, Office of Civil and Defense Mobilization, Stockpile Report to the Congress, July–December 1957 and 1958, chart 1.

ing the mobilization bases. For this purpose all purchases of domestic lead, zinc, chrysotile asbestos, Acid-grade fluorspar, columbium-tantalum, synthetic manganese dioxide, and chromium metal were terminated in 1958. Commodities delivered chiefly under previously executed Defense Production Act (DPA) and Commodity Credit Corporation (CCC) contracts were antimony, chromium metal, copper, diamond bort, jewel bearings, Metallurgical-grade manganese, nickel, and tungsten. Materials on order amounted to $1 million at the end of 1959, compared with $140 million at the end of 1957.

During the year previously unfilled stockpile objectives for Metallurgical-grade fluorspar, Jamaica-type metallurgical-grade bauxite, magnesium, and palladium were completed. The only metals and minerals for which basic objectives had not been completed were amosite asbestos, small diamond dies, jewel bearings, muscovite block and film mica, selenium, and silicon carbide. Purchases of selenium were halted early in 1958.

Loans.[8]—No new loans were authorized in 1958. Cumulative advances to contractors in connection with purchase contracts for metals and minerals by December 31, 1958, were $168 million, a 12-percent increase over the preceding year. Of this amount the balance outstanding was only $15 million owing to net receipts of $39 million during the year. New advances were made in the nickel and titanium programs.

Purchase Programs.[9]—The only new purchase contracts under the DPA in 1958 were for domestic and foreign mica. The regulation governing the domestic program was revised to encourage delivery of better quality hand-cobbed mica and an increased yield of stockpile-quality block mica. There were also new contracts for research on development of synthetic substitutes, investigation of properties of natural mica, experimental work in reconstitution of synthetic mica, and design of a natural-mica-testing machine.

[8] General Services Administration, Defense Materials Service, Financial Report, Defense Production Act, Dec. 31, 1957, June 30, 1958, and Dec. 31, 1958, Exhibit A–2 and p. 2.

[9] Work cited in footnotes 6, 7, and 8; Joint Committee on Defense Production Activities 8th Annual Rept., Senate Rept. 1, 86th Cong. 1st sess., Jan. 9, 1959, p. 105.

The domestic purchase program for metallurgical chromite begun in August 1951 was closed in the first half of 1958 when the quantity limitation of 200,000 long dry tons was reached. During the year 310,000 tons of primary aluminum were accepted by the Government on contractors' options to "put." The low copper market price in the first half of the year brought substantial quantities of copper to the stockpile under floor-price contracts. Because free world production of nickel was in excess of demand, companies that had previously diverted production to industry resumed shipments under their DPA contracts. Other commodities added to the Defense Production Act inventory were cobalt, manganese, and titanium. The extension of the mercury purchase program expired at the end of the year.

The Titanium Advisory Committee established to develop recommendations for the Government's expansion program was abolished June 11, 1958.

Although allotments for "A" products for defense programs under the defense materials system were continued routinely, the supply-demand position of the products under control—aluminum, copper, steel, and nickel alloys—was such that its significance was purely nominal.[10]

Tax Amortization Program.—The minerals section of the accelerated tax-amortization program is presented in tables 3 and 4, as well as a chart to show the amount certified by quarter since the beginning of the program. In 1958 all expansion goals had been met and all

TABLE 3.—Certificates of necessity on facilities for producing metals and minerals on which construction was complete by Dec. 31, 1958 [1]

Commodity	Number of certificates	Reported value in place 1958 (thousand)[2]
Metallic ores and materials:		
Alumina	13	$134,994
Antimony	1	194
Bauxite	7	30,021
Berryllium	1	4,662
Cadmium	2	276
Columbium-tantalum	3	3,831
Copper	29	208,427
Germanium	1	110
Lead and zinc	49	72,640
Magnesium	8	7,042
Manganese	9	19,135
Mercury	1	302
Molybdenum	3	22,994
Platinum	1	28
Selenium	2	101
Silicon	2	3,306
Tungsten	17	5,960
Uranium	23	83,452
Total metallic	172	597,475
Nonmetallic ores and materials:		
Arsenic	1	465
Barite	6	2,271
Borates	1	1,966
Nonmetallic ores and materials—Continued		
Bromine	7	$5,061
Cryolite	10	6,726
Diamond recovery	1	48
Diatomite	3	6,355
Fluorspar and fluorides	9	4,214
Garnet	1	299
Gypsum	1	158
Lime, limestone, and dolomite	43	42,045
Lithium	4	1,270
Mullite	1	47
Phosphate rock	6	11,360
Quartz crystals	5	632
Refractory clay	1	1,213
Fefractory magnesias	10	14,611
Rutile and monazite	6	2,393
Salt	1	451
Sand	2	805
Soda ash	1	16,200
Sulfur [3]	5	20,492
Total nonmetallic	125	139,082
Total metallic and nonmetallic	297	736,557

[1] Unpublished records of Defense Materials Service, General Services Administration; Bureau of Census, U.S. Department of Commerce.
[2] Revised.
[3] Mined only.

[10] Executive Office of the President, Office of Civil and Defense Mobilization, various releases.

TABLE 4.—Certificates of necessity on facilities for the production of metals and minerals on which construction was not complete by Dec. 31, 1958 [1]

Commodity	Number of certificates	Total reported value of facilities certified as of Dec. 31, 1958 (thousand)	Reported value in place as of Dec. 31, 1958 (thousand)	Percent reported in place Dec. 31, 1958
Metallic ores and materials:				
Aluminum	37	$776, 378	$748, 378	96
Iron, including taconite	138	1, 254, 944	1, 092, 548	87
Nickel and cobalt	9	131, 379	98, 432	75
Rare earths	4	4, 242	4, 070	96
Titanium	22	130, 207	128, 106	98
Zirconium	7	35, 782	35, 256	99
Total metallic	217	2, 332, 932	2, 106, 790	90
Nonmetallic ores and materials:				
Mica	4	1, 763	1, 726	98
Total metallic and nonmetallic	221	2, 334, 695	2, 108, 516	90

[1] Unpublished records of Defense Materials Service, General Services Administration; Bureau of the Census, U.S. Department of Commerce.

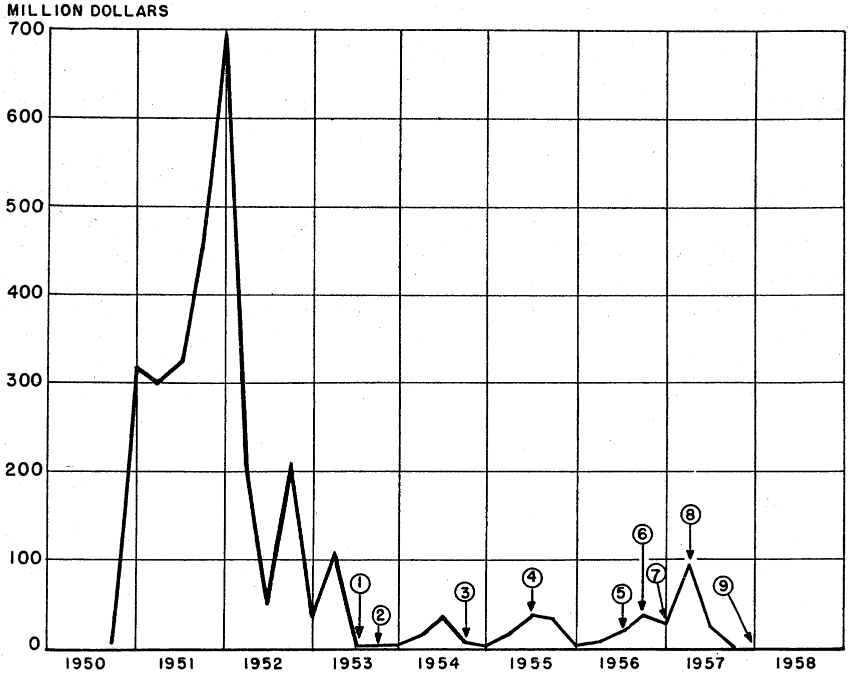

FIGURE 1.—Amount certified for tax amortization for metals and minerals, 1950–58 by quarters, with timing of significant actions.

1. July 26, 1953—Korean armistice.
2. 4th quarter, 1953—Expansion goals for clay refractories, diatomite, lime, limestone, and dolomite, magnesium, phosphate rock, potash, soda ash, and sulfur closed.
3. 4th quarter, 1954—Goal for lithium closed.
4. 3d quarter, 1955—Goals for aluminum, alumina, antimony, asbestos, barite, bauxite, beryl, chromite, (metallurgical and refractory) cobalt, columbite-tantalite, cryolite, fluorspar, iron ore, lead, metallurgical manganese, molybdenum, rare earths, titanium, tungsten, and zinc closed.
5. 3d quarter, 1956—Goals for copper and rutile-ilmenite closed.
6. 4th quarter, 1956—Goals for taconite and iron and steel scrap closed.
7. 1st quarter, 1957—Goals for chemical grade chromite, battery grade manganese, and selenium closed.
8. 2d quarter, 1957—Goals for mercury, mica, and nickel closed.
9. 1st quarter, 1958—All goals for total tax amortization program closed.

were closed except uranium, which was suspended until further action by the AEC. No certificates of necessity were granted (only 84 processed for all industries). The percentage of certified facilities reported in place by December 31, 1958, was 92 for metals and virtually 100 for nonmetallics.

Barter Program.[11]—Restrictions placed on barter transactions in 1957 were relaxed. In August 1958 Congress in extending Public Law 480 to December 31, 1959, transferred the responsibility for designating barter materials to the President from the Secretary of Agriculture. Also the base for selecting materials for barter was broadened. The burden of proof as to whether a barter transaction represented a net increase in export sales was shifted from the contractor to the Secretary of Agriculture. A change in the law permitted domestic processing of raw materials from foreign ores.

The total value of materials acquired by CCC for the strategic and supplemental stockpiles since the inception of the barter program through December 31, 1958, was $795 million.

Office of Minerals Exploration.[12]—During 1958, one program of Federal aid encouraging domestic exploration came to an end, and another was inaugurated. On June 6, 1958, the Defense Minerals Exploration Administration, acting on instructions from the Office of Defense Mobilization, announced that no contracts would be approved after June 30 and that contracts in force on the latter date would be continued in effect until terminated in accordance with their contract provisions. On August 21, 1958, the President approved legislation (Public Law 85–701), which authorized the establishment and maintenance of a new program of exploration by private industry for domestic mineral deposits (excluding organic fuels). The sum of $4 million was appropriated for the financing of the new program in the fiscal year 1959.

On September 11 the Secretary of the Interior established The Office of Minerals Exploration to conduct the new program and to administer liquidation of the DMEA program. By the close of 1958, regulations of the new agency had been published, and applications were being received.

Export Control.[13]—During 1958 supplies of metals and minerals that were still relatively scarce in 1957 became more plentiful. Accordingly, the commodities under short-supply export control through quotas were released from quantitative restriction. By the end of the year the only materials remaining under export control because of short supply were nickels: Pure nickel powder, nickel and nickel alloy metal, nickel and nickel-bearing scrap, cobalt-nickel alloy scrap, and nickel oxide, except for chemical use. This control was removed

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[11] Work cited in footnote 9, pp. 72–73; U.S. Department of Agriculture, various releases.

[12] Defense Minerals Exploration Administration; Annual Report to Congress: 1959, and monthly reports.

[13] Secretary of Commerce, Export Control, Report to the President, the Senate, and House of Representatives: 42d Quarterly, Feb. 1, 1958, pp. 23–28; 46th Quarterly, Feb. 15, 1959, p. 16.

from diamond bort and powder during the fourth quarter. At the end of the quarter iron and steel scrap was also released.

DOMESTIC PRODUCTION

Value of Mineral Production.—The value of production of metals, mineral fuels, and total minerals was sharply lower in 1958 as compared with 1957. The decrease in total value was almost $1.6 billion. The drop in value of metals was most striking—25 percent—but the actual dollar decrease of fuels was the major contributor to the overall 9 percent decline. Unlike the situation in 1957 production declines contributed the bulk of the value decrease, the declines in production being considerably larger than those in mineral prices in general.

Volume of Mineral Production.—The Bureau of Mines index of the physical volume of mineral production in the United States fell by 11 points in 1958, an 8 percent decline. All major groups shared in the decline except nonmetals, but the sharpest drop was in the ferrous metal group. The Federal Reserve Board indexes do not show as sharp a drop as recorded by the Bureau's index. These two sets of indexes use different weighting systems, the Bureau's index using value of production and shifting weights, the Reserve Board, using fixed weights based upon value added. These weight differences and some differences in coverage can result in differential movements between the indexes.

TABLE 5.—Value of mineral production in United States by mineral group [1]

(Millions)

Mineral groups	1949–53 (average)	1954	1955	1956	1957	1958	Change in 1958 from 1957 (percent)
Metals and nonmetals except fuels:							
Nonmetals	$1,995	$2,630	$2,957	$3,266	$3,267	$3,341	+2
Metals	1,510	1,518	2,055	2,358	2,137	1,597	−25
Total	3,505	4,148	5,012	5,624	5,404	4,938	−9
Mineral fuels	9,252	9,919	10,780	11,741	12,709	11,588	−9
Grand total	12,757	14,067	15,792	17,365	18,113	16,526	−9

[1] Beginning with 1953 Alaska and Hawaii are included.

The advantage of the Bureau's index is that it is available on a comparable basis since 1880. However, the Reserve Board indexes are available monthly and on a seasonally adjusted basis. The monthly indexes showed that the decline in metal-mining production was reversed in June and by yearend had almost reached the volume of December 1957. The bottom was reached in February in stone and earth minerals, and the monthly indexes were above the preceding year for 8 of the last 10 months.

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TABLE 6.—Indexes of the physical volume of mineral production in the United States, by groups and subgroups [1]

(1947–49=100)

Year	All minerals	Metals: Total	Metals: Ferrous	Metals: Nonferrous: Total	Metals: Nonferrous: Base	Metals: Nonferrous: Monetary	Metals: Nonferrous: Other	Nonmetals: Total	Nonmetals: Construction	Nonmetals: Chemical	Nonmetals: Other	Fuels
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	[2] 170.1	[2] 146.2	127.5	113.8
1956	125.8	117.1	116.6	117.4	116.1	94.9	206.8	172.5	179.7	163.5	135.8	120.5
1957	126.1	118.8	122.2	116.4	113.7	93.0	229.9	175.7	189.3	153.5	124.4	120.3
1958 [2]	115.5	91.1	79.7	99.0	98.2	87.9	144.5	176.0	195.2	143.2	111.5	110.2

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

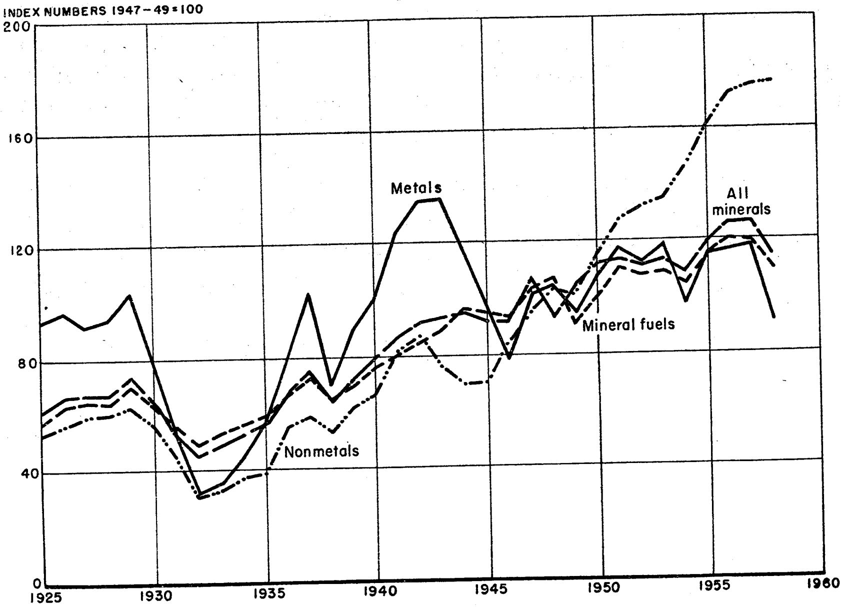

FIGURE 2.—Indexes of physical volume of mineral production in the United States, 1925–58, by groups.

TABLE 7.—Indexes of production of metal and mineral mining, metals, nonmetallic products, and total industrial production [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
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	145	155	139
1956	127	142	152	164	143
1957	129	140	[3] 150	[3] 153	143
1958	117	105	132	144	134

[1] Federal Reserve Bulletin, June, 1959, pp. 636–638.
[2] Weighted average, computed by author of this chapter from Federal Reserve indexes and weights.
[3] Revised figure.

TABLE 8.—Monthly indexes of production, metal mining, and stone and earth minerals, seasonally adjusted [1]

(1947–49 average=100)

Month	Metal mining			Stone and earth minerals		
	1957	1958	Change from 1957 (percent)	1957	1958	Change from 1957 (percent)
January	120	110	−8.3	142	144	+1.4
February	122	106	−13.1	142	133	−6.3
March	121	100	−17.4	143	138	−3.5
April	121	88	−27.3	140	139	−.7
May	114	73	−36.0	142	142	0
June	121	80	−33.9	142	145	+2.1
July	122	80	−34.4	143	146	+2.1
August	121	83	−31.4	146	144	−1.4
September	115	90	−21.7	144	149	+3.5
October	107	92	−14.0	143	148	+3.5
November	100	101	+1.0	140	148	+5.7
December	110	108	−1.8	141	142	+.7
Annual average	116	91	−21.6	142	143	+.7

[1] Federal Reserve Bulletin, various issues; 1958 data subject to revision.

NET SUPPLY

Net Supply.—The net supply [14] of minerals and metals generally declined. The ferrous group showed the greatest percentage decline as a whole, but magnesium and rutile decreased more sharply than any other commodity. The 1957–58 economic recession, which was reflected only spottedly in the 1957 data, was almost universally evident in 1958 yearly data. Aluminum was the only metal to show an increase in net supply, and of the nonmetals only those whose major markets were the construction or agricultural industry escaped the general decline. Of the 33 commodities included in the net-supply tabulation, 29 decreased in 1958, while only 4 increased. From other sources, it is evident that the minerals industry was recovering by the end of 1958. The net supply analysis, based upon annual data, clearly marked 1958 as a year of depression in the mineral industries.

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

TABLE 9.—Net supply of principal minerals in the United States and components of gross supply [1]

(Thousand short tons, unless otherwise stated)

Commodity	Net supply			Components as a percent of gross supply (gross supply=100)						Exports as a percent of gross supply	
				Primary shipments [2]		Secondary production [3]		Imports [4]			
	1957	1958	Change from 1957 (percent)	1957	1958	1957	1958	1957	1958	1957	1958
Ferrous ores, scrap, and metals:											
Iron (equivalent) [5]	[6] 118,896	80,478	−32	[6] 53	52	[7] 28	[7] 25	[6] 19	23	3	3
Manganese (content)	[6] 1,660	1,329	−20	14	14	----	----	[8] 86	[8] 86	1	([9])
Chromite (Cr_2O_3 content)	1,051	602	−43	6	10	----	----	94	90	([9])	([9])
Cobalt (content) thousand pounds	[6] 21,865	21,141	−3	19	23	[10] 2	[10] 2	79	75	----	----
Molybdenum (content) do	[6] 32,905	30,284	−8	97	100	----	----	[8] 3	([8] [9])	44	29
Nickel (content)	160	108	−32	8	13	4	4	87	83	----	([9])
Tungsten ore and concentrate (W content) short tons	[6] 9,297	5,135	−45	[6] 27	34	----	----	[6] [8] 73	[8] 66	4	2
Other metallic ores, scrap, and metals:											
Copper (content)	[6] 1,758	1,484	−16	51	52	[6] 21	22	[8] 28	[8] 26	[6] 17	21
Lead (content)	[6] 1,287	1,179	−8	26	23	[6] 33	29	[8] 41	[8] 48	([9])	([9])
Zinc (recoverable content)	[6] 1,308	1,063	−19	40	38	6	7	[8] 54	[8] 55	1	1
Aluminum (equivalent) [11]	[6] 2,116	2,354	+11	[12] 14	[12] 12	3	3	[13] 83	[13] 85	[13] 2	[13] 3
Tin (content) long tons	[6] 69,880	59,252	−15	----	----	21	23	79	77	2	2
Antimony (recoverable content) [14] short tons	[6] 38,100	30,353	−20	[6] 7	9	[6] 52	56	[6] [8] 41	[8] 35	([9])	([9])
Beryl ore (BeO content) do	7,811	5,062	−35	7	9	----	----	93	91	----	----
Cadmium (content) [15] do	5,724	5,064	−12	38	37	----	----	[8] 62	[8] 63	6	5
Magnesium (content)	85,984	34,824	−59	[16] 93	[16] 86	6	14	1	([9])	1	1
Mercury 76-pound flasks	79,435	63,148	−21	[16] 39	[16] 59	7	8	[8] 54	[8] 33	6	2
Platinum-group metals thousand troy ounces	[6] 748	721	−4	2	2	[17] 11	[17] 11	87	87	5	6
Titanium concentrate: Ilmenite and slag (TiO_2 content)	707	517	−27	58	57	----	----	42	43	----	----
Rutile (TiO_2 content)	[6] 88	35	−60	11	5	----	----	89	95	2	3
Nonmetals:											
Asbestos	723	685	−5	6	6	----	----	94	94	([9] [18])	([9] [18])
Barite, crude	1,986	1,132	−43	58	53	----	----	42	47	----	----
Boron minerals and compounds, finished products (gross wt.)	[6] 327	293	−10	[6] 100	100	----	----	([6] [9])	([9])	[6] 40	45
Bromine and bromine in compounds million pounds	181	166	−8	100	100	----	----	([9])	([9])	5	6
Clays	[6] 45,300	43,494	−4	100	100	----	----	([9])	([9])	1	1
Fluorspar, finished	[6] 894	732	−18	[6] 37	43	----	----	[6] [8] 63	[8] 56	([9])	1
Gypsum, crude	13,481	13,782	+2	[19] 68	[19] 71	----	----	32	29	----	----
Mica (except scrap) thousand pounds	[6] 12,932	11,742	−9	5	5	----	----	95	95	7	8
Phosphate rock (P_2O_5 content) thousand long tons	3,577	3,720	+4	99	99	----	----	1	1	22	20

Potash (K_2O equivalent)	2,085	2,298	+10	92	92			8	8	10	10
Salt (common)	[6] 24,114	22,754	−6	97	97			3	3	2	2
Sulfur, all forms (content)[20] thousand long tons	[6] 5,553	5,267	−5	91	89			9	11	22	23
Talc and allied minerals	672	658	−2	97	97			3	3	6	8

[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 production. Shipments more nearly represent quantities marketed by the domestic industry and as such are more comparable to imports. Use of shipments data rather than production data also permits 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 mineral 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 83 percent of bauxite mine production (rather than shipments) and imports, and 92 percent of alumina imports, both converted to estimated aluminum equivalent (3.862 long tons bauxite and 1.908 short tons of alumina to 1 short ton aluminum) in 1957; 87.5 and 92 percent in 1958 (3.925 and 1.922 conversion factors). These percentages are based on estimated proportions used in the production of metal. To avoid a duplicate adjustment for nonmetallic use, exports of bauxite to Canada were excluded from exports.

[12] Mine production of bauxite.

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

[14] Calculation of supply revised and now based on recovery from all forms as a byproduct from domestic and foreign sources.

[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 1958 the ratio was 41:59; in 1957, 44:56. 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 (that is, reexports) are included.

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

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

Sources of Supply.—Imports increased in importance as a source of supply for several major minerals, notably iron, lead, and zinc. However, the portion of supply from imports declined in copper, nickel, mercury, and fluorspar. Of the commodities shown in table 10, 9 showed increased import contribution, 13 decreased, and 11 showed no change.

Sources of Imports.—Canada and Mexico lost part of their market in 13 principal commodities, gained in 5, and maintained their position in 6. The "Other free world" area increased in importance, showing larger percentage shares in 11 commodities, and decreases in 8. The United Soviet Socialist Republic block was a supplier in only two commodities—platinum-group metals and potash—contributing 14 percent of the imports in each case.

TABLE 10.—Percentage distribution of imports of principal minerals consumed in the United States, 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]	
	1957	1958	1957	1958	1957	1958	1957	1958	1957	1958
Ferrous ores, scrap, and metals:										
Iron (equivalent) [4]	36	29	16	17	42	44	6	10	------	------
Manganese (content)	14	8	2	2	24	26	60	64	------	------
Chromite (Cr_2O_3 content)	------	------	3	4	4	3	93	93	------	------
Cobalt (content)	13	7	------	------	------	------	87	93	------	------
Nickel (content)	78	77	(5)	------	16	21	6	2	------	------
Tungsten ore and concentrate (W content)	12	10	37	33	28	49	23	8	------	------
Other metallic ores, scrap, and metals:										
Copper (content)	27	29	50	42	3	4	20	26	------	------
Lead (content)	30	33	43	45	4	2	23	20	------	------
Zinc (recoverable content)	63	68	20	18	2	1	15	13	------	------
Aluminum (equivalent) [6]	12	11	(5)	(5)	87	86	1	3	(5)	------
Tin (content)	1	(5)	(5)	(5)	(5)	10	100	90	------	------
Antimony (recoverable content) [7]	53	19	13	10	(5)	(5)	34	70	------	------
Beryl ore (BeO content)	------	------	------	------	51	36	49	64	------	------
Cadmium (content) [8]	82	78	2	7	------	------	17	16	------	------
Mercury	13	41	1	4	(5)	(5)	87	54	------	------
Platinum-group metals	37	18	(5)	(5)	4	3	56	65	3	14
Titanium concentrates: Rutile, ilmenite and slag (TiO_2 content)	44	33	14	14	------	(5)	42	53	------	------
Nonmetals:										
Asbestos	92	91	1	1	(5)	(5)	7	8	------	------
Barite, crude	62	62	15	14	4	1	19	23	------	------
Fluorspar, finished	65	65	------	------	------	------	35	35	------	------
Gypsum, crude	95	82	------	------	5	18	(5)	(5)	------	------
Mica (except scrap)	(5)	(5)	------	------	14	15	86	85	------	------
Potash (K_2O equivalent)	------	(5)	7	1	------	------	71	85	22	14
Sulfur (content)	100	100	------	------	------	------	(5)	(5)	------	------

[1] Data are based upon inports for consumption and are classified like net new supply shown in table 9. Differences in 1957 figures are due to corrections in classification as well as revisions in the basic data.
[2] West coast of South America (Salvador, Chile, Boliva, 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 9.
[7] Excludes antimony from foreign silver and lead ores.
[8] Metal and flue dust only.

CONSUMPTION

Patterns.—Consumption of minerals in 1958 was generally lower than in 1957. Declines were marked (over 10 percent) in 16 of the commodities in tables 11 and 12. Altogether, 28 showed decreases, 5 increases, and one no change. The largest decreases were in rutile, tungsten, manganese ore, nickel, mica, and chromite (all over 30 percent), while only beryl and potash showed substantial increases (39 and 10 percent, respectively). The steel-associated minerals, as a group, showed the severest declines, while the nonmetals held up best as a group. The consumption analysis reinforces the conclusions of the net supply analysis; that is only those commodities closely related to the construction and agricultural industries were able to maintain their markets in the face of the general business decline that reached its low point in 1958.

Sales and Orders.—Seasonally adjusted sales of the primary-metal-manufacturing industry dropped for the first 5 months of the year, then rose for the remaining 7 months. However, the total for the year

TABLE 11.—Reported consumption of principal metals and minerals in the United States

Commodity	1957	1958	Change from 1957 (percent)
Antimony, primary [1] ---- thousand short tons	[2] 12,389	11,880	−4
Barite, crude ---- do	1,671	1,196	−28
Bauxite ---- thousand long tons, dried equivalent	7,633	7,034	−8
Beryl ---- short tons, BeO content	4,309	6,002	+39
Chromite ---- thousand short tons, gross weight	1,760	1,221	−31
Cobalt ---- thousand pounds	9,157	7,542	−18
Copper, refined ---- thousand short tons	[2] 1,352	1,251	−7
Fluorspar, finished ---- do	645	494	−23
Iron ore ---- thousand long tons, gross weight	[2] 129,375	91,900	−29
Lead ---- thousand short tons	[2] 1,138	986	−13
Magnesium, primary ---- short tons	[2] 44,442	35,352	−20
Manganese ore ---- thousand short tons, gross weight	2,361	1,498	−37
Mercury ---- 76-pound flasks	52,889	52,617	−1
Mica splittings ---- thousand pounds	8,037	5,329	−34
Molybdenum, primary products ---- thousand pounds, Mo content	[2] 30,016	24,231	−19
Nickel, exclusive of scrap ---- short tons	122,466	79,000	−35
Platinum-group metals (sales to consumers) ---- thousand troy ounces	[2] 744	690	−7
Tin ---- long tons	82,507	72,585	−12
Titanium concentrate:			
Ilmenite and slag ---- thousand short tons, estimated TiO_2 content	517	463	−10
Rutile ---- do	[2] 51	21	−59
Tungsten concentrate ---- short tons, W content	4,272	2,660	−38
Zinc, slab ---- thousand short tons	936	868	−7

[1] Includes antimony content of imported alloys and of antimonial lead produced from foreign and domestic ores; other years, alloy was not included.
[2] Revised figure.

TABLE 12.—Apparent consumption of metals and minerals in the United States [1]

Commodity	1957	1958	Change from 1957 (percent)
Aluminum, primary [2] ---- thousand short tons	1,775	1,802	+2
Asbestos, all grades [3] ---- do	723	685	−5
Boron minerals and compounds [4] ---- thousand short tons, gross weight	[5] 327	293	−10
Bromine and bromine in compounds ---- million pounds	181	166	−8
Cadmium, primary [3] ---- thousand pounds, Cd content	10,999	8,177	−26
Clays ---- thousand short tons	[5] 45,299	43,494	−4
Gypsum, crude ---- do	[5] 13,481	13,782	+2
Phosphate rock ---- thousand long tons B_2O_5 content [6]	3,626	3,760	+4
Potash ---- K_2O equivalent	[5] 2,085	2,298	+10
Salt, common ---- thousand short tons	[5] 24,114	22,754	−6
Sulfur (all forms) ---- thousand long tons, S content	[5] 5,553	5,266	−5
Talc and allied minerals [3] ---- thousand short tons	[5] 692	694	----

[1] Covers commodities on which consumption is not reported.
[2] Mill shapes previously included in net imports have been excluded.
[3] No adjustments for national stockpile acquisitions.
[4] Reported in terms of finished products.
[5] Revised figures.
[6] Estimated at 31 percent of gross weight.

was sharply below that for 1957, down almost $5 billion. The sales of the stone, clay, and glass-manufacturing industry recovered in March but were still 10 percent lower in 1958 than in 1957, due in part to a secondary decline that began in the last quarter of the year. New orders in the primary-metal industry, as expected, led the increase in sales. New orders reached their low point in February, and had shown substantial recovery by the end of the year. Nevertheless, the total for the year was $3 billion lower than in 1957.

TABLE 13.—Sales, primary metal industry and stone, clay, and glass industry, and new orders, primary metal industry [1]

(Million dollars)

Year	Primary metal		Stone, clay, and glass	Year	Primary metal		Stone, clay, and glass
	Sales	Net new orders	Sales		Sales	Net new orders	Sales
1955	26,468	29,542	8,677	1958—Continued [2]			
1956	28,339	29,028	8,982	May	1,656	1,671	621
1957	27,852	25,504	8,489	June	1,854	1,952	645
1958	22,951	22,502	7,655	July	1,917	2,044	676
1958: [2]				August	1,984	2,063	657
January	1,952	1,556	634	September	2,065	2,334	701
February	1,733	1,369	583	October	2,182	2,414	653
March	1,635	1,371	586	November	2,113	2,262	667
April	1,657	1,543	605	December	2,256	2,210	655

[1] U.S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 39, March 1959, and previous issues.
[2] Seasonally adjusted data, therefore will not add to 1958 total.

STOCKS

Indexes of Stocks.—Indexes of physical stocks held by mineral manufacturers, consumers, and dealers at yearend, and stocks held by primary producers at yearend, are presented here for the first time. These indexes cover a 10-year period and are based upon 1955. Before the development of these indexes, stock data had to be analyzed commodity by commodity. With these indexes, more general patterns in stock movements become apparent, and the impact of stock movements on mineral markets can be better ascertained.

The indexes were developed by the author. For the index of stocks of manufacturers, consumers, and dealers, the following commodities are included: Aluminum, arsenic, bauxite, bismuth, cadmium, cement, chromite, copper, ferrous scrap and pig iron, fluorspar, iron ore, lead, manganese ore and ferromanganese, mercury, molybdenum primary products, nickel, platinum-group metals, tin, titanium concentrates, tungsten concentrates, and zinc. The index of stocks held by primary producers includes the following commodities: Antimony, bauxite, fluorspar, gypsum, iron ore, mercury, molybdenum, phosphate rock, potassium salts, sulfur, titanium concentrates, and tungsten. Primary market prices of each commodity were used as weights in the first index; average mine value was used in the second. The year average for 1955 was chosen as the weight period as well as the base year of the indexes.

These indexes measure the changes in the physical volume of stocks. The importance of any commodity in the index is a result of the physical stock of that commodity, valued at 1955 prices. The movements in the indexes reflect, therefore, movement in the physical volume of stocks. The indexes are of the same type as the indexes of physical volume of mineral production presented earlier in this Review.

That stocks were high during the 1957–58 and 1953–54 recessions is evident in tables 14 and 15. Monthly indexes would be a more powerful tool of analysis of the role played by stock changes in the mineral sector during business cycles, but there are serious data problems in their construction, namely the lack of comprehensive monthly data.

Stocks in Bonded Warehouses.—Changes in these stocks are not included in the indexes of stocks, therefore they are presented in table

TABLE 14.—Indexes of stocks of minerals of mineral manufacturers, consumers, and dealers as of end of year

(1955=100)

Year	Total metals and non-metals [1]	Metals					Non-metals [1]
		Total	Iron	Other ferrous	Base	Other non-ferrous	
1949	88	89	80	81	101	81	84
1950	81	81	78	72	84	89	77
1951	75	75	79	68	72	70	102
1952	90	90	94	86	87	89	97
1953	106	105	105	108	106	103	112
1954	99	99	101	116	95	102	94
1955	100	100	100	100	100	100	100
1956	111	111	102	98	117	136	128
1957	130	129	127	122	122	182	162
1958	[2] 130	[2] 129	132	[2] 122	119	160	173

[1] Excluding fuels.
[2] Figure not strictly comparable; tungsten concentrate figure omitted to avoid revealing individual company data.

TABLE 15.—Index of stocks of minerals at mines or in hands of primary producers as of end of year

(1955=100)

Year	Total metals and non-metals [1]	Metals				Non-metals [1]
		Total	Iron ore	Other ferrous	Other	
1949	103	147	125	562	66	85
1950	87	116	134	128	63	75
1951	91	121	131	149	83	79
1952	99	121	129	197	72	90
1953	105	135	133	326	73	93
1954	114	146	165	163	87	100
1955	100	100	100	100	100	100
1956	124	123	128	152	100	124
1957	144	158	157	405	73	138
1958	[2] 139	[2] 149	174	[2] 207	63	136

[1] Excluding fuels.
[2] Figure not strictly comparable; tungsten concentrate figure omitted to avoid revealing individual company data.

16. This class of stocks does not necessarily react to the same economic forces that cause other stock movements, so it was decided to continue to treat them separately.

TABLE 16.—Estimated changes in stocks of selected minerals in custom-bonded warehouses, Jan. 1, 1958 to Dec. 31, 1958 [1]

(Short tons, unless otherwise stated)

Commodity and unit	Estimated stock change	
	Component	Class
Aluminum		+494
Metal and alloys in crude form	+494	
Antimony		+73
Regulus or metal	+73	
Barite, crude		−330
Bismuth		−5, 203
Cadmium (content)		+16
Metal	+16	
Chromium (content)		−202
Metal	+84	
Ferrochromium	−286	
Clay		−3, 616
Copper (content)		+122, 509
Ore and concentrate	−3, 372	
Regulus, black, coarse	+122, 802	
Refined ingots, plates, bars	+3, 079	
Fluorspar, finished		+23, 613
Acid grade	−29, 517	
Metallurgical grade	+53, 382	
Reexports of foreign, both types	−252	
Lead (content)		−23, 545
Ores, flue dust, matte, base bullion	−40, 173	
Pigs and bars	+16, 628	
Manganese (content)		+325, 067
Ore, battery grade	+5, 856	
Ore, metallurgical grade	+307, 480	
Ferromanganese	+11, 408	
Manganese silicon	+739	
Reexports of foreign ore and metal	−416	
Mercury ... 76-pound flasks		−127
Mica, except scrap ... thousand pounds		−1, 596
Unmanufactured ... do	−209	
Film and splittings ... do	−1, 193	
Reexports of foreign, both types ... do	−194	
Molybdenum (content) ... do		−7
Ore and concentrate ... do	−7	
Nickel		+15, 107
Alloys and metal, including scrap	+15, 107	
Tungsten (content)		+80
Ore and concentrate	+83	
Reexports of foreign metal, alloys, and scrap	−3	
Zinc (content)		−80, 239
Zinc-bearing ores	−79, 408	
Blocks, pigs, or slabs	−831	

[1] Estimated by subtracting "imports for consumption" and "reexports of foreign merchandise" from "general imports." All data from U.S. Department of Commerce. Selected minerals included which enter bonded warehouses and for which a change occurred in 1958.

Value of Inventories.—The value of inventories held by firms in the primary metal industry and in the stone, clay, and glass industry, seasonally adjusted, indicates that stock accumulation continued well past the first quarter of 1958, and was begun again during the last 2 months of the year. For the year as a whole, the value of inventory fell, December 1958 being 4 percent lower than Decembr 1957 for the primary metal industry and 6 percent lower for the stone clay and glass industry.

TABLE 17.—Seasonally adjusted book value of inventory, primary metal industry and stone, clay, and glass, December 1955–57 and monthly 1958 [1]

(Million dollars)

Year and month	Primary metal	Stone, clay, and glass	Year and month	Primary metal	Stone, clay, and glass
1955: December	3,420	1,013	1958: May	4,277	1,236
1956: December	3,975	1,171	June	4,169	1,234
1957: December	4,269	1,270	July	4,122	1,228
1958: December	4,100	1,200	August	4,110	1,220
January	4,273	1,237	September	4,043	1,212
February	4,297	1,249	October	4,005	1,221
March	4,342	1,233	November	4,058	1,223
April	4,362	1,233			

[1] U.S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 39, February and March 1959, and earlier issues.

LABOR AND PRODUCTIVITY

Employment.—Total employment in the mineral industries was substantially lower in 1958. Employment in total metal mining continued the decline, which marked 1957, until the second half of 1958. Iron mining employment recovered in May while employment in copper and lead and zinc did not stop declining until November. Nonmetal mining and quarrying employment increased after March, but dropped during the last quarter of the year, following the usual seasonal pattern. All mining categories showed substantial decreases in average employment compared with 1957. However, the pattern was mixed in mineral manufacturing. The metal industries showed large decreases in average employment, but the nonmetal manufacturing industries were virtually unchanged from the preceding year. The nonmetal industry included in this analysis responds to the demand for construction materials and for fertilizers. Both the construction and agricultural industries were expanding during 1958, running counter to the trend in manufacturing as a whole, and to the downward movement in gross national product during the first half of the year. The following tabulation shows the major changes in average employment in 1958 compared with 1957:

	Percent
All industries	−3
Mining (including fuels)	−11
Metals and minerals (except fuels)	−10
Metal mining	−16
Nonmetal mining and quarrying	−4
Fuels	−11
Mineral manufacturing [1]	−15

[1] Based upon categories listed under "Mineral manufacturing" in table 18.

The mineral industries had relatively deep reductions in employment as compared with all industries. The 1957–58 recession was relatively severe in the durable goods industries, the major customers for metals, and this pattern was reflected in the mining and metal-manufacturing sectors. The reaction was somewhat delayed, as production was maintained during the latter part of 1957 in the face of declining consumption. Similarly, employment in the mining industry lagged behind increases in the rest of the economy in 1958.

TABLE 18.—Total employment in the mineral industries (nonfuel) in the continental United States, by industry [1]

(In thousands)

Year and month	Mining					
	Total	Nonmetallic mining and quarrying	Metal			
			Total [2]	Iron	Copper	Lead and zinc
1955	208.0	107.0	101.0	33.7	29.2	16.6
1956	[3] 224.0	[3] 115.2	[3] 108.8	[3] 35.1	33.3	17.4
1957	[3] 224.5	[3] 113.3	[3] 111.2	[3] 38.9	[3] 32.6	16.7
1958:						
January	207.3	106.1	101.2	33.9	29.9	14.8
February	201.0	103.2	97.8	32.0	29.3	14.4
March	200.9	105.0	95.9	31.3	28.9	14.1
April	198.8	107.6	91.2	27.6	28.1	13.9
May	201.2	109.5	91.7	28.7	28.2	13.7
June	204.7	111.8	92.9	30.4	28.2	13.3
July	202.7	112.4	90.3	30.4	27.1	12.1
August	200.4	111.6	88.8	29.9	27.7	11.5
September	203.7	113.0	90.7	31.8	28.4	11.4
October	203.0	112.4	90.6	31.9	27.5	11.1
November	204.9	111.2	93.7	31.2	29.6	12.1
December	200.7	107.3	93.4	30.3	30.2	12.7
Year (average)	202.4	109.3	93.2	30.8	28.6	12.9

Year and month	Mineral manufacturing				
	Fertilizers	Cement hydraulic	Blast furnaces, steel works, and rolling mills	Smelting and refining of nonferrous metals	
				Primary	Secondary
1955	36.9	42.6	635.3	63.8	12.7
1956	36.0	[3] 43.6	[3] 630.2	[3] 67.8	[3] 14.0
1957	[3] 35.8	[3] 42.0	[3] 642.7	[3] 68.1	[3] 13.2
1958:					
January	34.5	41.2	567.2	64.0	12.3
February	35.5	40.3	543.9	60.9	11.7
March	41.1	40.1	528.9	59.0	11.5
April	46.3	41.2	509.8	57.1	11.3
May	42.7	42.7	508.1	55.3	10.9
June	33.7	43.2	523.9	53.9	10.9
July	30.2	42.6	516.5	53.7	11.1
August	30.9	42.6	525.4	53.8	11.3
September	32.9	43.1	540.7	53.4	11.4
October	34.1	42.8	554.5	53.5	11.5
November	32.0	42.3	557.9	54.3	11.8
December	33.2	41.7	564.2	55.1	11.8
Year (average)	35.6	42.0	536.8	56.2	11.5

[1] U.S. Department of Labor, Bureau of Labor Statistics. Published in the Monthly Labor Review, Employment and Earnings, 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.

Hours and Earnings.—Average weekly hours of production workers in the mining industry continued to decline in 1958, the third successive year of decline. However, hourly earnings continued to rise, but not enough to offset the drop in hours, so weekly earnings were down by 2 percent.

All categories of mining showed decreased hours, but only lead and zinc mining failed to show increases in hourly earnings. Weekly earnings fell for all mining groups except nonmetallic mining and

TABLE 19.—Average hours and gross earnings of production and related workers in the mineral industries (nonfuel) in continental United States, by industries [1]

Year	Mining: Total [2] Weekly— Earnings	Mining: Total [2] Weekly— Hours	Mining: Hourly earnings	Metal: Total [3] Weekly— Earnings	Metal: Total [3] Weekly— Hours	Metal: Total [3] Hourly earnings	Metal: Iron Weekly— Earnings	Metal: Iron Weekly— Hours	Metal: Iron Earnings per hour
1955	$86.54	43.4	$2.00	$92.42	42.2	$2.19	$92.86	40.2	$2.31
1956	[4] 98.81	[4] 41.0	[4] 2.41	96.83	42.1	2.30	96.71	39.8	2.43
1957	[4] 102.21	[4] 40.4	[4] 2.53	[4] 98.74	[4] 40.8	2.42	103.49	39.5	2.62
1958	100.25	39.1	2.56	96.33	38.9	2.48	100.10	36.1	2.77

Year	Metal—Continued: Copper			Metal—Continued: Lead and zinc			Nonmetallic mining and quarrying		
1955	$95.70	44.1	$2.17	$83.82	41.7	$2.01	$80.99	44.5	$1.82
1956	100.28	43.6	2.30	89.24	41.7	2.14	85.63	44.6	1.92
1957	97.75	40.9	2.39	88.97	41.0	2.17	87.80	43.9	2.00
1958	94.74	39.1	2.43	86.01	40.4	2.17	89.46	43.2	2.07

Year	Mineral manufacturing: Fertilizer			Mineral manufacturing: Cement, hydraulic			Mineral manufacturing: Blast furnaces, steel works, and rolling mills [5]		
1955	[4] $63.90	[4] 42.6	$1.50	$78.85	41.5	$1.90	$95.99	40.5	[4] $2.38
1956	67.68	42.3	1.60	83.84	41.3	2.03	102.06	40.5	2.52
1957	71.83	42.5	1.69	87.91	40.7	2.16	104.79	39.1	2.68
1958	74.12	42.2	1.76	92.92	40.4	2.30	107.86	37.5	2.88

Year	*Electrometallurgical products*			*Other*			Primary smelting and refining of nonferrous metals [5]		
1955	$87.14	41.3	$2.11	$96.36	40.5	$2.38	[4] $84.66	[4] 40.7	$2.08
1956	[4] 88.22	[4] 40.1	2.20	102.47	40.5	2.53	91.46	41.2	2.22
1957	93.26	40.2	2.32	105.18	39.1	2.69	95.82	40.6	2.36
1958	99.79	40.3	2.48	108.12	37.5	2.89	99.53	40.2	2.48

Year	*Primary smelting and refining of copper, lead, and zinc*			*Primary refining of aluminum*			Secondary smelting and refining of nonferrous metals		
1955	$81.61	40.6	$2.01	$89.28	40.4	$2.20	[4] $81.45	[4] 42.2	$1.93
1956	[4] 88.81	[4] 41.5	[4] 2.14	95.34	40.4	2.36	85.04	42.1	2.02
1957	[4] 89.91	[4] 40.5	2.22	103.68	40.5	2.56	87.53	40.9	2.14
1958	90.40	39.8	2.27	112.59	40.5	2.78	88.77	40.2	2.21

[1] U.S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review: Vol. 82, No. 5, May 1959, table C-1, 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.

quarrying. In mineral manufacturing, the decrease in weekly hours was general, but increased hourly earnings more than offset the decline in hours, so weekly earnings were higher. However, the increases in weekly earnings were relatively small when compared with earlier years, just about matching the increases that occurred in 1957. As in the case of employment, the nonmetallic manufacturing industries showed relatively high gains in hourly and weekly earnings, and relatively slight declines in weekly hours.

Labor-Turnover Rates.—Accession rates rose and separation rates dropped in the mineral industries as 1958 progressed. This behavior was the reverse of that which occurred in 1957, but the average for 1958 was very little different from 1957. Movements of the series in both years followed closely the pattern of the recession and recovery. Layoff rates were very high for lead and zinc mining during the first 8 months of 1958, being over 11 percent of the work force in July. After the import quota program was instituted on October 1, the layoff rate dropped; also the accession rate rose from 1.4 in September to 9.1 in October.

TABLE 20.—Monthly labor-turnover rates in the mineral industries, 1957 average, and 1958 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	Metal mining: Iron mining	Metal mining: Copper mining	Metal mining: Lead and zinc mining
Total accession rate:								
1957 average	2.9	1.7	1.3	1.7	2.4	.8	2.4	2.0
1958:								
January	2.5	1.3	1.5	.7	.8	.3	.7	1.5
February	2.2	2.3	1.9	.3	1.4	1.9	1.3	1.0
March	2.4	3.2	1.8	.6	1.0	.5	1.2	.7
April	2.5	3.1	2.2	.9	2.6	2.7	3.2	1.4
May	3.0	2.0	3.4	1.2	2.5	4.8	1.9	.6
June	3.8	2.8	4.2	2.0	2.9	2.7	2.1	1.4
July	3.3	3.3	2.8	1.3	2.1	2.2	2.5	.9
August	3.9	2.4	3.9	2.4	2.5	3.8	1.9	.7
September	4.0	2.1	4.0	3.2	4.5	6.0	5.5	1.4
October	3.4	1.1	3.7	3.4	4.0	1.8	5.2	9.1
November	2.8	1.3	2.2	2.9	3.6	1.2	6.6	3.8
December	2.4	.5	2.6	2.1	2.7	3.0	2.5	2.3
1958 average	3.0	2.1	2.9	1.8	2.6	2.6	2.9	2.1
Total separation rate:								
1957 average	3.6	2.1	2.3	2.2	3.6	1.6	4.5	3.5
1958:								
January	5.0	3.7	6.9	2.6	6.5	8.9	8.2	2.2
February	3.9	5.0	4.5	3.3	2.5	1.9	3.2	2.4
March	4.2	1.7	6.1	2.6	6.9	8.3	10.0	2.9
April	4.1	1.2	4.3	1.8	4.8	8.0	2.3	3.2
May	3.6	1.3	2.7	4.6	3.7	2.1	3.7	3.2
June	2.9	1.7	2.1	3.4	4.2	4.5	4.3	5.4
July	3.2	3.1	3.4	1.9	3.6	.9	2.6	11.4
August	3.5	3.4	2.0	2.8	3.3	2.3	2.7	6.9
September	3.5	2.9	3.0	2.4	3.2	4.0	2.2	2.9
October	3.2	2.3	1.8	1.3	2.9	3.2	2.5	1.5
November	2.8	3.0	2.1	1.6	2.3	3.3	1.7	1.5
December	2.8	5.2	1.6	2.1	2.4	2.9	1.4	1.2
1958 average	3.6	2.9	3.4	2.5	3.9	4.2	3.7	3.7
Layoff rate:								
1957 average	1.7	.9	1.3	.7	1.0	1.0	1.0	2.0
1958:								
January	3.8	2.8	6.2	1.7	5.0	8.3	6.9	.8
February	2.9	4.4	3.9	2.6	1.5	1.5	2.2	1.4
March	3.2	1.1	5.4	2.0	5.4	7.7	8.8	1.6
April	3.0	.5	3.8	1.1	3.2	7.7	.8	1.9
May	2.4	.5	2.2	3.6	1.5	1.5	1.4	1.6
June	1.8	1.1	1.5	2.3	2.3	3.8	1.9	3.5
July	2.0	2.3	2.9	.8	1.4	.2	.3	8.6
August	1.9	2.0	1.4	1.8	1.7	1.5	1.0	5.0
September	1.6	1.0	2.2	.9	1.5	3.3	.4	1.2
October	1.7	1.5	1.2	.4	1.1	2.5	.3	.6
November	1.6	2.4	1.5	.6	1.0	2.6	.1	.4
December	1.8	4.6	1.1	.7	1.2	2.3	.2	.1
1958 average	2.3	2.0	2.8	1.5	2.2	3.6	2.0	2.2

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

Productivity.—Productivity declined for the third consecutive year in iron ore mining, but increased markedly in both copper and lead-zinc mining. Productivity indexes were at their lowest point since 1954 in iron mining, but were at an alltime high in copper and lead-zinc mining.

In 1956 an index of lead-zinc production per man-hour was derived to fill a void left when the Bureau of Labor Statistics ceased publication of that index. They have now published the index through 1957 on a 1947 base.[15] The following comparison between the index computed by the author for this chapter and the BLS index converted to a 1949 base shows little difference between the two. The computed index, since it is timely, will continue to be used in this review.

Year	*Mines Index* (1949=100)	*BLS Index* (1949=100)
1949	100	100.0
1950	110	110.7
1951	101	101.4
1952	98	96.9
1953	100	101.1
1954	100	99.9
1955	103	101.7
1956	102	102.1
1957	[1] 105	107.2
1958	109	([2])

[1] Revised figure. [2] Not available.

TABLE 21.—Labor-productivity indexes for copper- and iron-ore mining [1]

(1947–49=100)

Year	Copper: Crude ore mined per— Production worker	Copper: Crude ore mined per— Man-hour	Iron: Crude ore mined per— Production worker	Iron: Crude ore mined per— Man-hour
1949–53 (average)	117.2	114.9	114.7	110.5
1954	114.4	118.8	99.3	106.1
1955	134.2	134.3	132.7	133.4
1956	135.4	137.2	133.1	135.3
1957	138.1	149.0	131.4	134.4
1958 [3]	143.3	161.9	116.2	129.8
Year	**Copper: Recoverable metal [2] per— Production worker**	**Copper: Recoverable metal [2] per— Man-hour**	**Iron: Recoverable metal [2] per— Production worker**	**Iron: Recoverable metal [2] per— Man-hour**
1949–53 (average)	113.4	111.2	109.5	105.6
1954	104.0	108.1	87.4	93.4
1955	121.8	122.0	118.2	118.9
1956	116.1	117.6	109.6	111.4
1957	118.0	127.3	107.0	109.5
1958 [3]	125.0	141.2	88.9	99.4

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

[15] U.S. Department of Labor, Bureau of Labor Statistics, Indexes of Output per Man-Hour for Selected Industries: 1919 to 1958; April, 1959 (mimeographed release), p. 3.

PRICES AND COSTS

Prices.—Prices were firm for mineral commodities; the major exception was metals. Iron ore prices were not only below 1957 on an annual-average basis, but also were lower at yearend than in January 1958. On the other hand, nonferrous metals and iron and steel scrap declined substantially in annual average prices when compared with 1957 but rose during 1958. All commodities listed showed wider variations in price than the average for all commodities. The largest percentage decline in annual average price occurred in iron and steel scrap—a 20 percent drop below 1957—but the same commodity showed the greatest percentage rise January to December 1958—14 percent.

TABLE 22.—Price relatives for selected metals and mineral commodities, January and December 1958, and annual averages [1]

(1947–49=100)

Commodity	1958		Change from January (percent)	Annual average		Change from 1957 (percent)
	January	December		1957	1958	
Iron ore	182.4	172.9	−5	181.7	177.1	−3
Iron and steel scrap	86.9	98.9	+14	116.9	93.7	−20
Iron and steel	166.9	171.7	+3	166.2	168.8	+2
Nonferrous metals	128.6	133.2	+4	137.4	127.7	−7
Clay products	155.3	158.8	+2	154.0	156.5	+2
Gypsum products	127.1	133.1	+5	127.1	132.1	+4
Concrete ingredients	138.9	139.2	(2)	136.0	139.0	+2
Building lime, insulation material and asbestos-cement shingles and bituminous binders	[3] 131.1	131.4	(2)	[3] 128.0	131.2	+3
Fertilizer materials	110.5	105.3	−5	106.8	108.0	+1
All commodities (minerals and all other)	118.8	119.2	(2)	117.6	119.2	+1

[1] U.S. Department of Labor, Bureau of Labor Statistics, Wholesale Price Index: Annual and monthly releases. Also published currently in Monthly Labor Review.
[2] Less than 0.05 percent.
[3] Figure less bituminous binders.

Costs.—Decreases in cost items when compared with 1957 annual averages occurred for one-half of the commodities listed in table 23.

TABLE 23.—Price relatives for selected cost items in nonfuel mineral production, January and December 1958, and annual averages, 1957 and 1958 [1]

(1947–49=100)

Commodity	1958		Change from January (percent)	Annual average		Change from 1957 (percent)
	January	December		1957	1958	
Coal	126.0	123.7	−2	124.4	122.9	−1
Coke	161.9	161.9		161.7	161.9	(2)
Gas Fuels	100.0	107.8	+8	116.1	101.7	−12
Petroleum and products	122.9	117.2	−5	127.0	117.7	−7
Industrial chemicals	123.9	123.7	(2)	123.5	123.5	
Lumber	116.5	120.1	+3	119.7	118.0	−1
Explosives	139.5	139.8	(2)	136.7	139.6	+2
Construction machinery and equipment	165.5	170.3	+3	160.0	166.3	+4

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

The largest decrease occurred in the fuel items, while the greatest increase was in the machinery group.

Relative Labor Costs.—The index of labor costs per pound of recoverable metal decreased sharply in copper and lead-zinc but increased in iron ore mining. However, decreases in nonferrous metal prices more than offset the lower labor costs per pound; therefore in all three industries, the indexes of value of recoverable metal per man-hour and of labor costs per dollar of recoverable metal stood higher than in 1957. For lead-zinc and iron mining the indexes were at a 10-year high, and only 1949 was higher than the 1958 copper index.

TABLE 24.—Indexes of relative labor costs, copper-, lead-zinc-, and iron-ore mining

(1949=100)

Year	Labor costs per pound of recoverable metal [1]			Value of recoverable metal per man-hour [2]			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	[4] 119	124	128	[4] 233	102	168	[4] 62	125	93
1956	129	133	[4] 143	254	106	[4] 170	60	128	[4] 96
1957	[4] 124	133	[4] 158	[4] 194	96	[4] 176	[4] 81	144	[4] 101
1958	114	127	184	188	89	159	86	155	118

[1] Index computed by author from data in tables 19 and 21.
[2] Index computed by author from data in table 21, 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 19.
[4] Revised figures.

Index of Metal Mining Expenses.—Table 25 presents for the first time a detailed index of principal metal-mining expenses. This index does not represent changes in total unit costs of mining as it excludes capital costs and contract work. It does, however, gage the impact of labor costs and productivity changes as well as changes in prices of supplies and fuels used by the mining industry. The index is based upon 1947–49 and uses weights derived from the 1954 Census of

TABLE 25.—Index of principal metal-mining expenses [1]

(1947–49=100)

	Total	Labor	Supplies	Fuels
1950	96	94	100	101
1951	106	101	116	102
1952	113	114	114	102
1953	120	125	114	104
1954	128	136	115	104
1955	120	124	117	102
1956	129	136	121	101
1957	133	140	127	105
1958	138	147	129	106

[1] Indexes constructed by author, using weights derived from the 1954 Census of Mineral Industries.

Mineral Industries. The weights for each group are labor, 62.38; supplies, 29.68; and fuels, 7.94. Each group is derived from several items, each with weights derived from the same source. The index covers only copper, iron, lead, and zinc mining, but movements in these industries are believed to closely reflect all metal mining—they together furnished 80 percent of metal mine employment in 1954 (the weight year) and 79 percent in 1958.

Labor, the item with the heaviest weight, has changed most during the 9-year period. Fuels have varied least, while supplies have quite steadily increased in price.

INCOME

National Income Originated.—Income originated in metal mining dropped by 23 percent in 1958 as compared with 1957, and that in primary metal manufacturing dropped 19 percent. The relative severity of the recession in metals is emphasized in these statistics. The share of income attributable to mining declined for the second straight year. Nonmetal mining and manufacturing income declined relatively little, only 4 percent, although this was sufficient to decrease the percentage share contributed by these industries slightly.

TABLE 26.—National income originated in the mineral industries in the United States [1]

(Million dollars)

Industry	Income			
	1956 [2]	1957 [2]	1958	Change from 1957 (percent)
All industries	350,836	366,503	366,183	
Metal mining	1,092	911	699	−23
Nonmetallic mining and quarrying	836	794	760	−4
Total mining except fuels	1,928	1,705	1,459	−14
Total mining including fuels	6,243	6,206	5,302	−15
Primary metal industries	10,891	11,113	8,964	−19
Stone, clay, and glass products	3,920	3,888	3,747	−4
(Percent)				
All industries	100	100	100	
Metal mining	.31	.25	.19	
Nonmetallic mining and quarrying	.24	.22	.21	
Total mining except fuels	.55	.47	.40	
Total mining including fuels	1.78	1.69	1.45	
Primary metal industries	3.10	3.03	2.45	
Stone, clay, and glass products	1.12	1.06	1.02	

[1] U.S. Department of Commerce, Office of Business Economics, Survey of Current Business, July 1959, p. 13, T. I–10. In arriving at national income, depletion charges are not deducted, affecting the data for the mining industries.
[2] Revised figures.

Profits and Dividends.—The annual rate of profit in 1958 on stockholder's equity (after corporate income taxes) was considerably below 1957 for the mineral manufacturing corporations. However, profit rates were lowest in the first half of 1958, and showed considerable improvement by year end. Dividends distributed by these industries did not decline nearly as much as profits. These data are summarized in table 27.

TABLE 27.—Annual average profit rates on shareholder's equity, after taxes, and total dividends, mineral manufacturing corporations [1]

Corporations	Annual profit rate (percent)			Total dividends (million dollars)		
	1957	1958	Percent change 1958 from 1957	1957	1958	Percent change 1958 from 1957
All manufacturing	11.0	8.6	−21.8	7,563	7,383	−2.4
Primary metals	10.8	6.8	−37.0	964	878	−8.9
Primary iron and steel	11.4	7.2	−36.8	643	608	−5.4
Primary nonferrous metals	9.3	6.0	−35.5	321	270	−15 9
Stone, clay, and glass products	12.4	10.1	−18.5	287	269	−6.3

[1] Federal Trade Commission and Securities and Exchange Commission, Quarterly Financial Reports for Manufacturing Corporations, 1st Quarter, 1957 and 1st Quarter, 1958.

Business Failures.—The number of mining failures increased for the third successive year, and the current liabilities of the firms that failed were sharply higher than in 1957. The experience in mining approximated that in manufacturing and in all industrial and commercial industries.

TABLE 28.—Industrial and commercial failures and liabilities [1]

Industry	1956	1957	1958
Mining: [2]			
Number of failures	42	75	86
Current liabilities thousand dollars	8,193	11,588	17,619
Manufacturing:			
Number of failures	2,243	2,336	2,594
Current liabilities thousand dollars	183,037	185,253	227,979
All industrial and commercial industries:			
Number of failures	12,686	13,739	14,964
Current liabilities thousand dollars	562,697	615,293	728,258

[1] Dun & Bradstreet, Inc., Monthly Business Failures: New York, N.Y., Jan. 15, 1959.
[2] Including fuels.

INVESTMENT

New Plant and Equipment.—Expenditures on new plant and equipment by fuel- and nonfuel-mining firms were down by over $300 million in 1958, compared with 1957. This drop of 24 percent was not as relatively severe as the 28 percent decline in all manufacturing. Reflecting the recovery during the last part of 1958, expenditures turned upward in all categories except iron and steel during the last quarter of the year. Of the manufacturing firms, those in the primary metal industry decreased their investment expenditures most severely, by 46 percent, but the largest absolute decline was in the petroleum and coal product firms, which declined over $1 billion.

Issues of Mining Securities.—The mining industry (including fuels) was the source of 2.1 percent of all new corporate securities offered in 1958, almost the same percentage as in 1957 but sharply below the 5.7 percent contribution in 1954. The mining industry reversed the pattern of manufacturing and showed a substantially larger dependence upon common stock financing than in 1957. Manufacturing and total corporate both shifted strongly toward bond financing in 1958, reflecting the general uncertainty with respect to profit prospects. The total gross proceeds from corporate offerings were down by $1,326 million compared with 1957; mining proceeds dropped $42

TABLE 29.—Expenditures on new plant and equipment by firms in mining and selected mineral manufacturing industries [1]

(Million dollars)

Industry	1956	1957	1958	1958			
				January–March	April–June	July–September	October–December
Mining [2]	1,241	1,243	941	225	239	223	254
Manufacturing	14,954	15,959	11,433	2,898	2,939	2,664	2,932
Primary iron and steel	1,268	1,722	1,192	315	324	285	268
Primary nonferrous metals	412	814	441	151	107	87	96
Stone, clay, and glass products	686	572	399	102	101	84	112
Chemicals and allied products	1,455	1,724	1,320	340	352	304	324
Petroleum and coal products	3,135	3,453	2,431	587	629	554	661

[1] U.S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 39, No. 3, March 1959, p. 17.
[2] Including fuels.

million. The 15-percent decline in proceeds in mining was exceeded by manufacturing, down 17 percent, but was greater than the 10-percent decline in all corporate proceeds.

Prices of Mining Securities.—The index of common-stock annual average prices for mining dropped severely in 1958 in contrast to increases in the composite index and in the manufacturing index. The mining index was only slightly higher than its 1955 level, and 1958 was the third consecutive year of decline. When compared with 1957, the indexes dropped 8 percent in mining, and increased 1 and 3 percent in manufacturing and the composite, respectively.

TABLE 30.—Estimated gross proceeds of new corporate securities offered for cash in the United States in 1958 [1]

Type of security	Total corporate		Manufacturing		Mining [2]	
	Million dollars	Percent	Million dollars	Percent	Million dollars	Percent
Bonds	9,653	83	3,180	91	134	54
Preferred stock	571	5	40	1	3	1
Common stock	1,334	12	295	8	110	45
Total	11,558	100	3,515	100	247	100

[1] U.S. Securities and Exchange Commission, Statistical Bulletin, vol. 18, No. 6, June 1959, p. 12. Substantially all new issue 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.

TABLE 31.—Indexes of common stock annual average prices [1]

(1939=100)

Year	Composite [2]	Manufacturing	Mining [3]
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
1958	340.9	426.4	313.8

[1] Council of Economic Advisers, Economic Indicators (prepared for the Joint Committee on the Economic Report): March 20, 1959, p. 32. 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] In addition to mining and manufacturing, covers transportation, utilities, and trade, finance, and service.
[3] Including fuels.

TRANSPORTATION

Data on rail and water transportation are not available for the year covered in this review, since they are not published until the late fall of the year following the year reported upon. Therefore, this review will henceforth report such data with a 1-year lag.

Construction was almost completed on the St. Lawrence Seaway by the end of 1958, and it was to be opened to traffic in the spring of 1959. The Bureau of Mines, Office of Chief Economist, submitted to the U.S. Army Corps of Engineers, in March 1958, a study of projected levels of consumption for certain mineral commodities in the Great Lakes area. This study covered the major mineral commodities except iron ore and coal. It was found that the Great Lakes area consumed 4 million tons of foreign minerals in 1955, and that exports were 525,000 tons. It was estimated that consumption of foreign materials would reach 8.7 million tons by 1975, with exports remaining unchanged, making for a substantial demand upon the Seaway facilities. The commodities that show important foreign tonnages are the ferroalloys, both ores and metal, fluorspar, lead, zinc, petroleum, and asbestos. The analysis excluded the two largest items of commerce—iron ore and coal—both of which were subjects of studies (not yet published) conducted by the Corps.

TABLE 32.—Indexes of average freight rates on carload traffic, 1955–56, and average revenue per ton, originated or terminated, 1955–57, in the United States

Item	Indexes [1] (1950=100)		Average revenue per ton [2] (dollars)		
	1955	1956	1955	1956	1957
Products of mines	107	110	2.78	2.96	3.11
Iron ore	110	115	1.84	2.07	2.19
Clay and bentonite	114	119	6.35	6.58	7.34
Sand, industrial	108	113	2.82	3.05	3.28
Gravel and sand, n.o.s	109	110	1.25	1.29	1.40
Stone and rock, broken, ground and crushed	108	111	1.52	1.57	1.68
Fluxing stone and raw dolomite	113	117	1.50	1.58	1.73
Salt	108	109	6.24	6.37	6.76
Phosphate rock	105	108	2.56	2.32	2.47
Mineral manufactures and miscellaneous	108	112	10.54	10.68	11.52
Fertilizers, n.o.s	111	112	6.07	7.62	8.11
Iron, pig	114	117	4.20	4.49	5.34
Cement: Natural and portland	104	102	4.26	4.14	4.31
Lime, n.o.s	111	116	5.62	5.73	6.10
Scrap iron and scrap steel	108	113	3.62	3.97	4.13
Furnace slag	105	109	1.71	1.88	1.98
Nonmineral categories:					
Products of agriculture	109	112	8.38	8.48	8.71
Animals and products	112	116	21.78	22.34	23.73
Products of forests	113	117	7.83	7.58	8.04
Forwarder traffic	112	115	38.57	40.67	45.33
All commodities	108	112	6.23	6.32	6.79

[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. 1957 data are not available.

[2] U.S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Freight Commodity Statistics, Class 1 Steam Railways in the United States: Statement 56100, 1955; 57100, 1956; 58100, 1957, Table 5.

TABLE 33.—Rail and water transportation of mineral products in the United States, by products

(Thousand short tons)

Product	Rail [1]			Water [2]		
	1956	1957	Change from 1956 (percent)	1956	1957	Change from 1956 (percent)
Metals and minerals, except fuels:						
Iron ore	113,148	122,596	+8	77,155	86,663	+12
Iron and steel scrap	[3] 29,360	25,281	−14	2,115	2,209	+4
Metals and alloys	14,135	12,993	−8			
Other ores and concentrates	22,108	21,821	−1	2,989	3,015	+1
Other scrap	2,626	2,509	−4			
Slag	6,913	6,661	−4	(4)	(4)	(4)
Sand and gravel	76,527	66,149	−14	64,160	59,928	−7
Stone, crushed except limestone	59,588	53,603	−10			
Limestone, crushed	19,323	19,625	+2	31,342	31,269	(5)
Cement	35,769	32,148	−10	4,651	5,225	+12
Phosphate rock	21,057	19,352	−8	2,465	2,776	+13
Clays	10,911	10,000	−8	2,226	2,198	−1
Sulfur	4,663	4,016	−14	5,002	4,349	−13
Other	30,484	29,600	−3	4,478	3,904	−13
Total	[3] 446,612	426,354	−5	196,583	201,536	+3
Mineral fuels and related products:						
Coal:						
Anthracite [6]	[7] 35,106	[7] 30,285	−14	1,957	1,261	−36
Bituminous [6]	380,727	372,194	−2	150,640	151,161	(5)
Coke [6]	21,528	19,564	−9	477	480	+1
Crude petroleum	2,192	2,046	−7	67,336	74,090	+10
Gasoline	9,803	8,853	−10	87,617	90,640	+3
Distillate fuel oil	10,379	9,553	−8	74,390	69,125	−7
Residual fuel oil				45,200	43,940	−3
Kerosene	20,206	19,038	−6	10,410	8,918	−14
Other				12,892	13,105	+2
Total	479,941	461,533	−4	450,919	452,720	(5)
Total mineral products	[3] 926,553	887,887	−4	647,502	654,256	+1
Grand total all products	1,435,767	1,370,196	−5	766,223	772,862	+1
Mineral products, percent of grand total:						
Metals and minerals, except fuels	31	31		26	26	
Mineral fuels and related products	[3] 34	34		59	59	
Total mineral products	[3] 65	65		85	85	

[1] Revenue freight originated excluding forwarder and less than carload lot shipments, for which data are not available. Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Steam Railways in the United States, for years ended Dec. 31, 1956, and 1957: Statements 57100 and 58100.

[2] Domestic traffic, that is, all commercial movements between any point in continental United States or its territories and possessions and any other such point. Traffic with the Panama Canal Zone, the Virgin Islands, and Defense Department vehicles carrying military cargoes are excluded. Source: Department of the Army, Waterborne Commerce of the United States, Calendar Year 1956 and Calendar Year 1957, part 5, National Summaries.

[3] Revised figure.

[4] Not separately classified.

[5] Less than 0.5 percent.

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

[7] Includes "Anthracite to breakers and washeries" (thousand short tons): 1956—12,968; 1957—11,852.

FOREIGN TRADE

Value.—The value of imports of nonfuel minerals fell sharply in 1958, being 27 percent lower than in 1957. Exports dropped even more, showing a 34 percent decline. The metals declined most severely in import value, 37 percent, but all groups shared the general shrinkage of trade. The ratio of value of exports to value of imports dropped to 34 percent, as compared with 38 percent in 1958. This was the first decline in this ratio in recent years—it had been steadily increasing.

TABLE 34.—Value of minerals and mineral products imported and exported by the United States, by commodity groups and commodities,[1] in thousand dollars

[U.S. Department of Commerce]

SITC number	Group and commodity	Imports for consumption[2]			Exports of domestic merchandise[3]		
		1956	1957	1958	1956	1957	1958
	CRUDE METALLIC MINERALS[4]						
281-01	Iron ore and concentrates	250,855	285,062	231,563	48,805	49,227	34,426
282-01	Iron and steel scrap	11,331	10,168	10,095	300,620	217,938	97,447
	Ores of nonferrous base metals and concentrates:						
283-07	Manganese	66,975	99,828	76,364	664	724	700
283-11	Tungsten	58,011	34,525	11,960	225	227	17
283-06	Tin	9,423	118	11,244	---	---	---
283-01	Copper	65,213	70,238	74,561	11,648	9,964	5,865
283-08	Chromium	49,349	55,661	28,206	99	53	49
283-05	Zinc	53,110	89,075	51,902	162	1	---
283-03	Bauxite (aluminum ore) and concentrates	44,414	60,951	70,142	834	4,847	968
283-04	Lead	51,666	61,617	51,856	340	257	252
[5] 283-19	Columbium	8,387	3,038	2,346	9	44	37
283-02	Nickel	4,638	5,300	1,855	556	---	1
[5] 283-19	Titanium:						
	Ilmenite	9,198	10,317	6,766	312	278	172
	Rutile	7,148	11,843	4,513			
[5] 283-19	Cobalt	3,737	1,320	---	---	---	---
[5] 283-19	Molybdenum	---	55	5,530	21,296	32,428	15,045
[5] 283-19	Other	12,767	11,516	7,472	202	683	9,223
	Nonferrous metal scrap:						
284-01	Aluminum	10,770	5,396	2,969	8,127	6,435	5,595
	Old and scrap copper	3,463	3,039	2,676	20,056	28,414	9,429
	Old brass and bronze and clippings	3,003	2,393	1,852	[6] 29,814	[6] 32,968	[6] 10,456
	Other, not elsewhere included	9,839	4,932	3,663	5,946	5,852	3,285
285-02	Platinum-group metals	15,606	11,240	8,735	---	---	---
	Total crude metallic minerals	748,903	837,632	666,270	449,715	390,340	192,967
	METALS (UNWROUGHT)[4 7]						
681-01	Pig iron and sponge iron	19,108	14,525	12,750	15,250	57,158	6,928
681-02	Ferroalloys:						
	Ferromanganese	28,500	60,232	11,046	682	1,869	464
	Ferrochromium	11,403	14,460	7,818	2,891	2,419	1,012
	Other	3,861	4,512	1,276	4,836	3,639	2,730
682-01	Copper	383,965	276,554	133,234	191,452	212,515	191,932
687-01	Tin	145,835	130,739	90,381	821	1,526	1,336
684-01	Aluminum	100,137	107,339	117,297	19,109	14,051	24,220
683-01	Nickel (including scrap)	153,888	156,786	87,565	---	---	---
686-01	Zinc	65,034	63,947	35,625	2,540	2,618	797
685-01	Lead	81,111	89,993	76,217	1,300	1,345	661
	Cobalt	32,910	32,559	28,664	([8])	([8])	([8])
689-01	Mercury	11,010	9,333	3,914	284	484	95
	Other nonferrous base metals	17,073	32,643	21,795	12,349	9,479	8,123
671-02	Platinum-group metals, including unworked and partly worked	42,149	24,492	16,237	3,927	2,804	2,812
	Total metals	1,095,984	1,018,114	643,819	255,441	309,907	241,110
	Total metals and metallic minerals	1,844,887	1,855,746	1,310,089	705,156	700,247	434,077
	CRUDE NONMETALLIC MINERALS (EXCEPT FUELS)						
	Diamonds:						
[5] 672-01	Gems, rough or uncut	75,796	77,142	72,430	675	424	478
[5] 272-07	Industrial	73,989	50,870	23,680	98	544	537
	Total	149,785	128,012	96,110	773	968	1,015
272-12	Asbestos, crude, washed or ground	61,472	60,140	58,314	338	340	407
271-02	Sodium nitrate	16,337	17,107	13,431	210	182	---
272-13	Mica, unmanufactured (including scrap)	11,232	10,910	13,477	92	46	91
[5] 272-14	Fluorspar	11,225	16,031	9,777	31	81	191

See footnotes at end of table.

TABLE 34.—Value of minerals and mineral products imported and exported by the United States, by commodity groups and commodities,[1] in thousand dollars—Con.

SITC number	Group and commodity	Imports for consumption [2]			Exports of domestic merchandise [3]		
		1956	1957	1958	1956	1957	1958
	CRUDE NONMETALLIC MINERALS (EXCEPT FUELS)—continued						
272-11	Stone for industrial uses, except dimension	9,051	8,882	7,890	711	763	921
272-06	Sulfur	5,274	12,232	13,551	50,081	44,966	41,367
271-03	Phosphates, natural, ground or unground	2,626	3,090	2,944	25,704	28,189	25,234
272-04	Clay	2,971	2,938	2,900	12,593	13,528	12,129
(9)	Other nonmetallic minerals (except fuels)	23,971	30,884	44,248	24,930	26,590	26,375
	Total crude nonmetallic minerals (except fuels)	293,944	290,226	262,642	115,463	115,653	107,730
	Grand total, minerals and metals (except fuels)	2,138,831	2,145,972	1,572,731	820,619	815,900	541,807

[1] The grouping of the commodities is based upon Standard International Trade Classification of the United Nations. Basic data were compiled by the Office of the Chief Economist, Bureau of Mines, from copies of unpublished tabulations prepared by the Bureau of the Census for the United Nations, which tabulations represent a tentative conversion of United States import and export 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 cases be in accord with usual Bureau of Mines practice as followed in individual commodity chapters in this Minerals Yearbook. In a few cases, values will differ from those for the same commodity in the corresponding chapter because of reclassifications, exclusions, or other reasons usually explained by footnotes in the chapter.

[2] 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, which have been smelted, refined, manufactured, or otherwise processed in the United States.

[4] Excludes gold and silver.

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

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

[7] Includes alloys.

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

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

Tariffs.—For the 11th time since the enactment of the Trade Agreements Act in 1934, action was taken by the Congress to extend the President's authority to enter into trade agreements. On August 20, 1958, the President signed into law the Trade Agreements Extension Act of 1958 (Public Law 85–686). This act modified in several important respects the provisions of existing law with reference to authority to increase and decrease rates of duty and to administrative procedures under the escape clause, peril-point, and national defense provisions.

The new authority to reduce tariff rates was granted for 4 years, the longest period for which it has been granted in the history of the trade agreements program. Under this authority, there are three alternative methods for reducing United States duties by stages:

1. Reducing the rate existing on July 1, 1958, by not more than 20 percent, provided that no more than a 10-percent reduction can be made effective in any 1 year.

2. Reducing the rate existing on July 1, 1958, by not more than 2 percentage points ad valorem (or its ad valorem equivalent in the case of a specific rate, or a combination of ad valorem and specific rates). The reduction in any one year under this alternative may not exceed 1 percentage point.

3. Reducing to 50 percent ad valorem or its equivalent a rate that is in excess of that level, provided that not more than one-third of the total reduction may become effective in any one year.

The first alternative is controlling for commodities that carry a duty equivalent of between 10 and 62.5 percent ad valorem; the second is for those below 10 percent; and the third, for those over 62.5 percent.

The President's permissive authority to raise rates of duty under the new act is as follows:

1. A duty may be raised up to 50 percent over the rate existing on July 1, 1934.

2. A specific duty may be converted to its ad valorem equivalent in 1934, and this ad valorem rate increased by 50 percent.

3. A duty up to 50 percent ad valorem can be imposed on a duty-free item that has been bound under a trade agreement and is eligible for escape clause relief.

These powers are considerably enlarged over those contained in the previous law. Mineral commodities generally carry a specific duty, or are on the free list; so the last two points above are of real importance to the mineral industry. Table 34 gives for principal import commodities the actual rate of duty as of July 1, 1959, as its ad valorem equivalent based upon 1957 foreign value, and the maximum and minimum permissible rates under the 1958 Act also based upon 1957 values. Note that these are not official tabulations, but only illustrative, taking 1957 values as examples.

Other important changes were made in the escape-clause, peril-point, and national defense provisions. The Congress has the power to override the President if he rejects in whole or part the Tariff Commission's recommendation flowing from an escape-clause action. Such action requires a two-thirds vote of each House of Congress within 60 days of the President's action. The Tariff Commission is required to institute immediately an escape-clause investigation if it finds, during the course of a peril-point investigation, that additional duty is required to avoid serious injury. The national security provisions were made broader, and the possible action of the President delineated as follows:

> "If, as a result of such investigation, the Director is of the opinion that the said article is being imported into the United States in such quantities or under such circumstances as to threaten to impair the national security, he shall promptly so advise the President, and, unless the President determines that the article is not being imported into the United States in such quantities or under such circumstances as to threaten to impair the national security as set forth in this section, he shall take such action, and for such time, as he deems necessary to adjust the imports of such article and its derivatives so that such imports will not so threaten to impair the national security." [16]

[16] Public Law 85–686, section 8(a).

TABLE 35.—Permissible maximum and minimum rates of duty on principal mineral commodities, in ad valorem equivalents [1]

(Percent)

Commodity	1958 duty	Minimum permissible	Maximum permissible
Ferrous metals:			
Iron ore			50.0
Pig iron	.5	(2)	25.8
Manganese ore, over 35% Mn	4.3	2.3	170.3
Manganese metal	16.8	13.4	56.8
Chromite			50.0
Cobalt ore			50.0
Cobalt metal			50.0
Nickel ore			50.0
Nickel metal	1.6	(2)	17.7
Tungsten ore	20.3	16.2	186.9
Tungsten metal	39.6	31.7	212.1
Other metals:			
Copper ore	5.9	3.9	20.7
Copper metal, unrefined	5.7	3.7	90.2
Copper metal, refined	5.7	3.7	81.9
Lead ore	5.8	3.8	86.7
Lead pig, bars, etc	8.0	6.0	120.3
Zinc ore	9.2	7.2	163.7
Zinc blocks, pigs and slabs	5.8	3.8	86.7
Bauxite	6.3	4.3	20.9
Aluminum ingots, pigs, bars	5.2	3.2	30.9
Tin ore			50.0
Tin metal			50.0
Antimony metal	8.3	6.3	66.9
Cadmium metal	2.5	.5	80.3
Mercury	8.6	6.6	60.3
Platinum-group metals			50.0
Titanium ore-rutile			50.0
Titanium metal	20.0	16.0	45.0
Nonmetals:			
Asbestos (crude)			50.0
Barite	12.5	10.0	37.5
Fluorspar, under 97% CaF_2	48.5	38.8	180.6
Fluorspar, over 97% CaF_2	6.1	4.1	54.8
Gypsum, crude			50.0
Mica, block muscovite, over 15¢/lb. [3]	1.9	21.5	53.1
Mica, films and splittings [3]		10.0	50.0

[1] All equivalents are based upon 1957 foreign value. The first column is the equivalent of the rates in effect as of Dec. 31, 1958. The other two columns are derived from the alternatives given the President in the Trade Agreements Extension Act of 1958. The "ad valorem equivalent" is the percent the duty is of the foreign value of the commodity.

[2] The rate can be made infinitely small but not free.

[3] Public law 808, effective Aug. 28, 1958 reduced the tariff on mica. The President's authority rests on rates in effect July 1, 1958, so the 1958 tariff was lower than the minimum permissible.

The 1958 4-year extension of the Trade Agreements Act enabled the United States to propose to the Contracting Parties of the General Agreement on Tariffs and Trade (GATT) that a general tariff negotiation be held in 1960–61, with the objective of less restricted international trade. These negotiations would also serve to gain adjustment in the new common external tariff of the European Economic Community (the Common Market), and thereby facilitate adjustments in world trade, which are certain to occur as the Community develops. A committee was established by GATT to work out arrangements for these negotiations.[17]

The Tariff Commission found that the unmanufactured lead-zinc industry was being seriously injured by imports in increased quan-

[17] Third Annual Report of the United States on the Trade Agreements Program, June 25, 1959, p. 9.

tities, as a result in part of customs treatment reflecting concessions granted under GATT, and so reported to the President on April 24, 1958.[18] Three of the commissioners recommended that the maximum permissible rates of duty be imposed (under the law then in effect) and also that quantitative limitations be placed on imports. The other three commissioners denied the need for quotas and recommended that tariff be increased less than the maximum to the level of the Tariff Act of 1930. On July 19, 1958, the President suspended his consideration of the Commission's recommendations, stating:

> I am suspending my consideration of these recommendations at this time. A final decision will be appropriate after the Congress has completed its consideration during this session of the proposed Minerals Stabilization Plan which was submitted by the Secretary of the Interior with my approval. This Plan offers a more effective approach to the problems of the domestic lead and zinc industries, and in view of their urgent needs, it is hoped that the Congress will act expeditiously on this Plan to help assure a healthy and vigorous minerals industry in the United States.[19]

The Minerals Stabilization Plan was not enacted by the Congress, and on October 1, 1958, the President imposed import quotas on unmanufactured lead and zinc but did not change the tariff rates. Details of the quota provisions are given in the Lead and Zinc chapters in this volume.

At the beginning of 1958, an application under the national security amendment by the fluorspar industry was pending before the Office of Civil and Defense Mobilization (OCDM). This action was withdrawn after enactment of Public Law 85–686, and was refiled under the amended section 8. Applications were also filed under the new legislation by the cobalt and tungsten industries. All three investigations were in process at the end of 1958.

The Tariff Commission undertook investigations of mercury, tungsten, and iron ore under section 332 of the Tariff Act of 1930, pursuant to resolutions adopted by the Senate Committee on Finance. These studies were to cover "the condition of competition" between production in the United States and in foreign countries. Reports were issued on mercury and tungsten in November 1958.[20] This type of report is factual, and does not make any policy recommendations. The iron ore report had not been issued by yearend.

The Congress took several tariff actions of interest to the mineral industries. Public Law 85–463 continued the duty suspension on certain metal scrap to June 30, 1959. Public Law 85–808 transferred mica films and splittings not cut or stamped to dimensions to the free list, and changed the duty on block mica valued above 15 cents per pound to 4 cents a pound. And Public Law 84–415 continued the suspension of bauxite and alumina duties to July 15, 1960.

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[18] Report to the President on Escape-Clause Investigation No. 65, U.S. Tariff Commission, p. 3.

[19] Letter to Chairmen of House Ways and Means and Senate Finance Committees, June 19, 1958. U.S. Tariff Commission Press Release, June 19, 1958, p. 2.

[20] United States Tariff Commission, Report of Investigation No. 32, and Report of Investigation No. 33 Under Section 332 of the Tariff Act of 1930, November 1958.

WORLD REVIEW

World Production.—The United Nations Index of World Mining Production (including fuels) fell to 115 from 119 in 1957 (1953 = 100), but rose during the last half of the year. The index by quarters was 114, 111, 115, and 119. The decline in the world mine production index was considerably less marked than that for the United States, which fell by 8 percent, but the OEEC countries showed a lesser decline. The world metal-mining index showed a greater decline than that in all mining, from 121 in 1957 to 112 in 1958. The last quarter of the year also did not increase over the presiding quarter. As in the case of all mining, the U.S. metal index showed a greater decline.

World Prices.—Prices of metal ores in world markets were lower than in 1957 but were quite stable over most of the year, increasing somewhat during the last quarter. This pattern of stability at a lower level was also evident in the world total minerals and primary commodity price indexes. The general lower level in prices was due in part to continued declines in ocean freight rates as well as the lower level of activity in mineral-consuming industries throughout the world.

TABLE 36.—Index of world metal-mining industrial production [1]

(1953=100)

Year	Free World	North America [2]	Latin America [3]	Asia: East and Southeast [4]	Europe [5]
1954	97	86	99	106	99
1955	108	102	112	112	112
1956	114	106	[6] 113	119	[6] 120
1957	121	[6] 111	128	[6] 118	[6] 129
1958	112	96	118	109	126
First quarter	109	87	121	105	128
Second quarter	113	96	111	110	132
Third quarter	115	105	122	112	119
Fourth quarter [7]	112	94	116	109	125

[1] United Nations, Monthly Bulletin of Statistics: Vol. 13, No. 5, May 1959, pp. X–XIV.
[2] Canada and the United States.
[3] Central, 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] Revised figure.
[7] Provisional.

TABLE 37.—Index numbers of production in mining and quarrying, and production in basic metal industries in selected OEEC countries [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	94	88	99	96	91	41	75	100	77	89	77	99
1952	99	93	101	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	96	103	104	123	110	100	[3] 101	91	88	101
1955	105	116	100	110	110	132	123	101	[3] 100	104	97	[3] 100
1956	108	120	100	113	115	150	139	[3] 102	[3] 123	[3] 115	107	100
1957	[3] 111	127	99	120	119	195	156	[3] 105	[3] 124	[3] 120	110	100
1958	110	124	92	127	119	205	159	110	122	112	n.a.	95
					Basic metal industries							
1951	98	81	114	107	94	74	91	83	92	90	------	100
1952	104	91	111	112	105	90	101	81	97	102	------	103
1953	100	100	100	100	100	100	100	100	100	100	------	100
1954	113	119	108	114	116	103	119	117	104	110	------	108
1955	131	140	125	133	141	98	148	133	124	125	------	117
1956	139	151	135	140	150	102	162	131	160	[3] 137	------	[3] 119
1957	145	[3] 167	131	153	154	120	182	135	169	[3] 143	------	120
1958	139	165	126	158	146	132	170	134	172	141	------	109

[1] Organization for European Economic Cooperation, General Statistics, No. 3, May 1959, pp. 10, 14.
[2] Weighted average, computed by authors, using Organization for European Economic Cooperation weights.
[3] Revised figure.

Ocean Freight Rates.—Ocean freight-rate indexes dropped sharply for 1958 as a whole, continuing adjustments from the shortages created by the closing of the Suez Canal. However, the indexes turned sharply upward during the latter part of the year, and during the last quarter were well above the year average. The ore index was stable during the first 6 months and increased slightly during the next two quarters. The general cargo and fertilizer indexes exhibited more variation during the year.

TABLE 38.—World trade price and freight-rate indexes [1]

(1953=100)

Year	Price indexes			Trip charter freight rate indexes [2]		
	Primary commodities	Total minerals	Metal ores	General cargo	Ore	Fertilizers
1954	[3] 103	99	[3] 96	111	110	106
1955	[3] 99	102	[3] 103	165	144	141
1956	[3] 100	[3] 109	[3] 110	203	174	159
1957	[3] 102	[3] 114	[3] 107	145	138	131
1958	97	108	100	87	90	83
First quarter	97	109	99	83	89	83
Second quarter	97	108	99	83	89	72
Third quarter	97	108	99	85	90	72
Fourth quarter	97	108	102	95	92	98

[1] United Nations, Monthly Bulletin of Statistics, March 1959, special tables A and C.
[2] United Kingdom indexes based upon weighted average of quotations by all the nations on routes important to United Kingdom tramp fleet in 1951.
[3] Revised.

Review of Metallurgical Technology

By Earl T. Hayes[1]

THIS REVIEW primarily summarizes the developments in metallurgical technology during 1958 that had the greatest bearing on efficient utilization of resources and strengthening of our industrial machine. Perforce this eliminates from immediate consideration some excellent applied and basic research which can only be judged by its effect on the metallurgy of the future. Material has been drawn largely from the following sources: Engineering and Mining Journal, Metal Progress, Journal of Metals, Industrial and Engineering Chemistry, Mining Engineering and Bureau of Mines publications.

As in every year since 1950, a wealth of literature appeared on ways of reducing iron ore to the metallic state by reduction methods other than that commonly used. The modern blast furnace is a thing of metallurgical beauty and without parallel for producing large quantities of useful material at low cost; not even the most optimistic claimants of alternate reduction methods forecast its demise. It must be realized, however, that today's blast furnace costs \$40 to \$50 million, and the erection of 50 of these in the next 15 years to pace our physical and economic growth will require tremendous expenditure. This realization spurred the blast furnace people to improve existing equipment by increased use of self-fluxing sinter, richer iron ore feeds to the furnace, wider use of oxygen, and changes in pressure and composition of the blast; with these improvements it appeared that the 1940 blast furnace could be made to produce 50 percent more metal by 1960.

Typical of this change in feed preparation was the operation of the United States Steel Corp. new 5,000-ton-a-day sintering plant at Youngstown, Ohio. This new installation, using only iron ore fines, was almost completely automatic and devoid of the dust and fumes generally attendant upon older installations. Screened iron ore is mixed with coal fines and pelletized. The pellets drop onto a traveling grate, which carries them into an ignition area to burn the fuel and bind the ore particles together. The sinter is cooled and screened; large pieces go to the blast furnace, and fines and intermediate sizes are recirculated. All dusts arising from the operation are precipitated and returned to the pelletizer. Such devices as television cameras on the grate discharge permit one man to control the whole operation from an air-conditioned room. It was estimated that use of this porous burden could increase blast-furnace output as much as 25 percent.

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[1] Chief metallurgist.

The premium of about $1 that iron ore pellets for blast-furnace feed command over direct shipping ore becomes less of a problem as we look toward the future. In the effort to avoid new blast furnaces and to get every bit of capacity from existing ones—and direct reduction studies point in the same direction—richer feeds must be used.

Dollarwise the greatest development taking place in any sector of American metallurgy continued to be the developments in iron ore preparation and steelmaking. An old process in steelmaking—the use of oxygen rather than air in the converting step—continued to expand. These modern converters are vastly improved over the old Bessemer type. A charge consists of about 25 percent scrap and 75 percent hot metal, with a predetermined quantity of slag-forming constituents. As oxygen feeds into the melt through a pipe near the surface all starts quietly, in contrast to the great shower of sparks that went with all Bessemer operations. The temperature of the bath rises rapidly; more problems are associated with keeping the temperature of the bath and the combustion products at workable levels than with normal heating problems. The whole operation is very rapid, and an 80-ton converter vessel will produce up to 100 tons of steel an hour, four to eight times the production rate of a new 250-ton open hearth. What appeared to be a great economic problem a few years ago has now been solved because oxygen of over 99-percent purity can be produced for a price near $5 per ton in 500-ton-a-day plants. Such a plant costs about $3.5 million and will make enough oxygen to produce 5,000 tons of steel a day. Plants like these contributed to our alltime high consumption of 30 billion cubic feet of oxygen. Whereas there are no problems in obtaining cheap oxygen the use of additional hot metal (75 percent in the converter versus 50 percent in normal open-hearth practice) introduces a complication in that the capacity of the blast furnace must be considerably higher than it is today.

During the year, two noteworthy steels were introduced. One of these was an air-cooling, ultra-high-strength alloy which in sheet form had strengths up to 280,000 p.s.i. Another steel only slightly beyond the experimental stage showed strengths of 400,000 p.s.i.—the highest metal strengths known aside from those associated with special surface conditions created only in research laboratories. This was a reflection of the broad front on which metallurgical research is advancing. In contrast is the fact that the 25 years between World Wars I and II saw relatively little change, because steel specifications remained virtually unchanged.

A novel metal-forming process that became prominent during the year was called explosive forming. Here the high pressure suddenly generated by setting off explosives was used to form metals into both simple and intricate shapes, with a minimum of die expense. In effect, the impulsive force served two purposes by delivering energy normally furnished by an expensive power press and by acting as a die component. The method holds promise for certain powder metallurgy or metal sponge-forming applications, for producing a small number of interchangeable parts where normal die costs would be excessive, in sizing or finishing operations and in forming materials of borderline ductility. In this last example the sudden application of force produces better flow characteristics than the usual slower ones.

An interesting technologic development in the last part of 1958 was announcement by the Bureau of Mines laboratory at Albany, Oreg., of success in making the first shaped casting of molybdenum metal. A molybdenum electrode was rapidly arc-melted into a water-cooled copper crucible and the superheated metal then poured into a graphite trough, which carried it to a rotating graphite cylinder. This first molybdenum casting (which was about 8 inches in length and 5 inches in outside diameter) was more a mechanical-electrical triumph than a metallurgical one and demonstrated the feasibility of casting even such high-melting-point (about 4,650° F.) metals as molybdenum into useful shapes.

It was announced also in 1958 that high-purity chromium wire prepared in the Bureau of Mines laboratory at Albany, Oreg., when made radioactive, could be used in the treatment following cancer surgery. This was an unexpected dividend of many years' work by the Bureau of Mines on pure chromium and a striking example of benefits to be gained by all science from fundamental research in any field.

Surveys of this type are concerned too frequently with projections into the future and fail in their duty of following some interesting work of other years which is no longer in the limelight. Cermets—combinations of metals and refractory materials produced by powder metallurgy methods—enjoyed immense popularity a few years ago, when it was believed that the practical limit with metal combinations had been reached and that the future of high-temperature engines (notably the jet) lay in the use of oxidation-resistant cermets. The Germans started this work 12 or 14 years ago by combining iron powders and aluminum oxide. As the years went on this lead was followed in England, France, United States, U.S.S.R. and all countries having metallurgical research talent. The carbide tool industry from its inception in about 1928 had gone along essentially with only one metallic binder—cobalt—all this time. Suddenly dozens of research teams working on this materiel problem brought forth strange mixtures of refractories, such as aluminum oxide, magnesium oxide, titanium carbide, chrominum carbide, titanium nitride, and beryllium oxide, compounded with many of the common metals like nickel, chromium, iron, aluminum, and cobalt. Out of this work came many combinations, notably carbides and borides, which had good to phenomenal oxidation resistance. Others, like the modern SAP process of mixing aluminum oxide with aluminum, produced a marked increase in strength and corrosion resistance of aluminum. Many of these cermets found use in the handling of chemicals or fused salts, where corrosion is a paramount problem. Fundamentally, though, the ceramic engineers never solved the brittleness problem that was with them from the start. Almost without exception the class has low impact strength, and the bright hope of using these materials for turbine bucket blades in jet engines was never realized. At the same time, development of alloys capable of operation at 1,800° F. narrowed the field of cermet applications so much as to be restrictive. Probably the most important factor was that technology moved so fast as to pass the cermets by. Clearly in 1958 our planning left the jet engine age and moved into that of rockets. The increasingly higher service temperatures re-

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quired left no doubt that the future belonged to the alloys of refractory metals.

The use of cyclones for classifying and dewatering continued unabated as the greatest contribution to minerals benefication of the past 30 years. The cyclone is a cylindro-conical classification unit utilizing centrifugal force in place of gravity. The material to be treated, suspended in a carrying fluid, is pumped tangentially into the short cylindrical section. This sets up a spiral stream downward around the walls of the cylinder and in an attached cone. Force causes the larger and heavier particles to move toward the outside of the stream; the finer and lighter material is forced into the vortex. As the stream moves down the cone and the velocity increases, the action becomes intensified. The heavier particles leave the cyclone through an opening at the apex; the light material passes upward to an overflow orifice through a pipe that extends into the upper end of the vortex. This pipe, known as the vortex finder, prevents short circuiting of the stream in the cylindrical chamber. The size and shape of the cyclone, as well as the diameter and length of the vortex finder, influence the action of the unit. The variables used for control of the operation, however, are the diameter of the apex opening and the velocity (or pressure) of the feed stream.

Wet and dry cyclones are identical in principle; only the carrying fluid is different. When a cyclone is used as a heavy-medium separator the material to be treated is suspended in a slurry consisting of water and a dense solid of small particle size. The effect of the centrifugal force is thus reduced and only dense particles discharge through the apex opening.

Descriptions of the Moa Bay–Port Nickel project began to appear in the technical press. This gigantic undertaking will process 50 million pounds of nickel and over 4 million pounds of cobalt a year from Cuban laterites. When completed, this will be the largest plant using autoclave leaching. The technique of leaching ores under conditions of elevated temperature and pressure has developed rapidly in the last few years and along with solvent extraction is the greatest development in hydrometallurgy of the past decade. Pioneering plants by Sherritt-Gordon at Fort Saskatchewan, Alberta, Canada, on nickel-copper-cobalt recovery and Calera (Chemical Construction Co. process) at Salt Lake City, Utah, on cobalt ores have demonstrated the commercial feasibility of the process. The plant at Moa Bay, Cuba, simply dwarfs all previous efforts. The leaching of the raw ore is done with sulfuric acid at intermediate temperatures and pressures in banks of autoclaves over 40 feet high. Finally, an intermediate nickel-cobalt sulfide product is precipitated. The largest hydrogen sulfide plant ever built, with a capacity of 60 tons a day, and a 1,300-ton-a-day sulfuric acid plant—one of the world's 10 largest—are required to produce chemicals for this leaching process. The metal sulfides will be transported in a unique tanker to Port Nickel, La., where they will be processed to produce nickel and cobalt metal. An interesting sidelight of this process is that considerable quantities of the modern metal, titanium, are required to withstand the corrosive action of sulfuric acid under these conditions. Some 7 miles of titanium tubing and a quarter of a million dollars worth of titanium valves were used in constructing this plant.

An interesting development in utilization of pyrrhotite was announced by International Nickel Co. during 1958. The first unit to treat some 350,000 tons a year of pyrrhotite ore contained the world's largest reduction kiln. It is 180 feet long, with a diameter of 13 feet, and operates at 1,600° F. This produces a feed for two 550-ton-a-day fluid bed units. A gas rich in sulfur dioxide goes to a sulfuric acid plant and a high grade (about 68 percent Fe) iron oxide product is obtained.

Zone melting, which received its start in metallurgical life as a means of purifying germanium, continued to broaden its activities at a more versatile tool to be used for metal purification and impurity distribution. It can be applied to any crystalline material which has a difference in impurity concentration between the liquid and the solid states. It has spread therefore from its first use in purification of metals to inorganic chemicals, such as gallium and tungsten chloride, and to organic materials.

At least seven firms in the United States were producing ultra-high-purity silicon for transistor use in 1958. Improvements in preparing feed materials, as well as such refinements as elimination of contamination from the walls of the refining vessel (floating zone purification), produced material containing impurities in the order of parts per billion. Even at $400 a pound for this very high purity material, the cost of a transistor-size piece cut from a single crystal was only about 10 cents. Transforming this into a working counterpart of the vacuum tube was a more expensive process, and it was estimated that a few years would elapse before the transistor would compete economically with the vacuum tube for all applications. Foreign patents outlining procedures for producing high-purity silicon by decomposition of the silanes claimed that enough purity was obtained to eliminate the zone refining step.

During the year seven producers of the so-called rare earths initiated a research and development program at Battelle Memorial Institute. The Bureau of Mines produced some of the world's first high-purity cerium at its Reno, Nev., station by electrowinning processes from fused-salt baths. Not all the problems in this area were those of technology, because considerable education is needed to show that many elements in this group were not rare and were ready for development by the technological entrepreneur.

A new technique, known as ultrasonic welding, passed from the laboratory bench to wider use and even became a production tool in two instances. Basically, ultrasonic vibration introduced into metals through a welding tip produces enough vibrational energy to weld materials together. Plastic flow but not melting occurs during the welding process. In addition to the joining of thin aluminum sheets, where the process had its first application, it promises to have application in welding different types of stainless steels, molybdenum, zirconium, titanium, tantalum, and others as well as joining some dissimilar metals and extremely thin sections.

There was a great upsurge of interest in beryllium metal, both in extractive and in physical metallurgy. Several million dollars was spent by Government defense agencies on attempts to improve the ductility of the metal by various working procedures. There was a growing realization that considerable work was needed on minerals beneficiation and solution metallurgy, should demand beyond a few tons a year develop for the metal.

It became evident that the handling of metallurgical literature was bigger than any single technical problem. It was not that the industry was complacent, because abstracts the world over give metallurgy the best coverage of all industries; however, with the amount of new information doubling every 7 to 10 years, the task facing a new researcher in the field or an old researcher attacking a new problem and reviewing all past work is indeed formidable. An increasing number of conventions and frequent articles in the technical press were devoted to this subject and it appeared that the accumulation, filing, and dissemination of metallurgical information henceforth would receive the same attention as some of the glamorous parts of metallurgical technology.

Review of Mining Technology

By Paul T. Allsman[1] and James E. Hill[2]

THIS CHAPTER reviews the highlights of important developments in mining technology during 1958 and presents a special report on the adaptation of the techniques of statistical analysis to mineral deposit sampling.

Various phases of rock fragmentation by drilling, other mechanical methods, and explosives received attention from many quarters of the mining industry in 1958. There was a marked increase in the use of ammonium nitrate Fertilizer-grade blasting agents to break rock in open-pit mines. Several technical symposia at universities in the United States were devoted largely to these blasting agents.[3] A compilation of reports on problems of the theory of destruction of rocks by explosives was published by the Academy of Science of the U.S.S.R. Mining Institute during 1958.[4] In a more embryonic stage of research, attention was directed in several foreign countries and in the United States to less conventional means for fragmenting rock. The use of hydraulic jets was studied and has been applied to a limited extent.[5] Hydraulic, thermal, sonic, and electro fracturing of rock were subjects of research for possible mining application, either as a replacement or in combination with the more conventional mechanical and explosives fragmentation methods. Detonation of the "Rainier" shot, September 19, 1957, was the first demonstration of the possible effects of firing a nuclear device underground.[6]

EXPLORATION AND SAMPLING

Geophysical methods of exploration for ore appear to be coming into better focus in recent years, and the trend toward its increased use and success should continue. This may be ascribed to two principal developments, the gradual change toward exploiting larger low-grade ore deposits offering a bigger target and the necessity of discovering ore where there are few or no surface indications giving an added incentive for this method of exploration. Exploration geolo-

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[1] Chief mining engineer.
[2] Assistant chief mining engineer.
[3] Center of Continuation Study, University of Minnesota, Eighth Annual Drilling and Blasting Symposium: Minneapolis, Minn., Oct. 2–4, 1958. 131 pp.
School of Mines and Metallurgy, University of Missouri, Fourth Annual Symposium on Mining Research: Rolla, Mo., Nov. 13–15, 1958. (Unpub.)
[4] Khanukayev, E. W., Vlasov, O. E., and others, Problems of the Theory of Destruction of Rocks by Explosives: Publishing House, Acad. Sci., U.S.S.R., Moscow, 1958. 160 pp.
[5] Watson, W. B., Hydraulicking Coal in the U.S.S.R.: Min. Eng., vol. 10, No. 4, April 1958, pp. 463–465.
[6] Atomic Energy Commission, Press Release: Mar. 6, 1958, 8 pp.

gists are also tending more to question the classic theories of ore deposition and the relative importance of physiochemical controls versus structural control. As geophysical methods have been developed largely for structural investigations, better understanding of the relationship of structural control to ore deposits will increase the usefulness of geophysical methods in ore finding.[7] [8]

Extensive exploration programs in Canada during the past few years have been a proving ground for geophysical methods applied to mineral exploration. The general procedure has been initial reconnaissance with airborne scintillometer, magnetometer, or electromagnetic surveys, followed by more detailed magnetometer, electromagnetic, induced polarization, seismic, or combinations of these methods on the ground. The Varian magnetometer, based on the proton magnetic precession principle, found increased application for airborne magnetometer surveys. One-man magnetometers and portable electromagnetic equipment of varied designs were commonly used for ground followup work to airborne reconnaissance surveys. A modified resistivity type of equipment for induced polarization surveys was said to be particularly useful for deposits where mineralization is too disseminated for electromagnetic methods.[9]

The improved methods and better tools, such as helicopter, magnetometer, altimeter, scintillation counter, aero photography and sonar, used in combinations, have broadened the scope and improved the accuracy of exploration methods and allow rapid reconnaissance over vast areas.

A new method of investigating the electrical properties of the earth's crust, called AFMAG, measures natural alternating [10] magnetic fields of audio and subaudio frequencies. Distortion of these fields caused by geological features is measured with the aid of search coil detectors at several discrete frequencies. The general basis of the system is systematic measurement of the tilt of the plane of polarization of the natural magnetic fields in the audio frequency spectrum. Results of field surveys with the method illustrate its advantages and limitations when applied to the search for massive sulfide mineralization. AFMAG is a rapid, low-cost method, using light equipment that is simple to operate. Several crews can work simultaneously, and it does not require precut grid or traverse lines. It is practical to operate at very low frequencies where maximum information concerning the conductivity of massive sulfide bodies can be obtained. Field results are directly interpretable. The chief disadvantages are that signal strength is too inconsistent to permit continual measurements, and it is impossible to discriminate against certain members of several adjacent conductors and to control the direction of the induction field.

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[7] Torrones, Alberto J., Structural Control of Contact Metasomatic Deposits in the Peruvian Cordillera: Min. Eng., vol. 10, No. 3, March 1958, pp. 365–372.

[8] Wisser, E. H., Metal Mining Geology: Min. Eng., vol. 10, No. 2, February 1958, pp. 239–243.

[9] Smelliet, D. W., Exploration Geophysics: Canadian Min. Jour., vol. 79, No. 2, February 1958, p. 160.

[10] Ward, S. H., Cartier, W. O., and others, Prospecting by Use of Natural Alternating Magnetic Fields of Audio and Sub-Audio Frequencies: Canadian Min. and Met. Bull., vol. 51, No. 556, August 1958, p. 487.

SPECIAL REPORT ON REVIEW OF THE ADAPTATION OF THE TECHNIQUES OF STATISTICAL ANALYSIS TO MINERAL DEPOSIT SAMPLING

By S. W. HAZEN, JR.,[11] AND R. M. BECKER[12]

Statistical analysis and interpretation of sampling data can be either subjective or objective, depending on the nature of the data and the manner in which they are collected. Unless sampling methods are properly planned for statistical analysis, serious limitations will be placed on the analysis and interpretations.

Published information on the use of the techniques of statistical analysis in mineral deposit sampling is relatively scarce.[13-15] This is not indicative of the number of attempts to use statistics on mine sampling data. Some of these attempts have been successful.[16-18]

Others have found that existing sampling methods are not adequate to produce data that fulfill the requirements for statistical analysis. Some experimenters have attempted to use the techniques on complex mineral deposits, which required too many assumptions. Consequently, many analytical results have not been verified in mining the deposits. These failures have resulted primarily from lack of available information on the fundamental relationships between statistics and mineral deposit sampling distributions.

The Bureau of Mines published the results of a statistical investigation of the fundamentals of coal sampling in 1947.[19] A series of statistical studies on metal mine sampling were initiated by the Bureau in 1954. Results of the first study were published in 1958.[20] These investigations are being continued, and studies are being made on deposits of manganese, molybdenum, and copper. They include development of fundamental mathematical concepts of sampling as related to mineral deposits, as well as application of the techniques of statistical analysis to sampling data. Some of the problems investigated are random data, sample volumes, mineral distributions, change in grade of ore, density contrast, and accuracy of sampling.

Application of statistical techniques is based on the laws of probability and applies only to random data. Randomness in mine sample data may be obtained in two ways. One is to have only random fluctuations in the distribution of the minerals, so that any sample taken will reflect these random fluctuations. The other is to have a

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[11] Mining methods research engineer, Denver Mining Research Center, Bureau of Mines, Denver, Colo.

[12] Mining engineer, Denver Mining Research Center, Bureau of Mines, Denver, Colo.

[13] de Wijs, H. J., Statistics of Ore Distribution: Rept. from Geologic en Mijnbouw, Jour. Roy. Netherlands Geol. and Min. Soc., pt. I, November 1951, and pt. II, January 1953, 13 pp.

[14] Swanson, C. O., Probabilities in Estimating the Grade of Gold Deposits: Trans. Canadian Inst. Min. and Met., vol. 48, 1945, pp. 323–350.

[15] Sichel, H. S., An Experimental and Theoretical Investigation of Bias Error in Mine Sampling With Special Reference to Narrow Gold Reefs: Trans. Inst. Min. and Met. (London), vol. 56, 1946–47, pp. 403–474.

[16] Sichel, H. S., New Methods in the Statistical Evaluation of Mine Sampling Data: Trans. Inst. Min. and Met. (London), vol. 61, 1951–52, pt. 6, pp. 261–288.

[17] Krige, D. G., A Statistical Approach to Some Basic Mine Valuation Problems on the Witwatersrand: Jour. Chem. Met., and Min. Soc. South Africa, vol. 52, No. 6, December 1951, pp. 119–139.

[18] Van Voorhis, W. R., Andrews, L. E., Jr., and Creelman, G. D., Operations Research Applied to Ore Reserves at Riddle: Min. Cong. Jour., September 1955, pp. 71–76.

[19] Landry, B. A., Fundamentals of Coal Sampling: Bureau of Mines Bull. 454, 1944, 127 pp.

[20] Hazen, S. W., Jr., A Comparative Study of Statistical Analysis and Other Methods of Computing Ore Reserves, Utilizing Analytical Data From Maggie Canyon Manganese Deposit, Artillery Mountains Region, Mohave County, Ariz.: Bureau of Mines Rept. of Investigations 5375, 1958, 187 pp.

method of taking samples so that the sampling process imparts randomness to the sample data. Uniformly spaced channel samples or drill sampling on a grid pattern is systematic sampling with a random start. If, in drilling on a grid, only a single sample were taken at each grid intersection, this would give random sample data. It is known by the nature of mineral deposition that successive samples are influenced by each other; they are not completely independent. This influence is attributed to geologic conditions and environment at the time of deposition. Successive samples from a deep drill hole in ore introduces the problem of successive-sample influence or non-independence in the sample data. For most sampling methods it seems best to investigate the possibility of randomness in the distribution of the minerals as a means of obtaining randomness in the sample data.

Some of the minerals in certain deposits apparently are not randomly distributed. A test for random distribution of a mineral in a deposit can be made by obtaining a set of assays representing equal sample intervals from each of two different diameter drill holes. If the mineral is randomly distributed, the variance (s_1^2) for a frequency distribution of the assays from the large diameter hole times its sample volume (V_1) should equal the product of the variance (s_2^2) and sample volume (V_2) from the small diameter drill hole; that is $(s_1^2)(V_1)=(s_2^2)(V_2)$.

If the assay data are random, there is a simple relationship between the sample size (volume) and the second and third moments about the mean of a frequency distribution of sample assay data. The second moment is the variance (s^2) and is inversely proportional to sample size. The third moment, a measure of skewness, is inversely proportional to the square of sample size.

If the simplest mineral distribution is considered, which is a discrete distribution with equal-size particles of two kinds, such as mineral and gangue, then a binomial distribution may be utilized to describe the random-characteristics of the mineral distribution. The binomial distribution is $(p+q)^n$. In mineral distributions p can be determined by taking the average grade (mean) of the sample assays and dividing it by the maximum percentage of the metal element in the mineral. This would be 72 percent Fe for iron in the mineral magnetite. In the binomial, q is equal to $(1-P)$. The binomial power (n) equals the ratio of sample size to valued mineral size (particle size). The second moment (variance) of the binomial is inversely proportional to (n) and the third moment is inversely proportional to the square of (n).

Usually the analyzed element is present in more than one mineral. Although this tends to increase the complexity of the problem, mineral distributions, such as equal-size particles of (K) kinds, unequal-size particles of two kinds and unequal-size particles of (K) kinds can be represented by the multinomial, compound binomial and compound multinomial, respectively. These distributions arise not only in sampling ore in place but in sampling stockpiles of ore, mine dumps, and placer deposits.

Most techniques of statistical analysis have been developed for the normal or symmetrical, bell-shaped distribution. For the usual small-volume samples taken in mine sampling, low-grade-deposit distributions tend to positively skewed, with a majority of the sample assays falling on the low-valued side of the distribution.

For the same sample volume, medium-grade deposit distributions are more normal, and high-grade deposit distributions tend to be negatively skewed with the majority of the sample assays near the top-valued side of the distribution. Increasing sample volume in low-grade deposits will tend to "normalize" the distribution of minerals. Mathematically, the normal distribution is the simplest to compute. The log-normal distribution, which is a positively skewed distribution, is also fairly simple to compute. In between these ranges the binomial may be used. The binomial is a normal distribution when $q=0.5$ and $p=0.5$. In mine sampling data the (n) or power of the binomial equation $(q+p)^n$ is usually so large that table values do not exist for a solution of the equation and the mathematics, especially for confidence limits, becomes complicated. The simplest solution for the distributions lying between the normal and those approaching the log-normal is to use Pearson's type III curve. It is also possible to use the negative binomial in the area near the log-normal distribution.

Change of grade, which is defined statistically as trend, occurs throughout ore deposits, both vertically and horizontally. It is often of sufficient magnitude to obscure the random deviations in grade, and thus it tends to eliminate randomness in the assay data. The effect of trend can be reduced by using stratification or zoning, in which drill-hole assay data are grouped into strata or zones with reduced assay grade limits. This minimizes trend within the strata and the regular techniques of statistical analysis can be applied within strata.

If equal-size particles of valuable mineral are distributed randomly, the sampling distribution will be a binomial. The abscissa of a graph of the distribution will be scaled in fractional volume of valuable mineral when the scale is from zero to one. The statistical characteristics of the sampling distribution and of the deposit are therefore determined from the valuable mineral-volume distribution. Sampling data from mineral deposits are in the form of assays, which are expressed as weight-percent of valuable element or compound. When conversion of fractional mineral-volume to fractional element-weight is linear, the shape of the distributions based on these two measures is identical, and thus the computed statistical characteristics also will be the same. This is the case when there is no density contrast, and the weight-percent of ore element within the ore mineral is considered constant.

When a density contrast is present, conversion from volume-percent to weight-percent is not linear, and this will alter the shape of an assay distribution from that of the corresponding mineral-volume distribution. Although a bias will exist when a density contrast is present, the distribution moments computed from assay data will be less than those computed from a volume distribution when the density of the ore mineral is greater than the density of the rock. This problem of density contrast is important in high-grade deposits and quite small in low-grade deposits.

The fiducial interval can be used to establish accuracy limits on sampling data. It is possible to place a 95-percent confidence on the statement that the true average grade of the deposit is covered by the fiducial interval which is established on either side of the mean of the sample assay distribution. If some prior data are available on the standard deviation to be expected in a deposit, the fiducial interval technique can be used to set the desired accuracy limit of, say ±0.05 percent mineral for the drilling. From these data the most economic combination of number and size of samples can be computed before the drilling. The fiducial interval technique requires normal distribution of sample means; however, most sampling distributions, even though rather highly skewed, will meet this requirement.

More basic information must be obtained from many deposits on the distribution and randomness of minerals and on required sample sizes before any generalized rules can be developed. Once basic data are available the use of statistical analysis will permit the total number of samples used to be reduced and will increase the accuracy of grade estimates.

Studies on correlation between minerals should prove valuable in trace-element sampling and in establishing the relationship between minerals and precipitating agents, such as the uranium and carbon relationship.

More advanced investigation should be undertaken to develop and adapt the techniques of maximum ascent and response surfaces to deep exploration for mineral deposits.

DRILLING

Engineers have long recognized the desirability of eliminating losses of energy in drilling. Transmission of the force of the hammer blow through the drill rod is one source of loss which has been reduced by developing a down-the-hole drill. One manufacturer describes the drill as basically similar to a large paving breaker.[21] The drill backhead attaches to the lower end of the drill rod, and a tungsten carbide bit is retained in the drill fronthead. The drill piston strikes the bit shank about 1,000 blows per minute. Bit sizes range from 4¾ to 9 inches. Test results to date indicate a penetration rate of 10 to 12 feet per hour in trap rock, 18 to 20 feet in granite, 20 to 23 feet in hard limestone, and 50 to 80 feet in soft limestone and shale. Bit life can range from as low as 150 feet in quartzite to several thousand feet in limestone and shales.

A drill-bit manufacturer used miniature rock bits 1¼ inches in diameter as a model of large roller-cone bits, to establish data necessary for successful high-pressure drilling for oil.[22] The work will help to speed industry's solution of current problems and chart important guideposts for future drilling to depths of 30,000 feet or more. The microbits are being used in a drilling machine designed to simulate bottom-hole pressures due to rock formations overburden and mud column, so that conditions in drill holes up to 30,000 feet deep can be recreated and studied at the surface. The midget roller bits are

[21] Macaul, Robert T., Primary Blast Hole Drilling With Downhole Drills: 8th Ann. Drilling and Blasting Symposium, Univ. of Minnesota, Minneapolis, Minn., October 1958, pp. 9–13.

[22] Drilling Magazine, Research Microbits Tackle Drilling Problems: Vol. 20, No. 1, November 1958, p. 90.

used in conjunction with a laboratory drilling machine in which pressures can be varied between 0 and 15,000 p.s.i. The latter is approximately hydrostatic pressure of 9.5-pound mud in a 30,000 foot well. An interesting aspect of the work is application of scaled model studies of drilling conditions for drilling research.

FRAGMENTATION BY EXPLOSIVES

After 2 years of experimentation at Maumee Collieries Company, Terre Haute, Ind., a blasting process was patented in March 1955 that employed Fertilizer-grade ammonium nitrate. In less than 4 years the use of Fertilizer-grade ammonium nitrate has become of major importance for use in open-pit blasting and has aroused wide interest.

The first saving attributable to ammonium nitrate blasting was realized from the use of the less expensive explosive agent. Recent efforts have been directed at improving costs by mechanizing the handling of the bulk ammonium nitrate and the mixing process.[23] At Cedar City, Utah, the Utah Construction Co. used truck-mounted equipment to load vertical holes by gravity flow. A box on the truck, holding 2.8 tons of ammonium nitrate, is tilted by a winch to allow the ammonium nitrate to flow into a 300-pound-capacity measuring hopper at the back of the truck. The AN is admitted to the borehole through a butterfly valve in a 6-inch pipe on the bottom of the hopper. The pipe contains a cone, which forces the AN to flow through a 1¼-inch annular space at the periphery of the pipe. An oil nozzle at the bottom of the cone sprays an atomized stream of oil on the descending AN. The oil valve admits a metered quantity of oil to the nozzle at 100 p.s.i. and is actuated through mechanical linkage by the manually operated butterfly valve in the hopper-feed pipe. An excellent mixture of 6 percent oil and 94 percent ammonium nitrate is maintained. A borehole can be loaded with 200 to 300 pounds of nitrate mixed with oil in about 20 seconds.

The Utah Copper mine at Bingham, Utah, used a pneumatic loading device to load ammonium nitrate in 3-inch toeholes drilled at about 45° and previously sprung with conventional explosives. Bagged ammonium nitrate, an oil storage tank, and mixing devices are carried on a single truck. Dry ammonium nitrate is poured from bags into a top storage hopper, which feeds a lower hopper through a bell valve. Air is fed to the lower hopper at 35 p.s.i. pressure, which shuts the bell valve tightly and aids gravity in moving the ammonium nitrate into an air Venturi at the bottom. The Venturi, also fed with air at 35 p.s.i. pressure, moves the ammonium nitrate into a rubber feed hose. As the ammonium nitrate starts to flow, a metered quantity of oil is forced by air and a floating piston through an adjacent smaller feed hose to a junction point near the borehole, where the two ingredients mix. From the junction point, the nitrate-oil mixture is forced through a pipe into the borehole, until the hole is loaded with the proper amount of material. Boreholes can

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[23] Stromquist, Donald M., Better AN Loading=Lower Costs: Eng. Min. Jour., vol. 159, No. 10, October 1958, pp. 90–92.

be loaded with a properly portioned mixture at the rate of 100 pounds in 100 seconds.

A later development was the "slurry explosives" used by the Iron Ore Co. of Canada in its open pit iron mine.[24] Hard rock and wet holes prompted the operators to seek improvement of their method of blasting with oil-mix ammonium nitrate. The slurry explosive helped to overcome these difficulties by providing a water compatible ammonium nitrate mixture of higher density than oil-mix ammonium nitrate while retaining many of the advantages of AN explosives. It was found that ammonium nitrate could be made water compatible by adding TNT. A more startling discovery was that adding water increased explosion pressure almost three times. Comparing a 94-percent prilled AN and 6-percent fuel-oil-mixture with a 65-percent AN, 20-percent TNT, and 15-percent water slurry mixture the density is increased from 0.8 to 1.4, the rate of detonation from 2,800 to 5,500 meters per second, and the explosion pressure from 18.5 to 59 kilobars.

The slurry is less sensitive than the dry AN mix requiring twice as big a booster. Cast pentolite 2 inches in diameter and 2 inches in length is used as a booster. The slurry costs about 1.7 times more than an AN-oil mixture, but this is more than offset by its greater efficiency. Drill-hole spacing has been increased from 15 by 15 feet to 21 by 23 feet because of the increased efficiency of slurry explosives. The amount of drilling has been cut in half.

An unusually large, carefully engineered blast was used to remove a navigation hazard in the Strait of Georgia in British Columbia, Canada. Ripple Rock was successfully removed by an underground blast, according to a recent report.[25] After two unsuccessful attempts in 1942 and 1945 to drill and blast Ripple Rock from the surface, it was decided to make another attempt from workings beneath the bed of the channel and within the rock itself. A long corehole that encountered comparatively stable basalts and andesite proved the feasibility of an underground attack. A 570-foot shaft was sunk on Maud Island and a tunnel driven under the narrows to a point under the peak. Raises were driven into the rock and boxholes and coyote tunnels carved out to contain the explosive. The tunnel from Maud Island shaft to Ripple Rock was 2,400 feet long, and the raise under Ripple Rock was 300 feet from the tunnel to the blasting chambers. A unique procedure was instigated by a premature breakthrough into the sea from exploratory holes ahead of the coyote drift, which showed the peaks to be much narrower than the hydrographic surveys had previously indicated. Subsequently, breakthrough holes up to 100 feet in length were punched with the diamond drill and long-hole drifters. A special steelcored rubber plug was used to seal off the hole instead of grouting. With the information obtained, the contours of the rock were replotted, and the rock mass was recalculated.

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[24] Farnam, H. E., Jr., Developments in Ammonium Nitrate Blasting by Iron Ore Company: Canadian Min. Jour., vol. 79, No. 12, December 1958, pp. 58–61. Developments in the Use of Ammonium Nitrate Explosives in Canada: 8th Ann. Drilling and Blasting Symposium, Univ. of Minnesota, Minneapolis, Minn., October 1958, pp. 45–51. Blasting Results From Full Scale Use of Slurry Explosives; 4th Ann. Symposium on Mining Research, Univ. of Missouri, Sch. Mines and Metallurgy, Rolla, Mo., November 1958. (Unpub.)

[25] Smallwood, J. P., The Ripple Rock Blast: Canadian Min. Jour., vol. 79, No. 5, May 1958, p. 83.

Ratios of weight of explosives to the volume of rock were very much higher than in normal mining or quarrying. It amounted to 10 to 12 pounds of explosives per cubic yard of rock to be removed and an additional 3 to 5 pounds per cubic yard of water above the rock. This load was considered necessary to get the required dispersal and to break the rock into as fine particles as possible.

Evidence of the explosive effects of a nuclear detonation underground was demonstrated by the Rainier shot of Operation Plumbbob fired, September 19, 1957, at the Nevada test site.[26] The success of the project added impetus to the Plowshare project, devoted to the study of nonmilitary applications of nuclear detonations. The Rainier test shot had a TNT equivalent of 1,700 tons. Radioactive products of the nuclear detonation underground were contained, seismic effects from the standpoint of public annoyance were small and fission products were trapped in a highly insoluble fused rock that would minimize ground-water contamination. The Rainier shot in tuff produced 200,000 tons of permeable broken rock and twice that amount of crushed but relatively impermeable material.

Reports on the test shot stimulated speculations on possible applications of nuclear devices for rock excavation and mining.[27] [28] The possibility of excavating harbors and channels was suggested; artificial aquifers or underground water reservoirs might be produced. The projects most frequently mentioned for mining are shattering of low-grade ore deposits for leaching in place and underground retorting or recovery of oil shale and tar sands.

Investigation of the Rainier shot continued during the year by probing the shot area with diamond drills and tunnels to obtain more details on the shot debris. Four additional underground nuclear shots were fired in October 1958 to obtain further information on blasting results, shock, vibrations, and radioactivity. The four shots had a TNT equivalent, in tons, of 80, 90, 4,500, and 23,000, and were fired at depths from a free face that ranged from 100 to 1,000 feet. Bureau of Mines engineers participated in preparations for the Gnome shot to be fired in a New Mexico salt bed and in planning a shot in oil shale. The participation is undertaken to further evaluate the possibilities of nuclear explosives in mining. Additional data on yield, fragmentation, damage effects, both shock and radioactive, placement, and costs related to varied conditions of rock and geology are needed for proper evaluation of underground nuclear blasts for mining.

Concurrent with the interest in application of new practices for blasting was the interest in the theory of explosives and explosives action. Dr. M. A. Cook brought much of the theory of explosives up to date, including work done by the military departments.[29] The volume is confined to the more important problems in the physical

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[26] Johnson, G. W., Pelsor, G. T., and others, The Underground Nuclear Detonation of September 19, 1957, Rainier, Operation Plumbbob: Univ. of California Radiation Laboratory 5124, February 1958, 27 pp.

[27] Johnson, G. W., Rainier Blast Opens New Horizons: Eng. Min. Jour., vol. 159, No. 4, April 1958, pp. 21–23.

[28] Paris, Leonard, We'll Make the H-Blast Serve Us: Monsanto Mag., vol. 38, No. 3, summer 1958, pp. 14–17.

[29] Cook, Melvin A., The Science of High Explosives: Am. Chem. Soc. Mon. 139, Reinhold Publishing Corp., 1958, 440 pp.

chemistry of detonating explosives and includes studies of the application in commercial borehole blasting of the hydrodynamic theory.

High-speed photographs of quarry blasts were made by the Bureau of Mines to correlate physical actions of the explosives on the rock mass with theoretical considerations.[30] Motion pictures of production blasts in taconite and limestone were taken at speeds of 1,300 to 2,100 frames per second. A control box housed a 200-cycle-per-second oscillator, which energized a light bulb mounted in the camera and provided time marks at 5-millisecond intervals along the edge of the film strip.

Each bench was surveyed before blasting to establish blasthole locations with respect to face geometry and camera location. Recorded data included the hole-charging sequence, the amount and type of explosive, hole detonation and delay order, description of resultant muck pile (including its shape, location, and fragmentation), description of flyrock, macroscopic description of rock type, description of significant structural features, and pre- and post-blast fracturing. A comparison of photographed action of blasting under field conditions to theoretical predictions[31] indicate that rock breakage follows the theoretical principle but that the influence of such factors as cylindrical charge shape, multiple hole detonations, stemming, and structural variations in the rock mass cannot be adequately predicted on the basis of available data.

A report published by the Academy of Science of the U.S.S.R. indicates that Soviet work in the field of explosives fragmentation[32] closely parallels theoretical studies in the Western countries. Subjects for investigation include the theory of rock fragmentation by explosives, physical nature of the process of breaking rocks by explosives, effects of a single cylindrical charge, propagation of the explosion shock wave in the ground, relation between ore fragmentation and the parameters of the explosion work and stress fields, and the fissure-formation process when cylindrical charges are exploded in rock.

An air cushion was devised as an aid in submarine blasting on the Welland Canal, Canada, to produce a clean break surface and minimize damage effects.[33] The method consists of drilling a line of holes at the desired boundaries of an excavation. Hermetically sealed empty cans containing air at atmospheric pressure are placed in the holes. When the blast is fired, the force is directed toward the line of weakness formed by the line of air-cushion holes. Another air technique used on the Welland Canal for blasting is called an air curtain. It is used to protect the drill boats from underwater explosions. Several perforated pipes running crosswise under a drill boat have air piped to them, creating a blanket of air bubbles. This air blanket helps absorb the shock waves of the blast, because the homogeneity of the incompressive water mass has been broken.

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[30] Frantti, G. E., High-Speed Photographic Observations in Taconite and Limestone Blasting: 8th Ann. Drilling and Blasting Symposium, Univ. of Minnesota, Minneapolis, Minn., October 1958, pp. 60–69.
[31] Duvall, W. I., and Atchison, T. C., Rock Breakage by Explosives. Bureau of Mines Rept. of Investigations 5356, 1957, 52 pp.
[32] Work cited in footnote 4.
[33] Compressed Air Magazine, Air Cushion Aids Submarine Blasting: Vol. 63, No. 8, August 1958, pp. 21–22.

MECHANICAL FRAGMENTATION

Widespread interest has been evidenced in recent years toward nonexplosive methods for rock fragmentation in mining. Hydraulic breaking of coal and gilsonite, boring holes by fusion piercing, and the breaking action of continuous mining and tunneling machines have been the more successful applications to date. However, investigations are continuing on a variety of methods to fragment rock without using explosives.

A patent was issued on November 11, 1958, for mining taconite ores, using high-frequency magnetic energy.[34] The device is designed to generate high-frequency energy that will subject the rock to tensile stresses beyond the fracture strain of the ore. The general feature of the patent is a method of mining taconite ores which includes removal of the overburden from the ore to be mined and then subjecting the magnetic iron oxide, in place, to high-frequency magnetic energy to cause volumetric changes resulting in portions of the ore being subjected to tensile strains beyond the fracture strain and scraping away the fractured ore. It is stated that energy on the order of 25 kw. at a frequency of 4 to 7 mc. per second will fracture taconite. As a specific example, a 15-inch cube of Upper Cherty taconite placed in a test unit began to crack as soon as the high-frequency energy was applied; with additional time under full load the cracks enlarged, and spalling took place. The test unit consisted of a 16-inch-square loop of water-cooled copper tubing energized by a 25-kw., high-frequency induction unit of about 5 mc., employing a high-frequency current transformer on the output. The unit was adjusted for 2.7 to 2.9 plate amperes and 200 to 250 grid milliamperes.

The Soviet All-Union Coal Research Institute has been working since 1949 on the problem of breaking hard rocks such as granite and sandstone.[35] All thermal, chemical, and other nonchemical methods that have been tried were unsuccessful; because of this, the investigation has concentrated on the application of short radio waves. The latest development is a "transmitter" of extremely short waves (wavelength, 10 cm.; frequency, 3,000 mg. per second; and radiated power, 2½ kw.). The "transmitter" or, as it can rightly be called, "ray gun," weighs just over 20 pounds and is connected by a cable to a source of direct current. The radio waves are directed against the rock by a suitable wave guide. This particular instrument was designed for breaking large ore or rock fragments; the breaking occurs as a result of the stresses induced in the rock when the electromagnetic energy of the radio waves is changed into heat energy. The whole process takes aproximately 20 seconds. It is possible to adjust the radiation so as to cause fracture on the surface of the rock or deep inside it. In the latter case the rock explodes. Both this instrument and a larger one, which can be used for breaking up or direct mining, are already in serial production.

The Academy of Science, U.S.S.R., held a special conference in Moscow during November 1956 on special methods of rock disinte-

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[34] La Tour, H., and Wren, Howard D. (Assignors to Armco Steel Corp.) Mining of Taconite Ores, Using High-Frequency Magnetic Energy: U.S. Patent 2,859,952, Nov. 11, 1958.

[35] Mining Journal, Mining With Radio: Vol. 251, No. 6427, Oct. 24, 1958, p. 449.

gration.[36] Representatives of more than 50 scientific, educational, and mining organizations participated in the conference in an attempt to summarize work to date in research on rock disintegration. The research work discussed included:

(1) Disintegration of quartzite by a high-frequency magnetic field in which induction heating of magnetic quartzites produced uneven expansion of its components (quartz and magnetite). Large pieces of quartzite were broken into three and four parts after exposure of ½ to 1½ minutes. The method is considered of interest for secondary crushing.

(2) Disintegration of nonmagnetic sandstone by dielectric heating with a high-frequency electric field, a method also based on differential expansion of individual crystals. The whole rock is heated, as contrasted with heating the surface only by burners. The quartz crystals are inverted from one modification to another of different volume, resulting in fracturing of rock and reduction of its hardness. The method was tried under laboratory and production conditions and gave promising results.

(3) Disintegration of rock by an electric arc of high intensity passing through water, causing a sharp increase of pressure in water and disintegration of the rock at the place of discharge. Experiments show that the method is feasible in drilling holes, secondary crushing, and crushing in general to small fragments.

(4) Ultrasound disintegration due to cavitation and abrasive action of suspended particles in water was deemed possible but inefficient for rock fragmentation. The other research covered was hydraulic disintegration by jet and thermal disintegration.

Experiments were made on hydraulic mining of coal in several countries outside the U.S.S.R., according to W. L. Crentz, of the Bureau of Mines, who visited European Coal Research Installations in July 1958.

In 1957–58 experimental hydraulic workings were in operation at the Consolidation mine of the Essener Steinkohlenbergwerke A.G. at Gelsenkirchen-Schalke. German hydraulic studies have been directed toward the use of water under high pressure while water requirements are held to a minimum. It is necessary to hold the German nozzle within 50 cm. of the face, or the water jet will not cut. Water requirements in the German tests are 0.5 to 1.2 cubic meters per metric ton of coal extracted, and studies are in progress to reduce water needs to 0.3 cubic meter per ton of coal. Each hydraulic cut removes about 8.5 tons of coal. To mine and shovel-load this amount of coal, using hydraulic mining techniques, requires 110 minutes compared with 190 minutes to mine and load the same quantity of coal, using pneumatic hammers to extract the coal from the bed.

At the Central Engineering Establishment in England a hydraulic test monitor has been built, based upon the experience of the Russian engineers and the firefighting forces in England. This monitor is equipped with a jet 0.78 inch in diameter and a stream liner of honeycomb design. It delivers 450 g.p.m. at a pressure of 1,000 p.s.i.

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[36] Protodyakonoff, M. M., Current News, Ugol, March 1957, pp. 45–46 (Russian), (tran. by C. C. Popoff, Bureau of Mines).

The nozzle velocity is 400 f.p.s. At the laboratory, a pilot-plant-scale pipeline for coal transport has been built, using a vertical lock hopper with slide valves to feed the coal into the high-pressure line. The British have been unable to obtain high capacities with the vertical lock hopper and are now testing lock hoppers in a horizontal and inclined position to determine the type of hopper to use in their commercial applications.

A Bureau of Mines program for evaluating hydraulic mining techniques for coal has been outlined.[37] Material requirements were determined, necessary equipment purchased and a planned approach to evaluate the use of this method under American conditions is underway.

Remote control of mechanical mining machines has been under investigation for several years past.[38] A recent joint announcement by Joy Manufacturing Co. and Union Carbide Corp. states that final commercial development of a remote-controlled continuous mining system is now being undertaken by Joy.[39]

The system is operated by a man, at an electronic control center, who actuates the mining machine, which can penetrate high-wall coal to a depth of 1,000 feet or more. The continuous mining machine is equipped with sensing elements that electronically report to an operator outside the mine whether the machine is properly heading into coal. With this information the operator outside the mine electronically guides the course of the machine to follow the coal seam. A prototype machine reportedly has proved capable of advancing an entry at a rate of more than 100 feet in 1 hour.

The mining machine automatically loads coal onto a heavy duty continuous transport system that follows the machine into the mine and delivers the coal to an outside discharge station. This transportation system is said to be designed to operate under conditions where local roof falls may occur.

MATERIALS HANDLING: LOADING, TRANSPORTATION, HOISTING

Several superlatives were announced during the year in the field of materials-handling equipment. A 70-ton-capacity, earthmoving scraper claimed to be the world's largest was placed on the market.[40] Powered by a 600-hp. diesel generator, the scraper is self-propelled by powerful d.c. electric motors geared directly to the inner rim of each wheel. The scraper is 62 feet long, 14 feet wide, weighs 130,000 pounds empty, and will travel at 20 m.p.h. loaded. The largest dump truck was put in operation on the Oahe Dam construction near Pierre, S. Dak.[41] Designed with a capacity of 80 cubic yards struck measure, it is 14 feet high and 15½ feet wide; when the body is in dumping position, it reaches a height of 45 feet. It is an 18-wheel, 750-hp. semi-

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[37] Secretary of the Interior, Bituminous-Coal Research and Related Activities: Annual Report for Fiscal Year 1958, p. 171.

[38] Coal Age, Underground Mining From the Surface With the Carbide Miner: Vol. 57, No. 12, December 1952, pp. 73–78. Remotely Controlled Miner Works 350 Feet Beyond Highwall: Vol. 59, No. 1, January 1954, pp. 64–67.

[39] Coal Age, Remotely Controlled Continuous Mining System: Vol. 44, No. 12, December 1958, p. 92.

[40] Coal Age, World's Largest Scraper: Vol. 63, No. 11, November 1958, p. 134.

[41] Construction Methods and Equipment, Huge Truck Moves Dirt in 165-Ton Loads: Vol. 40, No. 4, April 1958, pp. 80–83.

Smith, Ralph, Eucnik: Canadian Min. Jour., vol. 79, No. 11, November 1958, p. 94.

trailer, with a top speed of 35 m.p.h. Two bulldozers, each reportedly the largest of its type, were placed on the market. One is a rubber-tired unit of 104,000-pound working weight, powered by a 600-hp. V-type diesel.[42] Nearly 27 feet long, 14 feet wide, and 12 feet high, the machine has a top speed of 28 m.p.h., both forward and reverse. It is designed for heavy-duty push loading, road building, land clearing, and general dozing. The other is a 25-ton, crawler-mounted bulldozer reported to be able to push-load 27 tons of earth in 40 seconds when used in conjunction with a scraper.[43] A worthy addition to the large capacity stripping shovels is the Big Paul, King of Spades reported to be the world's largest stripping shovel.[44] The shovel has a dipper capacity of 70 cubic yards, boom length of 140 feet, and working weight (with ballast) of 2,895 tons.

Highly mechanized mining operations with large-capacity machines must observe close control over scheduling operations and equipment maintenance. The Chino Mines Division of Kennecott Copper Corp. at Santa Rita, N. Mex., made an engineering study to improve data for estimating truck haulage costs in open pits.[45] The study was designed to study: (1) Significant unit costs, (2) a method of estimating traveltime from which truck needs and future stripping rate could be determined, and (3) yardstick of performance to measure haulage efficiencies. Average performance graphs were developed for estimating traveltime, empty and loaded, under varying road conditions, using a combination of time studies and kinetic energy formulas.

The Bagdad Mine in Arizona for many years has been a testing ground for primary haulage units.[46] The manufacturers of trucks work with the mining company to investigate untried design features and new parts. A detailed record of performance and costs for common truck haulage units used in open-pit mines was published. Performance details reported include hours and miles operated, tons hauled, miles per gallon, cost per mile, and cost per ton. Operating costs for fuel, lubrication, tires, repairs, labor, parts and operating labor are reported. The cost per ton shown varied from a low of $0.038 to a high of $0.10.

The "Metre" (Most Economical Time To Replace Equipment) method provides a guide to replacement of mine equipment with a low-yield or costly operating efficiency.[47] It is designed to aid the equipment owner to detect the point of lowest possible hourly operating costs. The factors considered are costs of total repairs and overhaul, productivity, unavailability, and capital decline which are plotted against years of service.

The Boliden Mining Co. in Sweden has tried to render all operations as automatic as possible.[48] The motor on haulage trains is

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[42] Bode, W. L., Clark's Powerful Dozer: Diesel and Gas Turbine Progress, vol. 24, No. 5, May 1958, p. 45.

[43] Walton, Harry, New D8 Cat; 25 Tons of Steel Muscles: Popular Sci., January 1958, pp. 143–147.

[44] A. E. Flowers, 70-yard King of Spades: Pacesetter at New Riber King Mine, Peabody Coal Co.: Coal Age, vol. 63, No. 1, January 1958, pp. 76–81.

[45] Wilmeth, H. A., Estimating Data for Open Pit Haulage Trucks: Min. Eng., vol. 10, No. 5, May 1958, pp. 577–580.

[46] Huttl, J. B., Bagdad Reports Haulage Costs: Eng. Min. Jour., vol. 159, No. 10, October 1958, pp. 112–116.

[47] Engineering and Mining Journal, Guides to the Logical Replacement of Costly Low-Yield Mine Equipment: Vol. 159, No. 11, November 1958, pp. 102–103.

[48] Ando, Sigvard, Some Automatic Devices at Boliden for Hauling, Hoisting Surface Transport: Canadian Min. Jour., vol. 79, No. 6, June 1958, pp. 88–91.

equipped with a remote-control device that allows the motorman to control train operations by means of pushbutton at the chute openings. The motorman can thus control operation of the train and pull chute at the same station. Bumping of cars during remote-control operations is eliminated by a combination of mechanical and electromagnetic brake systems. A similar system of remote control is used to control cars during the dumping operation.

Shaft hoisting at most of the Boliden mines is performed fully automatically. Mercury contacts regulate the entire skiploading station. Filling of the measuring pockets is based on a volumetric principle, and the two sides of the pocket operate alternatively. Opening and closing of the chute gates and control of the bin are worked by an operating unit. If there is no defect and the current circuit is closed, a time-relay starts hoisting after 6 seconds.

On the surface the ore is discharged into the headframe bin. If the bin is too full, a mercury-contact moved by a plate stops the skipping. The surface transport from the mine to the different central dressing plants is performed by trucks. Truck-loading stations are enclosed because of the severe winter weather. Trucks open the loading station doors automatically, and after a danger signal is given the door is lowered into place and closes the loading station.

The National Coal Board of Great Britain is carrying out experiments in the use of electrogyro locomotive for mine-transportation purposes.[49] The general principle involves storing energy in two flywheels, each combined with two squirrel-cage motors, which in turn drive the locomotive by means of reduction gears.

The two electrogyros work first as motors, taking energy from a three-phase supply and converting it into kinetic energy which is stored in the 1.48-ton flywheels. When the locomotive moves, the stored energy is reconverted into electrical form and supplied to two three-phase squirrel-cage induction motors, which drive the motor through double reduction gears. Because the operating cycle of the electrogyros corresponds closely to a haulage duty of a short run followed by a stop, it offers possibilities for hauling underground mine trains with improved efficiency.

GROUND SUPPORT AND CONTROL

Ground support and control, together with knowledge of the factors that influence ground conditions, is of overriding importance in modern underground mining and of increasing importance to open-pit mining as the pits become deeper. A mine disaster in 1958 at the Springhill coal mine in Nova Scotia and serious ground movement at the Sunnyside coal mines in Utah emphasized the importance of the ground support and control problem in mining.

Bumps are one manifestation of localized ground stress that must be eliminated or controlled. Progress in the control of bumps was

[49] Grindrod, J., N.C.B. Experiment With Electrogyro Locomotive: Canadian Min. Jour., vol. 79, No. 7, July 1958, pp. 87–88.

the subject of a symposium at the annual AIME meeting in February.[50] A study of 117 case histories brought out the important conclusion that almost invariably the bump occurred in a locality affected by the abutment zones of one or more pillar lines. In the Gary district of West Virginia experience has shown that certain known natural conditions and other indefinite characteristics combine to make a mining area vulnerable to bumps. Some of the known conditions are heavy overburden, an overlying stratum of strong, nonelastic rock, a structurally strong coal seam that does not crush easily (yet is the weakest stratum in the series), and a floor stratum of more than ordinary firmness.

Experience at the Sunnyside mines in Utah apparently does not conform to the general conditions associated with bumps. Rock cover varies from moderate depths of several hundred feet to a maximum of 2,500 feet under the crest of the divides. Bumps are not confined to pillar lines but may occur in virgin development. Regional structure undoubtedly has a major influence on the occurrence of bumps.

The Springhill No. 2 mine has had a long history of serious bumps. Developed on a slope to a depth of 4,400 feet of vertical cover, it has been necessary over the years of operations to change from room-and-pillar to longwall mining and to abandon operations in several areas of severe disturbance. A review of the occurrence of bumps showed that those at the face ordinarily were not severe and that the most dangerous zone was on the levels for a distance of several hundred feet from the face.

It is generally agreed that, for mining coal under deep, strong cover, no absolute preventive of rock bursts is known but an engineered approach based on present knowledge can lessen the probability of their occurrence. Studies conducted to date indicate that 80 percent of all bursts occurred on a pillar-line point.

Backfilling has long been an established practice as one form of mine support. The symposium on hydraulic stope filling at the Montana School of Mines in May focused attention on current practices and research in this field.[51] Discussions centered on the practical percolation rates for adequate stope drainage, fill setting characteristics and on factors involved in pipeline transport of slurries. At Anaconda's Mt. Con mine, 90 percent of the mining was cut-and-fill instead of square-set. John M. Suttie, mine superintendent of Mt. Con, reported that adoption of hydraulic fill reduced, by 36 percent, the number of active stopes required for production, resulted in a 54-percent increase in tons per man-shift, and reduced labor costs 12 percent. It was re-

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[50] Thomas, Edward. U.S. Bureau of Mines Investigations and Research of Bumps: Min. Eng., vol. 10, No. 8, August 1958, pp. 878–879.
Brown, A., Ground Stress Investigations in Canadian Coal Mines: Min. Eng., vol. 10, No. 8, August 1958, pp. 879–887.
Tolman, Woods G., and Schroder, John L., Jr., Control of Mountain Bumps in the Pocahontas No. 4 Seam: Min. Eng., vol. 10, No. 8, August 1958, pp. 888–891.
Peperakis, John, Mountain Bumps at the Sunnyside Mines: Min. Eng., vol. 10, No. 9, September 1958, pp. 982–986.
Campbell, Wm. F., Deep Coal Mining in Springhill No. 2, Mine: Min. Eng., vol. 10, No. 9, September 1958, pp. 987–992.
Mauck, H. E., Coal Mine Bumps Can Be Eliminated: Min. Eng., vol. 10, No. 9, September 1958, p. 993.
Holland, Charles T., Cause and Occurrence of Coal Mine Bumps: Min. Eng., vol. 10, No. 9, September 1958, pp. 994–1004.

[51] Mining World, Hydraulic Stope Filling Discussed by Mining Experts at Informative Montana Symposium: Vol. 20, No. 7, June 1958, p. 67.

ported that the cost of sand filling at the Homestake Mining Co., Lead, S. Dak., was 41 cents per ton of ore mined in 1957.

In a survey of plant operating conditions and costs for hydraulic backfilling, R. M. Stewart presented salient details on screen analysis, mineral composition, pulp density, dry solids, percolation rate, size of pipeline, friction loss, transport distance, and costs for six representative mines.[52] Costs ranged from 18 to 67 cents per ton mined, or 36 cents to $1.25 per ton of fill placed. Two basic advantages cited for hydraulic backfilling are (1) a faster filling cycle that permits mining more tons per unit of time, and (2) better control of ground conditions.

Radical changes in mine support methods at Butte which were not dictated by changes in ground conditions indicate management's alertness to new mining techniques.[53] Important changes in methods of ground support include use of concrete drift linings, limited use of both rigid and yieldable steel sets, decreased use of timber and rock fill, extensive use of rock bolts, and improved application of hydraulic backfilling.

K. P. Gupta, assistant research officer at Champion Reefs Gold mine, Kolar Gold Fields, Mysore, India, reported on progress made in rock-pressure measurements.[54] The principal difficulties involved in a complete solution of rock-pressure problems have resulted from lack of information concerning: (1) The magnitude and direction of inherent pressures in rocks of any specified region, (2) The type and magnitude of induced stresses due to mining operations, and (3) the behavior of rocks under increasing forces and particularly their behavior before failure.

The important principles or variables to measure, which may be used in assessing rock pressures, are listed as: (1) Strain or closure, (2) electrical resistance of strata, (3) natural electroactive force, (4) velocity of sound through the rock, (5) minor subaudible vibrations within a rock mass, (6) evolution of heat from rock within a block of ore being mined, and (7) size of blasted rock. The article outlines methods for measuring the stated variables.

The International Strata Control Congress held in Leipzig during October 1958 [55] was the latest of a series of international conferences on ground stabilization and control, which included the European Congress on Ground Movement at Leeds in 1957, the International Strata Control Congress at Essen in 1956, and the International Conference About Rock Pressure and Support in the Workings at Liège in 1951, and International Meetings on Pressure of Soil at Leoben in 1950. Earlier studies on the problems of rock pressures were based exclusively on the theory of the earth's pressure.[56] Subsequently, the rocks were considered an elastic medium, and problems in rock strata behavior resulting from mining excavations were solved

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[52] Stewart, R. M., Hydraulic Backfilling: Min. Eng., vol. 10, No. 4, April 1958, pp. 476–480.

[53] Whiting, Jerry M., Mine Support at Butte: Min. Cong. Jour., vol. 44, No. 10, October 1958, pp. 44–49.

[54] Gupta, K. P., How To Measure Rock Pressures: Eng. Min. Jour., vol. 159, No. 10, October 1958, pp. 95–100.

[55] German Academy of Sciences of Berlin, Mining Division, International Strata Control Congress, 1958: English trans. by Helios Literatur-Vertrick-g.m.b.h., 319 pp.

[56] Saustowicz, A., New Conceptions as to the Phenomena of Stress and Strain in Rocks Around Mining Excavations: Internat. Strata Control Cong., 1958, pp. 1–13.

on the theory of elastic behavior of a deflecting beam. The newest concept considers rock a plastic rather than an elastic medium, because rocks contain gaps, cracks, and fissures and do not form a continuous homogenous medium. Phenomena occurring in the rocks are of a rheological nature and depend upon time.

The study of rockbursts in deep mining has evidenced two types of rockbursts, extradosal and intradosal bursts.[57] Extradosal bursts represent a sudden failure of the solid ground adjacent to the fracture zone around a mine opening; intradosal bursts originate in the fracture zone itself. Most of the severe rockbursts that occur on the Witwatersrand probably are extradosal and are a typical feature of mining at great depths in hard, brittle rock, as on the Witwatersrand and the Kolar gold field in India. Properties of the rock are the important factors associated with extradosal bursts, while structural properties of the fracture zones are the important factors associated with intradosal bursts.

Investigations were in progress in South Africa to determine the "degree of fracturing" in the fracture zone. The method consists of transmitting sonic or ultrasonic waves through the ground. The velocity of wave propagation and the attenuation are then taken as indexes of the degree of fracturing.

Hofer reported a study on the principles of creep in rock salts and their significance to mining engineering.[58] The pseudoplastic or "inelastic" behavior of rocks was studied by measurements in the German potash mines. Initial evaluation of pillar measurements indicated a close relationship with creep and flow phenomena. Laboratory tests confirmed the experimental measurements and indicated that creep in rock salt is subject to the same principles established by research in metallurgy on plasticity. Research to date indicates that deformation and fracture in mine rock related to the nature of applied load conform to creep and flow theory.

Geophysical methods have been applied for diagnosing stress in solid rock in an attempt to evolve a means of measurement that does not itself affect the variables being tested.[59] Natural sonic pulses (microseismims)[60] and generated sonic pulses were employed. The possible applications reported were: (1) Recording patterns of sound velocity in pillars to determine symmetry or asymmetry in stress distribution, (2) correlation of the empirical sound velocity patterns with those obtained from an idealized elastic stress distribution to indicate plastic deformations in the interior of a rock pillar, and (3) record the advance of plastic deformation in the pillar by the variations of sound velocity displayed with time.

DRAINAGE

A serious problem in development of the Neiveli lignite deposit in India was existence of very high pressure artesian acquifers below the

[57] Denkhaus, H. G., The Significance of Some Problems of Rock in Relation to the Problem of Rockbursts in Deep Mining: Internat. Strata Control Cong., 1958, pp. 29–48.
[58] Hofer, K. H., The Principles of Creep in Rock Salts and Their General Significance to Mining Engineering: Internat. Strata Control Cong., 1958, pp. 49–63.
[59] Buckheim, W., Geophysical Methods for the Study of Rock Pressure in Coal and Potash-Salt Mining: Internat. Strata Control Cong., 1958, pp. 222–235.
[60] Obert, Leonard, and Duvall, Wilbur I., Micro-Seismic Method of Determining the Stability of Underground Openings: Bureau of Mines Bull. 573, 1957, p. 1.

lignite.[61] The artesian water exerts an upward thrust of 6 to 8 tons per square foot and would tend to burst through the lignite seam when the overburden was removed for open pit mining of the lignite. A detailed engineering study of the ground water conditions was made, and countering measures were taken to control the water. Large-scale pumping tests proved that the pressure surface of the artesian water could be reduced to a safe level below the lignite by pumping from a carefully designed pattern of wells around and within the area to be mined. Under the ground water control scheme, 48,000 g.p.m. will be pumped out of the aquifer through 48 wells. This will provide a drawdown of about 200 feet to maintain the pressure surface at a safe level. The water will be used for boiler feed and cooling purposes in the thermal power station, washing china clay removed during mining operations, water supply to the mine townsite, and irrigation.

An unusual pumping method was employed at the Chief mine in the Tintic district, Utah.[62] Pumping, which is one of the major cost items at the mine, is conducted in stages with about 7,000 gallons per minute being discharged into a permeable channel at the 1,800 level of the mine. An exploration drift driven in 1921 encountered a natural cavern, and strangely, it did not fill when an attempt was made to pump mine water into the cave. Tracers were used to determine if the flow was returning to the mine and being recirculated, but no trace of return water was evidenced. It appears that the caverns offer an opportunity in pumping water from a perched water table to another that is lower than the zone of mining operations. The pumping system is based on utilization of the caverns for disposal of water. Pumping costs in 1954 were $1.39 per ton of ore hoisted, over 15 percent of the total cost of mining.

VENTILATION

The importance of ventilation to an efficient mining operation in the deep gold mines of South Africa is emphasized by the fact that, due to high temperatures underground, even a 1-hour interruption of airflow may render many mines unserviceable. It has been established that a large part of the horsepower needed to send air into the mines was lost in the shaft structure.[63] A model mine shaft wind tunnel was built in the laboratories of the C.S.I.R. (Council of Scientific and Industrial Research), National Mechanical Engineering Research Institute, for research into the ventilation of mines. The effect of streamlining various components of the shaft structure was investigated to reduce ventilation power requirements. The ultimate aim is to reduce airflow losses by improved aerodynamic design of internal shaft structures. The 100-foot model shaft has been used for experiments that show, by streamlining shaft equipment, resistance to airflow can be reduced 60 percent or more.

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[61] Grindrod, John, Mining Conditions in the Heiveli Lignite Project: Min. Jour., vol. 251, No. 6426, Oct. 17, 1958, pp. 416–418.

[62] Young, W. E., Mining and Water-Control Methods at the Chief Lead-Zinc Mine, Chief Consolidated Mining Co., Juab County, Utah: Bureau of Mines Inf. Circ. 7828, 1958, 21 pp.

[63] South African Mining and Engineering Jour., South Africa's Research Into Mine Ventilation: Vol. 69, No. 3424, Sept. 26, 1958, p. 609.

The Port Radium mine of Eldorado Mining & Refining Co. in Canada used two types of plastic liners in airways to overcome air loss and contamination.[64] Polyethylene plastic sheeting, used in raises from the first level to the surface fan inlet, worked very well but was difficult to handle and tore easily. A liquid spray plastic overcame these difficulties and was used in the remaining airways. A disadvantage of the spray is that it is flammable in liquid or spray state and produces toxic vapor during spraying. Good circulation of air during application can minimize any hazard, and when dry the plastic will not support combustion. The cost of application was approximately 11 cents per square foot. With the plastic liners 18,000 c.f.m. of air reaches the extreme workings from an input of 34,000 c.f.m. at 2-inch water gage using 15 hp., against the original calculated requirements of 25 hp. and 3.5-inch water gage.

In the Sudbury district of Canada it is necessary to heat the fresh air when a large volume of air is supplied through a direct airway to operating levels within 2,000 feet of the surface. At the Creighton mine a heat exchange system at the collars of two adjacent airways is used to heat the fresh air.[65] Two ventilation systems are used at the mine, one for the deeper workings mined by square-set method, the other in the upper workings mined by panel caving. Exhaust air from the deep workings is used to heat the fresh air supplied to the caving area during the winter. Water is used as a heat exchange medium, and the system rated at more than 7 million B.t.u. per hour.

The serious problems of dust and gas control introduced by increasing use of continuous mining equipment was the subject of a panel discussion at the joint meeting of the West Virginia Coal Mining Institute and the Central Appalachian Section of the AIME in October 1958 at White Sulphur Springs, W. Va.[66] Steady and frequently high rate gas emissions plus dust concentration characterize continuous coal mining, instead of the occasional surges from caving pillars and the like encountered before the use of continuous miners. Increased air volume and velocity delivered at the face to dilute and remove gas emission usually tend to aggravate the dust problem. Current practice employs high volume and velocity air at the face, combined with water spraying and increased attention to positioning the airstream for removal of gas and control of dust.

The seriousness of the ventilation problem was evidenced when the joint Industry Safety Committee granted blanket test approval to the Federal Bureau of Mines to investigate use of auxiliary fans, use of which is barred by the Federal Mine Safety Code, except by special permit.[67] Air measurements were made on line-brattice installations and various combinations of blower and exhaust systems. A workable solution seems to be a small blowing fan attached to and operated

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[64] Bloy, H., Plastics in Mine Ventilation: Canadian Min. Jour., vol. 79, No. 10, October 1958, pp. 78–80.

[65] Rutherford, J. G., Ventilation Heat Exchanger at INCO's Creighton Mine: Canadian Min. Jour., vol. 79, No. 10, October 1958, pp. 97–100.

[66] Coal Age, Ventilation for Continuous Mining Major Topic at White Sulphur: Vol. 63, No. 12, December 1958, pp. 130–135.

[67] Stahl, R. W., Auxiliary Ventilation of Continuous Miner Places: Bureau of Mines Rept. of Investigations, 5414, 1958, 16 pp.

Kingery, D. S., Ventilation Problems in Connection With Continuous Mining Machines: Min. Cong. Jour., vol. 44, No. 9, September 1958, pp. 62–68.

by the machine with a Y-type duct, one end terminating near the face at each side of the machine. The Y-type duct was proposed so that the exhaust system may be used from each side of the machine as expedience may require.

Coal-mine mechanization requires a supporting efficient ventilation system. One possibility for improving efficiency in a system is elimination of doors to control main air current.[68] Splitting air currents to provide a separate air split for each section proved the most efficient ventilation system at many mines that have changed from doors to individual split ventilation for each section. The cost of overcasts is partly absorbed as better local control of the air is possible and air losses are reduced substantially. Less tangible savings result from improved haulage, ventilation efficiency, and greater safety.

HEALTH AND SAFETY

More than 400,000 feet of underground diamond drilling was done at the Kerr-Addison gold mine in Canada from 1953–57. A series of safety rules have been evolved based on their experience.[69]

In addition to the hazards common to most mining, a complex health problem of radiation damage is encountered in uranium mining.[70] Extensive control measures are necessary to reduce the concentration to the suggested working level of less than 300 micromicrocuries of total radon daughters per liter of air. Relatively simple and inexpensive equipment is available for sampling and determining atmospheric concentrations of radon daughters. The principal precaution to be taken other than normal good safety practices is to provide adequate ventilation to avoid concentration of radon daughters and proper control of gases and dust.

A series of tests have been made on the use of foam and foaming agents to control coal-mine fires.[71] The foam is formed by spraying a diluted solution of a foaming agent in water on a lace-knitted cotton net stretched across the mine entry. It was found that coal fires of moderate size and intensity can be brought under effective control by relatively moist foam plugs generated several hundred feet upwind from the fire.

Recommended safety standards for surface auger mining of coal were established.[72] This method of mining which was introduced after World War II has proved to be a reliable, economical way to mine coal, but a number of fatal accidents have indicated the need for a standard for safety. Collapse of highwall and rock slides, explosions at the auger hole, and asphyxiation underground have resulted in serious or fatal injuries.

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[68] Kingery, D. S., and Harris, E. J., Coal-Mine Ventilation Without Doors to Control Main Air Currents: Bureau of Mines Inf. Circ. 7853, 1958, 13 pp.

[69] Gagnon, Paul, and Oliver, P. S., Safe Diamond Drill Practice: Canadian Min. Jour., vol. 79, No. 9, September 1958, pp. 97–99.

[70] Westfield, James, Flinn, R. H., Look, A. D., and Morgis, G. G., Engineering Control of Health and Safety Hazards in Uranium Mines: Bureau of Mines, Inf. Circ. 7834, 1958, 20 pp.

[71] Hartmann, Irving; Nagy, John; Barnes, R. W., and Murphy, E. M., Studies With High-Expansion Foams for Controlling Experimental-Coal-Mine Fires: Bureau of Mines Rept. of Investigations 5419, 1958, 18 pp.

[72] Bureau of Mines, Recommended Safety Standards for Surface Auger Mining: Inf. Circ. 7845, 1958, 11 pp.

MINING METHODS AND PERFORMANCE

The Bureau of Mines conducted a general information canvass of the mining industry in 1957, which contained questions on various operating phases of the industry. A preliminary tabulation on a selected commodity grouping of mines (copper, iron, lead-zinc, gold-lode, silver-lead, and zinc) has been completed.

Within this grouping, 512 underground mines producing approximately 65 million tons of crude ore and 346 open-pit mines producing 224 million tons of crude ore reported the method of loading and hauling employed at the mine. Reported data from the underground mines indicate that 30 percent of the mines producing less than 1 percent of the total tonnage used hand loading; 19 percent of the mines producing 34 percent of the total tonnage used chute loading; and 39 percent of the mines producing 58 percent of the tonnage used machine loading. Among the reporting underground mines, 4 percent producing less than 1 percent of the total tonnage, signified "other" methods employed; and 8 percent of the mines, producing about 5 percent of the total tonnage, did not state the method employed. The data reported on open-pit mines within this group showed that 66 percent of the open-pit mines producing 80 percent of the total crude ore tonnage mined by this method used machine loading. Twenty-three percent of the open-pit mines producing 17 percent of the tonnage did not state method used.

The reported data on the principal type of haulage used in the underground mines showed that 62 percent of the mines producing 80 percent of the total tonnage used track haulage, 16 percent of the mines producing about 9 percent of the tonnage used trackless haulage, a little over 1 percent of the mines producing over 8 percent of the tonnage used conveyors, and nearly 7 percent of the mines producing a fractional percentage of the tonnage use hand haulage. The remaining 14 percent of the mines reporting did not state the method used or merely specified "other." Reports from open-pit mines in the commodity grouping showed that 57 percent of the mines producing 50 percent of the tonnage used trackless haulage, primarily trucks, and 13 percent of the mines producing 32 percent of the tonnage used track haulage.

The reported data on underground mines included principal mining method employed, commodity and tons of crude ore mined, and the man-hours of underground and surface labor chargeable to mining. The preliminary tabulation of the selected commodity grouping mentioned listed 80 mines reporting room-and-pillar as the principal mining method employed, 173 mines using open-stope method, 54 mines using the shrinkage method, 26 using square-set method, 4 using top slicing, 8 using block caving, 15 using sublevel caving, and 135 mines that did not state the method used or specified "other" methods.

A further breakdown of the reported figures on crude ore mined by underground methods shows 28 percent of total tonnage mined by room-and-pillar, 22 percent by open stoping, 4 percent by shrinkage stoping, 2 percent by square-set stoping, 1 percent by top slicing, 26 percent by block caving, 10 percent by sublevel caving, and 7 percent, method not specified.

Based on total man-hours of underground and surface labor charged to mining the tons per man-hour for room-and-pillar mining is 1.70, open-stope mining 1.24, shrinkage mining 0.56, square-set mining 0.25, top-slice mining 0.93, block caving 1.88, and sublevel caving 0.79. The reported data on open-pit mining shows that tons per man-hour range from a low of 2.0 in silver-lead mines to a high of 5.77 in copper mines with an average of 5.63 for all mines in the commodity grouping selected.

Several innovations in raising practice have been introduced in the last few years. At the Grangesberg mine in Sweden, raises are driven with the help of ladders made of angle iron mounted parallel to the hanging wall.[73] The upper ends of the ladders hook over two round stulls supported by means of steel plate saddles at each end held in place by a bolt protruding into holes drilled for that purpose. A collapsible platform is provided at the top of the ladder, with one end resting on the footwall, the other on the upper of the two stulls before a round is blasted. Holes are drilled for the next ladder support, and the saddle and round timbers are placed. The system is claimed to be safe, economical, and rapid. It can, however, be used only for raises flatter than 70°; otherwise, ladders and supports would be knocked down by the blasted rock.

The rapid adoption over a wide geographic area of a demonstrated practical mining procedure is well illustrated by the recent use of cage raising. Introduced at the Tennessee Copper Co. mines at Ducktown, Tenn., in 1953,[74] the cage-raising method as applied at the Irene shaft, Leadville, Colo., has been described in detail.[75] In general, cage raising consists of drilling a small-diameter pilot hole between levels. A work cage is suspended from a hoist rope passing from a host on the upper level down through the pilot drill hole. Drilling and loading of holes in the raise are done from a work platform on the cage. The cage is anchored in the raise for work on each raise round and lowered out of the way to blast the round. Muck is loaded out at the lower level with mechanical mucking machines. A similar system was used at the Cary mine, Hurley, Wis., to deepen a shaft by driving two successive, 200-foot, vertical pilot raises.[76] The method has also been employed at several of the mines of the Rhokana Corp. on the Copperbelt in Africa in shaft sinking.[77] The two sections of the St. Fillans tunnel of the North Scotland Hydroelectric Board are connected by a 600-foot vertical shaft, above which is a 200-foot surge shaft 25 feet in diameter. The shaft was excavated by drilling a

[73] Canadian Mining Journal, Grangesberg Raising Technique: Vol. 79, No. 3, March 1958, p. 73.

[74] Engineering and Mining Journal, New Raising Technique Developed Experimentally: Vol. 154, No. 6, June 1953, p. 102.

[75] Bolmer, R. L., and Greenlee, B. B., Raising With a Suspended Work Cage at the Irene Shaft, Leadville, Colo.: Bureau of Mines Inf. Circ. 7868, 1958, 27 pp.

[76] Wangaard, J. C., Driving a Vertical Raise by Use of a Cage, Gary Mine, Hurley, Wis.: Skillings' Mining Review, vol. 45, No. 48, Mar. 2, 1957, pp. 2–3.

[77] South African Mining and Engineering Journal, Cage Raising and Slipping Created Copperbelt Shaft: Vol. 69, pt. 2, No. 3423, Sept. 19, 1958, pp. 557–561.

5-inch borehole from the surface and then raising from below in a "bomb" cage suspended on a rope passing through the hole.[78]

Publication by the Bureau of Mines of a series of information circulars reporting mining methods, performance, and cost was continued during 1958. During the year 17 circulars were issued, making a total of 36 circulars published in this series since 1955.

SHIELDS, J. J., DOWD, J. J., AND HALEY, W. A. Mechanical Mining in Some Bituminous-Coal Mines, Progress Report 8, Methods and Equipment Used in Underground Development. Bureau of Mines Information Circ. 7813, 1958, 66 pp.

THURMOND, R. E., AND STORMS, W. R. Discovery and Development of Pima Copper Deposit, Pima Mining Co., Pima County, Ariz. Information Circ. 7822, 1958, 19 pp.

NETZEBAND, W. F. Mining Methods and Costs at the Rialto Mine, Nellie B. Division, American Zinc, Lead & Smelting Co., Ottawa County, Okla. Information Circ. 7823, 1958, 23 pp.

KELLY, L. W. Roof-Bolt Recovery in the Middle West. Information Circ. 7826, 1958, 17 pp.

YOUNG, W. E. Mining and Water-Control Methods at the Chief Lead-Zinc Mine, Chief Consolidated Mining Co., Juab County, Utah. Information Circ. 7828, 1958, 21 pp.

JOHNSON, A. C. Shaft-Sinking Methods and Costs at the T. L. Shaft, Eureka Corp., Ltd., Eureka, Nev. Information Circ. 7835, 1958, 25 pp.

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LONG, A. E., AND OBERT, LEONARD. Block Caving in Limestone at the Crestmore Mine, Riverside Cement Co., Riverside, Calif. Information Circ. 7838, 1958, 21 pp.

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JOHNSON, A. C. Exploration, Development, and Costs of the Stormy Day Tungsten Mine, Pershing County, Nev. Information Circ. 7854, 1958, 9 pp.

ALFRED, ROBERT, AND SCHROEDER, H. J. Methods and Practices for Producing Crushed Granite, Campbell Limestone Co., Pickens County, S.C. Information Circ. 7857, 1958, 24 pp.

PARSONS, E. W. Using Precast Reinforced-Concrete Sets in the Pioneer Tunnel of Great Northern Railway's Cascade Tunnel, King County, Wash. Information Circ. 7858, 1958, 10 pp.

BOLMER, R. L., AND GREENLEE, B. B. Raising With a Suspended Work Cage at the Irene Shaft, Leadville, Colo. Information Circ. 7868, 1958, 27 pp.

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LORAIN, S. H., WELLS, R. R., MIHELICH, MIRO, MULLIGAN, J. J., THORNE, R. L., AND HERDLICK, J. A. Lode-Tin Mining at Lost River, Seward Peninsula, Alaska. Information Circ. 7871, 1958, 76 pp.

[78] Mine & Quarry Engineering, vol. 24, No. 11, November 1958, p. 488.

Statistical Summary of Mineral Production

By Kathleen J. D'Amico [1]

THIS SUMMARY is identical to that in volume I 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 U.S. 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, 1955–58, 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.

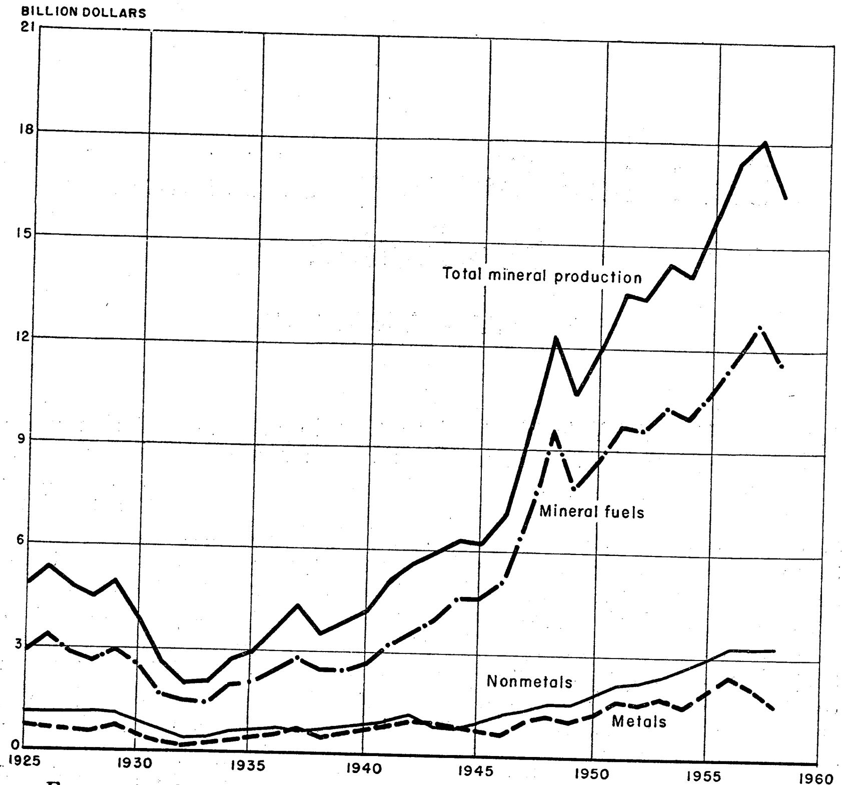

FIGURE 1.—Value of mineral production in the United States, 1925–58.

TABLE 1.—Value of mineral production in continental United States, 1925–58, 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	10,580
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	[3,4] 2,957	2,055	[4] 15,792
1939	2,423	754	631	3,808	1956 [2]	11,741	[3,4] 3,266	2,358	[4] 17,365
1940	2,662	784	752	4,198	1957 [2]	[4] 12,709	[3,4] 3,267	[4] 2,137	[4] 18,113
1941	3,228	989	890	5,107	1958 [2]	11,588	[3] 3,341	1,597	16,526

[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.
[4] Revised figure.

TABLE 2.—Mineral production [1] in the United States [2]

Mineral	1955		1956		1957		1958	
	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)
MINERAL FUELS								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone	1,427,207	$4,111	1,458,533	$4,114	1,168,507	$3,221	1,326,493	$3,343
Gilsonite	82,822	3,117	89,003	3,822	[3] 207,704	4,259	317,280	4,864
Carbon dioxide, natural (estimated) ... thousand cubic feet	702,417	234	713,030	235	794,276	139	722,615	102
Coal:								
Bituminous and lignite [4] ... thousand short tons	464,633	2,092,383	500,874	2,412,004	492,704	2,504,406	410,446	1,996,281
Pennsylvania anthracite ... do	26,205	206,097	28,900	236,785	25,338	227,754	21,171	187,898
Helium ... thousand cubic feet	235,868	3,881	266,937	4,413	310,365	5,112	352,134	5,741
Natural gas ... mililon cubic feet	9,405,351	978,357	10,081,923	1,083,812	10,680,258	1,201,759	[5] 11,030,298	[5] 1,317,492
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	5,844,904	423,775	5,807,100	431,958	5,734,307	415,791	5,596,458	393,139
LP-gases ... do	5,972,698	195,231	6,487,413	265,185	6,655,282	263,665	6,783,000	296,571
Peat	273,669	2,283	272,972	2,320	316,217	3,458	327,813	3,446
Petroleum (crude) ... thousand 42-gallon barrels	2,484,428	6,870,380	2,617,283	7,296,760	2,616,901	8,079,259	[5] 2,448,886	[5] 7,379,071
Total mineral fuels		10,780,000		11,741,000		[3] 12,709,000		11,588,000
NONMETALS (EXCEPT FUELS)								
Abrasive stone [6]	(6)	330	(6)	363	(6)	331	(6)	[7] 182
Asbestos	44,568	4,487	41,312	4,742	43,653	4,917	43,979	5,127
Barite	1,108,103	10,809	1,299,888	13,498	[3] 1,145,791	[3] 12,897	605,402	7,510
Boron minerals	[3] 522,466	[3] 30,739	[3] 546,815	[3] 32,848	[3] 541,124	[3] 38,041	528,209	38,310
Bromine ... thousand pounds	184,454	39,856	196,730	47,434	191,971	48,038	176,397	46,689
Cement ... thousand 376-pound barrels	306,128	884,381	321,395	989,233	229,189	961,499	317,263	1,038,672
Clays ... thousand short tons	48,106	139,540	50,775	163,048	[3] 45,620	[3] 155,805	43,750	143,487
Emery	10,735	151	12,153	174	11,893	184	7,687	126
Epsom salts from epsomite	100	5	(8)	(8)	(8)	(8)		
Feldspar ... long tons	[3] 550,861	[3] 4,528	[3] 560,074	[3] 5,829	[3] 498,057	[3] 4,935	469,738	4,278
Fluorspar	279,540	12,590	329,719	14,257	328,872	15,777	319,513	15,071
Garnet (abrasive)	11,835	1,191	9,812	1,073	9,776	1,080	10,035	860
Gem stones (estimated)	(9)	818	(9)	925	(9)	882	(9)	1,006
Gypsum ... thousand short tons	10,684	33,938	10,316	34,099	9,195	29,871	9,600	32,495
Lime ... do	10,470	126,890	10,567	135,532	10,266	135,143	9,203	118,026
Magnesite	486,088	2,713	686,569	2,502	678,489	3,258	492,982	2,409
Magnesium compounds from sea water and brines (except for metals) ... MgO equivalent	155,779	12,704	169,019	13,668	[3] 184,236	[3] 15,997	207,053	16,419
Marl:								
Calcareous (except for cement)	183,044	128	285,653	215	(10)	(10)	(10)	(10)
Greensand	5,704	218	(8)	(8)	(8)	(8)	(8)	(8)

See footnotes at end of table.

TABLE 2.—Mineral production [1] in the United States [2]—Continued

Mineral	1955		1956		1957		1958	
	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)
NONMETALS (EXCEPT FUELS)—continued								
Mica:								
Scrap	95,432	$2,058	86,309	$1,850	92,438	$2,109	93,347	$2,065
Sheet .... pounds	642,113	3,370	887,871	2,757	690,052	2,492	655,045	2,802
Perlite	286,157	2,282	310,800	2,550	301,605	2,562	291,994	2,463
Phosphate rock .... thousand long tons	12,265	75,379	15,747	97,922	13,976	87,689	14,879	93,693
Potassium salts .... thousand short tons, K_2O equivalent	2,067	78,602	2,172	82,107	2,266	84,612	2,147	75,000
Pumice .... thousand short tons	1,804	3,369	1,482	4,749	1,827	4,628	1,973	5,287
Pyrites .... thousand long tons	1,007	8,391	1,070	9,743	1,067	9,087	974	7,987
Salt (common) .... thousand short tons	22,693	123,276	24,206	136,139	23,844	[3] 148,887	[11] 21,911	[11] 141,486
Sand and gravel .... do	591,683	535,510	631,495	602,412	[3] 632,256	[3] 599,751	[11] 683,684	[11] 651,635
Slate	760	12,914	645	11,666	632	11,029	(12)	(12)
Sodium carbonate (natural)	613,594	15,001	652,891	17,400	652,717	17,792	628,619	17,032
Sodium sulfate (natural)	281,549	5,381	332,990	6,437	331,382	6,542	347,445	6,716
Stone [13] .... thousand short tons	467,272	702,142	504,031	763,313	[3] 532,791	[3] 814,373	535,340	826,209
Strontium minerals (crude)	177	4	4,040	77	(8)	(8)	(8)	(8)
Sulfur:								
Frasch-process mines .... thousand long tons	5,839	163,156	5,676	150,356	5,035	122,915	4,644	109,272
Other mines .... long tons	199,899	(8)	185,532	(8)	(8)	(8)	153,574	1,505
Talc, pyrophyllite, and soapstone	725,708	4,517	739,039	4,859	684,453	4,796	737,333	4,818
Tripoli	49,662	213	45,009	203	50,717	195	47,044	183
Vermiculite	204,040	2,702	192,628	2,543	183,987	2,603	181,716	2,610
Value of items that cannot be disclosed: Aplite, brucite, calcium-magnesium chloride, diatomite, graphite, iodine, kyanite, lithium minerals, nitrogen compounds (1957-58), olivine, staurolite (1957-58), sharpening stones, wollastonite, and values indicated by footnote 8		[3] 30,903		[3] 35,033		[3] 37,086		39,910
Total nonmetals [14]		[3] 2,957,000		[3] 3,266,000		[3] 3,266,000		3,341,000
METALS								
Antimony ore and concentrate .... antimony content	633	(15)	590	(15)	710	(15)	716	(15)
Bauxite .... long tons, dried equivalent	1,788,341	14,543	1,743,344	13,973	1,416,172	[3] 12,868	1,310,685	11,898
Beryllium concentrate .... gross weight	500	268	[3] 445	[3] 231	521	276	463	238
Chromite .... do	153,253	6,644	[16] 207,662	[16] 8,715	166,157	7,816	143,795	6,187
Cobalt (content of concentrate) .... thousand pounds	2,439	(15)	3,657	(15)	4,123	(15)	4,832	(15)
Columbium-tantalum concentrate [17] .... pounds	12,954	22	216,606	(15)	370,483	(15)	428,347	981
Copper (recoverable content of ores, etc.)	998,570	744,933	1,104,156	938,532	1,086,859	654,289	979,329	515,127
Gold (recoverable content of ores, etc.) .... troy ounces	1,880,142	65,805	1,827,159	63,950	1,793,597	62,776	1,739,249	60,874

Iron ore, usable (excluding byproduct iron sinted) thousand long tons, gross weight	105,237	748,602	96,944	750,354	104,157	865,703	66,525	572,735
Lead (recoverable content of ores, etc.)	338,025	100,731	352,826	110,787	338,216	96,730	267,377	62,566
Manganese ore (35 percent or more Mn) gross weight	287,254	21,651	344,735	26,990	366,334	29,363	323,108	23,300
Manganiferous ore (5 to 35 percent Mn) do	911,636	5,128	680,651	3,984	865,127	(15)	520,601	3,532
Manganiferous residuum do	213,370	(15)	130,129	(15)	(15)	(15)	(15)	(15)
Mercury 76-pound flask	18,955	5,504	24,177	6,284	34,625	8,552	38,067	8,720
Molybdenum (content of concentrate) thousand pounds	64,709	66,919	57,126	63,901	57,143	67,605	42,328	50,371
Nickel (content of ore and concentrate)	4,411	(15)	7,392	(15)	12,901	(15)	13,489	(15)
Rare-earth and thorium concentrates	(15)	(15)	(15)	(15)	[3] 3,079	[3] 653	2,021	286
Silver (recoverable content of ores, etc.) thousand troy ounces	37,198	33,666	38,722	35,044	38,165	34,541	34,111	30,872
Titanium concentrate:								
Ilmenite gross weight	573,192	10,268	735,388	14,199	782,975	[3] 21,802	565,164	11,152
Rutile do	9,182	1,122	12,065	1,749	10,644	1,544	1,863	210
Tungsten ore and concentrate 60-percent WO_3 basis	16,412	60,841	14,737	51,201	5,520	8,186	3,788	3,991
Uranium ore	(18)	(18)	3,003,590	70,601	3,682,543	[3, 11] 81,181	5,178,315	116,397
Vanadium (recoverable in ore and concentrate) thousand pounds	6,572	(15)	7,725	(15)	7,383	(15)	6,061	10,817
Zinc (recoverable content of ores, etc.)	514,671	126,609	542,340	148,503	531,735	123,235	412,005	84,113
Zirconium concentrate	28,913	1,426	(15)	(15)	(15)	(15)	(15)	(15)
Value of items that cannot be disclosed: Magnesium chloride for magnesium metal, platinum-group metals (crude), tin (1955), and values indicated by footnote 15		40,596		48,704		59,558		22,262
Total metals		2,055,000		2,358,000		[3] 2,137,000		1,597,000
Grand total mineral production		[3] 15,792,000		[3] 17,365,000		[3] 18,113,000		16,526,000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes Alaska and Hawaii.
[3] Revised figure.
[4] Includes small quantity of anthracite mined in States other than Pennsylvania.
[5] Preliminary figure.
[6] Grindstones, pulpstones, millstones, grinding pebbles, and tube-mill liners weight not recorded; excludes value of sharpening stones, value for which is included with "Nonmetal items that cannot be disclosed."
[7] Excludes tube-mill liners, value for which is included with "Nonmetal items that cannot be disclosed."
[8] Figure withheld to avoid disclosing individual company confidential data; value included with "Nonmetal items that cannot be disclosed."
[9] Weight not recorded.
[10] Beginning with 1947 calcareous marl included with stone.
[11] Final figure. Supersedes preliminary figure given in commodity chapter.
[12] Beginning with 1958 slate included with stone.
[13] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table.
[14] The total has been adjusted to eliminate duplicating value of clays and stone.
[15] Figure withheld to avoid disclosing individual company confidential data; value included with "Metal items that cannot be disclosed."
[16] 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.
[17] Total weight of columbite-tantalite plus $(Cb\text{-}Ta)_2O_5$ content of euxenite.
[18] Data not available.

TABLE 3.—Minerals produced in the United States and principal producing States in 1958

Mineral	Principal producing States, in order of quantity	Other producing States
Antimony	Idaho, Nev	
Aplite	Va	
Asbestos	Vt., Ariz., Calif., N.C	
Asphalt	Tex., Utah, Ala., Okla	Mo.
Barite	Mo., Ark., Ga., Nev	Calif., Idaho, Mont., N. Mex., S.C., Tenn., Wash.
Bauxite	Ark., Ala., Ga	
Beryllium	S. Dak., Colo., N. Mex., Ariz	Conn., Maine, N.H., N.C., Wyo.
Boron	Calif	
Bromine	Mich., Tex., Ark., Calif	W. Va.
Brucite	Nev	
Calcium magnesium chloride.	Mich., Calif., W. Va	
Carbon dioxide	N. Mex., Colo., Utah, Wash	Oreg.
Cement	Pa., Calif., Tex., Mich	All others except: Alaska, Conn., Del., Hawaii, Mass., Nev., N.H., N.J., N. Mex., N.C., N. Dak., R.I., Vt.
Chromite	Mont., Calif., Oreg., Wash	
Clays	Ohio, Tex., Pa., Ga	All others except Alaska, R.I.
Coal	W. Va., Pa., Ky., Ill	Ala., Alaska, Ariz., Ark., Colo., Ga., Ind., Iowa, Kans., Md., Mo., Mont., N. Mex., N. Dak., Ohio, Okla., S. Dak., Tenn., Utah, Va., Wash., Wyo.
Cobalt	Idaho, Mo., Pa	
Columbium-tantalum	Idaho, S. Dak., Colo	
Copper	Ariz., Utah, Mont., Nev	Alaska, Calif., Colo., Idaho, Mich., Mo., N. Mex., N.C., Oreg., Pa., Tenn., Vt., Wash., Wyo.
Diatomite	Calif., Nev., Oreg., Wash	
Emery	N.Y	
Feldspar	N.C., Calif., N.H., Colo	Ariz., Conn., Ga., Maine, S. Dak., Tex., Va., Wyo.
Fluorspar	Ill., Colo., Mont., Ky	Ariz., Calif., Nev., Utah.
Garnet	N.Y., Idaho	
Gold	S. Dak., Utah, Alaska, Calif	Ariz., Colo., Idaho, Mont., Nev., N. Mex., N.C., Oreg., Pa., Tenn., Wash., Wyo.
Graphite	Tex., R.I	
Gypsum	Calif., Mich., Tex., Iowa	Ariz., Ark., Colo., Idaho, Ind., Kans., La., Mont., Nev., N.Y., Ohio, Okla., S. Dak., Utah, Va., Wash., Wyo.
Helium	Tex., N. Mex., Kans	
Iodine	Calif	
Iron ore	Min., Mich., Ala., Utah	Ark., Calif., Colo., Ga., Idaho, Miss., Mo., Mont., Nev., N.J., N. Mex., N.Y., Pa. Tex., Wash., Wis., Wyo.
Kyanite	Va., S.C	
Lead	Mo., Idaho, Utah, Colo	Alaska, Ariz., Calif., Ill., Kans., Ky., Mont., Nev., N. Mex., N.Y., Okla., Oreg., Va., Wash., Wis.
Lime	Ohio, Mo., Pa., Tex	Ala., Ariz., Ark., Calif., Colo., Conn., Fla., Hawaii, Ill., Iowa, La., Maine, Md., Mass., Mich., Minn., Mont., Nev., N.J., N. Mex., N.Y., Okla., Oreg., S. Dak., Tenn. Vt., Va., W. Va., Wis.
Magnesite	Wash., Nev., Calif	
Magnesium chloride	Texas	
Magnesium compounds	Mich., Calif., N.J., Tex	N. Mex.
Manganese	Nev., Ariz., Mont., N. Mex	Ark., Calif., Colo., Ga., Tenn., Utah, Va.
Mercury	Calif., Nev., Alaska, Oreg	Ariz., Idaho, Tex., Wash.

TABLE 3.—Minerals produced in the United States and principal producing States in 1958—Continued

Mineral	Principal producing States, in order of quantity	Other producing States
Mica	N.C., Ga., Ala., S.C	Ariz., Calif., Colo., Conn., Idaho, Maine, Mont., N.H., N. Mex., Pa., S. Dak., Tenn., Utah, Va.
Molybdenum	Colo., Utah, Ariz., Calif	Nev., N. Mex.
Natural gas	Tex., La., N. Mex., Okla	Ala., Alaska, Ark., Calif., Colo., Fla., Ill. Ind., Kans., Ky., Md., Mich., Miss., Mont., Neb., N.Y., N. Dak., Ohio, Pa., Tenn., Utah, Va., W. Va., Wyo.
Natural-gas liquids	Tex., Calif., La., Okla	Ark., Colo., Ill., Kans., Ky., Mich., Miss., Mont., Neb., N. Mex., N. Dak., Ohio, Pa., Utah, W. Va., Wyo.
Nickel	Oreg., Mo., Idaho	
Olivine	N.C., Wash	
Peat	Mich., Wash., Fla., Calif	Colo., Conn., Ga., Idaho, Ill., Ind., Iowa, Maine., Mass., Minn., N.H., N.J., N.Y., Ohio, Pa., S.C., Wis.
Perlite	N, Mex., Nev., Calif., Ariz	Colo., Utah.
Petroleum	Tex., Calif., La., Okla	Ala., Alaska, Ariz., Ark., Colo., Fla., Ill., Ind., Kans., Ky., Mich., Miss., Mo., Mont., Neb., Nev., N. Mex., N.Y., N. Dak., Ohio, Pa., S. Dak., Tenn., Utah, Va., Wash., W. Va., Wyo.
Phosphate rock	Fla., Tenn., Idaho, Mont	Utah.
Platinum-group metals	Alaska, Calif	
Potassium salts	N. Mex., Calif., Utah, Mich	Md.
Pumice	N. Mex., Ariz., Calif., Hawaii	Colo., Idaho, Kans., Neb., Nev., N. Dak., Okla., Oreg., Tex., Utah, Wash., Wyo.
Pyrites	Tenn., Va., Calif., Colo	Ariz., Mont., Pa.
Rare-earth metals	Idaho, Colo., S.C., Calif	Fla.
Salt	Mich., N.Y., Tex., La	Ala., Calif., Colo., Hawaii, Kans., Nev., N. Mex., Ohio, Okla., Utah, Va., W. Va.
Sand and gravel	Calif., Mich., Wis., Tex	All other States.
Silver	Idaho, Utah, Ariz., Mont	Alaska, Calif., Colo., Ky., Mo., Nev., N. Mex., N.Y., N.C., Oreg., Pa., S. Dak., Tenn., Vt., Va., Wash., Wyo.
Sodium carbonate	Wyo., Calif	
Sodium sulfate	Calif., Tex., Wyo	
Stone	Pa., Tex., Ill., Calif	All other States.
Strontium	Wash	
Sulfur (Frasch)	Tex., La	
Sulfur ore	Calif., Nev	
Talc, pyrophyllite, and soapstone.	N.Y., Calif., N.C., Vt	Ala., Ark., Ga., Md., Mont., Nev., Pa., Tex., Va., Wash.
Titanium	N.Y., Fla., Va., Idaho	S.C.
Tripoli	Ill., Okla., Pa	
Tungsten	N.C., Colo., Calif., Idaho	Nev.
Uranium	N. Mex., Utah, Colo., Wyo	Alaska, Ariz., Calif., Idaho, Mont., Nev., S. Dak., Tex., Wash.
Vanadium	Colo., Utah, Ariz	N. Mex., Wyo.
Vermiculite	Mont., S.C	
Wollastonite	N.Y., Calif	
Zinc	Tenn., N.Y., Idaho, Utah	Ariz., Calif., Colo., Ill., Kans., Ky., Mo., Mont., Nev., N.J., N. Mex., Okla., Pa., Va., Wash., Wis.
Zirconium	Fla., S.C., Idaho	

TABLE 4.—Value of mineral production in the United States,[1] in thousand dollars, and principal minerals produced in 1958

State	1955	1956	1957	1958			
				Value	Rank	Percent of U.S. total	Principal minerals in order of value
Alabama	$186,453	$189,186	$209,549	$187,747	21	1.14	Coal, cement, iron ore, petroleum.
Alaska	25,412	23,408	28,792	21,450	43	.13	Coal, gold, sand and gravel, stone.
Arizona	378,277	484,959	372,641	314,520	16	1.90	Copper, sand and gravel, cement, uranium ore.
Arkansas	131,759	134,049	142,685	131,603	26	.80	Petroleum, bauxite, stone, sand and gravel.
California	1,450,501	1,543,978	1,650,035	1,502,660	3	9.09	Petroleum, cement, natural gas, sand and gravel.
Colorado	286,219	321,908	338,504	305,284	17	1.85	Petroleum, molybdenum, uranium ore, coal.
Connecticut	10,428	11,737	16,055	13,128	45	.08	Stone, sand and gravel, lime, clays.
Delaware	1,658	1,232	1,042	1,142	50	.01	Sand and gravel, stone, clays.
Dist. of Columbia	---	---	72	72	51	(1)	Clays.
Florida	108,957	140,490	140,467	142,111	25	.86	Phosphate rock, stone, cement, clays.
Georgia	60,417	67,912	69,799	75,106	30	.45	Clays, stone, cement, sand and gravel.
Hawaii	3,592	6,972	5,930	6,298	47	.04	Stone, sand and gravel, pumice, lime.
Idaho	68,513	75,150	73,502	64,456	33	.39	Silver, lead, zinc, sand and gravel.
Illinois	532,984	572,247	576,324	582,412	7	3.52	Petroleum, coal, stone, sand and gravel.
Indiana	183,209	196,439	198,034	197,677	20	1.20	Coal, cement, petroleum, stone.
Iowa	63,555	66,529	68,985	85,356	29	.52	Cement, stone, sand and gravel, gypsum.
Kansas	470,830	493,770	511,513	498,526	9	3.02	Petroleum, natural gas, cement, stone.
Kentucky	391,068	443,168	449,390	402,121	10	2.43	Coal, petroleum, natural gas, stone.
Louisiana	1,156,424	1,288,116	1,517,522	1,517,415	2	9.18	Petroleum, natural gas, natural-gas liquids, sulfur.
Maine	12,991	12,728	12,711	12,574	46	.08	Cement, sand and gravel, stone, mica.
Maryland	35,488	40,534	39,625	44,679	38	.27	Cement, stone, sand and gravel, coal.
Massachusetts	22,109	25,085	24,789	23,887	41	.14	Stone, sand and gravel, lime, clays.
Michigan	363,778	394,556	404,673	343,483	15	2.08	Cement, iron ore, sand and gravel, salt.
Minnesota	501,151	501,027	584,037	395,880	11	2.40	Iron ore, sand and gravel, stone, cement.
Mississippi	122,620	133,098	144,950	148,663	23	.90	Petroleum, natural gas, sand and gravel, cement.
Missouri	151,626	163,693	152,913	144,009	24	.87	Cement, stone, lead, zinc.
Montana	166,993	213,704	191,750	177,240	22	1.07	Petroleum, copper, sand and gravel, zinc.
Nebraska	54,237	71,311	82,928	90,032	28	.54	Petroleum, cement, sand and gravel, stone.
Nevada	113,220	126,681	86,023	68,293	32	.41	Copper, manganese ore, sand and gravel, gold.
New Hampshire	2,605	3,436	3,331	3,877	48	.02	Sand and gravel, mica, stone, feldspar.
New Jersey	57,251	63,988	64,642	50,380	36	.30	Stone, sand and gravel, iron ore, clays.
New Mexico	438,549	514,903	551,155	558,866	8	3.38	Petroleum, natural gas, potassium salts, uranium ore.
New York	216,907	237,016	244,114	204,920	18	1.24	Cement, stone, salt, sand and gravel.
North Carolina	41,210	40,873	37,570	39,891	40	.24	Stone, sand and gravel, lithium minerals, mica.
North Dakota	44,123	53,509	56,702	59,093	35	.36	Petroleum, sand and gravel, coal, natural-gas liquids.
Ohio	340,456	375,488	383,000	344,856	14	2.09	Coal, cement, stone, sand and gravel.
Oklahoma	711,044	757,080	809,004	767,856	5	4.65	Petroleum, natural gas, natural-gas liquids, cement.
Oregon	31,736	34,021	42,820	45,053	37	.27	Stone, cement, sand and gravel, nickel.
Pennsylvania	969,647	1,088,481	1,077,157	881,181	4	5.33	Coal, cement, stone, petroleum.
Rhode Island	1,834	1,627	1,369	2,249	49	.01	Sand and gravel, stone, graphite.
South Carolina	20,197	21,342	22,168	22,412	42	.14	Cement, stone, clays, sand and gravel.
South Dakota	40,526	42,281	39,997	41,534	39	.25	Gold, sand and gravel, cement, stone.

Tennessee	119,316	137,846	128,739	124,928	27	.76	Stone, cement, coal, phosphate rock.
Texas	3,990,166	4,241,258	4,484,538	4,038,656	1	24.44	Petroleum, natural gas, natural-gas liquids, cement.
Utah	332,002	399,759	359,335	365,960	13	2.21	Copper, petroleum, uranium ore, coal.
Vermont	23,884	23,131	21,893	21,443	44	.13	Stone, asbestos, sand and gravel, talc.
Virginia	172,541	208,806	227,108	203,226	19	1.23	Coal, stone, cement, sand and gravel.
Washington	67,334	61,723	60,471	60,897	34	.37	Sand and gravel, cement, stone, gold.
West Virginia	755,426	934,999	981,654	749,784	6	4.54	Coal, natural gas, natural-gas liquids, sand and gravel.
Wisconsin	65,813	65,860	68,644	71,334	31	.43	Sand and gravel, stone, cement, iron ore.
Wyoming	294,546	314,380	352,532	369,938	12	2.24	Petroleum, uranium ore, natural gas, clays.
Total	15,792,000	17,365,000	18,113,000	16,526,000	--------	100.00	

[1] Less than 1 percent.

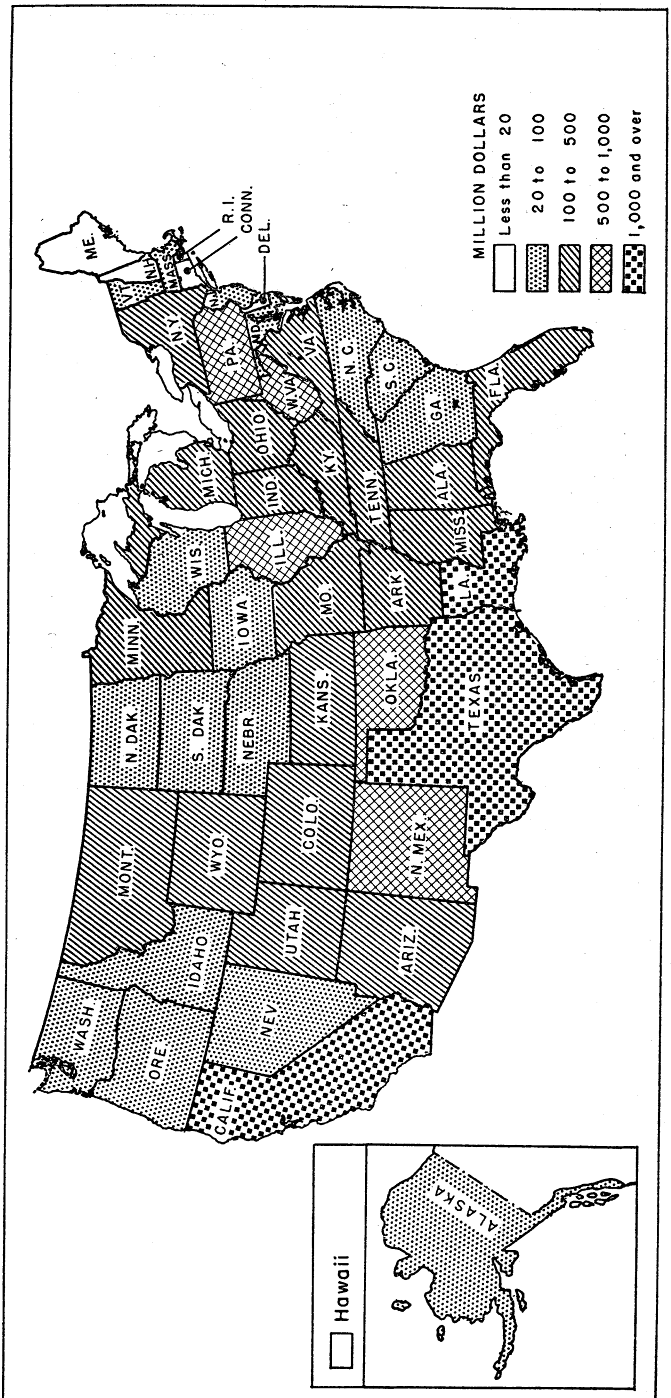

FIGURE 2.—Value of mineral production in the United States (including Alaska and Hawaii), 1958, by States.

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

ALABAMA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Cement [3] ...thousand 376-pound barrels	13,721	$38,350	14,065	$41,840	13,000	$40,279	13,588	$42,930
Clays ...thousand short tons	(4)	(4)	[5] 1,594	[5] 2,147	[5] 1,316	[5] 1,504	[5] 1,548	[5] 1,787
Coal ...do	13,088	79,337	12,663	79,322	13,260	86,114	11,182	72,360
Iron ore (usable) ...thousand long tons, gross weight	6,814	44,657	5,633	34,824	6,223	40,518	3,659	23,393
Lime ...thousand short tons	462	5,186	466	5,089	554	6,271	520	4,660
Mica (sheet)	(4)	(4)	1,122	7	(4)	(4)	(4)	(4)
Natural gas ...million cubic feet	282	20	42	3	190	12	[6] 323	[6] 30
Petroleum (crude) ...thousand 42-gallon barrels	1,411	2,910	3,069	7,335	5,406	(4)	[6] 5,887	(4)
Sand and gravel ...thousand short tons	3,680	3,524	4,999	4,621	5,065	4,883	4,128	4,210
Stone ...do	8,269	11,867	[7] 12,343	[7] 14,702	[7] 9,519	[7] 11,972	[7] 11,080	[7] 17,068
Talc	1,500	8	2,200	5	1,600	3	(4)	(4)
Value of items that cannot be disclosed: Native asphalt, bauxite, slag cement, clays (kaolin, 1956-58), scrap mica, salt, stone (dimension limestone and marble 1957-58, shell, 1957), and values indicated by footnote 4	----------	4,325	----------	4,083	----------	[8] 23,344	----------	26,508
Total Alabama [9]	----------	186,453	----------	189,186	----------	[8] 209,549	----------	187,747

ALASKA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Antimony ore and concentrate ...antimony content	----------	----------	28	(4)	17	(4)	----------	----------
Chromite ...gross weight	7,082	$625	7,193	$711	4,207	$431	----------	----------
Clays ...thousand short tons	1	4	----------	----------	----------	----------	----------	----------
Coal ...do	640	5,759	727	6,374	842	7,296	759	$6,931
Copper (recoverable content of ores, etc.)	1	1	(10)	(11)	(10)	(11)	5	3
Gold (recoverable content of ores, etc.) ...troy ounces	249,294	8,725	209,296	7,325	215,467	7,541	186,435	6,525
Lead (recoverable content of ores, etc.)	1	(11)	1	(11)	9	3	2	(11)
Mercury ...76-pound flasks	(4)	(4)	3,280	853	5,461	1,349	3,380	774
Natural gas ...million cubic feet	----------	----------	----------	----------	----------	----------	[6] 50	[6] 6
Sand and gravel ...thousand short tons	9,793	8,242	5,955	5,880	6,096	8,799	4,255	3,871
Silver (recoverable content of ores, etc.) ...thousand troy ounces	34	31	28	26	29	26	24	22
Stone ...thousand short tons	266	290	195	595	528	1,953	615	2,065
Tin (content of concentrate) ...long tons	86	183	----------	----------	----------	----------	----------	----------
Value of items that cannot be disclosed: Gem stones (1956-58), petroleum (1958), platinum-group metals, uranium ore (1957-58), and values indicated by footnote 4	----------	1,552	----------	1,644	----------	1,394	----------	1,253
Total Alaska	----------	25,412	----------	23,408	----------	28,792	----------	21,450

See footnotes at end of table.

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

ARIZONA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Beryllium concentrate......gross weight..	(4)	(4)	6	$3	5	$2	18	$10
Clays......thousand short tons..	254	$869	[5] 112	[5] 168	[5] 118	[5] 177	[5] 119	[5] 179
Columbium-tantalum concentrate......pounds..	(4)	(4)	------	------	2,435	7	------	------
Coal......thousand short tons..	9	59	10	66	9	62	8	54
Copper (recoverable content of ores, etc.)......	454,105	338,762	505,908	430,022	515,854	310,544	485,839	255,551
Gem stones......	(12)	97	(12)	104	(12)	75	(12)	86
Gold (recoverable content of ores, etc.)......troy ounces..	127,616	4,467	146,110	5,114	152,449	5,336	142,979	5,004
Gypsum......thousand short tons..	(4)	(4)	96	366	(4)	(4)	(4)	(4)
Lead (recoverable content of ores, etc.)......	9,817	2,925	11,999	3,768	12,441	3,558	11,890	2,782
Lime......thousand short tons..	112	1,438	127	1,756	138	2,127	126	1,817
Manganese ore (35 percent or more Mn)......gross weight..	1,444	(4)	42,088	3,468	79,505	6,626	62,279	5,220
Manganiferous ore (5 to 35 percent Mn)......do....	------	------	------	------	------	------	1,455	32
Mercury......76-pound flasks..	477	138	(4)	(4)	28	7	53	12
Mica (scrap)......	1,353	9	------	------	1,650	17	1,717	25
Molybdenum (content of concentrate)......thousand pounds..	1,497	1,511	2,392	2,670	2,385	3,071	2,320	2,827
Natural gas......million cubic feet..	(4)	(4)	21	3	22	3	------	------
Perlite......	10,568	84	15,928	108	15,646	114	(4)	(4)
Pumice......thousand short tons..	92	373	115	366	397	640	401	1,025
Sand and gravel......do....	7,755	6,519	7,932	6,167	10,287	9,222	12,208	9,526
Silver (recoverable content of ores, etc.)......thousand troy ounces..	4,634	4,194	5,179	4,687	5,279	4,778	4,685	4,240
Stone......thousand short tons..	1,601	2,329	1,623	2,474	2,101	2,982	1,528	2,731
Tungsten concentrate......60-percent WO_3 basis..	181	676	186	637	5	9	------	------
Uranium ore......	------	------	274,505	5,408	286,037	6,277	257,756	7,049
Zinc (recoverable content of ores, etc.)......	22,684	5,580	25,580	7,009	33,905	7,866	28,532	5,821
Value of item that cannot be disclosed: Asbestos, barite (1955), cement, clays (bentonite, 1955-56 and 1958), diatomite (1955), feldspar, fluorspar, nitrogen compounds (1957-58), petroleum (1958), pyrites (1957-58), rare-earth metals concentrates (1955), vanadium, and values indicated by footnote 4......	------	9,201	------	11,701	------	10,441	------	11,734
Total Arizona [9]......	------	378,277	------	484,959	------	[8] 372,641	------	314,520

ARKANSAS

Abrasive stones (whetstones)	(4)	(4)	35	$11				
Barite	462,986	$3,755	486,254	4,256	477,327	[8] $4,537	182,779	$1,668
Bauxite .... long tons, dried equivalent	1,721,243	14,026	1,668,432	13,307	1,356,898	[8] 12,314	1,257,916	11,394
Clays .... thousand short tons	739	2,376	719	1,636	617	1,586	578	1,578
Coal .... do	578	4,319	590	4,601	508	3,976	364	2,744
Gem stones	(12)	4	(12)	25	(12)	(4)	(12)	23
Iron ore (usable) .... thousand long tons, gross weight			(4)	(4)	7	35	(4)	(4)
Manganese ore (35 percent or more Mn) .... gross weight	23,744	1,727	29,485	2,066	23,261	1,726	22,221	1,737
Natural gas .... million cubic feet	32,123	1,799	30,162	1,810	31,327	2,256	[6] 32,890	[6] 2,664
Natural gas liquids:								
Natural gasoline and cycle products .... thousand gallons	47,483	3,239	41,529	2,541	39,869	2,313	37,197	2,574
LP-gases .... do	57,088	2,169	56,146	2,293	54,034	2,097	53,518	2,743
Petroleum (crude) .... thousand 42-gallon barrels	28,369	76,880	29,355	78,965	31,047	90,657	[6] 28,700	[6] 80,934
Sand and gravel .... thousand short tons	9,003	7,663	10,200	8,730	8,599	6,949	8,644	7,039
Slate .... do	(4)	(4)	(4)	(4)	(4)	(4)	(13)	(13)
Stone .... do	6,176	8,026	6,325	8,113	7,278	8,378	8,461	10,178
Value of items that cannot be disclosed: Abrasive stones, bromine (1957–58), cement, gypsum, lime, soapstone, and values indicated by footnote 4		[8] 6,553		8,182		[8] 6,933		7,241
Total Arkansas [9]		[8] 131,759		[8] 134,049		[8] 142,685		131,603

CALIFORNIA

Barite	(4)	(4)	(4)	(4)	(4)	(4)	24,812	$272
Boron minerals	[8] 522,466	[8] $30,739	[8] 546,815	[8] $32,848	[8] 541,124	[8] $38,041	528,209	38,310
Cement .... thousand 376-pound barrels	35,087	103,804	39,290	120,511	[14] 37,731	[14] 117,852	[14] 39,583	[14] 124,367
Chromite .... gross weight	22,105	1,834	27,082	2,192	34,901	2,789	20,588	1,646
Clays .... thousand short tons	2,860	5,027	2,982	6,137	2,729	[8] 5,740	2,394	5,012
Coal (lignite) .... do	8	77	12	120	(4)	(4)	(4)	(4)
Copper (recoverable content of ores, etc.)	613	457	859	730	945	569	749	394
Feldspar .... long tons	(4)	(4)	[8] 107,958	[8] 1,080	[8] 67,869	[8] 581	71,193	624
Gem stones	(12)	(4)	(12)	90	(12)	100	(12)	150
Gold (recoverable content of ores, etc.) .... troy ounces	251,737	8,811	193,816	6,784	170,885	5,981	185,385	6,489
Gypsum .... thousand short tons	1,308	3,274	1,399	3,402	1,268	2,995	1,423	3,184
Iron ore (usable) .... thousand long tons, gross weight	1,777	(4)	2,414	(4)	(4)	(4)	(4)	(4)
Lead (recoverable content of ores, etc.)	8,265	2,463	9,296	2,919	3,458	989	140	33
Lime .... thousand short tons	268	4,373	302	5,078	325	5,408	262	4,470
Magnesium compounds from sea water and bitterns (partly estimated) MgO equivalent	58,042	3,833	66,007	4,532	[8] 74,295	[8] 5,077	74,132	4,854
Manganese ore (35 percent or more Mn) .... gross weight	3,136	271	6,595	595	9,009	802	17,644	1,516
Mercury .... 76-pound flasks	9,875	2,867	9,017	2,344	16,511	4,078	22,365	5,123
Natural gas .... million cubic feet	538,178	119,476	504,458	113,503	492,338	116,684	[6] 465,582	[6] 108,481
Natural-gas liquids:								
Natural gasoline and cycle products .... thousand gallons	929,649	89,003	876,902	84,615	843,378	81,355	853,045	68,485
LP-gases .... do	360,902	19,379	410,232	21,332	390,743	20,421	342,992	18,678
Peat	(4)	(4)	18,918	215	35,916	424	28,617	374

See footnotes at end of table.

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

CALIFORNIA—Continued

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Perlite	15,653	$125	15,119	$135	15,109	$113	14,883	$114
Petroleum (crude) thousand 42-gallon barrels	354,812	887,030	350,754	918,975	339,646	1,035,920	[6] 314,429	[6] 911,844
Pumice thousand short tons	797	1,099	634	2,334	459	1,510	377	1,670
Salt (common) do	1,315	6,751	1,444	7,606	1,330	8,721	1,297	(4)
Sand and gravel do	64,879	66,820	86,447	96,526	[8] 78,983	87,030	84,137	95,340
Silver (recoverable content of ores, etc.) thousand troy ounces	954	864	938	849	522	473	188	170
Stone thousand short tons	24,708	37,164	32,583	46,109	41,351	53,591	32,423	48,345
Strontium minerals	177	4	(4)	(4)	(4)	(11)	----	----
Sulfur ore long tons	199,599	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Talc, pyrophyllite and soapstone	166,551	1,553	153,710	1,419	133,915	1,526	148,806	1,439
Tungsten concentrate 60-percent WO_3 basis	4,383	16,201	3,719	13,449	1,750	2,735	(4)	(4)
Wollastonite	----	----	----	----	----	----	1,652	17
Zinc (recoverable content of ores, etc.)	6,836	1,682	8,049	2,205	2,969	689	51	10
Value of items that cannot be disclosed: Asbestos, bromine, calcium-magnesium chloride, carbon dioxide (1955–57), masonry cement (1956–58), clay, (kaolin 1957), diatomite, fluorspar (1957–58), abrasive garnet (1955–56), iodine, lithium minerals (1958), magnesite (1955–56 and 1958), mica, molybdenum, platinum-group metals (crude), potassium salts, pyrites, rare-earth metals concentrates, slate (1955–57), sodium carbonate and sulfate, uranium ore (1956–58), and values indicated by footnote 4	----	[8] 52,755	----	[8] 63,654	----	[8] 65,352	----	68,562
Total California [9]	----	[8] 1,450,501	----	[8] 1,543,978	----	[8] 1,650,035	----	1,502,660

COLORADO

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Beryllium concentrate gross weight	46	$23	[8] 163	[8] $88	182	$91	134	$58
Clays thousand short tons	464	1,118	523	1,215	403	978	448	1,111
Coal do	3,568	20,100	3,502	19,832	3,594	21,831	2,974	19,305
Columbium-tantalum concentrate [15] pounds	4,325	7	52	(11)	103	(11)	2,280	7
Copper (recoverable content of ores, etc.)	4,323	3,225	4,228	3,594	5,115	3,079	4,193	2,206
Feldspar long tons	46,114	314	47,014	327	43,818	307	34,648	237
Gem stones	(12)	48	(12)	30	(12)	35	(12)	38
Gold (recoverable content of ores, etc.) troy ounces	88,577	3,100	97,668	3,418	87,928	3,078	79,539	2,784
Gypsum thousand short tons	77	329	88	353	(4)	(4)	103	341
Iron ore (usable) thousand long tons, gross weight	4	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Lead (recoverable content of ores, etc.)	15,805	4,710	19,856	6,235	21,003	6,007	14,112	3,302
Lime thousand short tons	----	----	----	----	2	45	(4)	(4)

Manganese ore (35 percent or more Mn)----gross weight--	----------	----------	----------	----------	175	14	210	17
Mica: Scrap----	699	13	517	7	312	6	387	6
Sheet----pounds--	----------	----------	8	(11)	14	(11)	----------	----------
Molybdenum----thousand pounds--	45,837	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Natural gas----million cubic feet--	49,152	4,866	54,205	5,312	95,259	9,526	[6] 82,464	[6] 8,659
Natural-gas liquids:								
Natural gasoline----thousand gallons--	(4)	(4)	(4)	(4)	(4)	(4)	49,505	3,410
LP-gases----do----	(4)	(4)	(4)	(4)	(4)	(4)	68,027	3,343
Peat----	----------	----------	----------	----------	3,559	(4)	7,143	41
Petroleum (crude)----thousand 42-gallon barrels--	52,653	144,800	58,516	162,674	54,982	166,046	[6] 48,309	[6] 144,444
Pumice----thousand short tons--	71	163	50	109	25	53	34	65
Pyrites----thousand long tons--	(4)	(4)	(4)	(4)	62	(4)	67	359
Rare-earth metals concentrates----	(4)	(4)	16	23	[8] 749	[8] 24	650	35
Salt----thousand short tons--	4	17	4	18	(4)	(4)	(4)	(4)
Sand and gravel----do----	12,912	8,915	15,152	11,082	16,400	13,994	20,626	17,842
Silver (recoverable content of ores, etc.)----thousand troy ounces--	2,772	2,509	2,285	2,068	2,788	2,523	2,056	1,860
Stone----thousand short tons--	2,149	3,508	2,250	5,217	2,438	4,168	2,930	4,943
Tungsten concentrate----60-percent WO_3 basis--	1,152	4,079	873	3,010	45	55	(4)	(4)
Uranium ore----	----------	----------	496,517	12,410	740,055	15,605	[16] 939,706	[16] 22,486
Vanadium----thousand pounds--	4,595	(4)	5,582	(4)	6,264	(4)	4,791	(4)
Zinc (recoverable content of ores, etc.)----	35,350	8,696	40,246	11,027	47,000	10,904	37,132	7,575
Value of items that cannot be disclosed: Carbon dioxide, cement, fluorspar, perlite, tin (1955), and values indicated by footnote 4----	----------	76,969	----------	75,632	----------	[8] 81,907	----------	62,855
Total Colorado [9]----	----------	286,219	----------	[8] 321,908	----------	[8] 338,504	----------	305,284
CONNECTICUT								
Beryllium concentrate----gross weight--	5	$3	(4)	(4)	(4)	(4)	(4)	(4)
Clays----thousand short tons--	325	315	338	$390	308	$409	199	$299
Gem stones----	----------	----------	----------	----------	(12)	(4)	(12)	3
Lime----thousand short tons--	35	503	40	609	30	503	29	464
Mica (sheet and scrap)----	3	13	[17] 310	[17] 2	(4)	(4)	(4)	(11)
Peat----	(4)	(4)	3,190	13	2,004	11	1,764	11
Sand and gravel----thousand short tons--	4,345	4,080	4,369	4,101	4,777	5,042	5,019	5,479
Stone----do----	3,642	5,451	[7] 4,428	[7] 6,590	6,199	10,040	4,223	6,863
Value of items that cannot be disclosed: Columbium-tantalum concentrate (1955), feldspar, stone (crushed granite and dimension limestone 1955, dimension limestone, 1956) and values indicated by footnote 4----	----------	123	----------	124	----------	119	----------	89
Total Connecticut [9]----	----------	10,428	----------	11,737	----------	16,055	----------	13,128
DELAWARE								
Sand and gravel----thousand short tons--	2,297	$1,407	1,160	$967	974	$860	1,090	$962
Stone----do----	79	228	83	232	(4)	(4)	(4)	(4)
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4----	----------	23	----------	33	----------	182	----------	180
Total Delaware----	----------	1,658	----------	1,232	----------	1,042	----------	1,142

See footnotes at end of table.

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

FLORIDA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays .... thousand short tons	413	$4,816	432	$5,826	422	$6,067	450	$5,808
Lime .... do	(4)	(4)	40	490	(4)	(4)	(4)	(4)
Natural gas .... million cubic feet	36	4	35	3	34	4	[6] 35	[6] 5
Peat	61,098	232	58,496	203	37,844	195	36,438	165
Petroleum (crude) .... thousand 42-gallon barrels	495	(4)	479	(4)	461	(4)	[6] 448	(4)
Phosphate rock .... thousand long tons	8,747	53,640	11,822	74,290	10,191	64,789	10,851	68,951
Sand and gravel .... thousand short tons	5,066	4,349	5,815	5,034	6,753	6,148	5,490	4,389
Stone .... do	[7] 17,028	[7] 22,966	18,779	25,183	21,786	30,467	[7] 23,549	[7] 30,983
Titanium concentrate:								
Rutile .... gross weight	9,182	1,122	(4)	(4)	(4)	(4)	(4)	(4)
Zirconium concentrate	28,913	1,425	43,794	2,160	56,802	1,976	30,302	1,018
Value of items that cannot be disclosed: Cement, abrasive garnet (1956), gem stones (1956), rare-earth metals concentrates (1956-58), staurolite (1957-58), stone (dimension limestone, 1955 and 1958), titanium concentrate (ilmenite), and values indicated by footnote 4		22,787		28,452		[8] 33,157		34,003
Total Florida [9]		108,957		140,490		[8] 140,467		142,111

GEORGIA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays .... thousand short tons	2,953	$26,145	3,047	$29,501	2,707	$30,120	2,942	$31,253
Coal .... do	12	62	8	42	13	63	9	44
Iron ore (usable) .... thousand long tons, gross weight	257	994	357	1,609	443	2,109	209	1,008
Iron oxide pigments	6,139	36	(4)	(4)	(4)	(4)	(4)	(4)
Manganiferous ore (5 to 35 percent Mn) .... gross weight	(4)	(4)	(4)	(4)	2,203	(4)	(4)	(4)
Mica (sheet) .... pounds	(4)	(4)	20,149	150	16,933	158	15,102	82
Peat	(4)	(4)	6,225	48	4,690	45	4,491	(4)
Sand and gravel .... thousand short tons	2,988	2,199	2,426	2,183	2,127	2,096	[10] 2,631	[10] 2,693
Stone .... do	[7] 7,488	[7] 14,250	[7] 9,196	[7] 20,714	[7] 9,065	[7] 15,833	12,129	31,108
Talc and soapstone	53,828	118	57,916	122	49,372	106	(4)	(4)
Value of items that cannot be disclosed: Barite, bauxite, beryllium concentrate (1955-57), cement, feldspar, gem stones, manganese ore, scrap mica, slate (1955-57), 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		17,495		14,558		20,081		10,145
Total Georgia [9]		60,417		67,912		69,799		75,106

HAWAII

Clays .... thousand short tons..	(4)	(4)	2	$2	2	$3	(4)	(4)
Lime .... do....	6	$202	10	306	8	271	8	$260
Pumice .... do....	130	76	59	92	266	493	260	481
Salt .... do....	(4)	(4)	(18)	18	(18)	15	(18)	(4)
Sand and gravel .... do....	165	426	193	503	286	538	438	1,112
Stone .... do....	1,414	2,884	3,494	6,076	2,585	4,632	2,377	4,446
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 4	....	22	....	....	....	....	....	13
Total Hawaii [19]	....	3,592	....	6,972	....	5,930	....	6,298

IDAHO

Antimony ore and concentrate .... antimony content..	633	(4)	549	(4)	664	(4)	677	(4)
Beryllium concentrate .... gross weight..	....	....	....	....	1	(11)	....	....
Clays .... thousand short tons..	35	$30	[5] 23	[5] $13	[5] 23	[5] $16	[5] 27	[5] $20
Cobalt (content of concentrate) .... thousand pounds..	1,691	(4)	2,385	(4)	2,618	(4)	3,078	(4)
Columbium-tantalum concentrate .... pounds..	(4)	(4)	215,900	(4)	364,768	(4)	422,612	(4)
Copper (recoverable content of ores, etc.)	5,618	4,191	6,656	5,658	7,912	4,763	9,846	5,179
Gold (recoverable content of ores, etc.) .... troy ounces..	10,572	370	9,210	322	12,301	431	15,896	556
Iron ore (usable) .... thousand long tons..	....	....	1	(4)	(4)	(4)	1	14
Lead (recoverable content of ores, etc.)	64,163	19,121	64,321	20,197	71,637	20,488	53,603	12,543
Mercury .... 76-pound flasks..	1,107	321	3,394	882	2,260	558	2,625	601
Mica:								
Scrap	....	....	....	....	....	....	1	(11)
Sheet .... pounds..	(4)	(4)	....	....	1,240	9	1,968	14
Nickel (content of ore and concentrate)	33	(4)	49	(4)	37	55	29	(4)
Phosphate rock .... thousand long tons..	1,330	6,038	1,438	6,539	1,307	5,684	1,291	5,652
Pumice .... thousand short tons..	(4)	(4)	102	206	100	168	108	172
Rare-earth metals concentrates	(4)	(4)	303	(4)	366	(4)	692	(4)
Sand and gravel .... thousand short tons..	8,652	3,934	7,874	5,661	[8] 6,665	[8] 5,274	6,714	6,305
Silver (recoverable content of ores, etc.) .... thousand troy ounces..	13,831	12,518	13,472	12,193	15,067	13,637	15,953	14,438
Stone .... thousand short tons..	1,525	1,866	1,791	2,752	1,542	2,759	1,122	1,710
Titanium concentrate .... gross weight..	1,330	7	48,619	261	28,397	(4)	2,223	(4)
Tungsten concentrate .... 60-percent WO_3 basis..	642	(4)	582	(4)	35	(4)	(4)	(4)
Zinc (recoverable content of ores, etc.)	53,314	13,115	49,561	13,580	57,831	13,417	49,725	10,144
Value of items that cannot be disclosed: Barite, cement, fire clay (1956-1958), bentonite (1958), fluorspar (1955), abrasive garnet, gem stones, gypsum (1958), peat (1955, 1957-58), stone (crushed limestone 1955), uranium ore (1957-58), zirconium concentrate (1958), and values indicated by footnote 4	....	[19] 7,002	....	[19] 6,885	....	[8] [19] 6,243	....	[19] 7,108
Total Idaho	....	68,513	....	75,150	....	[8] 73,502	....	64,456

See footnotes at end of table.

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

ILLINOIS

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Cement ... thousand 376-pound barrels	9,397	$25,032	9,301	$27,264	8,575	$26,356	9,618	$30,858
Clays ... thousand short tons	2,339	3,979	2,258	4,005	1,917	5,155	2,335	5,910
Coal ... do	45,932	167,938	48,102	184,678	46,993	187,908	43,912	176,614
Fluorspar	166,337	7,838	178,254	8,470	169,939	8,827	152,087	7,931
Gem stones	------	------	------	------	(12)	2	(12)	1
Lead (recoverable content of ores, etc.)	4,544	1,354	3,832	1,203	2,970	849	1,610	377
Lime ... thousand short tons	644	9,416	(4)	(4)	(4)	(4)	(4)	(4)
Natural gas ... million cubic feet	8,033	1,036	6,177	933	9,647	1,495	[6] 12,983	[6] 1,921
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	(4)	(4)	(4)	(4)	(4)	(4)	22,380	1,645
LP-gases ... do	(4)	(4)	(4)	(4)	(4)	(4)	353,129	20,866
Peat	(4)	(4)	14,451	158	11,480	106	11,588	72
Petroleum (crude) ... thousand 42-gallon barrels	81,423	236,940	82,346	241,274	77,083	240,499	[6] 82,125	[6] 246,375
Sand and gravel ... thousand short tons	26,362	28,139	31,239	33,254	30,151	32,572	29,866	33,453
Silver (recoverable content of ores, etc.) ... thousand troy ounces	3	3	2	1	------	------	------	------
Stone ... thousand short tons	28,866	35,621	31,855	40,859	31,861	41,835	35,016	44,245
Zinc (recoverable content of ores, etc.)	21,700	5,338	24,039	6,587	22,185	5,147	24,940	5,088
Value of items that cannot be disclosed: Tripoli, and values indicated by footnote 4	------	12,666	------	26,048	------	[8] 27,898	------	9,573
Total Illinois [9]	------	[8] 532,984	------	[8] 572,247	------	[8] 576,324	------	582,412

INDIANA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Abrasive stones	(4)	(4)	3	$5	4	$8	10	$10
Clays ... thousand short tons	1,729	$2,938	2,051	3,457	1,475	2,569	1,371	2,477
Coal ... do	16,149	58,000	17,089	64,061	15,841	62,055	15,022	58,506
Lime ... do	(4)	(4)	(18)	1	------	------	------	------
Marl, calcareous (except for cement)	17,080	10	99,561	66	(20)	(20)	(20)	(20)
Natural gas ... million cubic feet	1,226	152	791	96	671	88	[6] 378	[6] 59
Peat	(4)	(4)	11,383	79	13,805	130	12,106	145
Petroleum (crude) ... thousand 42-gallon barrels	10,988	31,980	11,513	33,733	12,662	39,632	[6] 11,864	[6] 35,711
Sand and gravel ... thousand short tons	17,082	14,306	18,302	15,432	16,750	14,206	16,862	15,045

Stone ... do	14,124	34,680	14,700	31,575	14,460	33,094	15,394	31,974
Value of items that cannot be disclosed: Cement, gypsum, and values indicated by footnote 4		[8] 43,618		[8] 50,284		[8] 48,417		56,397
Total Indiana [9]		[8] 183,209		[8] 196,439		[8] 198,034		197,677
IOWA								
Cement ... thousand 376-pound barrels	10,430	$29,539	10,760	$32,823	10,823	$34,881	12,675	$41,741
Clays ... thousand short tons	(4)	(4)	[5] 852	[5] 1,078	[5] 752	[5] 944	[5] 837	[5] 1,054
Coal ... do	1,258	4,402	1,358	4,732	1,312	4,543	1,179	4,147
Gypsum ... do	1,337	4,177	1,177	3,919	1,123	3,773	1,230	4,491
Peat	(4)	(4)	27,375	(4)	(4)	(4)	(4)	(4)
Sand and gravel ... thousand short tons	11,771	8,345	12,895	9,525	12,042	8,927	12,411	10,965
Stone ... do	15,705	18,555	14,035	17,256	15,214	18,768	21,045	26,138
Value of items that cannot be disclosed: Fire clay (1956–58), lime, and values indicated by footnote 4		1,252		467		614		633
Total Iowa [9]		63,555		66,529		68,985		85,356
KANSAS								
Cement [21] ... thousand 376-pound barrels	9,454	$25,854	10,598	$30,696	8,178	$24,814	9,600	$30,047
Clays ... thousand short tons	[5] 768	[5] 873	977	1,169	909	1,240	875	1,145
Coal ... do	742	3,166	884	3,856	749	3,331	823	3,711
Helium ... thousand cubic feet	42,750	663	45,035	698	36,743	570	27,888	432
Lead (recoverable content of ores, etc.)	5,498	1,638	7,635	2,398	4,257	1,217	1,299	304
Natural gas ... million cubic feet	471,041	52,286	526,091	59,448	586,690	66,883	[6] 561,816	[6] 64,047
Natural-gas liquids:								
Natural gasoline ... thousand gallons	118,599	6,318	105,482	5,928	119,247	6,569	110,293	6,229
LP-gases ... do	92,596	2,643	90,287	3,843	103,494	4,042	115,175	5,193
Petroleum (crude) ... thousand 42-gallon barrels	121,669	340,670	124,204	346,529	123,614	372,078	[6] 118,188	[6] 354,564
Pumice ... thousand short tons	2	60	(4)	(4)	(4)	(4)	(4)	(4)
Salt (common) ... do	911	8,432	1,004	9,167	1,018	10,353	1,073	11,348
Sand and gravel ... do	10,665	6,910	12,515	8,022	9,345	6,175	10,317	6,769
Stone ... do	12,483	15,946	13,434	15,703	[7] 10,412	[7] 11,926	[7] 12,424	[7] 15,036
Zinc (recoverable content of ores, etc.)	27,611	6,792	28,665	7,854	15,859	3,679	4,421	902
Value of items that cannot be disclosed: Natural cement, fire clay (1955), gypsum, stone (dimension and crushed sandstone, 1957–58), and values indicated by footnote 4		1,616		1,465		1,191		1,627
Total Kansas [9]		470,830		493,770		[8] 511,513		498,526

See footnotes at end of table.

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

KENTUCKY

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays ... thousand short tons	876	$4, 416	905	$4, 079	894	$3, 915	737	$2, 957
Coal ... do	69, 020	288, 665	74, 555	331, 358	74, 667	338, 109	66, 312	289, 385
Fluorspar	8, 899	308	14, 865	608	20, 626	979	25, 861	1, 201
Lead (recoverable content of ores, etc.)	-----	-----	228	72	411	118	516	121
Natural gas ... million cubic feet	73, 214	17, 352	73, 687	17, 022	70, 024	16, 666	[6] 72, 248	[6] 17, 412
Natural-gas liquids:								
Natural gasoline ... thousand gallons	34, 991	2, 492	35, 275	2, 414	34, 956	1, 935	37, 926	2, 165
LP-gases ... do	189, 247	6, 451	248, 992	8, 709	176, 033	7, 403	150, 655	8, 491
Petroleum (crude) ... thousand 42-gallon barrels	15, 518	44, 850	17, 628	51, 297	17, 029	53, 301	[6] 17, 509	[6] 51, 652
Sand and gravel ... thousand short tons	4, 899	5, 298	5, 684	5, 974	4, 482	4, 556	4, 685	4, 835
Stone ... do	11, 934	15, 579	11, 553	15, 324	12, 718	16, 714	12, 597	17, 360
Zinc (recoverable content of ores, etc.)	-----	-----	417	114	837	194	1, 258	257
Value of items that cannot be disclosed: Native asphalt (1955–57), cement, iron ore (1956), and silver (1956–58)	-----	6, 446	-----	7, 079	-----	6, 211	-----	7, 059
Total Kentucky [9]	-----	391, 068	-----	443, 168	-----	[8] 449, 390	-----	402, 121

LOUISIANA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays [5] ... thousand short tons	651	$659	785	$785	642	$642	755	$755
Gypsum ... do	335	587	276	598	(4)	(4)	(4)	(4)
Natural gas ... million cubic feet	1, 680, 032	189, 844	1, 886, 302	215, 038	2, 078, 901	232, 837	[6] 2, 451, 587	[6] 316, 255
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	782, 328	59, 158	773, 949	62, 394	775, 009	63, 956	783, 099	50, 371
LP-gases ... do	291, 138	10, 323	305, 222	14, 727	335, 142	14, 888	410, 869	21, 435
Petroleum (crude) ... thousand 42-gallon barrels	271, 010	793, 280	299, 421	877, 951	329, 896	1, 094, 402	[6] 312, 070	[6] 1, 017, 562
Salt (common) ... thousand short tons	3, 563	15, 407	3, 704	17, 695	3, 461	18, 944	3, 442	18, 960
Sand and gravel ... do	8, 574	10, 942	15, 074	18, 640	12, 579	14, 730	15, 061	17, 119
Stone ... do	3, 253	4, 961	4, 405	6, 674	4, 383	7, 152	5, 453	9, 532
Sulfur (Frasch-process) ... thousand long tons	2, 072	58, 028	2, 239	59, 330	2, 156	52, 690	2, 028	47, 651
Value of items that cannot be disclosed: Cement, bentonite, lime, and values indicated by footnote 4	-----	[8] 15, 096	-----	[8] 16, 348	-----	[8] 18, 966	-----	20, 475
Total Louisiana [10]	-----	[8] 1, 156, 424	-----	[8] 1, 288, 116	-----	[8] 1, 517, 522	-----	1, 517, 415

MAINE								
Beryllium concentrate.....gross weight..	22	$13	12	$7	4	$2	(10)	(11)
Cement.....thousand 376-pound barrels..	2,349	6,875	(4)	(4)	(4)	(4)	(4)	(4)
Clays.....thousand short tons..	33	33	26	23	30	28	23	$26
Feldspar.....long tons..	26,282	189	22,219	144	14,330	92	13,034	83
Gem stones.....	(12)	5	(12)	1	(12)	1	(12)	5
Lime.....thousand short tons..	(4)	(4)	12	179	(4)	(4)	(4)	(4)
Mica: Scrap.....	71	2	114	3	6	(11)	104	3
Sheet.....pounds..	21,121	129	19,913	146	25,453	202	20,097	278
Peat.....	(4)	(4)	(4)	(4)	3,770	175	(4)	(4)
Sand and gravel.....thousand short tons..	7,529	2,855	7,196	3,085	8,037	3,099	8,941	3,746
Stone.....do....	1,192	2,542	947	2,787	889	3,076	880	2,760
Value of items that cannot be disclosed: Columbium-tantalum concentrate (1955–56), slate (1955–57), and values indicated by footnote 4.....	.....	857	.....	6,912	.....	6,617	.....	6,363
Total Maine [19].....	.....	12,991	.....	12,728	.....	12,711	.....	12,574
MARYLAND								
Clays.....thousand short tons..	698	$1,265	[5] 636	[5] $1,046	[5] 631	[5] $963	[5] 605	$815
Coal.....do....	512	2,002	669	2,685	748	3,082	838	3,161
Gem stones.....	(12)	(4)	(12)	(4)	(12)	(4)	(12)	2
Lime.....do....	74	669	53	581	(4)	(4)	(4)	(4)
Natural gas.....million cubic feet..	3,116	626	4,619	1,169	4,649	1,218	[6] 4,266	[6] 1,148
Sand and gravel.....thousand short tons..	9,695	12,211	10,147	12,395	8,679	11,594	7,864	10,312
Stone.....do....	[7] 5,343	[7] 8,800	6,229	13,305	6,140	13,392	6,721	14,387
Value of items that cannot be disclosed: Beryllium concentrate (1955–57), cement, ball clay (1956–58), gem stones (1956–58), greensand marl, mica (1957), potassium salts, slate (1955), stone (oystershell 1955), talc and soapstone, and values indicated by footnote 4.....	.....	11,025	.....	10,729	.....	10,664	.....	16,224
Total Maryland [9].....	.....	35,488	.....	40,534	.....	[8] 39,625	.....	44,679
MASSACHUSETTS								
Clays.....thousand short tons..	125	$142	128	$213	78	$98	85	$111
Lime.....do....	135	1,957	134	2,093	137	2,233	139	2,121
Peat.....	(4)	(4)	300	(4)	600	(4)	1,014	(4)
Sand and gravel.....thousand short tons..	9,581	8,926	10,189	9,520	9,900	9,691	10,620	10,035
Stone.....do....	4,128	11,381	5,442	13,753	4,877	13,165	4,649	12,354
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4.....	.....	6	.....	3	.....	6	.....	9
Total Massachusetts [19].....	.....	22,109	.....	25,085	.....	24,789	.....	23,887

See footnotes at end of table.

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

MICHIGAN

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Cement ...thousand 376-pound barrels..	19,738	$58,048	21,880	$67,798	22,045	$71,606	20,912	$70,432
Clays ...thousand short tons..	1,938	2,019	2,110	2,401	1,842	1,982	1,663	1,813
Copper (recoverable content of ores, etc.) ...	50,066	37,349	61,526	52,297	58,400	35,157	58,005	30,511
Gypsum ...thousand short tons..	1,762	5,661	1,716	5,861	1,386	4,823	1,331	4,824
Iron ore (usable) ...thousand long tons, gross weight..	14,144	104,258	12,536	98,111	13,123	111,484	8,111	69,845
Magnesium compounds from well brines (partly estimated) MgO equivalent ...	46,336	5,064	(4)	(4)	(4)	(4)	(4)	(4)
Manganiferous ore (5 to 35 percent Mn) ...gross weight..					123,547	(4)	112,536	(4)
Marl, calcareous (except for cement) ...	119,313	57	157,246	95	(20)	(20)	(20)	(20)
Natural gas ...million cubic feet..	8,300	955	10,911	1,451	9,122	1,715	[6] 14,243	[6] 2,649
Natural-gas liquids:								
Natural gasoline ...thousand gallons..	(4)	(4)	(4)	(4)	(4)	(4)	382	28
LP-gases ...do..	(4)	(4)	(4)	(4)	(4)	(4)	2,754	112
Peat ...	(4)	(4)	31,111	475	80,271	1,406	107,342	1,684
Petroleum (crude) ...thousand 42-gallon barrels..	11,266	32,900	10,740	30,824	10,169	31,117	[6] 9,307	[6] 27,363
Salt (common) ...thousand short tons..	4,975	31,668	5,548	35,644	5,225	41,073	4,267	33,018
Sand and gravel ...do..	37,214	29,491	42,150	35,146	41,838	35,144	39,871	34,616
Silver (recoverable content of ores, etc.) ...thousand troy ounces..	478	433	380	344	430	389		
Stone ...thousand short tons..	33,636	28,909	33,999	31,010	34,495	34,176	27,188	26,846
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, gem stones (1955–57), lime, magnesium chloride for metal (1955), potassium salts, and values indicated by footnote 4 ...		31,841		38,737		[8] 40,324		45,418
Total Michigan [9] ...		363,778		394,556		[8] 404,673		343,483

MINNESOTA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays ...thousand short tons..	(4)	(4)	[5] 80	[5] $91	[5] 97	[5] $113	93	$150
Iron ore (usable) ...thousand long tons, gross weight..	69,419	$465,170	62,637	461,904	67,656	541,474	42,503	354,528
Manganiferous ore (5 to 35 percent Mn) ...gross weight..	864,628	(4)	633,919	(4)	692,295	(4)	370,603	(4)
Marl, calcareous (except for cement) ...	(4)	(4)	875	(4)	(20)	(20)	(20)	(20)
Peat ...	(4)	(4)	(4)	(4)	1,300	(4)	(4)	(4)
Sand and gravel ...thousand short tons..	25,896	17,429	28,197	18,254	28,493	19,385	29,634	21,680
Stone ...do..	[7] 3,005	[7] 7,043	[7] 3,084	[7] 7,552	[7] 2,968	[7] 8,175	3,519	9,560

Value of items that cannot be disclosed: Abrasive stones, cement, fire clay (1956–57), gem stones, lime, manganese ore (1955–57), stone (crushed sandstone, 1955–57, calcareous marl 1957), and values indicated by footnote 4	----------	11,739	----------	13,443	----------	[8] 15,107	----------	10,154
Total Minnesota [19]	----------	501,151	----------	501,027	----------	[8] 584,037	----------	395,880
MISSISSIPPI								
Clays .... thousand short tons	701	$3,913	613	$3,590	616	$3,635	576	$3,338
Iron ore .... thousand long tons	----------	----------	(22)	(11)	(22)	1	(22)	(11)
Natural gas .... million cubic feet	163,167	15,664	185,137	18,143	169,967	17,507	[6] 160,143	[6] 22,260
Natural-gas liquids:								
Natural gasoline and cycle products .... thousand gallons	22,382	1,573	24,829	1,751	25,152	1,469	25,738	1,658
LP-gases .... do	12,242	396	10,698	580	10,044	472	9,208	503
Petroleum (crude) .... thousand 42-gallon barrels	37,741	92,840	40,824	100,019	38,922	113,263	[6] 38,551	[6] 110,256
Sand and gravel .... thousand short tons	5,625	4,603	5,315	4,701	5,172	4,344	6,545	6,240
Stone .... do	573	573	656	656	[7] 60	[7] 54	[7] 102	[7] 92
Value of items that cannot be disclosed: Certain metals and nonmetals	----------	3,590	----------	4,174	----------	4,694	----------	4,820
Total Mississippi [19]	----------	122,620	----------	133,098	----------	[8] 144,950	----------	148,663
MISSOURI								
Barite	363,692	$4,004	381,642	$4,462	317,350	$3,938	199,268	$2,666
Cement .... thousand 376-pound barrels	[14] 12,255	[14] 34,912	[14] 12,012	[14] 36,888	[14] 10,794	[14] 34,307	12,116	40,657
Clays .... thousand short tons	2,402	6,902	2,658	8,016	2,648	7,648	2,060	5,986
Coal .... do	3,232	12,772	3,283	13,223	2,976	12,691	2,592	11,111
Copper (recoverable content of ores, etc.)	1,722	1,285	1,890	1,606	1,604	966	1,429	752
Iron ore (usable) .... thousand long tons, gross weight	261	(4)	365	(4)	530	4,625	387	3,820
Lead (recoverable content of ores, etc.)	125,412	37,373	123,783	38,868	126,345	36,135	113,123	26,471
Lime .... thousand short tons	1,465	14,408	1,482	15,814	1,393	16,475	1,173	14,136
Natural gas .... million cubic feet	15	3	12	2	12	2	----------	----------
Nickel (content of ore and concentrate)	(4)	(4)	(4)	(4)	(4)	(4)	763	(4)
Petroleum (crude) .... thousand 42-gallon barrels	72	190	65	176	(4)	(4)	(4)	(4)
Sand and gravel .... thousand short tons	9,984	9,981	9,585	10,117	8,480	8,942	8,972	9,728
Silver (recoverable content of ores, etc.) .... thousand troy ounces	269	243	295	267	184	166	251	227
Stone .... thousand short tons	[7] 22,369	[7] 29,580	24,578	33,577	22,098	29,836	24,276	32,878
Zinc (receoverable content of ores, etc.)	4,476	1,101	4,380	1,200	2,951	685	362	74
Value of items that cannot be disclosed: Native asphalt, masonry cement (1955–57), cobalt, gem stones (1957), iron oxide pigment materials (1955–56), manganese ore (1957–58), stone (dimension marble 1955), and values indicated by footnote 4	----------	4,833	----------	5,897	----------	[8] 2,793	----------	1,926
Total Missouri [9]	----------	151,626	----------	163,693	----------	[8] 152,913	----------	144,009

See footnotes at end of table.

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

MONTANA

Mineral	1955		1956		1957		1958	
	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)
Chromite...gross weight	118,703	$3,719	118,780	$3,807	119,149	$3,921	119,057	(4)
Clays...thousand short tons	(4)	(4)	[5] 33	[5] 31	[5] 32	[5] 24	[5] 23	[5] $19
Coal: Bituminous and lignite...do	1,247	3,782	846	3,468	413	2,161	305	1,475
Copper (recoverable content of ores, etc.)	81,542	60,830	98,426	81,962	91,512	55,090	90,683	47,699
Fluorspar	25,223	(4)	59,775	(4)	64,339	(4)	53,654	(4)
Gem stones	(12)	(4)	(12)	35	(12)	(4)	(12)	(4)
Gold (recoverable content of ores, etc.)...troy ounces	28,123	984	38,121	1,334	32,766	1,147	26,003	910
Iron ore (usable)...thousand long tons, gross weight	7	(4)	12	(4)	36	(4)	14	(4)
Lead (recoverable content of ores, etc.)	17,028	5,075	18,642	5,853	13,300	3,804	8,434	1,974
Manganese ore (35 percent or more Mn)...gross weight	106,026	(4)	80,552	(4)	68,298	(4)	53,123	4,036
Manganiferous ore (5 to 35 percent Mn)...do	6,341	(4)	4,752	(4)	4,547	(4)	(4)	(4)
Mica, sheet...pounds	----------	----------	56	1	13	(11)	(4)	(4)
Natural gas...million cubic feet	28,255	1,724	25,847	1,758	28,638	2,062	[6] 27,989	[6] 1,903
Petroleum (crude)...thousand 42-gallon barrels	15,654	35,380	21,760	56,141	27,172	73,364	[6] 28,291	[6] 74,971
Phosphate rock...thousand long tons	(4)	(4)	558	3,957	534	3,825	(4)	(4)
Sand and gravel...thousand short tons	13,772	6,615	10,024	7,174	[8] 11,403	[8] 8,732	13,432	12,593
Silver (recoverable content of ores, etc.)...thousand troy ounces	6,080	5,503	7,386	6,685	5,558	5,030	3,630	3,286
Stone...thousand short tons	1,274	1,200	1,247	1,816	2,567	3,654	1,545	2,214
Talc	(4)	(4)	22,197	210	(4)	(4)	(4)	(4)
Tungsten ore and concentrate...60-percent WO_3 basis	1,211	(4)	1,230	(4)	661	(4)	----------	----------
Uranium ore	----------	----------	(4)	(4)	(4)	(4)	689	20
Zinc (recoverable content of ores, etc.)	68,588	16,873	70,520	19,322	50,520	11,721	33,238	6,780
Value of items that cannot be disclosed: Barite, cement, clay (bentonite, 1956; bentonite and fire clay, 1957-58), gypsum, lime, natural-gas liquids, pumice (1955-56), pyrites, vanadium (1957), vermiculite, and values indicated by footnote 4	----------	25,637	----------	[8] 21,056	----------	[8] 17,951	----------	20,200
Total Montana [10]	----------	166,993	----------	[8] 213,704	----------	[8] 191,750	----------	177,240

NEBRASKA

Mineral	1955 Short tons	1955 Value	1956 Short tons	1956 Value	1957 Short tons	1957 Value	1958 Short tons	1958 Value
Clays...thousand short tons	151	$151	153	$154	134	$135	108	$110
Gem stones	(12)	2	(12)	3	(12)	2	(12)	2
Natural gas...million cubic feet	12,515	2,553	13,541	2,844	14,249	2,280	[6] 11,405	[6] 1,711
Natural-gas liquids:								
Natural gasoline...thousand gallons	(4)	(4)	(4)	(4)	(4)	(4)	10,870	727
LP-gases...do	(4)	(4)	(4)	(4)	(4)	(4)	31,178	1,565
Petroleum (crude)...thousand 42-gallon barrels	11,203	30,810	16,204	45,209	19,586	58,366	[6] 20,368	[6] 59,882

Sand and gravel .... thousand short tons..	8,405	6,193	10,350	7,404	7,944	5,889	10,441	7,945
Stone .... do....	3,081	4,177	3,063	4,142	3,065	3,749	3,555	4,747
Value of items that cannot be disclosed: Cement and pumice........	....	11,144	....	12,771	....	13,670	....	14,603
Total Nebraska [9]	....	54,237	....	71,311	....	[8] 82,928	....	90,032
NEVADA								
Antimony ore and concentrate .... antimony content..	....	....	13	(4)	29	$9	39	$8
Barite	113,694	$709	178,440	$1,067	109,663	721	59,407	405
Clays .... thousand short tons..	6	13	14	32	12	20	(4)	(4)
Copper (recoverable content or ores, etc.)	78,925	58,878	80,824	68,700	77,750	46,806	66,137	34,788
Fluorspar	(4)	(4)	(4)	(4)	(4)	(4)	12,338	340
Gem stones	(12)	(4)	(12)	50	(12)	100	(12)	100
Gold (recoverable content of ores, etc.) .... troy ounces..	72,913	2,552	68,040	2,381	76,752	2,680	105,087	3,678
Gypsum .... thousand short tons..	837	2,836	790	2,701	674	(4)	686	2,306
Iron ore (usable) .... thousand long tons, gross weight..	325	1,667	917	5,021	904	5,341	594	3,149
Lead (recoverable content of ores, etc.)	3,291	981	6,384	2,004	5,979	1,710	4,150	971
Manganese ore (35 percent or more Mn) .... gross weight..	101,469	(4)	121,482	(4)	129,046	(4)	127,322	7,566
Mercury .... 76-pound flasks..	5,750	1,669	5,859	1,523	6,313	1,559	7,336	1,681
Petroleum .... thousand 42-gallon barrels..	64	110	64	111	44	76	[6] 40	[6] 69
Pumice .... thousand short tons..	(4)	(4)	12	34	(4)	(4)	(4)	(4)
Sand and gravel .... do....	3,580	3,762	4,687	4,569	5,233	5,190	5,503	5,311
Silver (recoverable content of ores, etc.) .... thousand troy ounces..	845	765	994	899	959	868	933	844
Stone .... thousand short tons..	1,612	2,609	1,401	2,281	925	1,585	813	1,335
Talc and soapstone	10,732	79	10,540	98	7,467	57	5,391	41
Tungsten concentrate .... 60-percent WO_3 basis..	6,155	22,751	5,400	19,263	1,196	1,676	(4)	(4)
Zinc (recoverable content of ores, etc.)	2,670	657	7,488	2,052	5,292	1,228	91	19
Value of items that cannot be disclosed: Brucite (1956-58), diatomite, lime, magnesite, calcareous marl (1955-56), molybdenum, perlite, salt, sulfur ore, uranium (1956-58), and values indicated by footnote 4........	....	13,752	....	14,446	....	16,756	....	6,020
Total Nevada [10]	....	113,220	....	126,681	....	86,023	....	68,293
NEW HAMPSHIRE								
Beryllium concentrate .... gross weight..	20	$12	(4)	(4)	4	$2	14	$8
Clays .... thousand short tons..	35	35	36	$47	37	51	26	26
Gem stones	(12)	5	(12)	1	(12)	(11)	(12)	5
Mica:								
Sheet .... pounds..	(4)	(4)	50,873	178	53,554	460	75,173	604
Scrap	(4)	(4)	305	10	522	17	314	12
Peat	(4)	(4)	320	(4)	85	(4)	100	(4)
Sand and gravel .... thousand short tons..	2,432	1,593	3,862	1,822	4,505	1,970	4,940	2,620
Value of items that cannot be disclosed: Abrasive stones (1955-57), columbium-tantalum concentrate (1955), feldspar, stone, and values indicated by footnote 4........	....	960	....	1,378	....	831	....	602
Total New Hampshire	....	2,605	....	3,436	....	3,331	....	3,877

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

NEW JERSEY

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays ......thousand short tons	644	$1,562	[5] 651	[5] $2,214	[5] 593	[5] $1,872	684	$2,181
Gem stones	(12)	(4)	(12)	(4)	(12)	(4)	(12)	4
Iron ore (usable) ......thousand long tons, gross weight	760	13,633	912	16,842	877	16,668	(4)	(4)
Manganiferous residuum ......gross weight	213,370	(4)	130,129	(4)	(4)	(4)	(4)	(4)
Peat	(4)	(4)	(4)	(4)	(4)	(4)	18,397	185
Sand and gravel ......thousand short tons	11,153	16,425	11,194	18,239	10,323	17,619	9,877	16,145
Stone ......do	[7] 8,358	[7] 17,528	9,012	20,825	8,792	21,222	8,229	19,193
Zinc (recoverable content of ores, etc.)[23]	11,643	2,864	4,667	1,260	12,530	2,857	607	125
Value of items that cannot be disclosed: Ball clay (1956–57), lime, magnesium compounds, greensand marl, stone (crushed marble, 1955), and values indicated by footnote 4. Excludes limestone used in manufacturing lime	------	5,239	------	4,608	------	[8] 4,404	------	12,547
Total New Jersey	------	[8] 57,251	------	[8] 63,988	------	[8] 64,642	------	50,380

NEW MEXICO

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Barite	(4)	(4)	4,059	$81	4,441	$98	(4)	(4)
Beryllium concentrate ......gross weight	106	$56	31	(4)	29	15	27	$16
Clays ......thousand short tons	45	109	40	95	33	83	[6] 40	[6] 73
Coal ......do	202	1,236	158	923	137	829	117	719
Columbium-tantalum concentrate ......pounds	76	(11)	95	(11)	866	1	------	------
Copper (recoverable content of ores, etc.)	66,417	49,547	74,345	63,193	67,472	40,618	55,540	29,214
Gem stones	(12)	25	(12)	30	(12)	30	(12)	28
Gold (recoverable content of ores, etc.) ......troy ounces	1,917	67	3,275	115	3,212	112	3,378	118
Helium ......thousand cubic feet	53,721	946	76,072	1,350	69,336	1,189	29,793	502
Iron ore (usable) ......thousand long tons, gross weight	9	(4)	(4)	(4)	(22)	1	(22)	(4)
Lead (recoverable content of ores, etc.)	3,296	982	6,042	1,897	5,294	1,514	1,117	261
Lime ......thousand short tons	------	------	31	373	24	290	21	260
Manganese ore (35 percent or more Mn) ......gross weight	1,390	(4)	22,011	1,834	25,459	2,114	24,665	1,996
Manganiferous ore (5 to 35 percent Mn) ......do	40,320	(4)	38,782	(4)	42,535	152	(4)	(4)
Mica:								
Scrap	84	3	767	22	1,347	47	787	24
Sheet ......pounds	9,431	65	6,247	53	2,134	16	1,791	18
Natural gas ......million cubic feet	540,664	48,119	626,340	55,118	723,004	67,962	[6] 761,446	[6] 79,190

Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	261,023	15,425	306,595	16,560	309,010	19,941	258,312	15,131
LP-gases ... do	278,403	6,767	308,218	11,065	375,930	13,046	458,178	17,331
Perlite	147,805	1,091	167,705	1,271	187,259	1,568	202,046	1,790
Petroleum (crude) ... thousand 42-gallon barrels	82,958	227,310	87,893	241,706	94,759	283,128	[6] 98,323	[6] 293,400
Potassium salts ... thousand short tons, K_2O equivalent	1,899	71,839	1,997	75,122	2,080	77,197	1,978	69,106
Pumice ... thousand short tons	394	780	292	667	321	756	507	959
Salt (common) ... do	50	597	58	501	53	429	31	275
Sand and gravel ... do	4,556	6,005	6,054	5,776	7,991	7,803	13,205	11,413
Silver (recoverable content of ores, etc.) ... thousand troy ounces	251	227	393	356	309	280	159	144
Stone ... thousand short tons	1,573	1,547	1,268	1,272	1,348	1,618	1,730	1,507
Tungsten ore and concentrate ... 60-percent WO_3 basis	1	3	(10)	2				
Uranium ore			1,105,183	24,086	1,175,742	20,538	1,888,499	32,264
Zinc (recoverable content of ores, etc.)	15,277	3,758	35,010	9,593	32,680	7,582	9,034	1,843
Value of items that cannot be disclosed: Carbon dioxide, fire clay (1957), diatomite (1955), fluorspar (1955), molybdenum, magnesium compounds (1956–58), rare-earth metals concentrates (1956), vanadium, and values indicated by footnote 4		[8] 2,045		[8] 1,933		[8] 2,276		1,345
Total New Mexico [19]		[8] 438,549		[8] 514,903		[8] 551,155		558,866

NEW YORK

Cement ... thousand 376-pound barrels	[21] 17,942	[21] $52,150	(4)	(4)	(4)	(4)	(4)	(4)
Clays ... thousand short tons	1,394	1,676	1,235	$1,508	1,002	$1,270	1,085	$1,419
Emery	10,735	151	12,153	174	11,893	184	7,687	126
Gem stones	(12)	(4)	(12)	2	(12)	5	(12)	8
Gypsum ... thousand short tons	1,249	4,404	1,140	4,817	864	3,749	834	3,869
Iron ore (usable) ... thousand long tons, gross weight	3,202	38,019	3,188	41,094	3,329	44,567	1,944	25,683
Lead (recoverable content of ores, etc.)	1,037	309	1,608	505	1,667	477	579	135
Lime ... thousand short tons	83	1,366	87	1,030	(4)	(4)	(4)	(4)
Natural gas ... million cubic feet	3,637	1,073	4,098	1,160	2,869	815	[6] 2,808	[6] 859
Peat	(4)	(4)	2,900	23	(4)	(4)	13,606	117
Petroleum (crude) ... thousand 42-gallon barrels	2,904	10,310	2,748	12,091	2,677	12,662	[6] 1,664	[6] 7,039
Salt (common) ... thousand short tons	3,780	25,214	3,873	27,545	3,691	28,002	3,896	30,609
Sand and gravel ... do	25,562	25,542	27,815	28,722	25,640	26,480	24,730	27,541
Silver (recoverable content of ores, etc.) ... thousand troy ounces	66	60	84	76	64	58	67	60
Slate ... thousand short tons	91	1,345	64	944	59	961	(13)	(13)
Stone ... do	22,812	37,919	22,805	36,135	24,265	43,276	22,598	38,219
Zinc (recoverable content of ores, etc.)	53,016	13,042	59,111	16,196	64,659	15,001	53,014	10,815
Value of items that cannot be disclosed: Natural cement (1955 and 1958), abrasive garnet, iron oxide pigments, talc, titanium concentrate, wollastonite, and values indicated by footnote 4		8,773		68,969		70,699		61,859
Total New York [9]		216,907		237,016		[8] 244,114		204,920

See footnotes at end of table.

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

NORTH CAROLINA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Abrasive stones	[24] 227	$12	[24] 454	$16	([12])	[25] $5	([12])	[25] $2
Beryllium concentrate ..... gross weight	([4])	([4])	3	2	1	1	([16])	([11])
Clays ..... thousand short tons	2,375	1,792	2,663	2,027	[5] 2,392	[5] 1,407	[5] 2,046	[5] 1,187
Feldspar ..... long tons	242,724	2,185	255,637	3,192	233,439	2,728	([4])	([4])
Gem stones	([12])	([11])	([12])	1	([12])	([11])	([12])	1
Gold (recoverable content of ores, etc.) ..... troy ounces	190	7	882	31	1,373	48	876	31
Lead (recoverable content of ores, etc.)	2	1	10	3	9	3	----	----
Mica:								
Scrap	60,887	1,377	47,125	1,065	53,452	1,173	50,897	1,041
Sheet ..... pounds	553,444	2,745	770,903	2,135	577,607	1,575	521,701	1,722
Sand and gravel ..... thousand short tons	7,786	5,911	7,581	6,264	6,829	5,724	7,044	5,880
Silver (recoverable content of ores, etc.) ..... thousand troy ounces	([26])	([11])	1	1	12	11	15	14
Stone ..... thousand short tons	10,903	16,533	[7] 8,352	[7] 11,472	[7] 9,455	[7] 12,839	12,385	19,132
Talc and pyrophyllite	125,206	572	125,487	529	120,905	558	126,158	614
Tungsten concentrate ..... 60-percent WO_3 basis	2,609	([4])	2,732	([4])	1,828	([4])	([4])	([4])
Zinc	----	----	----	----	2	([11])	----	----
Value of items that cannot be disclosed: Abrasive stone (grinding pebbles and tube-mill liners, 1957-58), asbestos (1955, 1957-58), clay (bentonite 1957, kaolin 1958), 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 (1955), and values indicated by footnote 4	----	10,075	----	14,135	----	11,498	----	10,267
Total North Carolina	----	41,210	----	40,873	----	37,570	----	39,891

NORTH DAKOTA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays ..... thousand short tons	([4])	([4])	[5] 52	[5] $71	[5] 54	[5] $67	[5] 54	[5] $66
Coal (lignite) ..... do	3,102	$7,261	2,815	6,578	2,561	5,947	2,314	5,409
Gem stones	----	----	----	----	([12])	([11])	([12])	1
Natural gas ..... million cubic feet	5,256	405	11,725	950	15,450	1,468	[6] 17,325	[6] 1,672
Petroleum (crude) ..... thousand 42-gallon barrels	11,143	32,200	13,495	39,136	13,259	41,501	[6] 14,141	[6] 42,282
Pumice ..... thousand short tons	4	10	5	5	2	2	11	11
Sand and gravel ..... do	11,169	2,638	5,946	4,259	7,048	4,967	11,464	6,605
Stone ..... do	77	80	83	87	29	52	23	35

Value of items that cannot be disclosed: Clays (bentonite), natural gas liquids, and values indicated by footnote 4		1,529		2,423		2,698		3,012
Total North Dakota		44,123		[8] 53,509		[8] 56,702		59,093
OHIO								
Abrasive stones, grindstones and pulpstones	(4)	(4)	(4)	(4)	1,505	$132	852	$83
Cement ......thousand 376-pound barrels	14,914	$42,966	16,065	$49,794	16,238	52,184	15,700	53,043
Clays ......thousand short tons	6,297	15,677	6,703	17,675	6,136	16,073	5,220	13,082
Coal ......do	37,870	133,814	38,934	148,650	36,862	146,134	32,028	126,241
Lime ......do	3,039	39,394	2,995	40,805	2,763	38,383	2,411	32,471
Natural gas ......million cubic feet	33,756	7,595	25,368	6,088	30,384	7,201	31,786	6,802
Peat	22,484	249	15,509	174	5,478	102	5,660	104
Petroleum (crude) ......thousand 42-gallon barrels	4,353	12,580	4,785	15,025	5,478	17,694	[6] 6,260	[6] 18,091
Salt (common) ......thousand short tons	2,905	14,769	2,972	15,923	2,825	16,936	2,443	17,443
Sand and gravel ......do	27,906	31,995	30,200	36,146	30,596	37,503	29,624	36,619
Stone ......do	33,273	49,841	[7] 33,418	[7] 50,947	[7] 37,451	[7] 61,847	29,122	49,782
Value of items that cannot be disclosed: Calcium-magnesium chloride (1955-56), gypsum, natural gasoline, stone (crushed sandstone, 1956; dimension limestone and calcareous marl, 1957), and values indicated by footnote 4		[8] 2,864		5,394		[8] 2,453		1,905
Total Ohio [9]		[8] 340,456		375,488		[8] 383,000		344,856
OKLAHOMA								
Clays ......thousand short tons	[5] 724	[5] $727	[5] 705	[5] $701	[5] 641	[5] $642	[5] 576	[5] $579
Coal ......do	2,164	12,668	2,007	12,341	2,195	14,165	1,629	10,858
Lead (recoverable content of ores, etc.)	14,126	4,209	12,350	3,878	7,183	2,054	3,692	864
Natural gas ......million cubic feet	614,976	45,508	678,603	54,288	719,794	59,743	[6] 696,504	[6] 70,347
Natural-gas liquids:								
Natural gasoline and cycle products ......thousand gallons	504,692	28,770	489,963	26,543	460,644	25,329	440,798	26,029
LP-gases ......do	512,320	14,297	579,101	23,427	587,140	21,824	657,114	25,822
Petroleum (crude) ......thousand 42-gallon barrels	202,817	563,830	215,862	600,096	214,661	650,423	[6] 202,699	[6] 599,989
Pumice ......thousand short tons			(18)	3	(4)	(4)	(4)	(4)
Salt (common) ......do	(4)	(4)	10	90	7	63	4	41
Sand and gravel ......do	6,294	4,786	5,947	4,842	4,960	4,507	7,232	5,859
Stone ......do	10,933	12,295	10,547	12,417	12,016	14,064	10,794	12,232
Tripoli	(4)	(4)	(4)	(4)	22,236	67	(4)	(4)
Zinc (recoverable content of ores, etc.)	41,543	10,220	27,515	7,539	14,951	3,469	5,267	1,074
Value of items that cannot be disclosed: Native asphalt, clay (bentonite), cement, gypsum, lime, manganese ore (1957), uranium ore (1956), and values indicated by footnote 4		[8] 15,480		[8] 12,929		[8] 14,573		16,022
Total Oklahoma [9]		[8] 711,044		[8] 757,080		[8] 809,004		767,856

See footnotes at end of table.

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

OREGON

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Chromite ... gross weight	5,341	$463	[27] 54,577	[27] $2,001	7,900	$675	4,133	(4)
Clays ... thousand short tons	251	276	257	278	240	266	252	$293
Copper (recoverable content or ores, etc.)	4	3	7	6	23	14	10	5
Gem stones	(12)	(4)	(12)	250	(12)	200	(12)	(4)
Gold (recoverable content of ores, etc.) ... troy ounces	1,708	60	2,738	96	3,381	118	1,423	50
Iron ore (usable) ... thousand long tons	2	(4)	1	(4)	(22)	(4)	----------	----------
Lead (recoverable content of ores, etc.)	3	1	5	2	5	1	1	(11)
Mercury ... 76-pound flasks	1,056	307	1,893	492	3,993	986	2,276	521
Nickel (content of ore and concentrate)	4,181	(4)	6,866	(4)	12,276	(4)	12,697	(4)
Pumice ... thousand short tons	(4)	(4)	(4)	(4)	123	294	138	331
Sand and gravel ... do	11,954	11,832	11,637	11,647	12,843	13,481	10,464	10,265
Silver (recoverable content of ores, etc.) ... thousand troy ounces	9	8	14	12	16	14	3	2
Stone ... thousand short tons	7,742	9,418	6,098	7,890	[8] 10,583	[8] 11,745	15,004	15,483
Value of items that cannot be disclosed: Carbon dioxide, cement, diatomite, iron oxide pigments (1956-57), lime (1957-58), sodium carbonate (1956), tungsten concentrate (1955-57), uranium ore (1956-57), and values indicated by footnote 4	----------	10,500	----------	12,689	----------	15,954	----------	19,311
Total Oregon [9]	----------	31,736	----------	34,021	----------	[8] 42,820	----------	45,053

PENNSYLVANIA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Cement ... thousand 376-pound barrels	48,090	$141,969	51,964	$162,387	44,680	$148,130	42,115	$142,399
Clays ... thousand short tons	4,020	12,413	[5] 4,413	[5] 23,782	4,074	22,012	[5] 3,318	[5] 17,051
Coal:								
Anthracite ... do	26,205	206,097	28,900	236,785	25,338	227,754	21,171	187,898
Bituminous ... do	85,713	440,452	90,287	479,437	85,365	492,539	67,771	373,812
Cobalt (content of concentrate) ... thousand pounds	479	(4)	533	(4)	599	(4)	564	(4)
Gem stones	(12)	(4)	(12)	(4)	(12)	(4)	(12)	2
Gold (recoverable content of ores, etc.) ... troy ounces	1,610	56	(4)	(4)	(4)	(4)	(4)	(4)
Iron ore (usable) ... thousand long tons, gross weight	838	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Iron oxide pigments (crude)	519	7	600	7	998	9	(4)	(4)
Lime ... thousand short tons	1,424	17,632	1,443	18,282	1,298	18,406	1,003	12,457
Natural gas ... million cubic feet	99,172	29,652	104,508	33,652	101,801	31,660	95,869	27,131

Natural-gas liquids:								
Natural-gasoline ... thousand gallons	4,305	281	4,081	251	3,106	192	1,608	107
LP-gases ... do	995	90	1,127	99	1,211	106	1,363	123
Peat	23,277	220	20,498	213	26,086	236	23,623	203
Petroleum (crude) ... thousand 42-gallon barrels	8,531	30,200	8,230	35,718	[6] 8,179	[6] 38,687	[6] 6,678	[6] 27,380
Sand and gravel ... thousand short tons	13,313	20,512	14,047	21,321	12,406	19,570	11,825	19,180
Silver (recoverable content of ores, etc.) ... thousand troy ounces	10	9	(4)	(4)	(4)	(4)	(4)	(4)
Slate ... thousand short tons	186	4,421	154	4,194	139	4,005	(13)	(13)
Stone ... do	44,438	[7] 68,918	[7] 44,913	[7] 73,831	43,258	73,090	40,049	69,694
Tripoli	1,090	6	1,030	7	(4)	(4)	(4)	(4)
Zinc (recoverable content of ores, etc.) [23]							10,812	2,229
Value of items that cannot be disclosed: Clays (kaolin 1956–58), copper, mica, pyrites, pyrophyllite and soapstone, stone (dimension basalt 1956, shell 1956), and values indicated by footnote 4		15,819		16,202		[8] 16,604		15,960
Total Pennsylvania [9]		[8] 969,647		[8] 1,088,481		[8] 1,077,157		881,181
RHODE ISLAND								
Sand and gravel ... thousand short tons	1,941	$1,498	1,308	$1,263	1,058	$1,060	2,038	$1,883
Stone ... do	(4)	(4)	42	221	[7] 4	[7] 14	[7] 3	[7] 8
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 4		336		143		295		358
Total Rhode Island		1,834		1,627		1,369		2,249
SOUTH CAROLINA								
Clays ... thousand short tons	1,086	$5,463	1,087	$5,450	937	$5,161	929	$5,157
Mica (sheet) ... pounds	(4)	(4)	5,400	14	2,278	12	1,144	8
Peat							4,865	(4)
Sand and gravel ... thousand short tons	3,127	2,677	3,229	2,926	2,647	2,571	2,946	2,858
Stone ... do	3,455	4,921	3,304	4,285	[7] 3,413	[7] 4,581	[7] 3,637	[7] 5,229
Zirconium concentrate					(4)	(4)	141	5
Value of items that cannot be disclosed: Barite, cement, kyanite, scrap mica, rare-earth metal concentrates (1956–58), staurolite (1957–58), stone (dimension granite, 1956–57, crushed limestone 1956–58, calcareous marl 1957–58), titanium (1956–58), vermiculite (1955–57) and values indicated by footnote 4		7,400		9,277		10,491		9,586
Total South Carolina [19]		20,197		21,342		22,168		22,412

See footnotes at end of table.

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

SOUTH DAKOTA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Beryllium concentrate...gross weight	294	$157	195	$95	268	$145	240	$129
Clays...thousand short tons	(4)	(4)	[5] 201	[5] 201	[5] 176	[5] 176	[5] 155	[5] 155
Coal (lignite)...do	26	90	25	90	21	79	20	78
Columbium-tantalum concentrate...pounds	5,638	10	237	(11)	2,311	6	4,294	10
Feldspar...long tons	42,164	267	45,226	289	41,316	267	23,229	145
Gem stones	(12)	7	(12)	10	(12)	15	(12)	16
Gold (recoverable content of ores, etc.)...troy ounces	529,865	18,545	568,523	19,898	568,130	19,885	570,830	19,979
Gypsum...thousand short tons	13	16	16	63	13	53	12	49
Iron ore (usable)...thousand long tons, gross weight	2	(4)	22	100	(22)	(4)	---	---
Mica:								
Scrap	1,322	27	1,268	31	1,626	43	1,003	24
Sheet...pounds	4,854	21	12,494	67	9,093	46	16,772	68
Sand and gravel...thousand short tons	13,538	10,097	12,539	8,423	14,758	8,001	14,705	9,179
Silver (recoverable content of ores, etc.)...thousand troy ounces	154	140	136	123	135	122	153	138
Stone...thousand short tons	2,262	5,680	2,200	5,725	1,718	5,068	1,395	4,095
Uranium ore	---	---	35,302	475	69,800	760	35,489	530
Value of items that cannot be disclosed: Cement, clays (bentonite, 1956–58), lime, lithium minerals (1958), petroleum, and values indicated by footnote 4	---	6,115	---	7,547	---	[8] 6,090	---	7,555
Total South Dakota [9]	---	40,526	---	42,281	---	[8] 39,997	---	41,534
TENNESSEE								
Cement...thousand 376-pound barrels	8,812	$23,673	8,755	$25,435	7,415	$22,806	8,375	$26,408
Clays...thousand short tons	1,208	4,170	1,379	4,888	1,154	4,228	935	4,210
Coal...do	7,053	28,747	8,848	35,609	7,955	31,147	6,785	25,969
Copper (recoverable content of ores, etc.)	9,911	7,394	10,449	8,882	9,790	5,894	9,109	4,791
Gem stones	---	---	---	---	---	---	(12)	1
Gold (recoverable content of ores, etc.)...troy ounces	221	8	189	7	172	6	124	4
Lead (recoverable content of ores, etc.)	---	---	5	1	---	---	---	---
Lime...thousand short tons	103	1,102	125	1,436	94	1,134	(4)	(4)
Manganese ore (35 percent or more Mn)...gross weight	15,895	1,280	17,821	1,417	12,938	1,007	5,935	452
Natural gas...million cubic feet	39	5	45	6	38	6	[6] 54	[6] 9
Phosphate rock...thousand long tons	1,466	10,526	1,685	11,643	1,812	12,514	1,903	13,041
Sand and gravel...thousand short tons	5,137	5,814	5,629	6,480	5,617	6,641	5,612	6,671
Silver (recoverable content of ores, etc.)...thousand troy ounces	67	60	65	59	54	49	44	40
Stone...thousand short tons	14,381	22,276	[7] 15,556	[7] 23,796	[7] 15,354	[7] 24,155	[7] 16,850	[7] 26,814

Zinc (recoverable content of ores, etc.)	40,216	9,893	46,023	12,610	58,063	13,470	59,130	12,062
Value of items that cannot be disclosed: Barite, fluorspar (1956–57), iron ore (1955–57), scrap mica (1956–58), petroleum, pyrites, stone (crushed sandstone 1956–58, crushed granite 1957, dimension limestone 1958) and values indicated by footnote 4	----	6,994	----	8,772	----	8,029	----	6,878
Total Tennessee [9]	----	119,316	----	137,846	----	[8] 128,739	----	124,928
TEXAS								
Cement .... thousand 376-pound barrels	24,856	$67,549	25,966	$75,695	22,144	$68,541	25,875	$79,756
Clays [4] .... thousand short tons	3,097	5,100	3,146	4,765	2,992	4,934	3,720	5,424
Copper (recoverable content of ores, etc.)	1	1	----	----	----	----	----	----
Gem stones	(12)	115	(12)	115	(12)	100	(12)	100
Gypsum .... thousand short tons	1,349	4,220	1,157	3,623	1,043	3,343	1,240	4,120
Helium .... thousand cubic feet	139,397	2,272	145,830	2,364	204,286	3,353	294,452	4,807
Iron ore (usable) .... thousand long tons, gross weight	875	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Lime .... thousand short tons	585	5,549	592	6,938	796	7,489	691	7,146
Natural gas .... million cubic feet	4,730,798	378,464	4,999,889	434,990	5,156,215	500,153	5,178,073	517,807
Natural-gas liquids:								
Natural gasoline and cycle products .... thousand gallons	2,987,808	206,506	2,964,609	216,378	2,944,381	201,423	2,871,589	204,501
LP-gases .... do	3,450,430	110,414	3,731,047	144,745	3,831,664	147,618	3,786,575	151,896
Petroleum (crude) .... thousand 42-gallon barrels	1,053,297	2,989,330	1,107,808	3,131,225	1,073,867	3,338,119	[6] 940,706	[6] 2,873,988
Salt (common) .... thousand short tons	3,583	12,867	3,963	14,370	4,612	17,104	3,843	15,115
Sand and gravel .... do	31,518	28,480	29,336	27,213	23,685	23,427	32,871	30,808
Sodium sulfate	46,718	1,099	(4)	(4)	(4)	(4)	(4)	(4)
Stone .... thousand short tons	27,321	33,544	32,773	36,350	[8] 31,248	[8] 36,153	36,076	40,912
Sulfur (Frasch-process) .... thousand long tons	3,767	105,128	3,437	91,026	2,879	70,226	2,616	61,621
Talc and soapstone	35,064	213	41,332	244	47,780	199	60,827	168
Value of items that cannot be disclosed: Abrasive stones (1955–57), native asphalt, bromine, clay, (fuller's earth), coal (lignite), feldspar (1957–58), graphite, magnesium chloride (for metal), magnesium compounds (except for metal), mercury, pumice, silver (1955), uranium ore (1956–58), and values indicated by footnote 4	----	50,069	----	62,354	----	71,510	----	50,635
Total Texas [9]	----	[8] 3,990,166	----	[8] 4,241,258	----	[8] 4,484,538	----	4,038,656
UTAH								
Asphalt and related bitumens, native: Gilsonite	82,822	$3,117	(4)	(4)	[8] 207,704	$4,259	317,280	$4,864
Clays .... thousand short tons	(4)	(4)	[5] 227	[5] $492	[5] 164	[5] 473	[5] 157	[5] 488
Coal .... do	6,296	40,005	6,522	34,436	6,858	40,263	5,328	30,340
Copper (recoverable content of ores, etc.)	232,949	173,780	250,604	213,013	237,857	143,190	189,184	99,511
Fluorspar	7,328	151	10,581	265	11,087	387	16,109	564
Gem stones	(12)	6	(12)	10	(12)	12	(12)	40
Gold (recoverable content of ores, etc.) .... troy ounces	441,206	15,442	416,031	14,561	378,438	13,245	307,824	10,774
Iron ore (usable) .... thousand long tons, gross weight	3,847	24,688	4,002	27,508	4,156	30,383	3,514	25,202
Lead (recoverable content of ores, etc.)	50,452	15,035	49,555	15,560	44,471	12,719	40,355	9,443
Lime .... thousand short tons	39	583	55	830	53	821	80	1,513
Manganese ore (35 percent or more Mn) .... gross weight	----	----	----	----	142	12	1,043	84
Mica (sheet) .... pounds	----	----	----	----	----	----	12	(11)

See footnotes at end of table.

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

UTAH—Continued

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Natural gas ... million cubic feet	17,163	$2,386	17,268	$2,435	16,824	$2,473	19,247	[6] $2,829
Natural gasoline ... thousand gallons	(4)	(4)	(4)	(4)	(4)	(4)	240	15
Perlite	(4)	(4)	2,271	9	(4)	(4)	(4)	(4)
Petroleum (crude) ... thousand 42-gallon barrels	2,227	5,140	2,466	5,302	4,367	9,913	[6] 24,386	[6] 72,914
Phosphate rock ... thousand long tons	(4)	(4)	125	772	114	756	(4)	(4)
Pumice ... thousand short tons	2	20	45	330	36	148	41	84
Salt (common) ... do	196	1,339	184	1,471	221	2,013	184	2,275
Sand and gravel ... do	5,158	3,309	5,836	4,476	26,958	15,485	25,304	14,379
Silver (recoverable content of ores, etc.) ... thousand troy ounces	6,251	5,657	6,572	5,948	6,199	5,610	5,278	4,777
Stone ... thousand short tons	1,926	2,650	2,322	3,298	7,854	8,540	13,126	13,949
Tungsten ore and concentrate ... 60-percent WO_3 basis	65	225	11	41	----------	----------	----------	----------
Uranium ore	----------	----------	926,273	25,214	1,075,759	[8] 32,501	1,239,767	[16] 38,583
Vanadium ... thousand pounds	996	(4)	1,099	(4)	1,017	(4)	752	(4)
Zinc (recoverable content of ores, etc.)	43,556	10,715	42,374	11,610	40,846	9,476	44,982	9,176
Value of items that cannot be disclosed: Carbon dioxide, cement, clay (kaolin, 1956–58), gypsum, molybdenum, potassium salts, and values indicated by footnote 4	----------	28,806	----------	33,352	----------	27,651	----------	25,219
Total Utah [19]	----------	332,002	----------	399,759	----------	[8] 359,335	----------	365,960

VERMONT

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays ... thousand short tons	14	$14	(4)	(4)	(4)	(4)	(4)	(4)
Copper (recoverable content of ores, etc.)	4,305	3,212	3,403	$2,893	3,405	$2,050	475	$250
Gem stones	(12)	(4)	----------	----------	----------	----------	(12)	1
Gold (recoverable content of ores, etc.) ... troy ounces	181	6	(4)	(4)	62	2	----------	----------
Pyrites ... thousand long tons	22	(4)	23	107	10	56	----------	----------
Sand and gravel ... thousand short tons	1,763	1,169	1,910	905	2,216	1,051	1,882	1,316
Silver (recoverable content of ores, etc.) ... thousand troy ounces	50	46	(4)	(4)	37	33	5	5
Slate ... thousand short tons	(4)	(4)	162	3,772	(4)	3,269	(13)	(13)
Stone ... do	582	11,061	621	11,622	557	11,404	808	15,789
Value of items that cannot be disclosed: Asbestos, lime, talc, and values indicated by footnote 4	----------	8,400	----------	3,915	----------	4,058	----------	4,106
Total Vermont [19]	----------	23,884	-------	23,131	----------	21,893	----------	21,443

VIRGINIA								
Beryllium concentrate ... gross weight	(4)	(11)	1	(11)	—	—	—	—
Clays ... thousand short tons	936	$874	1,000	$1,033	893	$986	1,153	$1,143
Coal ... do	23,508	108,174	28,063	138,127	29,506	153,959	26,826	130,319
Gem stones	(12)	(4)	(12)	(4)	—	—	(12)	3
Lead (recoverable content of ores, etc.)	2,997	893	3,035	953	3,143	899	2,934	687
Lime ... thousand short tons	494	5,049	512	5,926	510	6,029	471	5,533
Manganese ore (35 percent or more Mn) ... gross weight	32,654	2,779	20,231	1,902	12,655	1,058	8,128	647
Manganiferous ore (5 to 35 percent Mn) ... do	—	—	(4)	(4)	—	—	56	1
Marl, calcareous (except for cement)	(4)	(4)	10,522	12	(20)	(20)	(20)	(20)
Mica, sheet ... pounds	(4)	(4)	396	6	529	6	147	2
Natural gas ... million cubic feet	968	259	2,926	810	2,465	661	[6] 2,521	[6] 681
Petroleum (crude) ... thousand 42-gallon barrels	4	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Sand and gravel ... thousand short tons	6,461	8,076	7,783	9,420	7,047	9,877	7,158	10,834
Silver (recoverable content of ores, etc.) ... thousand troy ounces	2	2	2	2	(4)	(4)	2	2
Slate ... thousand short tons	32	820	32	1,035	(4)	1,003	(13)	(13)
Stone ... do	11,966	19,870	14,082	23,076	[7] 14,244	[7] 21,158	15,413	27,504
Zinc (recoverable content of ores, etc.) [23]	18,329	4,509	19,196	5,181	23,080	5,277	18,472	3,808
Value of items that cannot be disclosed: Aplite, cement, feldspar, gypsum, iron oxide pigments (1955–57), kyanite, mica (scrap 1955), pyrites, salt, stone (dimension miscellaneous dimension sandstone and calcareous marl (1957), talc and soapstone, titanium concentrate, and values indicated by footnote 4		24,046		24,931	—	[8] 29,746	—	25,420
Total Virginia [9]	—	172,541	—	208,806	—	[8] 227,108	—	203,226
WASHINGTON								
Abrasive stone: Pebbles (grinding)	(4)	(4)	25	(11)	25	(11)	18	(11)
Barite	25	(11)	—	—	(4)	(4)	(4)	(4)
Chromite ... gross weight	22	$2	30	$3	—	—	17	$2
Clays ... thousand short tons	365	412	320	440	298	$488	[5] 196	[5] 183
Coal ... do	610	4,263	473	3,432	360	2,761	252	1,968
Copper (recoverable content of ores, etc.)	3,958	2,953	2,926	2,487	1,700	1,023	52	27
Epsomite	100	5	(4)	(4)	(4)	(4)	—	—
Gem stones	(12)	(4)	(12)	75	(12)	75	(12)	75
Gold (recoverable content of ores, etc.) ... troy ounces	74,360	2,602	70,669	2,473	(4)	(4)	(4)	(4)
Gypsum ... thousand short tons	4	14	(4)	(4)	6	(4)	(4)	(4)
Iron ore ... thousand long tons	2	(4)	2	(4)	4	(4)	4	(4)
Lead (recoverable content of ores, etc.)	10,340	3,081	11,657	3,660	12,734	3,642	9,020	2,111
Peat	37,640	113	37,043	129	39,364	153	34,642	116
Pumice ... thousand short tons	(4)	(4)	5	15	(4)	(4)	(4)	(4)
Sand and gravel ... do	21,645	19,351	16,842	15,037	[8] 20,415	[8] 17,510	24,389	20,086
Silver (recoverable content of ores, etc.) ... thousand troy ounces	436	395	448	406	(4)	(4)	(4)	(4)
Stone ... thousand short tons	6,593	10,580	8,057	11,660	[8] 8,897	[8] 11,645	7,837	9,991
Talc and soapstone	(4)	(4)	(4)	(4)	4,065	25	4,000	21
Tungsten concentrate ... 60-percent WO_3 basis	12	46	2	(4)	(10)	(4)	—	—

See footnotes at end of table.

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

WASHINGTON—Continued

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Zinc (recoverable content of ores, etc.)	29,536	$7,266	25,609	$7,017	24,000	$5,568	18,797	$3,835
Value of items that cannot be disclosed: Carbon dioxide, cement, fire clay (1958), diatomite, lime (1955-57), magnesite, mercury (1957-58), olivine, petroleum (1957-58), strontium minerals (1956-58), uranium ore (1956-58), and values indicated by footnote 4		19,765		17,736		18,950		24,128
Total Washington [9]		67,334		61,723		[8] 60,471		60,897

See footnotes at end of table.

WEST VIRGINIA

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Clays	707	$2,563	770	$2,449	708	$2,691	510	$1,960
Coal ... thousand short tons	139,168	653,338	155,890	824,043	156,842	875,587	119,468	635,201
Marl, calcareous ... do	(4)	(4)	1,685	1	(20)	(20)	(20)	(20)
Natural gas ... million cubic feet	212,403	49,915	204,717	48,518	202,440	48,181	[6] 204,581	[6] 50,734
Natural-gas liquids:								
Natural gasoline ... thousand gallons	35,756	2,352	35,728	2,594	30,435	2,185	27,917	5,643
LP-gases ... do	286,871	6,376	240,989	12,031	235,881	6,543	235,524	12,806
Petroleum (crude) ... thousand 42-gallon barrels	2,320	7,080	2,179	8,411	2,215	9,436	[6] 2,186	[6] 7,629
Salt (common) ... thousand short tons	638	3,477	681	3,453	648	2,642	627	2,784
Sand and gravel ... do	5,171	9,779	5,110	10,711	5,354	9,893	5,253	11,729
Stone ... do	5,899	9,714	6,579	10,765	6,989	11,934	[7] 5,599	[7] 9,990
Value of items that cannot be disclosed: Abrasive stone, (1955), bromine, calcium-magnesium chloride, cement, lime, manganese ore (1957), stone (crushed sandstone 1958), and values indicated by footnote 4		[8] 12,844		[8] 14,515		[8] 14,938		13,104
Total West Virginia [9]		[8] 755,426		[8] 934,999		[8] 981,654		749,784

WISCONSIN

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Abrasive stones	(4)	(4)	1,093	$31	1,790	$43	858	$26
Clays ... thousand short tons	165	$166	163	172	131	136	154	167
Iron ore (usable) ... thousand long tons, gross weight	1,886	(4)	1,488	(4)	1,576	(4)	867	(4)
Lead (recoverable content of ores, etc.)	1,948	581	2,582	811	1,900	543	800	187
Lime ... thousand short tons	135	1,768	(4)	(4)	(4)	(4)	141	2,193
Marl, calcareous (except for cement)	14,087	7	11,074	6	(20)	(20)	(20)	(20)
Peat					400	(4)	(4)	(4)

Sand and gravel .... thousand short tons	27,978	19,958	27,715	19,097	29,394	18,694	39,383	25,845
Stone .... do	12,180	18,843	11,126	20,102	12,434	22,455	13,722	23,334
Zinc (recoverable content of ores, etc.)	18,326	4,508	23,890	6,546	21,575	5,006	12,140	2,477
Value of items that cannot be disclosed: Cement, gem stones (1957), stone (crushed basalt, 1955), and values indicated by footnote 4	....	20,528	....	19,451	....	22,590	....	18,083
Total Wisconsin [9]	....	65,813	....	65,860	....	68,644	....	71,334
WYOMING								
Beryllium concentrate .... gross weight	....	....	(4)	(4)	5	$3	17	$9
Clays .... thousand short tons	10,036	$10,924	1,086	$11,864	[5] 1,069	[5] 11,973	[5] 1,075	[5] 9,968
Coal .... do	2,927	11,845	2,553	9,920	2,117	7,777	1,629	5,820
Copper (recoverable content of ores, etc.)	....	....	3	3	4	2	(10)	(11)
Feldspar .... long tons	....	....	1,201	8	(4)	(4)	(4)	(4)
Gem stones	(12)	57	(12)	75	(12)	55	(12)	52
Gold (recoverable content of ores, etc.) .... troy ounces	52	2	762	27	573	20	117	4
Gypsum .... thousand short tons	22	89	11	46	(4)	(4)	6	19
Iron ore (usable) .... thousand long tons, gross weight	749	(4)	650	(4)	736	(4)	557	(4)
Natural gas .... million cubic feet	77,819	6,615	84,398	7,258	117,256	10,201	[6] 121,682	[6] 10,221
Natural-gas liquids:								
Natural gasoline .... thousand gallons	40,290	2,775	48,859	3,160	47,709	2,866	49,451	3,052
LP-gases .... do	46,106	1,961	49,838	2,337	57,805	2,566	54,496	2,614
Petroleum (crude) .... thousand 42-gallon barrels	99,483	239,750	104,830	255,785	109,584	291,493	[6] 115,572	[6] 301,643
Phosphate rock .... thousand long tons	55	345	119	721	18	121	124	937
Pumice .... thousand short tons	(4)	(4)	46	38	49	41	45	40
Rare-earth metals concentrates	....	....	....	....	2	5	....	....
Sand and gravel .... thousand short tons	3,952	3,978	3,904	2,935	2,425	1,905	5,333	4,760
Sodium carbonate (natural)	(4)	(4)	337,851	8,345	(4)	(4)	(4)	(4)
Stone .... thousand short tons	1,303	2,034	1,333	2,076	1,291	2,266	1,099	1,472
Tungsten ore and concentrate .... 60-percent WO_3 basis	....	....	2	7	....	....	....	....
Uranium ore	....	....	156,509	2,765	274,699	4,669	651,790	13,286
Value of items that cannot be disclosed: Cement, fire clay (1957–58), silver, sodium sulfate, vanadium, and values indicated by footnote 4	....	14,983	....	7,824	....	17,527	....	16,760
Total Wyoming [9]	....	[8] 294,546	....	[8] 314,380	....	[8] 352,532	....	369,938

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Includes Alaska and Hawaii.
[3] Excludes slag cement, 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] Revised figure.
[9] Total adjusted to eliminate duplicating the value of clays and stone.
[10] Less than 1 ton.
[11] Less than $1,000.
[12] Weight not recorded.
[13] Beginning with 1958 slate included with stone.
[14] Excludes masonry cement, value for which is included with "Items that cannot be disclosed."
[15] Total weight of columbite-tantalite plus $(Cb\text{-}Ta)_2O_5$ content of euxenite.
[16] Final figure. Supersedes preliminary figure given in commodity chapter.
[17] Sheet mica only.
[18] Less than 1,000 short tons.
[19] Total has been adjusted to eliminate duplicating the value of raw materials used in manufacturing cement and/or lime.
[20] Beginning with 1957 calcareous marl included with stone.
[21] Excludes natural cement, value for which is included with "Items that cannot be disclosed."
[22] Less than 1,000 long tons.
[23] 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.
[24] Grinding pebbles and tube-mill liners, weight of millstones not recorded.
[25] Millstones only.
[26] Less than 1,000 troy ounces.
[27] 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.

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

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
American Samoa:								
Sand and gravel .... thousand short tons..	1	$1	----	----	----	----	----	----
Stone .... do....	9	4	2	$6	34	$37	30	$59
Total American Samoa	----	5	----	6	----	37	----	59
Canal Zone:								
Sand and gravel .... thousand short tons..	36	47	40	48	----	----	41	34
Stone (crushed) .... do....	169	240	177	230	59	99	140	237
Total Canal Zone	----	287	----	278	----	99	----	271
Canton: Stone (crushed) .... thousand short tons..	1	2	2	5	----	----	----	----
Guam:								
Sand and gravel .... do....	----	----	19	24	1	1	9	23
Stone .... do....	1,241	3,352	341	311	1,034	1,132	684	751
Total Guam	----	3,352	----	335	----	1,133	----	774
Johnston: Stone .... thousand short tons..	12	33	----	----	----	----	----	----
Midway: Stone (crushed) .... do....	----	----	203	304	3,875	6,700	175	476
Virgin Islands: Stone (crushed) .... do....	1	5	12	32	11	31	25	81
Wake: Stone (crushed) .... do....	1	3	22	22	5	6	10	37

[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.

TABLE 7.—Mineral production [1] in the Commonwealth of Puerto Rico

Mineral	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)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
Cement ..... thousand 376-pound barrels	4,117	$12,507	4,255	$14,065	5,552	$17,232	4,748	$15,175
Clays ..... thousand short tons	137	122	143	129	159	140	165	83
Lime ..... do	10	254	(2)	(2)	(2)	(2)	(2)	(2)
Salt (common) ..... do	10	112	10	101	10	104	1	14
Sand and gravel ..... do	433	679	183	192	497	754	476	763
Stone ..... do	1,784	2,516	2,076	2,556	2,452	3,505	1,986	2,768
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 2	-----	-----	-----	195	-----	180	-----	272
Total Puerto Rico [3]	-----	14,917	-----	16,395	-----	20,265	-----	17,689

[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] Total has been adjusted to eliminate duplicating the value of stone.

TABLE 8.—Principal minerals imported for consumption in the United States

[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	1957		1958	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
METALS				
Aluminum:				
Metal	222,158	[1] $107,336	255,322	$117,297
Scrap	16,271	[1] 5,396	9,922	2,969
Plates, sheets, bars, etc	[2] 19,577	[1,2] 15,124	27,943	20,183
Antimony:				
Ore (antimony content)	8,198	1,973	3,427	643
Needle or liquated	38	17	136	58
Metal	5,412	2,587	4,282	1,871
Oxide	1,893	790	1,634	643
Arsenic: White	10,135	794	6,524	720
Bauxite:				
Crude ... thousand long tons	[2,3] 7,098	[2] 60,933	[3] 7,919	70,142
Calcined:				
Imports for manufacturing firebrick ... long tons	67,172	1,522	29,414	715
Other ... do	[1] 204	4	100	2
Beryllium ore	7,290	2,526	4,599	1,517
Boron carbide ... pounds	74,162	123	47,368	133
Cadmium:				
Metal ... thousand pounds	1,586	2,424	1,002	1,312
Flue dust (cadmium content) ... do	1,400	837	1,218	661
Calcium:				
Metal ... pounds	24,204	[1] 39	15,694	24
Chloride	1,989	77	475	17
Chromate:				
Ore and concentrates (Cr_2O_3 content)	[2] 983,492	[2] 55,675	544,447	28,206
Ferrochrome (chromium content)	30,910	14,460	15,965	7,818
Metal	1,354	[1] 2,748	2,353	4,768
Cobalt:				
Alloy (cobalt content) ... thousand pounds	817	(4)	------	------
Ore (cobalt content) ... do	15	20	------	------
Metal ... do	[2,5] 16,173	[2,3] 32,431	[3] 15,719	[3] 30,995
Oxide (gross weight) ... do	647	853	837	1,116
Salts and compounds (gross weight) ... do	364	179	234	145
Columbium ore ... pounds	3,348,706	3,038	2,555,942	2,346
Copper (copper content):				
Ore	[2] 20,951	[2] 12,217	5,926	2,357
Concentrates	[2] 62,361	[2] 34,258	84,871	37,968
Regulus, black, coarse	[2] 5,361	[2] 3,213	4,925	2,172
Unrefined, black, blister	[2] 301,186	179,140	138,633	66,320
Refined in ingots, etc	162,309	97,025	124,629	61,139
Old and scrap	5,843	[1,2] 3,049	5,849	2,676
Old brass and clippings	4,643	[1] 2,393	4,201	1,852
Ferroalloys: Ferrosilicon (silicon content)	3,813	1,679	2,398	905
Gold:				
Ore and base bullion ... troy ounces	1,185,917	41,474	1,099,484	38,457
Bullion ... do	6,515,253	231,167	7,020,242	251,298
Iron ore:				
Ore ... thousand long tons	[2] 33,651	[2] 285,051	27,530	231,553
Pyrites cinder ... long tons	567	[1] 2	2,721	9
Iron and steel:				
Pig iron	225,387	13,528	209,743	12,041
Iron and steel products (major):				
Semimanufactures	[2] 283,475	[2] 33,753	788,235	66,880
Manufactures	[2] 1,011,419	[2] 170,872	1,030,758	152,974
Scrap	203,407	9,078	295,859	10,069
Tin-plate scrap	35,203	1,072	36,763	1,000
Lead:				
Ore, flue dust, matte (lead content)	[2] 234,616	[2] 62,284	241,297	51,707
Base bullion (lead content)	25	8	416	136
Pigs and bars (lead content)	[2] 321,708	[2] 85,146	351,759	71,404
Reclaimed, scrap, etc (lead content)	[2] 7,576	[1,2] 1,641	8,619	1,441
Sheets, pipe, and shot	5,917	[1] 1,377	2,625	596
Babbitt metal and solder (lead content)	2,100	[1] 3,049	2,049	4,677
Type metal and antimonial lead (lead content)	4,858	1,527	4,525	1,190
Manufactures	659	[1] 360	1,272	446

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States—Continued

Mineral	1957 Short tons (unless otherwise stated)	1957 Value (thousands)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
METALS—continued				
Magnesium:				
Metallic and scrap	982	[1] $480	537	$280
Alloys (magnesium content)	35	283	9	38
Sheets, tubing, ribbons, wire, and other forms (magnesium content)	8	17	16	97
Manganese:				
Ore (35 percent or more manganese) (manganese content)	[2] 1,167,232	[2] 96,670	837,100	76,256
Ferromanganese (manganese content)	257,821	[2] 60,236	49,521	11,046
Mercury:				
Compounds ... pounds	19,221	[1] 68	9,125	29
Metal ... 76-pound flasks	42,005	9,333	20,158	3,914
Minor metals: Selenium and salts ... pounds	[2] 172,178	[1] [2] 1,909	204,311	1,380
Molybdenum: Ore and concentrates (molybdenum content) ... pounds	27,461	55	1,344	6
Nickel:				
Ore and matte	13,177	5,202	4,574	1,765
Pigs, ingots, shot, cathodes	[2] 99,787	[2] 156,393	62,793	87,311
Scrap	410	573	271	254
Oxide	37,080	42,925	29,622	35,106
Platinum group:				
Unrefined materials:				
Ore and concentrates ... troy ounces	1,572	119	------	------
Grains and nuggets, including crude, dust, and residues ... troy ounces	[2] 26,328	[2] 1,936	21,635	1,341
Sponge and scrap ... do	[2] [3] 2,043	[3] 160	[3] 13,167	[3] 823
Osmiridium ... do	2,851	168	1,450	85
Refined metal:				
Platinum ... do	[2] [3] 301,611	[2] [3] 25,217	[3] 247,763	[3] 15,363
Palladium ... do	327,558	6,303	360,077	5,211
Iridium ... do	1,431	109	1,156	78
Osmium ... do	126	9	145	8
Rhodium ... do	16,629	[1] 1,688	17,280	1,803
Ruthenium ... do	1,864	75	7,758	259
Radium:				
Radium salts ... milligrams	76,206	1,061	38,419	538
Radioactive substitutes	(6)	[1] 844	(6)	908
Rare earths: Ferrocerium and other cerium alloys ... pounds	7,948	[1] 26	11,544	46
Silver:				
Ore and base bullion ... thousand troy ounces	99,926	78,260	134,650	102,286
Bullion ... do	106,193	79,400	31,316	27,807
Tantalum: Ore ... pounds	828,265	949	1,035,588	1,838
Tin:				
Ore (tin content) ... long tons	94	118	5,440	11,244
Blocks, pigs, grains, etc ... do	[2] 56,158	[2] 120,739	41,149	84,624
Dross, skimmings, scrap, residues, and tin alloys, n.s.p.f. ... long tons	[2] 5,077	[2] 9,485	3,208	5,771
Tinfoil, powder, flitters, etc	(6)	[1] 561	(6)	610
Titanium:				
Ilmenite	460,353	[1] 10,317	348,144	6,766
Rutile	84,837	11,843	36,563	4,513
Metal ... pounds	7,064,672	16,722	4,146,896	6,287
Ferrotitanium ... do	256,000	100	201,333	73
Compounds and mixtures ... do	135,116	[1] 79	1,417,522	285
Tungsten (tungsten content):				
Ore and concentrates ... thousand pounds	14,018	[1] 34,525	6,542	11,960
Metal ... pounds	82,617	[1] 239	101,363	230
Ferrotungsten ... thousand pounds	415	674	159	154
Other ... pounds	66,955	[1] 112	83	1
Zinc:				
Ores (zinc content)	[2] 679,416	[2] 88,516	538,566	51,361
Blocks, pigs, and slabs	[2] 268,824	[1] [2] 64,129	185,693	35,612
Sheets	732	245	901	285
Old, dross, and skimmings	590	89	972	108
Dust	112	[1] 28	96	14
Manufactures	(6)	[1] 264	(6)	390
Zirconium: Ore, including zirconium sand	41,692	1,142	19,225	467

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States—Continued

Mineral	1957 Short tons (unless otherwise stated)	1957 Value (thousands)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
NONMETALS				
Abrasives: Diamonds (industrial)____carats	[2] 12,612,641	[1 2] $51,524	10,070,816	$39,346
Asbestos	682,732	[1] 60,104	644,331	58,314
Barite:				
Crude and ground	833,049	[1] 5,875	527,571	3,754
Witherite	3,029	138	2,240	108
Chemicals	5,369	[1] 502	4,171	416
Bromine____pounds	1,512	38	11,925	38
Cement____376-pound barrels	[3] 4,427,047	[1] 14,819	3,390,086	9,682
Clays:				
Raw	159,866	[1] 2,859	158,980	2,835
Manufactured	2,967	79	35,030	65
Cryolite	32,712	[2] 4,001	24,186	2,332
Feldspar: Crude____long tons	72	7	73	5
Fluorspar	631,367	[1] 16,031	392,164	9,777
Gem stones:				
Diamonds____carats	[2] 1,606,937	[1 2] 142,588	1,847,719	140,495
Emeralds____do	37,245	[1] 1,595	38,848	1,100
Other	(6)	[1 2] 24,480	(6)	24,212
Graphite	41,530	2,107	27,067	1,203
Gypsum:				
Crude, ground, calcined	4,335,337	[1] 7,604	4,049,522	6,898
Manufactures	(6)	[1] 911	(6)	967
Iodine, crude____thousand pounds	2,685	2,769	1,561	1,329
Jewel bearings____number, thousands	70,127	[1] 2,780	40,969	1,418
Kyanite	5,999	263	1,965	95
Lime:				
Hydrated	245	5	1,000	21
Other	39,002	687	18,822	318
Dead-burned dolomite	10,419	640	5,686	322
Magnesium:				
Magnesite	80,638	4,298	77,630	4,912
Compounds	12,582	510	12,477	505
Mica:				
Uncut sheet and punch____pounds	1,841,840	[1] 3,359	2,181,056	5,092
Scrap	5,187	57	4,064	48
Manufactures	5,766	[1] 8,032	5,052	8,800
Mineral-earth pigments: Iron oxide pigments:				
Natural	3,079	[1] 125	2,485	123
Synthetic	7,033	[1] 1,046	5,933	889
Ocher, crude and refined	203	12	217	10
Siennas, crude and refined	676	56	555	49
Umber, crude and refined	1,944	[1] 65	2,278	73
Vandyke brown	139	10	204	15
Nitrogen compounds (major), including urea	[2] 1,453,678	[1 2] 63,107	1,349,585	59,840
Phosphate, crude____long tons	109,546	3,090	108,182	2,944
Phosphatic fertilizers____do	29,175	[2] 2,246	24,562	1,711
Pigments and salts:				
Lead pigments and salts	8,565	1,912	8,557	1,770
Zinc pigments and salts	6,967	1,336	13,206	2,520
Potash	338,690	[1] 11,823	398,823	13,679
Pumice:				
Crude or unmanufactured	35,182	291	38,613	274
Wholly or partly manufactured	2,124	[1] 70	1,873	48
Manufactures, n.s.p.f.	(6)	[1] 14	(6)	15
Quartz crystal (Brazilian pebble)____pounds	1,546,236	729	473,000	356
Salt	[2] 650,845	[1 2] 3,523	611,043	3,368
Sand and gravel:				
Glass sand	683	621	6,516	224
Other sand	290,280	[1] 437	317,860	486
Gravel	14,877	[1] 22	7,619	7
Sodium sulfate____thousand short tons	74	1,511	97	1,968
Stone, including slate	(6)	[1] 8,792	(6)	8,312
Strontium: Mineral	6,525	131	6,647	141
Sulfur and pyrites:				
Sulfur:				
Ore____long tons	14,454	350	18,906	445
Other forms, n.e.s.____do	[2] 484,947	[1] 11,882	571,781	13,106
Pyrites____do	[7] 70,632	[1 7] 408	343,060	1,194
Talc: Unmanufactured	20,395	[1] 701	22,890	785

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States—Continued

Mineral	1957 Short tons (unless otherwise stated)	1957 Value (thousands)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
COAL, PETROLEUM, AND RELATED PRODUCTS				
Carbon black:				
Acetylene black ... pounds	7,571,116	$1,342	7,154,224	$1,287
Gas black and carbon black ... do	20	(8)	125,958	22
Coal:				
Anthracite	1,138	9	4,363	34
Bituminous, slack, culm, and lignite	366,506	[1] 3,146	306,940	2,547
Briquets	850	10	184	2
Coke	117,951	[1] 1,544	121,517	1,571
Peat:				
Fertilizer grade	236,370	[1] 10,700	258,824	11,433
Poultry and stable grade	10,389	[1] 587	10,272	602
Petroleum:				
Crude ... thousand barrels	[2] 385,802	[1 2] 980,142	383,981	940,343
Gasoline [9] ... do	11,483	48,202	29,133	111,071
Kerosine ... do	125	537	34	148
Distillate oil [10] ... do	9,148	[1] 31,277	14,878	47,103
Residual oil [11] ... do	176,021	464,960	195,756	451,736
Unfinished oils ... do	[2] 1,959	[2] 5,292	20,510	56,316
Asphalt ... do	[2] 6,569	[2] 17,175	7,501	18,935
Miscellaneous ... do	(8)	[1] 44	14	222

[1] Data known to be not comparable with 1958.
[2] Revised figure.
[3] Adjusted by the Bureau of Mines.
[4] Data not available.
[5] Includes 4,903 pounds of scrap ($1,698).
[6] Weight not recorded.
[7] In addition to data shown an estimated 282,400 long tons ($889,100) were imported.
[8] Less than 1,000.
[9] Includes naphtha but excludes benzol, 1957—1,317,212 barrels ($14,516,000); 1958—1,060,597 barrels ($10,928,459).
[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[1]

[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	1957		1958	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
METALS				
Aluminum:				
Ingots, slabs, crude	[2] 29,105	[2] $14,613	52,711	$24,220
Scrap	18,166	6,435	18,906	5,595
Plates, sheets, bars, etc	13,767	13,179	9,183	10,240
Castings and forgings	1,333	3,064	1,633	3,022
Antimony: Metals and alloys, crude	4	3	39	23
Arsenic: Calcium arsenate ... pounds	2,779,954	201	1,274,000	81
Bauxite, including bauxite concentrates ... long tons	60,993	4,847	11,868	968
Aluminum sulfate	19,689	834	9,864	423
Other aluminum compounds	48,390	5,251	32,803	4,438
Beryllium ... pounds	208,771	260	57,636	247
Cadmium ... thousand pounds	693	1,060	580	771
Calcium chloride	47,965	1,628	37,632	1,325
Chrome:				
Ore and concentrates:				
Exports	837	53	717	49
Reexports	4,872	194	52,303	2,158
Chromic acid	674	388	486	281
Ferrochrome	4,535	2,419	1,920	1,012
Cobalt ... pounds	[2] 1,061,275	[2] 946	1,757,600	1,102
Columbium metals, alloys, and other forms ... do	59,241	47	54,711	42
Copper:				
Ores, concentrates, composition metal, and unrefined copper (copper content)	15,656	9,964	11,475	5,865
Refined copper and semimanufactures	430,446	288,936	428,015	231,102
Other copper manufactures	238	321	2,302	1,567
Copper sulfate or blue vitriol	33,644	6,534	7,248	1,176
Copper base alloys	(3)	[2] 56,319	(3)	26,906
Ferroalloys:				
Ferrosilicon ... pounds	5,297,681	502	4,353,279	392
Ferrophosphorous ... do	100,635,032	1,901	89,006,784	1,468
Gold:				
Ore and base bullion ... troy ounces	23,953	834	26,929	945
Bullion, refined ... do	4,781,780	167,498	859,042	30,077
Iron ore ... thousand long tons	5,002	[2] 47,543	3,439	34,427
Iron and steel:				
Pig iron	882,342	[2] 57,184	103,348	6,725
Iron and steel products (major):				
Semimanufactures	3,395,118	574,548	[4] 1,676,749	[4] 298,943
Manufactured steel mill products	2,521,622	579,236	[4] 1,625,576	[4] 406,812
Advanced products	(3)	[2] 169,204	(3)	[4] 170,772
Iron and steel scrap: Ferrous scrap, including rerolling materials	[2] 6,765,992	[2] 329,511	2,954,969	97,447
Lead:				
Ore, matte, base bullion (lead content)	906	257	1,012	252
Pigs, bars, anodes	4,339	1,345	1,359	467
Scrap	885	215	1,015	237
Magnesium:				
Metal and alloys and semifabricated forms, n.e.c	1,574	1,890	1,041	1,280
Powder	22	39	11	16
Manganese:				
Ore and concentrates	5,270	724	4,833	700
Ferromanganese	7,395	1,866	1,406	464
Mercury:				
Exports ... 76-pound flasks	1,919	484	320	95
Reexports ... do	3,275	763	934	199
Molybdenum:				
Ores and concentrates ... pounds	25,465,515	32,428	11,962,938	15,045
Metals and alloys, crude and scrap ... do	98,513	182	14,151	5
Wire ... do	13,750	231	11,346	215
Semifabricated forms, n.e.c ... do	4,289	49	20,878	63
Powder ... do	28,222	43	4,841	16
Ferromolybdenum ... do	383,271	447	226,246	245
Nickel:				
Ore			10	1
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc	12,756	14,089	13,305	17,066
Catalysts	(5)	(5)	485	1,023
Nickel-chrome electric resistance wire	151	632	154	678
Semifabricated forms, n.e.c	508	1,797	563	2,491

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States[1]—Continued

Mineral	1957 Short tons (unless otherwise stated)	1957 Value (thousands)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
METALS—continued				
Platinum:				
Ore and concentrates ____ troy ounces__	------	------	35,075	$1,233
Bars, ingots, sheets, wire, sponge, and other forms, including scrap ____ troy ounces__	17,199	$1,329		
Palladium, rhodium, iridium, osmiridium, ruthenium and osmium metals and alloys, including scrap ____ troy ounces__	23,155	374	12,293	379
Platinum group manufactures, except jewelry__	(3)	1,960	(3)	2,103
Radium metal (radium content) ____ milligrams__	750	7	80	3
Rare earths:				
Cerium ores, metals, and alloys ____ pounds__	13,270	33	29,998	24
Lighter flints ____ do____	3,372	24	7,720	47
Silver:				
Ore and base bullion ____ thousand troy ounces__	1,373	1,246	1,640	1,456
Bullion, refined ____ do____	8,927	8,238	1,093	1,000
Tantalum:				
Ore, metal, and other forms ____ pounds__	4,877	252	20,076	302
Powder ____ do____	5,997	228	5,773	212
Tin:				
Ingots, pigs, bars, etc:				
Exports ____ long tons__	1,112	1,526	917	1,336
Reexports ____ do____	419	919	424	899
Tin scrap and other tin bearing material except tinplate scrap ____ do____	9,545	3,911	2,291	992
Tin cans finished or unfinished ____ do____	30,166	14,309	35,849	18,322
Tin compounds ____ pounds__	489,227	867	(6)	(6)
Titanium:				
Ores and concentrates ____	2,019	276	1,246	172
Sponge (including iodide titanium) and scrap__	71	78	97	172
Intermediate mill shapes ____	698	7,174	192	1,772
Mill products n.e.c ____	81	2,230	144	3,456
Ferrotitanium ____	367	130	323	138
Dioxide and pigments ____	52,960	19,687	37,016	11,347
Tungsten: Ore and concentrates:				
Exports ____	163	227	22	17
Reexports ____	572	724	162	207
Vanadium ore and concentrates (vanadium content) ____ pounds__	1,000,340	2,115	1,261,083	2,625
Zinc:				
Ores and concentrates (zinc content) ____	7	(7)	------	------
Slabs, pigs, or blocks ____	10,785	2,553	1,736	627
Sheets, plates, strips, or other forms, n.e.c ____	4,056	2,950	[4] 3,818	[4] 2,637
Scrap (zinc content) ____	5,469	822	5,344	364
Dust ____	595	195	519	170
Semifabricated forms, n.e.c ____	485	247	1,168	542
Zirconium:				
Ores and concentrates ____	3,160	315	1,994	336
Metals and alloys and other forms ____ pounds__	66,784	384	100,556	757
NONMETALS				
Abrasives:				
Grindstones ____ pounds__	660,057	54	280	45
Diamond dust and powder ____ carats__	199,252	622	123,194	378
Diamond grinding wheels ____ do____	194,934	1,135	203,095	1,294
Other natural and artificial metallic abrasives and products ____	(3)	25,777	(3)	24,987
Asbestos: Unmanufactured:				
Exports ____	2,775	340	2,937	407
Reexports ____	118	10	89	17
Boron: Boric acid, borates, crude and refined pounds__	428,994,042	15,975	[4] 471,167,767	[4] 18,292
Bromine, bromides, and bromates ____ do__	10,510,719	3,053	10,071,033	3,129
Cement ____ 376-pound barrels__	1,330,520	5,322	641,159	2,975
Clay:				
Kaolin or china clay ____	54,879	1,327	66,419	1,602
Fire clay ____	136,819	1,794	125,923	1,880
Other clays ____	292,921	10,407	257,436	8,646
Cryolite ____	165	55	164	46
Fluorspar ____	754	81	3,374	191

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States [1]—Continued

Mineral	1957 Short tons (unless otherwise stated)	1957 Value (thousands)	1958 Short tons (unless otherwise stated)	1958 Value (thousands)
NONMETALS—continued				
Graphite:				
Amorphous	902	$93	767	$97
Crystalline flake, lump or chip	167	57	164	52
Natural, n.e.c	280	75	235	43
Gypsum:				
Crude, calcined, crushed thousand short tons	24	763	29	921
Plasterboard, wallboard, and tile square feet	8,866,572	520	(6)	1,544
Manufactures, n.e.c	(3)	62		
Iodine, iodide, iodates thousand pounds	233	335	199	314
Kyanite and allied minerals	2,588	130	2,493	127
Lime	65,195	1,329	45,844	1,047,310
Mica:				
Unmanufactured pounds	911,006	46	1,030,540	90
Manufactured:				
Ground or pulverized do	9,256,170	521	8,198,367	431
Other do	541,432	983	254,198	696
Mineral-earth pigments: Iron oxide, natural and manufactured	3,675	1,038	3,914	1,065
Nitrogen compounds (major)	[2] 1,218,122	[2] 59,208	704,492	38,938
Phosphate rock long tons	3,126,215	28,189	2,818,073	25,234
Phosphatic fertilizers do	575,387	24,705	514,227	23,388
Pigments and salts (lead and zinc):				
Lead pigments	3,953	1,422	3,446	1,095
Zinc pigments	4,135	1,163	3,156	912
Lead salts	608	231	1,050	412
Potash:				
Fertilizer	459,699	16,096	496,805	16,478
Chemical	7,796	1,410	9,871	1,799
Quartz crystal (raw)	(3)	153	(3)	285
Radioactive isotopes, etc	(3)	1,367	(3)	1,534
Salt:				
Crude and refined	390,707	2,591	363,009	2,273
Shipments to noncontiguous Territories	10,975	857	12,790	1,026
Sodium and sodium compounds:				
Sodium sulfate	23,667	859	20,193	786
Sodium carbonate thousand short tons	174	6,282	104	4,279
Stone:				
Limestone, crushed, ground, broken	[2] 1,088,004	[2] 1,650	767,757	1,390
Marble and other building and monumental cubic feet	415,903	1,158	349,366	1,236
Stone, crushed, ground, broken	129,559	2,699	173,340	3,697
Manufactures of stone	(3)	506	(3)	432
Sulfur:				
Crude long tons	[2] 1,578,359	[2] 43,940	1,570,979	39,317
Crushed, ground, flowers of do	[2] 14,620	[2] 1,458	27,949	2,050
Talc:				
Crude and ground	39,985	1,127	58,647	1,358
Manufactures, n.e.c	291	138	212	93
Powders-talcum (face and compact)	(3)	1,322	(3)	1,341
COAL, PETROLEUM, AND RELATED PRODUCTS				
Carbon black thousand pounds	459,671	40,468	440,542	39,748
Coal:				
Anthracite	4,331,785	65,012	2,279,859	35,762
Bituminous	[2] 76,445,529	[2] 764,666	50,279,706	489,881
Briquets	86,464	1,383	54,961	899
Coke	822,244	14,356	392,817	7,127
Petroleum:				
Crude thousand barrels	[2] 50,243	[2] 173,366	4,345	14,748
Gasoline [9] do	30,792	206,914	20,370	142,554
Kerosine do	4,914	21,780	1,140	5,369
Distillate oil do	45,071	182,163	17,115	63,638
Residual oil do	32,875	95,951	22,772	54,078
Lubricating oil do	13,193	[2] 194,887	12,464	185,807

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States[1]—Continued

Mineral	1957		1958	
	Short tons (unless otherwise stated)	Value (thousands)	Short tons (unless otherwise stated)	Value (thousands)
NONMETALS—continued				
Petroleum—Continued				
Asphalt .... thousand barrels..	1, 545	$9, 992	1, 083	$6, 013
Liquefied petroleum gases .... do....	4, 538	21, 100	2, 854	8, 423
Wax .... do....	1, 023	22, 741	905	19, 861
Coke .... do....	5, 176	20, 970	4, 406	18, 026
Petrolatum .... do....	270	5, 962	256	6, 084
Miscellaneous products .... do....	1, 032	18, 480	518	13, 655

[1] Changes in Minerals Yearbook 1957, p. 115, should read as follows; 1956, titanium dioxide and pigment 64,806 short tons ($25,158).
[2] Revised figure.
[3] Weight not recorded.
[4] Due to changes in classifications by the Bureau of the Census data not strictly comparable with 1957.
[5] Not separately classified prior to 1958.
[6] Beginning Jan. 1, 1958, not separately classified.
[7] Less than $1,000.
[8] Curie: 156,191.
[9] Includes naphtha but excludes benzol: 1957—64,158 barrels ($1,154,633), 1958—273,428 barrels ($3,562,974).

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

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

Mineral	1957			1958		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Coal:						
Bituminous	1, 761, 225	490, 097	27	1, 846, 370	408, 019	22
Lignite	655, 496	2, 607	(2)	677, 365	2, 427	(2)
Pennsylvania anthracite	156, 800	25, 338	16	161, 400	21, 171	13
Coke (excluding breeze):						
Gashouse[3]	52, 196	(4)	(4)	51, 283	(4)	(4)
Oven and beehive	293, 848	75, 951	26	280, 246	53, 604	19
Fuel briquets and packaged fuel	120, 830	1, 152	(2)	116, 760	1, 072	(2)
Natural gas .... million cubic feet..	(5)	10, 680, 258	(5)	(5)	11,030,298	(5)
Peat	69, 260	316	(2)	65, 670	328	(2)
Petroleum (crude) .... thousand barrels..	6, 450, 666	2, 616, 901	41	6, 617, 656	2, 448, 866	37
Nonmetallic minerals:						
Asbestos	2, 070	44	2	2, 020	44	2
Barite	3, 500	1, 305	37	2, 500	486	19
Cement .... thousand barrels..	1, 447, 912	313, 756	21	1, 541, 996	326, 352	21
Corundum	10	----------	--------	11	----------	--------
Diamonds .... thousand carats..	20, 800	----------	--------	22, 000	----------	--------
Diatomite	770	368	48	825	368	45
Feldspar[6] .... thousand long tons..	1, 050	498	47	1, 025	470	46
Fluorspar	1, 920	329	17	1, 760	320	18
Graphite	405	(4)	(4)	335	(4)	(4)
Gypsum	36, 430	9, 195	25	36, 660	9, 600	26
Magnesite	5, 600	678	12	5, 900	493	8
Mica (including scrap) thousand pounds..	320, 000	185, 566	58	320, 000	187, 348	59
Nitrogen, agricultural[6 7]	7, 606	2, 105	28	8, 267	2, 218	27
Phosphate rock .... thousand long tons..	32, 560	13, 976	43	34, 870	14, 879	43
Potash .... K_2O equivalent..	8, 700	2, 266	26	8, 800	2, 147	24
Pumice	9, 000	1, 827	20	9, 100	1, 973	22
Pyrites .... thousand long tons..	17, 800	1, 067	6	17, 650	974	6
Salt	77, 350	23, 844	31	81, 800	21, 911	27
Strontium[6]	13	(4)	(4)	13	(4)	(4)
Sulfur, native .... thousand long tons..	7, 300	5, 579	76	6, 500	4, 646	71
Talc, pyrophyllite, and soapstone	2, 030	684	34	2, 000	737	37
Vermiculite[6]	249	184	74	238	182	76

See footnotes at end of table.

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

Mineral	1957			1958		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Metals, mine basis:						
Antimony (content of ore and concentrate)[6] ... short tons	50,000	709	1	44,000	705	2
Arsenic[6]	43	10	23	40	12	30
Bauxite ... thousand long tons	20,100	1,416	7	20,700	1,311	6
Beryllium concentrates ... short tons	11,900	521	4	7,000	463	7
Bismuth ... thousand pounds	5,500	(4)	(4)	4,900	(4)	(4)
Cadmium ... do	21,070	10,549	50	19,850	9,673	49
Chromite	5,125	166	3	4,050	144	4
Cobalt (contained) ... short tons	15,900	1,651	10	14,600	2,012	14
Columbium-tantalum concentrates thousand pounds	6,910	370	5	5,000	428	9
Copper (content of ore and concentrate)	3,900	1,087	28	3,740	979	26
Gold ... thousand fine ounces	39,600	1,800	5	40,400	1,739	4
Iron ore ... thousand long tons	422,633	106,148	25	397,036	67,947	17
Lead (content of ore and concentrate)	2,610	338	13	2,520	267	11
Manganese ore (35 percent or more Mn)	14,126	366	3	13,049	323	2
Mercury ... thousand 76-pound flasks	245	35	14	248	38	15
Molybdenum (content of ore and concentrate) ... thousand pounds	76,200	60,753	80	56,500	41,069	73
Nickel (content of ore and concentrate)	314	10	3	245	12	5
Platinum groups (Pt, Pd, etc.) thousand troy ounces	1,310	19	1	880	14	2
Silver ... thousand fine ounces	230,100	38,720	17	236,800	36,800	16
Tin (content of ore and concentrate) thousand long tons	200	----------	--------	152	----------	--------
Titanium concentrates:						
Ilmenite	1,972	757	38	1,711	563	33
Rutile	156	11	7	103	7	7
Tungsten concentrate-60 percent WO_3 short tons	75,000	5,520	7	63,500	3,788	6
Vanadium (content of ore and concentrate)[6] ... short tons	4,295	3,691	86	4,231	3,030	72
Zinc (content of ore and concentrate)	3,510	532	15	3,350	412	12
Metals, smelter basis:						
Aluminum	3,725	1,648	44	3,890	1,566	40
Copper	4,070	1,178	29	3,930	1,069	27
Iron, pig (incl. ferroalloys)	233,200	80,920	35	216,440	58,867	27
Lead	2,510	533	21	2,480	469	19
Magnesium	155	81	52	101	30	30
Selenium ... thousand pounds	1,940	1,077	56	1,630	727	45
Steel ingots and castings	322,000	112,715	35	298,400	85,255	29
Tellurium ... thousand pounds	287	255	89	214	170	80
Tin ... thousand long tons	195	2	1	160	(4)	(4)
Zinc	3,240	986	30	3,010	781	26

[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 U.S. 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).

Employment and Injuries in the Metal and Nonmetal Industries

By John C. Machisak[1]

THIS CHAPTER of the Minerals Yearbook covers employment and injury experience in the metal, nonmetal, and quarrying industries of the United States. Each industry is treated separately, and no attempt has been made to combine data and show an overall total for this group of mineral industries. Employment and injury experience for all mineral industries may be found in volume III.

The Federal Bureau of Mines started collecting employment and injury data from metal and nonmetal mines and stone quarries in 1911. The information upon which these data are based was submitted voluntarily by operators of these mines and quarries. Their reports have contributed substantially to the promotion of safety in these industries.

TABLE 1.—Employment and injury experience at metal mines in the United States

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 [2]	68,273	264	18,017	144,407	89	5,475	.62	37.91
1957	68,457	259	17,751	142,181	71	4,554	.50	32.03
1958 [3]	59,000	222	13,108	104,966	63	3,080	.60	29.34

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

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

METAL MINES

Preliminary estimates indicate that the safety record for metal mines improved somewhat in 1958 over that of 1957. Both fatal and nonfatal injuries decreased, lowering the overall injury-frequency rate of 32.53 in 1957 to 29.94 in 1958, an 8-percent decrease. Man-hours of employment and the number of active mine days also decreased. Each employee worked an average of 1,779 hours. The average length of shift was 8 hours per day.

Copper.—The combined (fatal and nonfatal) injury-frequency rate for copper mines increased slightly (3 percent). Fatalities increased by 1; however, nonfatal injuries declined by 241 (19 percent). A decrease also was noted in both employment and man-hours. Copper mines were active an average of 260 days. Each employee accumulated an average of 2,082 hours, working an 8-hour shift.

Gold Placer.—There were no fatalities reported in placer-mining operations; nonfatal injuries declined 7 percent, from 140 reported in 1957 to an estimated 132 in 1958. A decrease of 3 percent in employment was noted; however, man-hours of employment increased 4 percent. The injury-frequency rate was 52.38 per million man-hours of work, a decrease of 12 percent from the rate of 59.67 for the preceding year. An 8.27-hour shift was estimated, and 1,655 hours of work were accumulated for each employee during the year.

Gold-Silver Lode.—The estimated combined (fatal and nonfatal) injury-frequency rate for gold-silver lode mines was 35.18 compared with 45.76 in 1957—a decrease of 23 percent. Estimated average employment and man-hours varied only slightly from their 1957 levels of 3,411 and 7,276,295, respectively, and the average length of shift remained the same for both years (7.99 hours).

Iron.—Estimated injuries (fatal and nonfatal) decreased 29 percent resulting in an overall injury-frequency rate of 13.06 per million man-hours of worktime. Employment and man-hours declined 15 and 34 percent, respectively. Each employee averaged an 8.01-hour shift daily and worked an average of 1,577 hours.

Lead-Zinc.—Employment in the lead-zinc mines revealed a marked decline, according to preliminary estimates. Estimated injuries (fatal and nonfatal) decreased 43 percent from the previous year, resulting in a combined injury-frequency rate of 43.64 compared with an overall rate of 57.57 for 1957. Active mine days for lead-zinc mines averaged 228, and each worker accumulated an average of 1,819 hours while working a 7.98-hour shift.

Miscellaneous Metals.—Included in this group of mines are those producing antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, pyrite, titanium, tungsten, vanadium-uranium, and minor metals. Both fatal and nonfatal injuries decreased substantially—82 and 43 percent, respectively—resulting in a combined (fatal and nonfatal) injury-frequency rate of 46.18 per million man-hours worked. An estimated 17-percent decrease in employment and a 32-percent decline in man-hours was noted. The average worker accumulated a total of 1,541 hours while working an 8.02-hour daily shift. Active mine days averaged 192, 45 days less than reported in 1957.

TABLE 2.—Employment and injury experience at metal mines in the United States, by industry groups

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:								
1949–53 (average)	15,697	301	4,718,333	37,704,009	20	1,209	0.53	32.07
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	17,664	294	5,187,512	41,452,321	19	1,276	.46	30.78
1958 [1]	15,800	260	4,111,000	32,890,000	20	1,035	.61	31.47
Gold placer:								
1949–53 (average)	2,931	215	629,216	5,039,809	1	182	.20	36.11
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	1,551	186	287,819	2,379,782	2	140	.84	58.83
1958 [1]	1,500	200	300,000	2,482,000		130		52.38
Gold-silver:								
1949–53 (average)	4,308	256	1,104,577	8,640,942	10	973	1.16	112.60
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]	2,631	259	681,718	5,453,661	4	473	.73	86.73
1957	3,411	267	910,244	7,276,295	6	327	.82	44.94
1958 [1]	3,400	263	893,000	7,134,000	6	245	.84	34.34
Iron:								
1949–53 (average)	29,744	262	7,795,104	62,581,430	25	1,149	.40	18.36
1954	27,840	220	6,131,671	49,177,496	14	713	.28	16.92
2955	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	25,669	252	6,479,970	51,958,001	13	617	.25	11.87
1958 [1]	21,700	197	4,271,000	34,215,000	17	430	.50	12.57
Lead-zinc:								
1949–53 (average)	15,028	258	3,882,448	31,036,883	28	2,538	.90	81.77
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	11,777	246	2,897,346	23,168,427	14	1,320	.60	56.97
1958 [1]	9,600	228	2,188,000	17,460,000	17	745	.97	42.64
Miscellaneous: [3]								
1949–53 (average)	4,035	257	1,036,664	8,357,652	7	593	.84	70.95
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	8,385	237	1,987,818	15,945,699	17	874	1.07	54.81
1958 [1]	7,000	192	1,345,000	10,785,000	3	495	.28	45.90
Total:								
1949–53 (average)	71,743	267	19,166,342	153,360,725	91	6,644	.59	43.32
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 [2]	68,273	264	18,017,282	144,406,908	89	5,475	.62	37.91
1957	68,457	259	17,750,709	142,180,525	71	4,554	.50	32.03
1958 [1]	59,000	222	13,108,000	104,966,000	63	3,080	.60	29.34

[1] Estimate.
[2] Revised figures.
[3] Includes antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, platinum, titanium, tungsten, vanadium-uranium, magnesium, and minor metals.

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. Estimated data show a decrease of 621 in the number of men employed, a 3-percent decline from 1957, with the man-hours of work also decreasing. There were 12 fatalities compared with 9 for the preceding year—an increase of 33 percent; however, there were 262 fewer nonfatal injuries, a 24-percent decrease. The overall (fatal and nonfatal) injury-frequency rate of 24.68 per million man-hours of work declined approximately 17 percent from the rate of 29.60 for 1957. The length of shift averaged 8.09 hours per day, and each man worked an average of 2,019 hours during the year.

Nonmetal Mills.—Employment at nonmetal mills declined both in number of men employed and in number of man-hours worked, and the resulting injury-frequency rate declined proportionately. The overall (fatal and nonfatal) rates decreased 8 percent from 25.47 in 1957 to 23.33. The mills operated on an 8.06-hour shift and averaged 268 days during the year. Each worker accumulated approximately 2,158 hours of worktime.

Clay Mines and Mills.—The preliminary estimates for clay mines and mills indicate a decrease in both men employed and in number of man-hours worked from that of the preceding year. Clay mines worked an 8-hour shift and averaged 193 days; each worker averaged 1,542 hours during the year. The overall (fatal and nonfatal) injury-frequency rate of 32.30 per million man-hours decreased 16 percent from the corresponding rate of 38.66 for the preceding year. A slight decline was also noted in the overall (fatal and nonfatal) injury-frequency rate for clay mills—from 29.74 in 1957 to 29.62 in 1958. The mills worked an 8.07-hour shift and averaged 254 days. Each worker accumulated approximately 2,050 hours during the year.

Sand and Gravel.—Injury and employment rates for sand and gravel were slightly lower than for the preceding year both in number of men employed and in man-hours worked. The estimated overall (fatal and nonfatal) injury-frequency rate was 18.57, compared with 30.09 in 1957, a decrease of 38 percent. Current estimates were compiled from reports sent to the Branch of Accident Analysis on or before the May 31, 1959 cutoff date for preliminary data.

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

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	17,921	262	4,691	37,877	9	1,112	.24	29.36
1958 [3]	17,300	250	4,318	34,927	12	850	.34	24.34

[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[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
1949–53 (average)	12,353	290	3,579,397	28,995,403	16	1,261	0.55	43.49
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	17,921	262	4,690,737	37,877,405	9	1,112	.24	29.36
1958 [3]	17,300	250	4,318,000	34,927,000	12	850	.34	24.34

[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 (except stone quarries) in the United States

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
1955 [1]	8,723	283	2,466,533	19,842,736	3	451	0.15	22.73
1956	17,585	288	5,056,390	40,675,317	7	1,157	.17	28.44
1957	27,081	274	7,415,452	59,764,701	10	1,512	.17	25.30
1958 [2]	26,000	268	6,956,000	56,098,000	9	1,300	.16	23.17

[1] Shown separately for the first time in 1955—beginning 1956, clay mill figures included.
[2] Estimate.

TABLE 6.—Employment and injury experience at clay mines and mills in the United States

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	5,024	208	1,046,044	8,354,919	3	320	.36	38.30
1958 [1]	5,000	193	963,000	7,708,000	4	245	.52	31.79
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	15,516	258	3,995,927	32,079,317	5	949	.16	29.58
1958 [1]	14,800	254	3,759,000	30,345,000	4	895	.13	29.49

[1] Estimate.

TABLE 7.—Employment and injury experience at sand and gravel operations in the United States

Year	Men working daily	Average active days	Man-days worked	Man-hours worked	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1957 [1]	31,531	221	6,954,007	59,763,892	35	1,763	0.59	29.50
1958 [2]	31,000	217	6,718,000	57,718,000	37	1,035	.64	17.93

[1] Employment data from Branch of Construction and Chemical Materials, Division of Minerals.
[2] Estimate.

METALLURGICAL PLANTS

The overall employment and injury experience at metallurgical plants (ore-dressing and nonferrous smelters and refineries combined) showed a marked decline. Estimated fatalities decreased 43 percent from those of the preceding year, while nonfatal injuries decreased 38 percent, resulting in a combined (fatal and nonfatal) injury-frequency rate of 10.71. Employment and man-hours decreased 14 and 20 percent, respectively, from those of the preceding year. The average employee worked a 7.97-hour shift per day and a total of 2,397 hours.

TABLE 8.—Employment and injury experience at metallurgical plants in the United States

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	37,966	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 [1]	65,681	327	21,470	171,578	20	2,543	.12	14.82
1957	65,212	322	21,003	167,489	21	2,280	.13	13.61
1958 [2]	56,000	301	16,842	134,221	12	1,425	.09	10.62

[1] Revised figures.
[2] Estimate.

ORE-DRESSING PLANTS

Ore-dressing plants include the crushing, screening, washing, jigging, magnetic separation, flotation, and other milling operations of metallic ores. Estimated figures show a decline of 67 and 45 percent, respectively, from 1957 in fatal and nonfatal injuries. The estimated overall injury-frequency rate for ore-dressing plants was 10.69 compared with the rate of 15.10 for 1957. A decrease of 11 percent in employment and 13 percent in days active resulted in a 22-percent decrease in man-hours. The average worker accumulated a total of 2,012 hours while working a 7.99-hour daily shift.

TABLE 9.—Employment and injury experience at ore-dressing plants in the United States, by industry groups

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:								
1949-53 (average)	6,165	331	2,041,497	16,337,170	1	244	0.06	14.94
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	7,083	319	2,260,958	18,095,232	4	279	.22	15.42
1958 [1]	6,700	276	1,849,000	14,790,000	2	175	.14	11.83
Gold-silver:								
1949-53 (average)	716	289	206,798	1,624,887		58		35.69
1954	385	301	116,066	925,843	1	34	1.08	36.72
1955	408	298	121,420	971,223		43		44.27
1956 [2]	367	295	108,402	865,748		24		27.72
1957	468	267	125,043	1,000,667		20		19.99
1958 [1]	400	238	95,000	757,000		5		6.61
Iron:								
1949-53 (average)	3,842	234	899,563	7,272,316	2	76	.28	10.45
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	5,218	262	1,366,846	11,003,839	1	67	.09	6.09
1958 [1]	4,900	221	1,083,000	8,628,000	1	60	.12	6.95
Lead-zinc:								
1949-53 (average)	3,755	260	975,269	7,803,959	2	222	.26	28.45
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	3,280	252	825,800	6,608,584		104		15.74
1958 [1]	2,600	226	588,000	4,709,000		35		7.43
Miscellaneous metals: [3]								
1949-53 (average)	2,579	309	797,476	6,391,732		208		32.54
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	5,517	296	1,635,330	13,087,150	4	273	.31	20.86
1958 [1]	4,600	265	1,218,000	9,745,000		135		13.85
Total:								
1949-53 (average)	17,057	288	4,920,603	39,430,064	5	808	.13	20.49
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 [2]	19,261	294	5,668,460	45,439,548	9	679	.20	14.94
1957	21,566	288	6,213,977	49,795,472	9	743	.18	14.92
1958 [1]	19,200	252	4,833,000	38,629,000	3	410	.08	10.61

[1] Estimate.
[2] Revised figures.
[3] Includes antimony, bauxite, chromite, manganese, mercury, molybdenum, titanium, tungsten, uranium-vanadium, magnesium, columbium-tantalum, and minor metals.

NONFERROUS REDUCTION PLANTS AND REFINERIES

The reduction plants and refineries that comprise this section of the mineral industries are engaged in the primary extraction of nonferrous metals from ores and concentrates and the refining of crude primary nonferrous metals, exclusive of iron and steel plants. Estimated data indicate a decrease in fatal and nonfatal injuries of 25 and 34 percent, respectively, from those of 1957. An overall decrease in both employment and man-hours of 16 and 19 percent, respectively, was also recorded in 1958. Hours worked per employee totaled 2,598 on the basis of a 7.96-hour shift per day.

TABLE 10.—Employment and injury experience at primary nonferrous reduction and refinery plants in the United States, by industry groups

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	Non-fatal	Fatal	Non-fatal
Copper:								
1949–53 (average)	11,423	320	3,655,980	29,289,160	5	448	0.17	15.30
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	11,826	323	3,820,769	30,582,780	5	375	.16	12.26
1958 [1]	10,600	312	3,309,000	26,489,000	3	260	.11	9.82
Lead:								
1949–53 (average)	3,865	305	1,177,285	9,415,256	2	125	.21	13.28
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	3,439	314	1,078,679	8,629,463	1	137	.12	15.88
1958 [1]	3,100	294	911,000	7,285,000	2	125	.27	17.16
Zinc:								
1949–53 (average)	9,444	346	3,268,942	25,983,181	4	808	.15	31.10
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	9,263	326	3,023,225	24,083,462	4	632	.17	26.24
1958 [1]	7,700	318	2,447,000	19,495,000	3	400	.15	20.52
Miscellaneous metals: [2]								
1949–53 (average)	7,465	320	2,386,600	18,760,501	2	517	.11	27.56
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 [3]	20,849	362	7,550,053	60,208,786	2	591	.03	9.82
1957	19,118	359	6,865,927	54,398,215	2	393	.04	7.22
1958 [1]	15,400	347	5,342,000	42,323,000	1	230	.02	5.43
Total:								
1949–53 (average)	32,197	326	10,488,807	83,448,098	13	1,898	.16	22.74
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 [3]	46,420	340	15,801,668	126,138,167	11	1,864	.09	14.78
1957	43,646	339	14,788,600	117,693,920	12	1,537	.10	13.06
1958 [1]	36,800	326	12,009,000	95,592,000	9	1,015	.09	10.62

[1] Estimate.
[2] Includes aluminum, antimony, cobalt, magnesium, titanium, and minor metals.
[3] Revised figures.

STONE QUARRIES

The preliminary data compiled for the quarrying industry from reports received by the Bureau of Mines revealed an improvement in the injury experience over 1957. An estimated 42 fatalities occurred at the rate of 0.24 per million man-hours of work, a 17-percent decrease from 1957. The nonfatal injury-frequency rate of 21.92 was 5 percent lower than in 1957. The number of men working daily declined from 84,126 to 80,500 (4 percent). Man-hours decreased 5 percent, and the average employee accumulated 2,153 hours of worktime—a decrease of 1 percent from 1957.

Cement.—The estimated combined injury experience of the cement industry, including quarry and mill employees, was slightly less favorable than in the preceding year. Fatal and nonfatal injuries declined 43 and 1 percent, respectively, from those of the preceding year. The estimated overall (fatal and nonfatal) injury-frequency rate rose from

3.94 in 1957 to 4.03 in 1958. The number of active days worked was 299, or 18 less than in the preceding year. The average employee worked an 8-hour shift and accumulated 2,397 hours of worktime during the year.

Granite.—The overall injury experience at granite quarries and related plants revealed a slight increase as shown by the combined (fatal and nonfatal) injury-frequency rate of 45.25 compared with 43.20 for 1957. Fatalities decreased 38 percent, while nonfatal injuries increased 4 percent. Fewer men were employed and the average man worked an 8.44-hour shift and accumulated 2,076 hours of worktime compared with 1,979 hours in 1957.

Limestone.—Improvement in the injury experience for the limestone-quarrying industry and related plants is reflected in both the fatal and nonfatal injuries. The combined (fatal and nonfatal) frequency rate was 34.70 compared with 35.61 for 1957. The number of men working declined 6 percent from 28,692 in 1957 to 26,900 in 1958. The number of active days increased from 230 in 1957 to 238, and the average hours of worktime accumulated, while working a slightly longer shift, increased to 1,986 hours from 1,939 hours in 1957.

Lime.—The combined (fatal and nonfatal) injury rate for quarries that produced stone chiefly for the manufacture of lime was 21.70, a decline of 10 percent from 23.98 for 1957. Nonfatal injuries decreased from the 447 reported in 1957 to 350, while the number of fatalities remained the same for both years. A 16-percent decline was noted in the number of men working daily and an approximately similar decline in man-hours was revealed. The length of shift worked was slightly longer than that for the preceding year, and the annual average number of hours accumulated by each worker rose to 2,344 from 2,273 in 1957.

Marble.—Injury and employment experience for marble quarries and their associated plants was less favorable than in 1957. Nonfatal injuries increased to 195 from 188 reported in 1957, while the number of fatalities remained the same for both years. The combined (fatal and nonfatal) injury-frequency rate rose to 34.58 from the rate of 28.00 in 1957. The average number of men employed decreased to an estimated 3,000 as compared to 3,160 working in 1957. Fewer man-hours were recorded while working the same length of shift.

Sandstone.—The safety record at sandstone operations was more favorable. No fatalities were reported. The number of nonfatal injuries decreased from 259 in 1957 to 220. The estimated combined frequency rate decreased 6 percent from that of the preceding year. The number of men employed dropped 9 percent, the length of shift was the same, and each man accumulated an average of 1,659 hours of worktime, compared with 1,674 in 1957.

Slate.—Injury experience for slate quarries and related plants improved sharply. No fatal injuries were reported. Nonfatal injuries decreased approximately 56 percent, resulting in an estimated combined (fatal and nonfatal) injury-frequency rate of 28.47, a decline of 52 percent from that of 59.21 in 1957. The average number of men working daily decreased 57 percent from that of 1957. Man-hours of work decreased 8 percent, while working approximately the same length of shift as in 1957.

Traprock.—The traprock industry's safety record improved substantially. The estimated combined (fatal and nonfatal) injury-frequency rate declined 20 percent from 53.08 in 1957 to 42.60. Fatalities increased in number over those of the preceding year. Nonfatal injuries, on the other hand, decreased 87 in number, or 31 percent from those reported in 1957. Employment declined 6 percent; and the average worker accumulated 1,730 hours of worktime—119 fewer than in 1957.

Miscellaneous Stone.—This category comprises all stones not otherwise classified and was first canvassed in 1957. The preliminary figures show a slight downward trend in overall injury experience and employment. No fatal injuries were reported in either 1957 or 1958. Forty-one nonfatal injuries occurred in 1957 compared with 40 in 1958. The average employee worked a 7.97-hour shift and accumulated 1,992 hours during the year.

TABLE 11.—Employment and injury experience at stone quarries in the United States

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	84, 126	266	22, 410	183, 394	53	4, 210	. 29	22. 96
1958 [1]	80, 500	263	21, 189	173, 348	42	3, 800	. 24	21. 92

[1] Estimate.

TABLE 12.—Employment and injury experience at stone quarries in the United States, by industry groups

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]								
1949–53 (average)	28,846	327	9,440,322	74,523,726	16	499	0.21	6.70
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	29,167	317	9,253,955	73,939,963	14	277	.19	3.75
1958 [2]	29,800	299	8,923,000	71,418,000	8	280	.11	3.92
Granite:								
1949–53 (average)	6,943	248	1,720,407	14,264,370	6	575	.42	40.31
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	7,017	238	1,667,718	13,889,747	8	592	.58	42.62
1958 [2]	6,600	246	1,624,000	13,700,000	5	615	.36	44.89
Lime: [1]								
1949–53 (average)	9,091	295	2,682,633	21,506,027	7	644	.33	29.95
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	8,220	284	2,331,917	18,682,666	1	447	.05	23.93
1958 [2]	6,900	291	2,010,000	16,172,000	1	350	.06	21.64
Limestone:								
1949–53 (average)	27,301	236	6,443,562	54,044,535	23	1,947	.43	36.03
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	28,692	230	6,603,218	55,636,944	21	1,960	.38	35.23
1958 [2]	26,900	238	6,393,000	53,411,000	18	1,835	.34	34.36
Marble:								
1949–53 (average)	2,563	252	645,428	5,356,450	1	189	.19	35.28
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	3,160	258	814,093	6,750,288	1	188	.15	27.85
1958 [2]	3,000	227	680,000	5,668,000	1	195	.18	34.40
Sandstone:								
1949–53 (average)	4,115	241	990,455	8,154,338	3	366	.37	44.88
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	2,980	206	612,865	4,988,746	1	259	.20	51.92
1958 [2]	2,700	204	550,000	4,479,000		220		49.12
Slate:								
1949–53 (average)	1,849	266	492,746	4,155,478	1	214	.24	51.50
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	1,357	254	344,556	2,871,355	1	169	.35	58.86
1958 [2]	1,300	244	317,000	2,634,000		75		28.47
Traprock:								
1949–53 (average)	2,944	231	79,955	5,842,027	3	263	.51	45.02
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	2,883	215	619,954	5,331,952	6	277	1.13	51.95
1958 [2]	2,700	201	542,000	4,671,000	9	190	1.93	40.68
Miscellaneous Stone: [3]								
1957	650	248	161,497	1,302,060		41		31.49
1958 [2]	600	250	150,000	1,195,000		40		33.47
Total:								
1949–53 (average)	83,652	276	23,095,508	187,846,951	60	4,697	.32	25.00
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	84,126	266	22,409,773	183,393,721	53	4,210	.29	22.96
1958 [2]	80,500	263	21,189,000	173,348,000	42	3,800	.24	21.92

[1] Includes burning or calcining and other mill operations.
[2] Estimate.
[3] Not compiled before 1957.

Abrasive Materials

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

Contents

SUBSTANTIALLY lower steel and automobile output was the primary cause of a sharp decline in quantity and value of natural and artificial abrasive materials sold or used in 1958.

Production of natural abrasives in 1958 was down 12 percent in tonnage and 18 percent in value. Artificial abrasive production in the United States and Canada was lower by 31 percent in tonnage and 26 percent in value. Imports and exports declined but reexports gained. Grinding-wheel sales decreased 25 percent in value, and coated abrasive sales were down more than 10 percent.

TABLE 1.—Salient statistics of the abrasives industries in the United States

Kind	1949-53 (average)	1954	1955	1956	1957	1958
Natural abrasives (domestic) sold or used by producers:						
Tripoli: [1]						
Short tons	35, 673	41, 625	49, 662	45, 009	50, 717	47, 044
Thousand dollars	1, 030	1, 459	213	203	195	183
Special silica-stone products: [2]						
Short tons	8, 147	6, 221	4, 929	6, 180	5, 847	4, 023
Thousand dollars	394	323	264	411	331	305
Garnet:						
Short tons	10, 368	14, 183	11, 835	9, 812	9, 776	10, 035
Thousand dollars	903	971	1, 191	1, 073	1, 080	860
Emery:						
Short tons	8, 681	9, 758	10, 735	12, 153	11, 893	7, 687
Thousand dollars	116	132	151	174	184	126
Artificial abrasives: [3]						
Short tons	405, 131	404, 376	428, 243	431, 461	484, 702	334, 483
Thousand dollars	40, 681	44, 480	51, 081	55, 692	65, 634	48, 806
Foreign trade (natural and artificial abrasives):						
Imports thousand dollars	[4] 57, 174	72, 023	89, 795	99, 968	[5] 85, 097	60, 866
Exports do	19, 302	20, 757	24, 876	26, 845	27, 589	26, 704
Reexports do	----------	6, 264	6, 444	7, 755	8, 702	12, 964

[1] Figures are for processed tripoli sold or used in 1949-54 and for crude tripoli sold or used in 1955-58.
[2] Includes grindstones, pulpstones (1949-52), oilstones and other sharpening stones (1956 and 1958), value of millstones (1949-53 and 1956-58), grinding pebbles, and tube-mill liners (1949-54 and 1956-58).
[3] Production of silicon carbide and aluminum oxide (United States and Canada); shipments of metallic abrasives (United States).
[4] Includes value of pumice, 1949.
[5] Revised figure.

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

FOREIGN TRADE [3]

Imports.—Imports of abrasive materials into the United States during 1958 declined 28 percent in value from 1957, principally because of reductions of $12 million each in the values of industrial diamond and artificial abrasive imports. Corundum imports increased in tonnage, but the average declared value decreased nearly $20 a short ton. Imports of coated abrasives and abrasive grinding wheels also increased.

Only a small quantity of emery was imported; no industrial garnet imports were reported.

Exports.—The total exports of abrasive materials showed only a slight decline in value from the previous year. For the first time the exports of diatomaceous earth and its products were reported separately.

TABLE 2.—Abrasive materials (natural and artificial) imported for consumption in the United States, by kinds

[Bureau of the Census]

Kind	1957		1958	
	Quantity	Value	Quantity	Value
Burrstones:				
Unmanufactured ... short tons	65	$432		
Hones, oilstones, and whetstones ... number	30,007	[1] 27,711	90,763	$40,781
Corundum (including emery):				
Corundum ore ... short tons	4,104	238,106	4,685	180,355
Emery ore ... do	1,334	17,300	12	713
Grains, ground, pulverized, or refined ... do	722	168,962	517	130,403
Paper and cloth coated with emery or corundum ... reams		[1] 531,757		728,975
Wheels, files, and other manufactures of emery ... short tons	31	[1] 63,802	49	58,148
Wheels of corundum or silicon carbide ... do	13	[1] 18,842	36	49,256
Garnet in grains, or ground, pulverized, etc ... do	2	240		
Tripoli, rottenstone, and diatomaceous earth ... do	9	322	43	3,558
Diamond:				
Bort, manufactured ... carats	6,057	[1] 275,000	752	97,111
Crushing bort (including all types of bort suitable for crushing) ... carats	6,833,237	17,802,373	5,171,390	13,940,946
Other industrial diamond (including glaziers' and engravers' diamond unset and miners') ... carats	[2] 5,385,064	[2] 32,242,100	4,318,407	23,680,308
Carbonado and ballas ... do	2,080	18,343	11,346	107,190
Dust and powder ... do	386,203	1,186,227	568,921	1,520,168
Flint, flints, and flintstones, unground ... short tons	11,502	[1] 280,740	8,637	209,671
Grit, shot, and sand, of iron and steel ... do	852	298,764	1,012	329,523
Artificial abrasives:				
Crude, not separately provided for:				
Carbides of silicon (carborundum, crystalon, carbolon, and electrolon) ... short tons	84,040	11,205,376	73,134	10,986,026
Aluminous abrasives, alundum, aloxite, exolon, and lionite ... short tons	192,778	19,872,664	81,214	8,258,897
Other ... do	4,695	456,322	3,382	317,591
Manufactures:				
Grains, ground, pulverized, refined or manufactured ... short tons	1,624	[1] 350,508	892	201,881
Wheels, files, and other manufactures, not separately provided for ... short tons	14	[1] 41,015	18	24,574
Total		[2] 85,096,906		60,866,075

[1] Data known to be not comparable with 1958.
[2] Revised figure.

[3] Figures of 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.

Reexports.—Reexports were nearly all industrial diamond of various types, of which 49 percent went to the United Kingdom, 30 percent to Canada, and 14 percent to Belgium-Luxembourg. The remainder was divided among seven countries.

TABLE 3.—Abrasive materials exported from the United States
[Bureau of the Census]

Kind	1957 Quantity	1957 Value	1958 Quantity	1958 Value
Natural abrasives:				
Diamond grinding wheels, sticks, hones, and laps ... carats	194,934	$1,134,871	203,095	$1,294,444
Diamond dust and powder ... do	199,252	622,480	123,194	378,326
Diamond suitable only for industrial use ... do	54,413	543,793	96,014	536,744
Grindstones and pulpstones ... short tons	330	54,306	280	44,616
Emery powder, grains, and grits (natural) ... pounds	2,343,422	204,829	2,203,925	181,238
Corundum grains and grits (natural) ... do	417,576	78,822	332,848	53,540
Whetstones, sticks, etc. (natural) ... do	196,128	109,216	204,705	119,028
Diatomaceous earth and products ... do	147,057,093 (includes next item)	5,394,900 (includes next item)	120,517,046	4,234,850
Natural abrasives not elsewhere classified ... do			[1] 23,916,613	[1] 1,182,063
Manufactured abrasives:				
Aluminum oxide, fused, crude, and grains ... do	21,475,167	3,146,515	18,268,725	2,921,457
Silicon carbide, fused, crude, and grains ... do	15,299,644	2,729,166	21,292,813	3,557,565
Alumina, unfused ... do	112,791	14,357	152,260	28,407
Manufactured abrasives, not elsewhere classified ... do	308,337	59,491	199,889	65,346
Abrasive pastes, compounds, and cake (except chemical) ... do	750,902	186,216	585,097	138,568
Grinding wheels, except diamond wheels ... do	5,368,241	4,530,502	3,439,036	3,691,605
Pulpstones of manufactured abrasives ... do	2,488,732	655,817	2,080,734	571,141
Whetstones, etc., of manufactured abrasives ... do	363,955	687,033	276,382	687,977
Abrasive paper and cloth (natural abrasives) ... reams	68,237	1,225,363	38,162	773,687
Abrasive paper and cloth (artificial abrasives) ... do	142,910	5,124,091	139,643	5,222,503
Metallic abrasives (except steel wool) ... pounds	12,409,004	1,087,050	11,678,965	1,021,205
Total	------	27,588,818	------	26,704,310

[1] Includes flint, garnet, tripoli, rottenstone, natural rouge, polishing rouge, and pumice.

TABLE 4.—Abrasive materials reexported from the United States, by kinds
[Bureau of the Census]

Kind	1957 Quantity	1957 Value	1958 Quantity	1958 Value
Natural abrasives:				
Diamond grinding wheels, sticks, hones, and laps ... carats	937	$4,165	------	------
Diamond dust and powder ... do	71,378	221,804	129,534	$344,647
Diamond suitable only for industrial use ... do	1,261,209	8,465,637	1,795,786	12,608,371
Manufactured abrasives:				
Aluminum oxide, fused, crude, and grains ... pounds	129,600	5,800	136,960	6,643
Grinding wheels, except diamond wheels ... do	450	543	1,000	684
Abrasive paper and cloth (natural abrasives) ... reams	61	3,610	7	1,702
Abrasive paper and cloth (artificial abrasives) ... reams	------	------	10	770
Whetstones, etc., of manufactured abrasives ... pounds	------	------	800	562
Manufactured abrasives, not elsewhere classified ... pounds	------	------	800	562
Total	------	8,701,559	------	12,963,941

NATURAL SILICA ABRASIVES

Tripoli.—The combined sales of prepared tripoli, amorphous silica, and rottenstone decreased 5 percent in tonnage and 4 percent in value during 1958 from 1957. A few tons were imported during 1958. Of the domestic sales 71 percent were for abrasive purposes.

Companies mining and processing tripoli, amorphous silica, or rottenstone in 1958 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 5.—Processed tripoli [1] sold or used by producers in the United States, by uses [2]

Year	Abrasives		Filler		Other, including foundry facings		Total	
	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)
1949-53 (average)	26,768	$809	6,113	$135	2,792	$86	35,673	$1,030
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
1958	29,994	1,257	7,385	178	4,778	159	42,157	1,594

[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 and Quartz.—Tonnage and value data for sands used for abrasive purposes, formerly given in the Abrasive Materials chapter, can be found in the Sand and Gravel chapter of this volume. The tonnage and value of the abrasive quartz, quartzite, and sandstone can be found in the Stone chapter.

SPECIAL SILICA-STONE PRODUCTS

During 1958 the sales of grindstones produced from natural abrasive material declined 43 percent in tonnage and 37 percent in value from 1957. Sales of grinding pebbles declined 32 percent in tonnage, but increased 13 percent in value.

Grindstone sales were reported in 1958 from Ohio; grinding pebbles from Arkansas, Minnesota, North Carolina, Washington, and Wisconsin; tube-mill liners from Minnesota, North Carolina, and Wisconsin; natural material for oilstones and other sharpening stones from Arkansas and Indiana; and millstones from North Carolina.

TABLE 6.—Special silica-stone products sold by producers in the United States

Year	Grindstones		Grinding pebbles		Tube-mill liners		Millstones[1]
	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Value (thousand)
1949-53 (average)	4,185	$241	2,658	$76	1,280	$64	$11
1954	2,218	164	3,070	100	933	59	(2)
1955	2,799	196	2,130	68	(2)	(2)	(2)
1956	[3] 2,789	[3] 262	2,330	71	1,061	74	4
1957	1,505	132	2,902	86	1,440	108	5
1958	852	83	1,985	97	(2)	(2)	2

[1] Produced in New York (1953-54), North Carolina, and Virginia (1949-50). Quantity data not available.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes oilstones and other sharpening stones.

NATURAL SILICATE ABRASIVES

Garnet.—Domestically produced garnet sold or used during 1958 increased 3 percent in tonnage but declined 20 percent in total value from 1957. The Idaho Garnet Abrasive Co., Spokane, Wash., was involved in a land title dispute with the Federal Government in 1958 concerning a portion of its land in the St. Joe National Forest, Idaho. Although final settlement of the dispute was pending, the company obtained court authorization to ship garnet already mined. The domestic producers during 1958 were Baumhoff-Marshall, Valley County, Idaho; Idaho Garnet Abrasive Co., Fernwood, Idaho; Spokane Garnet Sand and Sales 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.

Industrial garnet production was reported during 1958 in Madagascar,[4] Argentina,[5] and Tanganyika.[6]

TABLE 7.—Abrasive garnet sold or used by producers in the United States

Year	Short tons	Value (thousand)	Year	Short tons	Value (thousand)
1949-53 (average)	10,368	$903	1956	9,812	$1,073
1954	14,183	971	1957	9,776	1,080
1955	11,835	1,191	1958	10,035	860

NATURAL ALUMINA ABRASIVES

Corundum.—Since 1954 Southern Rhodesia has been the principal world source of corundum. The reserve of massive corundum is large.[7]

Imports of Southern Rhodesian massive corundum into the United States increased. Tests indicated that it was suitable for optical polishing and could be used for refractories and grinding wheels.

[4] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 88: Sept. 26, 1958.
[5] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 3: Apr. 29, 1958.
[6] U.S. Consulate, Dar-es-Salaam, Tanganyika, State Department Dispatch 157: Feb. 19, 1958.
[7] Variety, E. R., Corundum, Natural Versus Synthetic; New Commonwealth (London), vol. 37, No. 1, January 1959, pp. 36-38.

Owing to more efficient methods of mining and shipping, Rhodesian corundum was available at lower prices than crystal corundum from the Union of South Africa. No change was reported in the price of processed corundum.

TABLE 8.—World production of corundum by countries,[1] in short tons [2]

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

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
Argentina	68	26				
Australia	12		10			
India	735	527	269	395	477	370
Malaya, Federation of	12		[3] 2	[3] 100		
Mozambique	3	1	9			
Rhodesia and Nyasaland, Federation of:						
Nyasaland	99	17	20			
Southern Rhodesia	169	2,840	1,168	4,448	4,506	4,594
South-West Africa	2					
Union of South Africa	3,463	1,443	834	2,068	1,539	2,164
World total (estimate) [1] [2]	10,400	10,000	8,000	11,000	10,000	11,000

[1] In addition to countries listed, corundum is produced in the 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 because of rounding where estimated figures are included in the detail.

[3] Exports.

Emery.—Emery production in the United States during 1958 was confined to New York. An emery-processing plant was in operation at Peekskill, N.Y. The only domestic producers were the DeLuca Emery Mine and DiRubbo & Ellis, both of Peekskill, N.Y. The emery ore mined was a gray variety, tough, nonabsorbent, and resistant to heat and abrasion. Its main use was as an additive to the surfaces of heavy-duty concrete floors and pavements to provide a nonslip surface. It was mixed with cement and spread to a depth of ½ to 1 inch.

Emery from Greece and Turkey continued to supply the European market, and emery from the U.S.S.R. did not enter world trade. Only a few tons of emery was imported into the United States in 1958.

TABLE 9.—Emery sold or used by producers in the United States

Year	Short tons	Value (thousand)	Year	Short tons	Value (thousand)
1949–53 (average)	8,681	$116	1956	12,153	$174
1954	9,758	132	1957	11,893	184
1955	10,735	151	1958	7,687	126

INDUSTRIAL DIAMOND

The many uses of diamond in industry were described, and diamond-mining methods were illustrated.[8]

[8] Switzer, G. S., The Many-Sided Diamond: Nat. Geographic Mag., vol. 113, No. 4, April 1958, pp. 568–586.

Production.—World production of industrial diamond in 1958 reached an alltime record for the ninth consecutive year, the total being about 23 million carats, an increase of 11 percent over 1957. The increase resulted from further mechanization of the larger diamond fields of Angola, Belgian Congo, Tanganyika, and South Africa and from the expanding operations of native miners in Ghana and Sierra Leone.[9]

Industrial diamond production in the Belgian Congo reached 16 million carats in 1958, mainly from the Bakwanga mine. This mine was highly mechanized and a new concentrating plant was under construction. Further search for alluvial and eluvial deposits by the diamond-mining companies continued in the Belgian Congo. Detailed examination of large areas where prospects were regarded as encouraging were expected to take several years.[10]

In 1958 the Government of the Union of South Africa decided to increase the annual diamond output of the State Diggings near the mouth of the Orange River from 100,000 to 150,000 carats.

At Kimberley, Union of South Africa, the DeBeers Consolidated Mines, Ltd., operated two pipe mines, Wesselton and Dutoitspan, during 1958. A new central washing plant to handle the material from these mines began operating June 19, 1958. The new plant was designed to treat over 400,000 tons of "blue ground" a month. Preliminary and secondary concentration was with 14-foot-diameter pans. The concentrate from the pans was treated by the heavy-medium process, followed by grease tables to recover the diamond.[11]

Ghana became the second largest diamond-producing area, with native miners accounting for over half of the output. About 85 percent of its diamond production was classed as industrial material.

Organized diamond production in Australia virtually came to an end with the closing of the gold-dredging operations of Wellington Alluvials, Ltd., on the Macquarie River, of which diamond was a byproduct.

Siberian diamond fields in the Yakutia S.S.R. were being developed during 1958, but no information was available regarding their possible production. The diamond deposits are in an area with climate and accessibility comparable with those of central Alaska. Development work was concentrated in two areas 400 miles apart. The more southerly Malo-Botoubin district is situated on a tributary of the Vilyui River near Suntar and contains the "Mir" pipe, now under development, and the new diamond-mining camp of Mirny. The more northerly Daldyn-Alakit district is situated near the Arctic Circle.

In both diamond fields the kimberlite pipes cut through flat-bedded Ordovician dolomitic limestones. A 7-year plan for their development was drafted, and production was expected eventually to meet domestic needs and a surplus for export. The average size of the diamonds is small—about 20 to the carat. The largest stone so far

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[9] Devlin, S. W., Mining Procedure and Methods at Consolidated Diamond Mines: Jour. South African Inst. Min. and Met., vol. 59, No. 4, November 1958, pp. 184–201.
Louwrens, C. P. A., Earthmoving in the Diamond Mines of Southern Africa: Jour. South African Inst. Min. and Met., vol. 58, No. 11, June 1958, pp. 563–587.

[10] Mining Journal (London), The Diamond Industry in the Belgian Congo: Vol. 259, No. 6394, Mar. 7, 1958, pp. 267–268.

[11] South African Mining and Engineering Journal (Johannesburg), New Diamond Recovery Plant at Kimberley Mines: Vol. 69, No. 3408, June 6, 1958, p. 981.

TABLE 10.—World production of industrial diamond, in thousand carats[1]

Country	1956	1957	1958
Africa:			
Angola	300	350	400
Belgian Congo	13,280	15,100	15,900
French Equatorial Africa	95	70	60
French West Africa	260	150	160
Ghana (Gold Coast)	1,415	1,950	1,900
Sierra Leone[2 3]	780	1,000	1,400
South-West Africa	100	100	60
Tanganyika	187	200	290
Union of South Africa:			
"Pipe" mines:			
Premier	1,100	1,150	960
DeBeers Group	400	400	480
Others	100	90	70
"Alluvial" mines	60	40	100
Total Africa	18,100	20,600	21,780
Other areas:			
Brazil[3]	150	150	150
British Guiana	18	15	20
Venezuela	75	70	75
Australia, Borneo, India, and U.S.S.R.[3]	3	5	5
World total[3]	18,300	20,800	22,000

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

reported weighed 32.5 carats and was found in the southerly district. Industrial material predominates. A magnetic survey, partly airborne, was used to find the kimberlite pipes. The presence in alluvial deposits of minerals usually associated with diamond contributed to the discovery of the fields. Reserves appeared to be mostly in the pipe deposits, and the only alluvial deposit known was a small one in the southern district. Diamond discoveries in three other districts were being evaluated. A paved highway from a river port on the Lena River to the Malo-Botoubin district was under construction.[12]

Diamond was recovered from the bed of the Tocantins River in Brazil by divers.

General Electric Co. reported it would be able to produce 3.5 million carats of minus-40-mesh manufactured diamond by 1959.

Prices.—The price of manufactured industrial diamond was reduced during 1958 from $4.25 to $2.96 a carat. The material was more rough and blocky than the natural, and had good retention when used in grinding wheels.[13]

Prices in natural industrial diamond in London showed little change.

Foreign Trade.—Because of slackening demand and reduction in stockpile purchases, imports of industrial diamond into the United States during 1958 declined 22 percent in quantity and 25 percent in value from 1957. The value of exports decreased slightly, while reexports increased 41 percent in quantity and 49 percent in value.

[12] Mining Journal (London), vol. 251, No. 6428, Oct. 31, 1958, p. 478.
Bobrievich, A. P., The Diamond of Siberia: Econ. Geol., vol. 53, No. 2, March–April 1958, pp. 220–226.
[13] Chemistry, Synthetic Diamond Prices Drop: Vol. 32, No. 3, November 1958, pp. 39–40.
Precambrian (Winnipeg), Man-Made Industrial Diamonds: Vol. 31, No. 6, June 1958, pp. 12, 14, 16–18.

TABLE 11.—Industrial diamond (excluding diamond dust and manufactured bort) imported for consumption in the United States

[Bureau of the Census]

Year	Thousand carats	Thousand dollars	Year	Thousand carats	Thousand dollars
1949-53 (average)	11,135	$39,702	1956	16,166	$73,291
1954	13,807	48,018	1957	[1] 12,220	[1] 50,063
1955	14,952	65,672	1958	9,501	37,728

[1] Revised figure.

World Review.—An English-language edition of a world review of the diamond industry by a Belgian authority was published in 1958.[14]

Fluctuating market conditions during 1958 did not seem to effect diamond mining operations, as the larger producers sold their output through a central agency under delivery contracts. The value of industrial diamond sales made through Industrial Distributors (Sales) Ltd., in London, on behalf of its producing members during 1958 was approximately $45 million. This was a reduction of about one-third in value from the 1957 sales. Industrial diamond was marketed only in quantities equal to the demand, the selling agency absorbing the difference between production and sales. Apparently there were no cutbacks in diamond production during the year.

Industrial Distributors (Sales), Ltd., in 1958 began the shipment to the United States of fragmented natural diamond bort in graded mesh sizes ready for use by diamond wheel and saw manufacturers to meet competition from manufactured diamond. Formerly, each buyer performed his own grading. This new practice will save buyers the expense of crushing and sizing, and the loss by dusting during fragmentation.[15]

On July 30, 1958, the International Consultations Group of the Strategic Control of Trade removed the embargo on industrial diamond and core and oil drilling equipment to the U.S.S.R. and allied countries. The Department of Agriculture included industrial diamond in a revised list of commodities eligible for barter.

Dr. John T. Williamson, the discoverer and for 18 years the operator of the Williamson diamond mine in Tanganyika, died January 8, 1958. In August 1958 his heirs sold the company, Williamson Diamonds, Ltd., to the Tanganyika Government and the De Beers Consolidated Mines, Ltd.; each acquired a half interest. The purchase price was reported to be $11½ million. De Beers was to manage the property. New mine equipment and a new concentrating mill with a capacity of 7,200 tons daily materially increased the output during 1958.

The Liberian diamond fields were reopened for exploitation by Liberian miners on July 15, 1958, with the restriction that a strip of 500 feet on both sides of the Lofa River was to be reserved for concessions to mining companies whose capital was at least 50 percent owned by Liberian nationals. During 1958, 750,000 carats of diamond was officially exported from Liberia.

[14] Moyar, A., The Diamond Industry in 1956-57: Brussels, Belgium, 169 pp.
[15] E&MJ Metal and Mineral Markets, Nov. 20, 1958, p. 7.

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TABLE 12.—Industrial diamond (including diamond dust and manufactured bort) imported for consumption in the United States, 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
1957										
North America:										
Bermuda					1,998	$31,550				
Canada			53,600	$209,946	[1] 722,031	5,011,011			20,117	$43,735
Total			53,600	209,946	[1] 724,029	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] 1,994,484	[1] 5,161,269	3,076,441	16,377,752	894	5,285	77,215	228,301
Total	6,031	273,244	[1] 1,995,484	[1] 5,163,769	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
French West Africa					36	248				
Ghana					802	2,747				
Liberia					6,331	85,672				
Union of South Africa	(2)	980	282,176	825,962	[1] 883,435	[1] 5,181,696			191,314	616,592
Total	(2)	980	[3] 4,784,153	[3] 12,428,658	[1] 1,149,316	[1] 6,392,355			284,051	898,101
Grand total	6,057	[4] 275,000	6,833,237	17,802,373	[1] 5,385,064	[1] 32,242,100	2,080	18,343	386,203	1,186,227
1958										
North America: Canada	1	103	72,080	189,454	536,369	3,494,099			15,597	35,381
South America:										
Argentina					470	9,104				
Brazil					7,608	240,284	11,291	106,720		
Venezuela					4,481	90,322				
Total					12,559	339,710	11,291	106,720		
Europe:										
Belgium-Luxembourg					682,356	4,312,499			9,751	28,613
France	390	47,699			17,461	289,436				
Germany, West	158	15,609			10,436	189,868				
Netherlands	50	10,033	590	1,623	47,202	287,639			5,175	14,140
Sweden	32	10,788							350	400
Switzerland	89	9,348			7,350	26,328				
United Kingdom	6	556	876,728	2,459,130	2,278,756	11,253,087	55	470	252,092	708,639
Total	725	94,033	877,318	2,460,753	3,043,561	16,358,857	55	470	267,368	751,792
Asia:										
Israel	26	2,975			221	2,498				
Japan					221	1,554				
Total	26	2,975			442	4,052				
Africa:										
Belgian Congo			4,036,492	10,761,796	108,222	601,327			247,256	599,777
British West Africa, n.e.c.			11,600	32,548						
French Equatorial Africa					35,505	311,466				
Ghana					6,190	28,036				
Liberia					2,733	3,967				
Union of South Africa			173,900	496,395	572,826	2,538,794			36,508	130,906
Total			4,221,992	11,290,739	725,476	3,483,590			283,764	730,683
Oceania: Australia									2,192	2,312
Grand total	752	97,111	5,171,390	13,940,946	4,318,407	23,680,308	11,346	107,190	568,921	1,520,168

[1] Revised figure.
[2] Less than 1 carat.
[3] Changes in Minerals Yearbook 1957, p. 154, should read as follows: 1957 crushing bort (including all types of bort suitable for crushing)—British West Africa, n.e.c. revised to none.
[4] Data known to be not comparable with 1958.

It was proposed to dredge the sea bottom offshore from the low-tide mark for diamond in South-West Africa.

A publication describing the geology, mining, and diamond resources of British Guiana was issued.[16]

Technology.—Various methods of analyzing samples of material believed to contain diamond were described.[17]

New recovery methods for fine diamond material were developed in South Africa. The ore was milled to reduce the softer associated materials into slime, which was washed away. The rough concentrate was further treated by electrostatic or heavy-medium separation or both, depending upon the size of the diamond particles remaining after milling. The efficiency of the methods was tested by the addition of identifiable diamond material to the mill feeds. Results showed a high percentage of recovery.[18]

A progress report on the production of manufacture diamond indicated that the material had been accepted for many industrial uses.[19] Future possibilities in the development of diamond tools included the mixing of diamond with tungsten carbide in the manufacture of cutting tools.[20]

An oil-well drilling bit using 5,800 diamonds weighing 1,200 carats, designed to drill a 12⅛-inch hole, was sent to Venezuela.[21]

Diamond-bit performance in various types of rock was described. Factors that influenced the cost of diamond-drilling included the size and grade of the diamond and the size and type of bit used.[22]

At one diamond-salvage installation nearly one-quarter of the diamond contained in the original wheels was recovered.[23]

Several new types of electrolytic grinders were tested, and the influence of coolant on diamond wheel wear was noted.[24] Uses of industrial diamond in the United States,[25] the basic principles governing their use,[26] and the effect on diamond-tool life of feed rates and coolants was explained.[27]

Increased production was claimed by changing to diamond wheels [28] and by the proper orientation of the diamond in cutting tools.[29]

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[16] British Guiana Geological Survey, Diamond Resources of British Guiana: Georgetown, Demerara, British Guiana, 1957, 45 pp.

[17] Weavind, R. G., and Linari-Linholm, A. A., The Recovery of Diamonds From Prospection Samples: Jour. South African Inst. Min. and Met., vol. 58, No. 12, July 1958, pp. 635–642.

[18] Engineering and Mining Journal, New Plant Separates Near-Microscopic Diamonds: Vol. 159, No. 10, October 1958, pp. 145, 147.

[19] Iron Age, Man-Made Diamonds Hit Market: Vol. 180, No. 19, Nov. 7, 1958, p. 87.

[20] Slawson, C. B., and Denning, R. M., Is Our Future With Cemented Diamond Cutting Tools?: Carbide Eng., vol. 10, No. 7, July 1958, pp. 15–18.

[21] Chemical Engineering and Mining Review, Large Oil Well Drilling Bit for Venezuela: Vol. 50, No. 6, Mar. 15, 1958, p. 41.

[22] Rambosek, A. J., and Long, A. E., Diamond-Bit Performance in Quartzite: Bureau of Mines Rept. of Investigations 5402, 1958, 23 pp.

Johnson, G. H., and Long, A. E., Diamond-Bit Performance in Cherty Limestone and Cherty Dolomite: Bureau of Mines Rept. of Investigations 5403, 1958, 23 pp.

[23] Patterson, M. M., How Brick Saves Diamond Dust: Grinding and Finishing, vol. 4, No. 4, August 1958, pp. 30–31.

[24] Patterson, M. M., A Study of Electrically Aided Grinding: Grinding and Finishing, vol. 4, No. 6, October 1958, pp. 23–28.

[25] Industrial Diamond Review (London), Industrial Diamonds in the U.S.: Vol. 18, No. 216, November 1958, p. 218.

[26] Diamonds in Industry, How to Get the Most From Diamond Wheels: Vol. 17, No. 6, Spring 1958, pp. 10–13.

[27] Reuss, C. E., In-Plant Diamond Mines: Tooling & Production, vol. 23, No. 11, February 1958, pp. 67–78.

[28] Sinclair, E. L., Techniques in Ceramic Grinding: Grinding and Finishing, vol. 4, No. 1, May 1958, pp. 50–52, 54.

[29] Miller, H. C., Increased Life and Accuracy of Diamond Dressers Achieved by Diamond Cutting and Orientation: Grinding and Finishing, vol. 3, No. 12, April 1958, pp. 31–33.

Typical shapes of industrial diamond found in nature were illustrated.[30]

Investigation revealed that correct orientation of the diamond in a diamond tool is of primary importance, since it was shown that a diamond will wear better in some directions than others. Tool life will be affected by this factor; but in a grinding wheel the diamond particles are distributed in a random manner, and enough hard points will be exposed to offset the lack of cutting by the softer points.[31]

ARTIFICIAL ABRASIVES

Production of artificial abrasives in the United States and Canada during 1958 followed the downtrend in steel production and the Gross National Product in constant dollars. All types registered losses both in tonnage and value. Silicon carbide production declined 11 percent in tonnage and 8 percent in value; aluminum oxide, 46 percent in tonnage and 40 percent in value; and metallic abrasives, 23 percent in tonnage and 20 percent in value. All crude aluminum oxide and silicon carbide produced in Canada is shipped to the United States for processing.

TABLE 13.—Crude artificial abrasives produced in the United States and Canada

Year	Silicon carbide [1]		Aluminum oxide [1] (abrasive grade)		Metallic abrasives [2]		Total	
	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)
1949–53 (average)	77,375	$9,065	181,399	$16,705	146,357	$14,911	405,131	$40,681
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
1958	110,456	17,597	122,868	16,870	101,159	14,339	334,483	48,806

[1] Figures include material used for refractories and other nonabrasive purposes.
[2] Shipments from United States plants only.

Aluminum oxide production included 13,766 short tons of "white high-purity" material, valued at $2,363,595. Nonabrasive uses were 27 percent of the silicon carbide tonnage and 5.9 percent of the aluminum oxide. Silicon carbide production was 78 percent of capacity, aluminum oxide was 41 percent, and metallic abrasives was 31 percent.

[30] Diamonds in Industry, Standard Categories of Industrial Diamonds: Vol. 17, No. 6, Spring 1958, pp. 4–7.
[31] Taeyaerts, Jan, Proper Grain Orientation Improves Diamond Cutting Tool Life: Am. Soc. Tool Eng., vol. 58, Paper No. 93, 1958, 4 pp.

TABLE 14.—Production, shipments, and stocks of metallic abrasives in the United States, by products

Product	Manufactured during year		Sold or used during year		Stocks on hand Dec. 31		Average annual capacity
	Short tons	Value (thou sand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons
1957							
Chilled iron shot and grit	60,774	$5,847	61,181	$6,336	[1] 7,886	[1] $727	164,294
Annealed iron shot and grit	35,634	4,404	36,111	4,708	[1] 1,713	[1] 215	69,044
Steel shot	29,098	5,420	27,986	5,849	[2] 6,813	[2] 1,439	53,100
Other types (including cut wire shot)	6,808	1,423	6,225	1,387	[2] 119	[2] 21	11,190
Total	132,314	17,094	131,503	18,280	[1] 16,531	[1] 2,402	297,628
1958							
Chilled iron shot and grit	46,499	4,903	45,959	4,872	8,426	830	177,834
Annealed iron shot and grit	28,045	3,532	27,145	3,601	2,613	314	68,564
Steel shot [3]	26,729	5,088	27,454	5,765	6,088	1,178	77,780
Other types (including cut wire shot)	689	111	601	101	207	33	2,360
Total	101,962	13,634	101,159	14,339	17,334	2,355	326,538

[1] Revised figure.
[2] Steel grit included with steel shot.
[3] Includes steel grit.

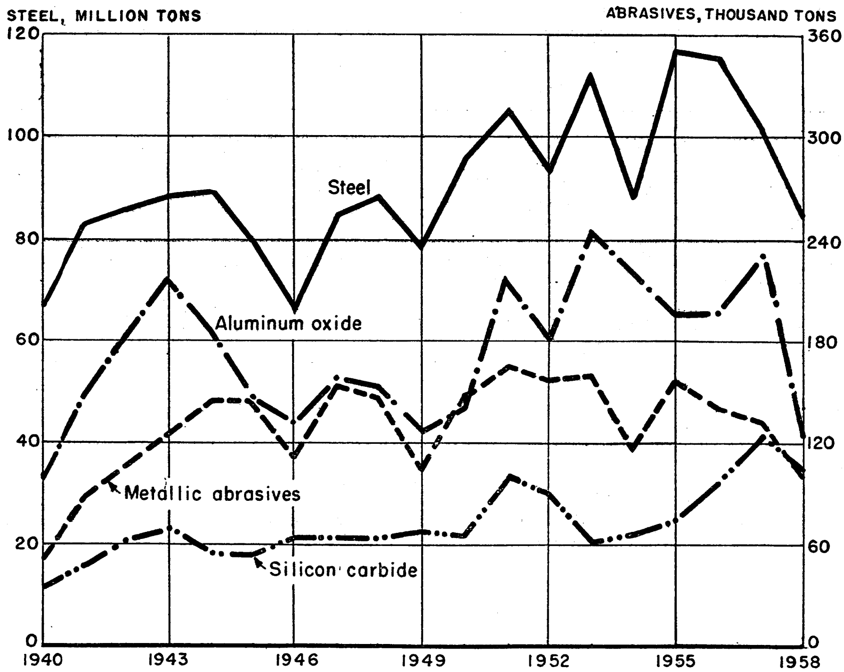

FIGURE 1.—Relationship between ingot-steel and artificial abrasive production, 1940–58.

TABLE 15.—Stocks of crude artificial abrasives and capacity of manufacturing plants, as reported by producers in the United States and Canada, in thousand 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
1949–53 (average)	17.3	98.9	37.9	250.6	9.8	233.5
1954	27.9	120.0	29.9	280.2	14.4	255.0
1955	11.0	118.8	39.9	282.2	14.6	264.3
1956	10.3	118.9	38.6	283.5	16.5	290.5
1957	14.0	131.9	36.7	298.7	[2] 16.5	297.6
1958	10.4	141.9	36.4	299.5	17.3	326.5

[1] United States only.
[2] Revised figure.

The sales value of abrasive grinding wheels in 1958 was approximately $130 million, a decline of 25 percent from the 1957 figure. Sales of vitrified bonded grinding wheels in 1958 were 43 percent of the total; reinforced and nonreinforced resenoid and shellac bonded wheels, 40 percent; rubber bonded wheels, 5 percent; and all other types, including diamond grinding wheels, 12 percent. During the last quarter of 1958 an improvement in sales was noted in all types of grinding wheels.

During 1958 the sales of coated abrasives were 1,947,853 reams, a reduction of 11 percent from the previous year. Their sales value declined 12 percent.

Certain statistical correlations were found to exist between artificial abrasive production and steel and motor vehicle production and are useful in predicting artificial abrasive requirements.[32]

In testing abrasive grain for toughness the percentage of breakdown due to impingement on a steel plate is a measure of a grain's friability or tendency to fracture under shock. Uniform sizing of abrasive grain assures proper structure and density in a grinding wheel. Differences in the shape of abrasive grain particles are determined by bulk density tests, since certain grain shapes take up more room than others. In certain instances the color of an abrasive grain may be important. The cleanliness and purity of an abrasive grain is indicated by capillary action.[33]

Developments in abrasive wheels and cutting-off machines made the abrasive cutting of metals, plastics, and stone easier and more economical.[34]

The effect of mechanical variable on grinding-wheel action and chemical reactions between abrasive grit and the material being ground were summarized.[35]

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[32] Forchheimer, O. L., Predicting Abrasive Production From Steel, Auto Forecasts: Grinding and Finishing, vol. 4, No. 8, December 1958, pp. 26–29.
[33] Gilman, J. R., Raw Material Testing: Grinding and Finishing, vol. 4, pt. 1, No. 1, May 1958, pp. 36–38, 40; pt. 2, No. 2, June 1958, pp. 23–25.
[34] Perry, R. N., Jr., Cutting With Abrasives: Plant Eng., vol. 2, No. 12, December 1958, pp. 100–102.
[35] Krabacher, E. J., Factors Influencing the Performance of Grinding Wheels: A.S.M.E. (58–SA–40), 1958, 7 pp.

A book describing the manufacture and various uses of coated abrasives was published during 1958.[36]

Simplified Practice Recommendation R45-57, issued by the Commodity Standards Division of the Office of Technical Services and the National Bureau of Standards, established new standards for sizes, dimensions, and varieties of grinding wheels, and superseded R45-47.

Coated abrasive belts and the contact wheels supporting them were designed to grind and polish irregularly shaped castings and machine parts.[37] The advantages of "throwaway" abrasive inserts were: Elimination of tool grinding, increased cutting speeds, reduction in machine time for tool changes, low cost per cutting edge, and reduced cutting tool inventory. These inserts cannot replace all forms of cutting tools. They usually are successful on high production automatic machines and heavy duty operations with high stock-removal rates.[38]

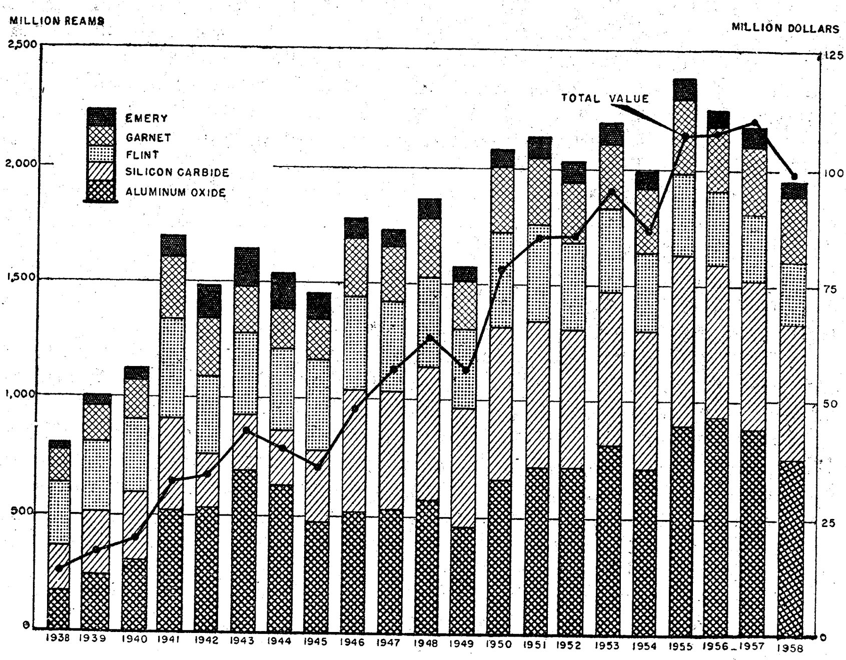

FIGURE 2.—Coated-abrasives industry in the United States, 1938–58.

A series of articles on the manufacture of vitrified grinding wheels, giving detailed descriptions of the various problems encountered, appeared in an industry publication.[39]

[36] Coated Abrasives Manufacturers' Institute, Coated Abrasives—Modern Tool of Industry: McGraw-Hill Book Co., Inc., New York, N.Y., 1958, 426 pp.

[37] Wilson, G. G., Coated Abrasives Grind All Types of Castings: Foundry, vol. 85, No. 12, December 1958, pp. 196–200.

[38] Wick, C. H., When and How to Use Throw-Away Inserts for Cutting Tools: Machinery, vol. 65, No. 5, January 1958, pp. 161–175.

[39] Gormly, M. W., Technical Aspects of Vitrified Grinding Wheel Manufacture: Bull. Am. Ceram. Soc., vol. 37, No. 2, Feb. 15, 1958, pp. 77–80; No. 3, Mar. 15, 1958, pp. 144–147; No. 4, Apr. 15, 1958, pp. 189–192; No. 5, May 15, 1958, pp. 210–212.

The Norton Co., Worcester, Mass., expanded its manufacturing facilities in Brazil and Argentina.[40]

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.

[40] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 223: Aug. 27, 1958, p. 1.
Mining World, Argentina: Vol. 20, No. 11, October 1958, p. 83.

Aluminum

By R. August Heindl,[1] C. I. Wampler,[2]
and Mary E. Trought [2]

WORLD production of primary aluminum in 1958 continued the upward trend begun in 1947, but United States output was 5 percent less than in 1957 and 7 percent below the record high of 1956. Two additional domestic companies began producing primary aluminum. The average rate of output was less than 80 percent of average capacity.

Domestic primary aluminum capacity was increased from about 1.8 million short tons a year to nearly 2.2 million tons, and plants under construction were expected to increase capacity to 2.6 million tons.

Primary aluminum was shipped to the Government under the terms of contracts negotiated during the Korean War.

Production increased at the end of the year and in December reached an alltime monthly peak of 152,000 tons. In sharp contrast was the June 1958 production of 115,000 tons—the lowest since the labor strikes in August 1956.

TABLE 1.—Salient statistics of the aluminum industry

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Primary production short tons	869, 662	1, 460, 565	1, 565, 721	1, 678, 954	1, 647, 709	1, 565, 557
Value, thousands	$314, 398	$592, 837	$684, 038	$805, 782	$836, 944	$773, 610
Average ingot price per pound cents	18. 8	21. 8	23. 7	26. 0	27. 5	26. 9
Secondary recovery short tons	278, 025	[1] 292, 041	[1] 335, 994	[1] 339, 768	[1 2] 361, 819	[1] 289, 555
Imports (crude and semicrude) short tons	210, 614	243, 750	239, 475	264, 975	[2] 258, 006	293, 187
Exports (crude and semicrude) short tons	20, 676	50, 096	33, 834	68, 032	[2] 62, 552	82, 470
Apparent consumption short tons	1, 329, 326	1, 966, 884	2, 111, 224	2, 127, 523	2, 136, 526	2, 092, 149
World: Production thousand short tons	2, 018	[2] 3, 095	3, 460	3, 720	[2] 3, 725	3, 890

[1] Not strictly comparable with previous years' data. The 1954–58 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.
[2] Revised figure.

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

LEGISLATION AND GOVERNMENT PROGRAMS

Beginning in December 1956 the three major domestic primary-aluminum producers, Aluminum Company of America, Kaiser Aluminum & Chemical Corp., and Reynolds Metals Co., tendered metal to the Government under aluminum supply contracts negotiated in 1950–52. In 1958, shipments to the Government totaled 323,128 tons. Of this total, Alcoa shipped 97,497 tons, Kaiser 95,272 tons, and Reynolds 130,359 tons. Previous shipments under the contracts had been 104,998 tons from Alcoa, 116,804 tons from Kaiser, and 102,509 tons from Reynolds, bringing the total to 647,439 tons as of December 31, 1958. The Government contracts with Alcoa and Kaiser expired at the end of 1958; that with Reynolds was to end in 1959; and a contract with Harvey Aluminum, Inc., was to continue until 1963.

Under the Defense Materials system effective since July 1953, aluminum supply in the United States above the quantity set aside for defense and atomic-energy requirements and the national stockpile was free for civilian consumption. 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. The total of the two allotments, by quarters, as announced by U.S. Department of Commerce, Business and Defense Services Administration, was:

	Short tons		*Short tons*
First quarter	59,500	Third quarter	54,000
Second quarter	54,000	Fourth quarter	54,000

The grand total of 221,500 tons was a decrease of 53,500 tons (19.5 percent) from 1957.

In March, April, and May, 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 problems of small business in the aluminum industry.[3]

The Subcommittee examined the impact of the following in relation to small business:

1. The incentive-type expansion contracts entered into between the prime producers and the Government under the authority of the Defense Production Act.
2. The long-term contracts between producers of primary metal and large nonintegrated users.
3. "Molten metal" contracts.
4. The possible price squeeze on small nonintegrated users of primary metal.
5. The effect of increased scrap purchases by prime producers of aluminum on the secondary-aluminum market.

The Subcommittee recommended that: (1) The Select Committee of the House on Small Business continue its study of the problems of small business in the aluminum industry; (2) General Services Administration continue its efforts to obtain amendment of the contracts

[3] Subcommittee 3 on Minerals and Raw Materials to the Select Committee on Small Business, Report: House of Representatives, 85th Cong. 2d sess., Washington, D.C., 1959, 19 pp.

Modern Metals, The Yates Committee Resumes Its Probe of Competition in Aluminum: Vol. 14, No. 4, May 1958, pp. 60, 62, 64, 66–72, 74–80, 82: No. 5, June 1958, pp. 62–64, 66–68, 70–71; No. 6, July 1958, pp. 31–32, 34, 36, 40, 42, 44, 48, 50.

with the primary-aluminum companies to protect small business; and (3) nonintegrated fabricators and processors consider organizing a "buying corporation" for the purpose of entering into long-term, guaranteed buying contracts for primary metal.

In midyear domestic primary-aluminum producers expressed concern over the increased availability of aluminum from the U.S.S.R. on world markets and the undiminished importation of aluminum to the United States when the domestic industry was operating at only 70 percent of capacity. They suggested that the Government: (1) Consider channeling surplus aluminum to areas of the world that lacked primary industrial materials; (2) investigate the desirability of import controls; and (3) study the possibility of enactment of antidumping legislation.[4]

By the end of 1958 no action had been taken on the proposals and the improved domestic demand apparently had removed some of the pressure for their enactment.

DOMESTIC PRODUCTION

Primary

Primary aluminum production in the United States was nearly 1.57 million tons, a decrease of more than 80,000 tons or 5 percent from 1957 and 7 percent below the record production of 1956. The lower production rate was caused by decreased demand in 1957 which continued into mid-1958. Shipments of primary metal by producers increased 12,000 tons over 1957, to 1.59 million tons, and in the last half of the year were nearly 8 percent greater than in the first half.

Despite the lower demand for aluminum three new plants were activated. Ormet Corp., owned jointly by Olin Mathieson Chemical Corp. and Revere Copper & Brass, Inc., began producing in May at a $110-million plant near Clarington, Ohio. By the end of 1958, four of the five lines were in operation. Alumina for the plant was produced from Surinam bauxite at Burnside, La. Power was generated from coal mined nearby. When the plant reached full production of 180,000 tons per year, Olin Mathieson was to receive 120,000 tons and Revere 60,000 tons.

TABLE 2.—Production of primary aluminum in the United States,[1] in short tons

Quarter	1957	1958
First	401,794	395,909
Second	422,333	366,652
Third	414,768	369,896
Fourth	408,814	433,100
Total	1,647,709	1,565,557

[1] Quarterly production adjusted to final annual totals.

[4] Church, F. L., Aluminum Imports—How Great Is the Threat?: Modern Metals, vol. 14, No. 7, August 1958, pp. 65–66, 68–70.
Modern Metals, Aluminum Imports: Pro & Con: Vol. 14, No. 9, October 1958, pp. 70, 72, 74, 76.

TABLE 3.—Primary-aluminum production capacity in the United States

(Short tons per year)

Company and plant	End of 1957	End of 1958	Being built in 1958	Total
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	118,000	[1] 32,000	150,000
Point Comfort, Tex	120,000	120,000	[1] 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			[2] 150,000	150,000
Total	792,500	798,250	202,000	1,000,250
Reynolds Metals Co.:				
Arkadelphia, Ark	55,000	55,000		55,000
Jones Mills, Ark	109,000	109,000		109,000
Listerhill, Ala	77,500	190,000		190,000
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
Massena, N.Y			[1] 100,000	100,000
Total	488,500	601,000	100,000	701,000
Kaiser Aluminum & Chemical Corp.:				
Chalmette, La	247,500	247,500		247,500
Mead, Wash	176,000	176,000		176,000
Tacoma, Wash	41,000	41,000		41,000
Ravenswood, W. Va	36,250	72,500	[1] 72,500	145,000
Total	500,750	537,000	72,500	609,500
Anaconda Aluminum Co.: Columbia Falls, Mont	60,000	60,000		60,000
Harvey Aluminum, Inc.: The Dalles, Oreg		54,000		54,000
Ormet Corp.: Clarington, Ohio		144,000	[1] 36,000	180,000
Grand total	1,841,750	2,194,250	410,500	2,604,750

[1] Completion expected in 1959.
[2] Completion expected in 1960.

A second new producer, Harvey Aluminum, Inc., started a new plant at The Dalles, Oreg. The first of two potlines began producing in August and the second line later. This plant uses hydroelectric power generated at The Dalles Dam of the Bonneville Power Administration. Alumina was obtained from Japan under a long-term contract.

Reynolds Metals Co.'s first line of its new $70-million reduction plant at Listerhill, Ala., began producing in January. The third and last line was placed onstream in July. Approximately 32,000 tons of the 112,500 tons to be produced annually was to be used at the adjacent Ford Motor Co. foundry. Molten aluminum was to be transported by truck in covered 5,000-pound-capacity ladles.

Early in the year Kaiser began producing metal at a second line of 164 electrolytic cells at its Ravenswood (W. Va.) plant. At this plant a potline consists of two potrooms, 1,170 feet long and 54 feet wide. Individual cells are 10 feet wide by 20 feet long, use prebaked anodes, and are designed for 80,000-ampere operation. Molten metal from the reduction cells is carried to Kaiser's adjacent rolling mill, where most of it is cast into rolling ingots weighing up to 5 tons each. Operation of the rolling mill and the major items of equipment were described.[5]

Alcoa, at Massena, N.Y., completed and placed in operation two of three new potlines to become the first industrial user of power from

[5] Modern Metals, Ravenswood Works: Vol. 14, No. 6, July 1958, pp. 68–78.

the St. Lawrence project of the Power Authority of the State of New York. These facilities replaced potlines using power from Alcoa's own generating station, which was to become permanently inoperable with the completion of the Seaway.

The four largest producers, Alcoa, Reynolds, Kaiser, and Ormet, had additional new facilities under construction at the end of the year. Ormet's fifth line at Clarington, Ohio, was to begin producing in January 1959 and Kaiser was to add two new lines at Ravenswood, W. Va., during the first half of 1959. Production at Reynolds' Massena, N.Y., plant was expected to start in June 1959. In December Alcoa had virtually completed a new potline at Point Comfort, Tex., and construction on the new smelter at Evansville, Ind., was continued at a reduced rate. The date of activation of the Alcoa facilities was dependent, to some extent, upon increased demand for aluminum.

Through an agreement with the Government of Surinam signed in 1958, Suriname Aluminum Co. (Suralco), a subsidiary of Alcoa, extended its rights for bauxite concessions in that country and initiated a program to build a hydroelectric development and aluminum-smelting facilities in Surinam. Preliminary engineering investigations were underway.

In July the competitive position of the Northwest aluminum industry was improved when railroad freight rates were reduced for shipping aluminum pig, sheet, and plate east and alumina from the South to the Northwest. The reductions were expected to make the cost of aluminum shipped from the Pacific Northwest into the area between the Rocky Mountains and the Mississippi River competitive with the cost of aluminum shipped into this area by Eastern plants.

SECONDARY

The secondary-aluminum industry operated at a much lower level than in 1957. According to reports to the Bureau of Mines, domestic recovery of aluminum alloys (including all constituents) from 376,000 tons of nonferrous scrap totaled 310,000 tons, a decline of 20 percent from 1957 and 13 percent below the 4-year average of 357,000 tons (1954–57). It is estimated that reports to the Bureau account for nearly 85 percent of the total scrap consumption. The value of 290,000 tons of aluminum (excluding alloying ingredients) recovered, computed from the average value of primary-aluminum pig of 24.71 cents per pound, was $143 million.

Aluminum-alloy ingot production, as reported to the Bureau of Mines, totaled 241,000 tons, 18 percent less than in 1957 and the smallest quantity produced since 1954. Data on remelt ingots exclude alloys produced from purchased scrap by the primary producers. Shipments of many casting alloys declined sharply in 1958. Alloy No. 12 and variations dropped 2,600 tons; No. 319 and variations, 5,000 tons; and AXS 679 and variations, which exceeds in quantity all other secondary alloys, declined 20,000 tons. Shipments of the aluminum-silicon-copper-nickel group dropped 13,000 tons below 1957, and ingots for deoxidizing and destructive uses declined 7,000 tons. Shipments of only one alloy, aluminum-silicon (maximum Cu 0.6 percent), increased.

The aluminum-scrap supply increased nearly fivefold from 1940 to 1958. More aluminum was recovered from scrap in 1958 than was obtained from all sources (including primary production and imports) in any year before 1940. Changes and developments in technology have had an important impact on the secondary-aluminum industry. The increased growth in the use of diecastings and the sharp rise in the use of aluminum extrusions resulted in changes in types and alloys of available scrap. Technologic advances at secondary smelters in recovering aluminum from drosses and skimmings were significant. At one time these materials were considered waste products. Important advances have been made in the use of scrap, which formerly was used primarily in castings. Metallurgical research has resulted in large tonnages of remelt ingot being used in wrought products, such as extrusions, sheet, rod, and wire.[6]

TABLE 4.—Aluminum recovered from scrap processed in the United States, by kind of scrap and form of recovery

Kind of scrap	1957	1958	Form of recovery	1957	1958
New scrap:					
Aluminum-base [1]	288,682	224,983	As metal	9,218	7,924
Copper-base	124	64	Aluminum alloys	346,775	277,197
Zinc-base	326	240	In brass and bronze	397	217
Magnesium-base	228	141	In zinc-base alloys	2,880	2,001
			In magnesium alloys	320	242
Total	289,360	225,428	In chemical compounds	2,229	1,974
Old scrap:			Total	361,819	289,555
Aluminum-base [2]	71,655	62,995			
Copper-base	115	105			
Zinc-base	275	653			
Magnesium-base	414	374			
Total	72,459	64,127			
Grand total	361,819	289,555			

[1] Aluminum alloys recovered from new aluminum-base scrap, including all constituents, totaled 306,908 tons in 1957 and 238,985 tons in 1958.
[2] Aluminum alloys recovered from old aluminum-base scrap, including all constituents, totaled 80,811 tons in 1957 and 71,240 tons in 1958.

TABLE 5.—Stocks and consumption of new and old aluminum scrap in the United States in 1958, gross weight in short tons [1]

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption		Stocks, end of year
			New scrap	Old scrap	
Secondary smelters: [2]					
Segregated 2S and 3S sheet and clips, less than 1.0 percent Cu	703	9,354	9,204		853
Segregated 51S, 52S, 61S, etc.; sheet and clips, less than 1.0 percent Cu	514	8,328	8,273		569
Segregated sheet and clips, more than 1.0 percent Cu (14S, 17S, 24S, 25S, etc.)	890	16,663	15,455		2,098
Mixed-alloy sheet and clips	2,482	41,623	36,695	3,766	3,644
Cast scrap	302	4,979	4,982		299
Borings and turnings	2,934	62,682	62,760		2,856
Dross and skimmings	4,063	37,770	38,215		3,618
Foil (includes both new and old)	175	3,191	3,187		179
Wire and cable	156	1,614		1,526	244
Pots and pans	819	13,477		13,780	516
Aircraft	883	9,328		9,589	622

See footnotes at end of table.

[6] Lipkowitz, Irving, Scrap and Aluminum Industry: Am. Metal Market, vol. 65, No. 202, Oct. 18, 1958, pp. 10–11.

TABLE 5.—Stocks and consumption of new and old aluminum scrap in the United States in 1958, gross weight in short tons [1]—Con.

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption		Stocks, end of year
			New scrap	Old scrap	
Secondary smelters [2]—Continued					
Castings and forgings	1,809	22,856		23,438	1,227
Pistons	216	3,980		3,970	226
Irony aluminum	493	8,259		7,568	1,184
Miscellaneous	3,628	33,087	7,727	25,627	3,361
Total	20,067	277,191	186,498	89,264	21,496
Primary producers and fabricators:					
Segregated 2S and 3S sheet and clips, less than 1.0 percent Cu	686	20,867	20,962		591
Segregated 51S, 52S, 61S, etc., sheet and clips, less than 1.0 percent Cu	771	22,538	21,863		1,446
Segregated sheet and clips, more than 1.0 percent Cu (14S, 17S, 24S, 25S, etc.)	573	8,824	9,213		184
Mixed-alloy sheet and clips	204	6,443	6,337	8	302
Cast scrap	21	2,223	2,243		1
Borings and turnings	80	1,563	1,590		53
Dross and skimmings	1	933	933		1
Foil (includes both new and old)	314	6,855	6,880		289
Wire and cable	102	202		291	13
Castings and forgings	4	119		119	4
Miscellaneous	736	6,559	6,840	3	452
Total	3,492	77,126	76,861	421	3,336
Foundries and miscellaneous manufacturers:					
Segregated 2S and 3S sheet and clips, less than 1.0 percent Cu	222	6,389	6,452		159
Segregated sheet and clips, more than 1.0 percent Cu (14S, 17S, 24S, 25S, etc.)	42	547	525		64
Mixed-alloy sheet and clips	492	3,454	3,626	43	277
Cast scrap	377	3,930	3,532		775
Borings and turnings	267	2,005	1,908		364
Dross and skimmings	59	127	139		47
Foil (includes both new and old)	16	37	50		3
Wire and cable		14		14	
Pots and pans		1,108		754	354
Aircraft		8		8	
Castings and forgings	53	551		518	86
Pistons	4	138		137	5
Irony aluminum		26		22	4
Miscellaneous	14	191	41	148	16
Total	1,546	18,525	16,273	1,644	2,154
Chemical plants:					
Borings and turnings		8	6		2
Dross and skimmings	332	4,800	4,414		718
Foil (includes both new and old)	201		67		134
Miscellaneous	87	110	90	26	81
Total	620	4,918	4,577	26	935
Grand total of all scrap consumed:					
Segregated 2S and 3S sheet and clips, less than 1.0 percent Cu	1,611	36,610	36,618		1,603
Segregated 51S, 52S, 61S, etc., sheet and clips, less than 1.0 percent Cu	1,285	30,866	30,136		2,015
Segregated sheet and clips, more than 1.0 percent Cu (14S, 17S, 24S, 25S, etc.)	1,505	26,034	25,193		2,346
Mixed-alloy sheet and clips	3,178	51,520	46,658	3,817	4,223
Cast scrap	700	11,132	10,757		1,075
Borings and turnings	3,281	66,258	66,264		3,275
Dross and skimmings	4,455	43,630	43,701		4,384
Foil (includes both new and old)	706	10,083	10,184		605
Wire and cable	258	1,830		1,831	257
Pots and pans	819	14,585		14,534	870
Aircraft	883	9,336		9,597	622
Castings and forgings	1,866	23,526		24,075	1,317
Pistons	220	4,118		4,107	231
Irony aluminum	493	8,285		7,590	1,188
Miscellaneous	4,465	39,947	14,698	25,804	3,910
Total	25,725	377,760	284,209	91,355	27,921

[1] Includes imported scrap.
[2] Excludes secondary smelters owned by primary aluminum companies.

TABLE 6.—Production and shipments of secondary aluminum ingot by independent smelters and recovery of metal from aluminum scrap, gross weight in short tons [1]

Product	1957		1958	
	Production	Shipments	Production	Shipments
Secondary-aluminum ingot: [2]				
Pure aluminum (Al min., 97.0 percent)	9,218	8,974	7,924	7,586
Aluminum-silicon (maximum Cu, 0.6 percent)	23,660	23,816	25,129	24,624
Aluminum-silicon (Cu, 0.6 to 2 percent)	7,188	7,443	6,658	6,434
No. 12 and variations	7,811	8,022	5,421	5,463
Aluminum-copper (maximum Si, 1.5 percent)	1,329	1,397	1,529	1,384
No. 319 and variations	39,756	39,884	35,016	34,735
AXS 679 and variations	107,785	107,917	87,652	87,778
Aluminum-silicon-copper-nickel	30,043	30,671	16,828	17,314
Deoxidizing and other destructive uses	32,333	31,747	24,190	24,470
Aluminum-base hardeners	9,427	9,374	7,714	7,589
Aluminum-magnesium	2,924	2,907	2,696	2,610
Aluminum-zinc	6,894	6,707	6,034	6,280
Miscellaneous	16,300	16,901	14,611	14,811
Total	294,668	295,760	241,402	241,078
Secondary-aluminum alloys recovered by primary producers and independent fabricators	105,045	----------	74,109	----------
Secondary-aluminum-alloy castings	18,858	----------	17,003	----------
Secondary aluminum in chemicals	2,229	----------	1,925	----------

[1] Includes companies and military establishments producing aluminum "remelt" or "scrap pig".
[2] Gross weight, including copper, silicon, and other alloying elements, at independent secondary smelters; total secondary aluminum and aluminum-alloy ingot contained 21,348 tons primary aluminum in 1957, and 12,725 tons in 1958.

CONSUMPTION AND USES

The total apparent consumption of aluminum, including domestic primary metal, net imports of crude, semicrude, and scrap, and recovery from scrap, was slightly lower than in 1957. As more than 320,000 tons of metal was shipped to the Government in both 1957 and 1958, industrial consumption in these 2 years was below that in 1956. In 1958 shipments by primary producers and net imports increased over 1957; however, the recovery of aluminum from scrap fell sharply.

TABLE 7.—Apparent consumption of aluminum in the United States, in short tons

Year	Primary sold or used by producers	Imports (net)[1]	Recovery from old scrap	Recovery from new scrap	Total apparent consumption
1949–53 (average)	864,432	186,869	69,550	208,475	1,329,326
1954	1,478,740	196,103	[2] 59,989	[2] 232,052	1,966,884
1955	1,571,845	203,385	[2] 76,372	[2] 259,622	2,111,224
1956	1,591,478	196,277	[2] 71,673	[2] 268,095	2,127,523
1957	[3] 1,579,063	195,644	[2 4] 72,459	[2 4] 289,360	2,136,526
1958	[5] 1,590,978	211,616	[2] 64,127	[2] 225,428	2,092,149

[1] Crude and semicrude. Includes ingot equivalent of scrap imports and exports (wt. ×0.9).
[2] Not strictly comparable with previous years' data. The 1954–58 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.
[3] Includes 324,311 tons (revised) shipped to the Government.
[4] Revised figure.
[5] Includes 323,128 tons shipped to the Government.

The Aluminum Association survey compared the percentage distribution of aluminum end uses during selected 6-month periods from the latter half of 1954 through the first half of 1958.[7] The data showed

[7] American Metal Market, Aluminum Association End-Use Statistics, Aluminum Wrought Products: Vol. 65, No. 237, Dec. 11, 1958, p. 9; Aluminum Association End-Use Statistics, Aluminum Sand Castings, p. 9.
American Metal Market, Aluminum Association End-Use Statistics on Aluminum Permanent Mold Castings: Vol. 65, No. 239, Dec. 13, 1958, p. 5.

that wrought products represented approximately 80 percent of all shipments, followed by diecastings, permanent mold castings, and sand castings. According to the Association's statistics, 22.5 percent of the wrought products shipped by members of the Association from January through June 1958, went to the building-materials industry, 13.9 percent to the transportation industry, and 10.3 percent to the electrical industry. Nearly 58 percent of the permanent mold castings was shipped to transportation-motor vehicles (except military). Nearly 43 percent of the shipments of aluminum sand castings went to manufacturers of industrial and commercial machines, equipment, and tools—a sharp increase over shipments in earlier periods. For example, in June–December 1956 only 25 percent of the shipments of sand castings went to industrial and commercial machines.

TABLE 8.—Net shipments [1] of aluminum wrought and cast products by producers, in short tons

[Bureau of the Census]

	1957	1958		1957	1958
Wrought products:			Castings:		
Plate, sheet, and strip	698,251	676,517	Sand	[2] 71,996	58,710
Rolled structural shapes, rod, bar, and wire	[2] 199,548	172,917	Permanent mold	116,163	92,800
Extruded shapes, tube bloom, and tubing	[2] 394,787	410,836	Die	[2] 186,793	146,300
Powder, flake, and paste	14,094	12,814	Other	(3)	(3)
Forgings	32,132	25,352	Total	[2] 375,909	298,228
Total	[2] 1,338,812	1,298,436	Grand total	[2] 1,714,721	1,596,664

[1] Net shipments consist of total shipments less shipments to other metal mills for further fabrication.
[2] Revised figure.
[3] Withheld because estimates did not meet publication standards of the Bureau of the Census owing to the associated standard error.

The following distribution for wrought products was obtained from the figures published by the Bureau of the Census:

	Percent 1957	Percent 1958
Plate, sheet and strip:		
Non-heat-treatable	35.2	36.4
Heat-treatable	9.3	8.0
Foil	7.6	7.7
Rolled structural shapes:		
Rod, bar, etc	4.3	2.9
Cable, bare (including steel-reinforced)	6.8	6.7
Wire and cable, covered or insulated	1.9	2.0
Bare wire, conductor and nonconductor	1.9	1.7
Extruded shapes (including tube blooms):		
Soft alloys	24.1	26.7
Hard alloys	2.3	1.9
Tubing:		
Drawn, soft and hard alloys	2.1	2.3
Welded, non-heat-treatable [1]	1.0	.7
Powder, flake, and paste:		
Atomized	.3	.3
Flaked	.2	.1
Paste	.6	.6
Forgings	2.4	2.0
	100.0	100.0

[1] Includes some heat-treatable welded tube.

The surplus supply of aluminum stimulated the industry's effort to expand existing markets and develop new ones. One of the most promising large markets was the automotive industry. A survey by Alcoa indicated that 1959 automobiles averaged 9 percent more aluminum than 1958 models.[8] A similar survey by Kaiser, which included scrap, generated, showed that the 1959 models required an average of 57.1 pounds of aluminum per car,[9] compared with 51.6 pounds shown by Alcoa's survey, which excluded scrap.

The automotive industry's growing use of aluminum was exemplified by the opening of Ford Motor Co.'s new aluminum foundry near Reynolds' new Listerhill reduction plant. Molten aluminum, containing 0.6 percent iron, from the Reynolds' plant is used to produce permanent-molded transmission housings. Iron is added for producing diecastings, and the addition of magnesium yields an alloy used in producing pistons in permanent molds. Sixty-seven engine and automatic transmission parts, weighing from 0.05 pound to 23.8 pounds, are produced.[10]

It was predicted that the average car would use 200 pounds of aluminum by 1970 and 500 pounds by 1980.[11] Early passenger cars used a relatively large quantity of aluminum in castings, but light-gage steel stampings subsequently replaced the aluminum.

By the end of 1958 it seemed that a least one automobile manufacturer in the United States would produce, late in 1959, a small car powered by an engine made largely of aluminum. It was estimated that aluminum V–8 engines for larger cars would weigh 200 pounds less than the 650-pound cast-iron engines used in the 1959 models. The most difficult problem to be solved was to reduce wear of the cylinder walls. Proposed solutions included the use of liners, plating cylinder walls with a wear-resistant coating, or casting the block from hard, high-silicon (more than 20 percent Si) alloys.[12]

The Federal highway program was expected to use increasing quantities of aluminum in such applications as railings, fencing, signs, traffic-light bridges, and light standards.[13] The first aluminum girder-type highway bridge in the world was installed in Iowa. The 222-foot welded structure was erected under the cosponsorship of the Iowa State Highway Commission, Alcoa, Kaiser, and Reynolds.[14] An experimental bridge, also jointly sponsored, was constructed by Fairchild Engine & Airplane Corp. and successfully tested at Lehigh University.[15] Another experimental bridge, developed by Reynolds, was tested at New York University.[16]

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[8] Light Metal Age, Aluminum in Autos—51.58 Lbs. Per Car!: Vol. 17, Nos. 1 and 2, February 1959, pp. 8–10.

[9] Modern Metals, Forecast 50% Greater Use of Aluminum in '59 Autos: Vol. 14, No. 7, August 1958, p. 78.

[10] Herrmann, Robert H., Ford Opens New Aluminum Diecasting and Permanent Mold Foundry: Foundry, vol. 87, No. 1, January 1959, pp. 64–69.

[11] American Metal Market, Utilization of Aluminum in Autos to Double Every Five Years: Reach 500 Pound Per Car Level by 1980: Vol. 65, No. 209, Oct. 29, 1958, pp. 15, 21.

[12] Caris, Darl F., and Thomson, Robert F., Dr., An Automobile Manufacturer Looks at Aluminum Casting Use: Foundry, vol. 86, No. 11, November 1958, pp. 92–95.
Huntington, Roger, Aluminum Engines Are Coming: Motor Life, vol. 8, No. 6, January 1959, pp. 76–79.

[13] Modern Metals, In Bridge, Highway Specs: Aluminum's Making The Grade: Vol. 14, No. 5, June 1958, pp. 26, 28, 30, 32.

[14] Chemical and Engineering News, Des Moines Gets Aluminum Bridge: Vol. 36, No. 39, Sept. 29, 1958, p. 37.

[15] Modern Metals, Prototype of Tomorrow's Highway Bridge: Vol. 14, No. 8, September 1958, pp. 66–67.

[16] Engineering News-Record, Enter Another Aluminum Bridge: Vol. 161, No. 16, Oct. 16, 1958, p. 25.

Most aluminum used in residences went into products such as storm windows and doors, awnings, and siding for existing homes; however, the aluminum industry was attempting to expand the use of aluminum in new homes. One builder of prefabricated homes announced that its 1959 models would include a complete line of aluminum-sheathed homes. As the average conventional house uses less than 100 pounds of aluminum, widespread acceptance of the new homes, which use 1,400 to 3,000 pounds of the metal, would represent a large increase in aluminum consumption. Major applications of aluminum in the prefabricated houses were siding, roofing, windows, rain-carrying equipment, and hardware. It was indicated that the aluminum-sheathed model house would be priced the same as equivalent models covered with other high quality sheathing.[17]

The first contracts for the manufacturing of aluminum cans were signed in 1957. In 1958 the United States Can Corp., a subsidiary of Victor Metal Products Corp., began producing one-piece seamless aerosol cans of aluminum at a new plant in Newport, Ark.[18] Coors Porcelain Co. was producing an aluminum beer can and supplying impact extrusion slugs for manufacturing cans in Hawaii. American Can Co. announced that it had an order for aluminum sardine cans, and National Can Corp. signed a contract calling for as much as 25 million aluminum oilcans.[19]

Aluminum's lightness, corrosion resistance, and ease of fabrication have given it an important role in the United States missile program. The aluminum content of missiles ranged from 2 to 15,000 pounds. The metal was used in the skin, powerplant, frame body, booster components, and fuel tanks.[20] The addition of fine aluminum powder to solid fuels for missiles was reported to increase thrust by 10 to 15 percent.[21]

STOCKS

Inventories of primary-aluminum pig at reduction plants on December 31, 1958, were 146,000 tons, a decrease of 15 percent or 25,000 tons from stocks at the end of 1957. From 171,000 tons at the beginning of January, stocks increased rapidly to 190,000 tons at the end of March then declined to a 22-month low of 124,000 tons at the end of October. After midyear the low stocks reflected the June production rate of only 70 percent of capacity. Despite record high production in December the yearend stock was well below the alltime peak of 195,000 tons in May 1957. Based on the December rate of production, the yearend stock was equivalent to 30 days' output. In addition to the pig-

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[17] Church, F. L., Breakthrough for Aluminum in Home Building; Modern Metals, vol. 14, No. 8, September 1958, pp. 74, 76, 78.
Church, F. L., Light Metals Man of the Year, Mr. Prefab: Modern Metals, vol. 14, No. 12, January 1959, pp. 72–74, 76, 78, 80, 82.

[18] Wall Street Journal, Production of Aerosol Aluminum Can by New Process Is Under Way: Vol. 151, No. 83, Apr. 28, 1958, p. 8.

[19] American Metal Market, Aluminum Cans Contract Signed by National Can: Vol. 65, No. 73, Apr. 16, 1958, pp. 1, 9.
Light Metal Age, Aluminum Cans—A Rapidly Growing Outlet for Aluminum—Potential of 25,000 Tons of Aluminum Seen by '68: Vol. 16, Nos. 7 and 8, August 1958, pp. 10–11, 36.
American Metal Market, West Coast Firm to Pioneer in Aluminum Cans for Food Packing: Vol. 65, No. 199, Oct. 15, 1958, pp. 1, 10.
Chemical and Engineering News, Briefs—Aluminum Is Getting Ready: Vol. 36, No. 42, Oct. 20, 1958, p. 34.

[20] Fabun, Don, Aluminum in Rockets & Missiles: Modern Metals, vol. 14, No. 3, April 1958, pp. 30–32, 34, 36, 38, 41–42, 44.

[21] Steel, New Market for Aluminum: Vol. 142, No. 11, Mar. 17, 1958, p. 37.

aluminum stocks reported, reduction plants also had inventories of ingot and aluminum in process.

Stocks of secondary-aluminum pig and ingot of 18,700 tons on December 31, 1958, were unchanged from the end of the preceding year. From March through August 1958, stocks of secondary aluminum were slightly higher than for the rest of the year. Consumers' stocks of aluminum-base scrap increased 2,200 tons during 1958 to 27,900. At the December rate of consumption the scrap stock represented a 23-day supply.

PRICES

On January 1, 1958, the price of aluminum pig, 99.5-percent guaranteed minimum, was 26.0 cents per pound and that of aluminum ingot, 99 percent plus, was 28.10 cents per pound. A drop in the price of aluminum on the world market resulted in the first price decrease in the United States since 1941. The decrease was effective April 1 when the price of pig was reduced to 24.0 cents per pound and the price of ingot to 26.1 cents per pound. In August, after an increase in wages and benefits in compliance with terms of a 3-year labor contract signed in August 1956, prices for both pig and ingot increased 0.7 cent to 24.7 and 26.8 cents per pound. All prices were base prices, f.o.b. shipping point with freight allowance to United States destinations. Before October 3, aluminum-ingot price quotations from the American Metal Market were for ingot 99 percent plus; on and after that date the quotation was for 99.5 percent plus aluminum. To stabilize the market the primary producers announced in December that there would be no further increase in prices for orders delivered before July 1, 1959.

Prices of smelters' alloys were relatively stable throughout the year. The combined average price for No. 12 alloy was 21.62 cents per pound, a decrease of 0.85 cent per pound below the 1957 average. The American Metal Market listed the following closing market prices on December 31, 1958: Alloy 195, 25.00 to 26.00 cents per pound; No. 12, 21.50 to 22.00 cents; and No. 380, 21.75 to 22.75 cents. These prices were ¼ to 1 cent per pound lower than at the end of 1957. The prices quoted applied to 20,000-pound lots delivered to buyers' plants.

Scrap prices were also relatively stable but decreased in April and increased in August, reflecting changes in the price of primary metal. Dealer's buying prices for new aluminum clips averaged 12.97 cents per pound, down from 14.07 cents in 1957. Monthly averages ranged from a high of 13.52 cents per pound in January to 12.75 cents during May through October. Cast-aluminum-scrap prices averaged 9.76 cents per pound—1.10 cents below the 1957 average. The high of 10.34 cents per pound was quoted in January and the low of 9.25 cents in June and July. The closing market prices for scrap on December 31, 1958, according to the American Metal Market, were: 2S, 3S, 51S, and 52S, 17.00 to 17.50 cents per pound; 75S clips, 11.50 to 12.50 cents per pound; and aluminum borings and turnings, 13.00 to 14.00 cents per pound. These prices ranged from unchanged to down 1 cent per pound from the end of 1957.

FOREIGN TRADE [22]

The tariff on imports of crude aluminum was 1.3 cents a pound until July, when the duty was reduced to 1.25 cents a pound under the General Agreement on Tariffs and Trade of 1956. At the same time the duty on typical aluminum manufactured items was reduced from 3.65 cents a pound plus 18 percent ad valorem to 3.5 cents a pound plus 17 percent ad valorem.

Suspension of the 1½-cent-per-pound duty on scrap was continued in 1958. There was no export quota on aluminum scrap.

TABLE 9.—Aluminum imported for consumption in the United States, by classes

[Bureau of the Census]

Class	1957		1958	
	Short tons	Value (thousands)	Short tons	Value (thousands)
Crude and semicrude:				
Metal and alloys, crude	222,158	[1] $107,336	255,322	$117,297
Plates, sheets, bars, etc	[2] 19,577	[1,2] 15,124	27,943	20,183
Scrap	16,271	[1] 5,396	9,922	2,969
Total	[2] 258,006	[1,2] 127,856	293,187	140,449
Manufactures:				
Foil less than 0.006 inch thick	1,752	[1] 2,882	2,771	3,693
Folding rules	(3)	[1] 5	(3)	(4)
Leaf (5½ by 5½ inches)	(5)	[1] 11	(5)	5
Powder and powdered foil (aluminum bronze)	60	67	50	53
Table, kitchen, hospital utensils, etc	2,015	[1] 3,495	2,380	3,874
Other manufactures	(6)	[1] 2,332	(6)	2,718
Total	(6)	[1] 8,792	(6)	10,343
Grand total	(6)	[1,2] 136,648	(6)	150,792

[1] Data known to be not comparable to 1958.
[2] Revised figure.
[3] Number: 1957, 2,400; 1958, 422; equivalent weight not recorded.
[4] Less than $1,000.
[5] Leaves: 1957, 3,050,680; 1958, 1,721,042.
[6] Quantity not recorded.

[22] 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.—Aluminum imported for consumption in the United States, by classes and countries, in short tons

[Bureau of the Census]

Country	1957			1958		
	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap	Metal and alloys, crude	Plates, sheets, bars, etc.	Scrap
North America:						
Canada	205,343	3,346	12,335	213,862	3,118	9,089
Other North America			36			58
Total	205,343	3,346	12,371	213,862	3,118	9,147
South America						28
Europe:						
Austria	5	54		2,849	1,109	
Belgium-Luxembourg	5	[1] 5,985		59	9,116	
France	178	639	805	11,910	2,763	364
Germany, West	780	[1] 1,618	357	2,120	2,089	176
Italy		[1] 1,947		773	3,892	32
Norway	14,862		55	21,782	382	17
United Kingdom	217	[1] 4,453	1,005	12	1,779	70
Yugoslavia	165	324		1,213	654	
Other Europe	160	[1] 457	1,572	191	1,069	88
Total	16,372	[1] 15,477	3,794	40,909	22,853	747
Asia:						
Japan	2	753			1,972	
Other Asia	441		31	551		
Total	443	753	31	551	1,972	
Africa		1				
Oceania			75			
Grand total: Short tons	222,158	[1] 19,577	16,271	255,322	27,943	9,922
Value, thousands	[2] $107,336	[1,2] $15,124	[2] $5,396	$117,297	$20,183	$2,969

[1] Revised figure.
[2] Data known to be not comparable to 1958.

TABLE 11.—Aluminum exported from the United States, by classes

[Bureau of the Census]

Class	1957 Short tons	1957 Value (thousands)	1958 Short tons	1958 Value (thousands)
Crude and semicrude:				
Ingots, slabs, and crude	[1] 29,105	[1] $14,613	52,711	$24,220
Scrap	18,166	6,435	18,906	5,595
Plates, sheets, bars, etc	13,767	13,179	9,183	10,240
Castings and forgings	1,333	3,064	1,633	3,022
Semifabricated forms, n.e.c	181	192	37	61
Total	[1] 62,552	[1] 37,483	82,470	43,138
Manufactures:				
Foil and leaf	887	1,138	295	492
Powders and pastes (aluminum and aluminum bronze) (aluminum content)	475	573	331	435
Cooking, kitchen, and hospital utensils	1,308	3,056	1,192	3,017
Sash sections, frames (door and window)	730	1,323	1,547	2,762
Venetian blinds and parts	1,836	2,099	1,262	1,656
Wire and cable	4,977	3,613	4,374	2,540
Construction materials, n.e.c	4,610	8,552	(2)	(2)
Other manufactures	(3)	350	(2)	(2)
Total	(4)	20,704	(4)	10,902
Grand total	(4)	[1] 58,187	(4)	54,040

1 Revised figure.
2 Beginning Jan. 1, 1958, not separately classified.
3 Weight not recorded.
4 Quantity not recorded.

TABLE 12.—Aluminum exported from the United States, by classes and countries, in short tons

[Bureau of the Census]

Country	1957			1958		
	Ingots, slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap	Ingots, slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap
North America:						
Canada	[2] 1,807	6,331	258	11,322	4,726	364
Cuba	31	1,309	----------	52	1,326	4
Mexico	2,804	196	50	3,900	102	82
Other North America	8	803	10	19	900	114
Total	[2] 4,650	8,639	318	15,293	7,054	564
South America:						
Argentina	5,542	25	----------	231	20	----------
Brazil	3,094	73	10	642	125	----------
Colombia	1,298	536	----------	2,088	371	1
Venezuela	38	1,319	----------	62	1,136	(3)
Other South America	532	315	----------	403	142	----------
Total	10,504	2,268	10	3,426	1,794	1
Europe:						
Germany, West	516	6	8,140	1,654	6	11,094
Italy	770	25	2,777	----------	35	4,626
United Kingdom	3,486	105	17	25,986	47	408
Other Europe	788	255	140	1,240	297	148
Total	5,560	391	11,074	28,880	385	16,276
Asia:						
India	1,240	3,250	1,438	720	1,049	28
Japan	2,982	69	5,312	88	23	2,036
Philippines	2,681	65	14	2,324	34	----------
Other Asia	1,482	326	----------	1,951	300	1
Total	8,385	3,710	6,764	5,083	1,406	2,065
Africa	6	243	----------	29	129	----------
Oceania	----------	30	----------	----------	85	----------
Grand total: Short tons	[2] 29,105	15,281	18,166	52,711	10,853	18,906
Value, thousands	[2] $14,613	$16,435	$6,435	$24,220	$13,323	$5,595

[1] Includes plates, sheets, bars, extrusions, castings, forgings, and unclassified "semifabricated forms."
[2] Revised figure.
[3] Less than 1 ton.

WORLD REVIEW

New facilities placed in operation raised the world aluminum capacity to an estimated 4.9 million short tons—an increase of nearly 500,000 tons.

NORTH AMERICA

Canada.—Aluminum Company of Canada, Ltd., operated at 72 percent of capacity. No new capacity was added, as the company decided in 1957 to defer completion of the 80,000-ton-capacity plant addition at Kitimat. However, construction was continued on a new hydroelectric project on the upper Peribonca River in Quebec. Completion of the project in 1960 was to increase Alcan's installed power capacity by 1 million horsepower.

TABLE 13.—World production of aluminum, by countries, in short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [2]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	452,329	557,897	612,543	620,321	556,715	646,000
United States	869,662	1,460,565	1,565,721	1,678,954	1,647,709	1,565,557
Total	1,321,991	2,018,462	2,178,264	2,299,275	2,204,424	2,211,557
South America: Brazil	[3] 988	1,612	1,834	6,920	9,794	[4] 10,500
Europe:						
Austria	30,730	52,920	63,051	65,490	62,125	62,716
Czechoslovakia	[5] 2,976	17,000	26,900	23,400	18,400	29,100
France	93,491	132,426	142,191	165,082	176,603	186,415
Germany:						
East	[6] 7,366	23,100	29,100	37,800	[4] 38,100	[4] 37,500
West	74,566	142,439	151,089	162,439	169,576	150,756
Hungary	23,063	36,115	40,740	38,374	28,700	43,540
Italy	48,713	63,462	68,010	69,896	72,962	70,603
Norway	52,312	67,573	79,102	101,349	105,430	134,021
Poland		5,732	22,500	24,000	22,400	[4] 24,900
Rumania [4]			6,200	8,800	11,000	11,200
Spain	3,533	4,545	3,466	14,283	16,721	[4] 17,600
Sweden (includes alloys)	7,182	11,768	11,063	13,734	16,806	16,931
Switzerland	27,315	28,660	33,069	33,069	34,172	34,400
U.S.S.R.[4]	242,500	375,000	475,000	500,000	550,000	605,000
United Kingdom	32,807	35,395	27,378	30,892	32,933	29,517
Yugoslavia	2,779	3,854	12,675	16,162	19,989	23,899
Total [4]	650,000	1,000,000	1,190,000	1,305,000	1,375,000	1,480,000
Asia:						
China (Manchuria)[4]		3,300	11,000	11,000	22,000	30,000
India	4,090	5,439	8,091	7,281	8,718	9,167
Japan	37,709	58,544	63,392	72,749	74,931	93,231
Taiwan	3,267	7,861	7,717	9,655	9,104	9,455
Total [2]	45,066	75,144	90,200	100,685	114,753	141,853
Africa: Cameroon					8,379	34,723
Oceania: Australia			1,398	10,240	11,899	12,196
World total (estimate)[1,2]	2,018,000	3,095,000	3,460,000	3,720,000	3,725,000	3,890,000

[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] In addition to countries listed, North Korea produced a negligible quantity of aluminum.
[3] Average for 1951–53.
[4] Estimate.
[5] Average for 1 year only, as 1953 was the first year of commercial production.
[6] Average for 1950–53.

Canadian British Aluminium Co., Ltd., completed construction of Stage II of the Baie Comeau smelter and ancillary facilities in December, several months ahead of schedule. Stage I was operating at capacity by the end of April; Stage II began operating in mid-October and by the end of the year was producing 72 percent of its rated capacity. Substantial deliveries of aluminum were made to British Aluminium Co., Ltd., under a 20-year sales agreement, and sales to Canadian consumers were begun in July. The company had a trucking service that enabled it to make deliveries to Canadian customers when navigation on the upper St. Lawrence was closed. Several papers on the Baie Comeau project were presented at the annual meeting of the Engineering Institute of Canada.[23]

[23] Miller, C., and Street, W. G., Aluminium Reduction Plant at Baie Comeau: Eng. Jour. (Canada), vol. 41, No. 7, July 1958, pp. 41–49.
Hughes, T. A., and Wallingford, V. M., Aluminium Smelter Dock at Baie Comeau, Que.: Eng. Jour. (Canada), vol. 41, No. 7, July 1958, pp. 50–59.
Higgins, J. M., and Miller, C., The Manicouagan Power Development: Eng. Jour. (Canada), vol. 41, No. 7, July 1958, pp. 60–69.

TABLE 14.—Primary-aluminum production capacity in Canada

(Short tons per year)

	End of 1958	Being built or planned
Aluminum Company of Canada:		
Arvida, Quebec	367,500	
Beauharnois, Quebec	37,000	
Isle Maligne, Quebec	113,400	
Kitimat, British Columbia	186,000	[1] 77,000
Saguenay area, Quebec		[1] 120,000
Shawinigan Falls, Quebec	70,800	
Total	774,700	197,000
Canadian British Aluminium Co., Ltd.: Baie Comeau, Quebec	90,000	
Grand total	864,700	197,000

[1] Reactivation of these projects depends upon improvement of world markets for aluminum.

On April 1 Aluminium Ltd., reduced the basic price for primary aluminum produced in Canada by the equivalent of 2 cents per pound in all markets. The price of the company's metal in the United States market was raised by 0.7 cent per pound, effective August 1, 1958.

SOUTH AMERICA

Brazil.—Aluminio Minas Gerais, S.A., subsidiary of Aluminium Ltd., completed its Franco Falls hydroelectric plant on the Juquia River in October, thus permitting the company to add a new potline of 7,300 tons to its Saramanha plant in Ouro Preto. The company's total capacity at the end of the year was 9,700 short tons.

Surinam.—A final agreement between Alcoa and the Surinam Government for developing the Brokopondo Plan was signed in January. Alcoa was to begin construction of a dam, powerhouse, and transmission line to supply 150,000 kilowatts of power in 1960. The overall project, which includes a 66,000-ton aluminum plant near Paranam and an alumina plant, will cost $150 million. Suriname Aluminum Co. (Suralco), formerly Surinaamsche Bauxite Maatschappij, will direct all Alcoa activities in the country, including power development, exploration, mining, and aluminum smelting.

EUROPE

France.—A record output of aluminum was reported. Compagnie Péchiney accounted for 153,000 short tons and Société Ugine the remaining 33,400 tons.

The 55,000-ton plant of Péchiney at Nogueres-Mourenix and Société Ugine's new 25,000-ton plant at Lannemezan were expected to be completed in 1960. These plants will use natural gas from the Lacq field for generating electric power. An article describing equipment to be used in the new plants was published.[24] Other articles gave the history of the French aluminum industry and described it.[25]

[24] Baudart, G. A., Aluminium-Lacq, Revue de l'Aluminium (in French): Vol. 35, No. 253, April 1958, pp. 390–395.

[25] Starratt, F. Weston, Aluminum and France: Jour. Metals, vol. 10, No. 1, January 1958, pp. 38–43.
Baudart, Georges A., The French Aluminum Industry: Metal Progress, vol. 73, No. 1, January 1958, pp. 72–75.

Exports of crude aluminum totaled 18,000 tons, and aluminum was shipped to China for the first time.

Germany, West.—The West German Government voted to maintain the duty-free import quota of 40,000 tons in 1959. The duty on imports in excess of this quantity was to be 7 percent ad valorem.

Hungary.—A 3-year expansion program provided for increasing aluminum production to 50,000 short tons and emphasized the export of finished aluminum products instead of raw aluminum.[26]

The U.S.S.R. decided in mid-September to grant a loan of 20 million rubles ($5 million) to Hungary for establishing an aluminum-products plant at Szekesfehervar.

Norway.—Production of aluminum increased 27 percent and reached a new peak. The increase was attributed to the addition of approximately 30,000 short tons to capacity and a rise in demand resulting from larger exports under long-term contracts.

Mosjøen Aluminium A/S plant at Mosjøen in northern Norway was completed and added 27,000 short tons to annual capacity. The company in which A/S Elektrokemisk has a two-thirds interest and Aluminium-Industrie Aktiengesellschaft (AIAG) (Swiss) a one-third interest, was reported to have produced 18,000 tons of aluminum in 1958, most of which was shipped to the United Kingdom, West Germany, and Belgium. Most of the 1959 output has been contracted for.[27] Annual capacity of the plant was to be expanded to 33,000 tons and later to 99,000 tons.

Aardal og Sunndal Verk A/S completed installations at the Sunndal II plant. The plant, with a capacity of 11,000 short tons annually, was expected to be in full operation in February 1959. The Aardal II plant, with a capacity of 39,600 tons, also was expected to begin operating in February 1959.[28] The Storting approved construction of the Aardal III plant, which will bring the company's total capacity to 176,000 tons in 1963–64. A new barter agreement was signed with Aluminium, Ltd., on August 25, 1958. Aluminium, Ltd., was to supply Aardal with 4.1 million tons of alumina until 1978 and would receive aluminum in exchange.

Norsk Aluminium A/S added about 5,000 short tons of capacity to its Höyanger plant in 1958, bringing capacity to 14,300 tons.

Exports of primary aluminum increased approximately 50 percent to an alltime high of 125,700 tons.

An article by the managing director of Norsk Aluminium A/S included information on the historical background of the aluminum industry in Norway and its status in 1958.[29]

Spain.—Empresa Nacional del Aluminio, S.A., announced authorization for installing a 33,000 short ton aluminum plant at Aviles.

Aluminio de Vigo, S.A. (ALVISA), was formed to build a 22,000-ton plant in the Vigo Free Zone. Participants are the Aluminum Company of Canada, Industrias Navarras del Aluminio, Aluminio Iberico, Banco Iberico, and an electric-power company. The plant will have an initial capacity of 11,000 tons.

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[26] Metal Industry (London), Aluminium in Hungary: Vol. 93, No. 6, Aug. 8, 1958, p. 119.
[27] Metal Bulletin (London), Mosjøen Sold for 1959: No. 4360, Jan. 9, 1959, p. 21.
[28] American Metal Market, Norwegian Company Activating Its New Capacity in February: Vol. 66, No. 13, Jan. 20, 1959, p. 9.
[29] Murer, Johan, Aluminum's Booming in Norway: Modern Metals, vol. 15, No. 3, April 1959, pp. 44, 46.

U.S.S.R.—The 33,000-short-ton aluminum plant at Stalingrad was completed by the end of the year and was to begin operating in January 1959.

Trade statistics were published for the first time since World War II. The Soviet Union exported 66,000 short tons of aluminum in 1956 and 94,000 tons in 1957 and imported 10,700 tons in 1956 and only 330 tons in 1957.[30]

A review of the history of the aluminum industry in the Soviet Union with a discussion of current developments was published.[31]

Several articles stressed the impact of the entry of Soviet aluminum in the world market.[32]

United Kingdom.—Imports of primary aluminum totaled 264,000 short tons—184,000 tons from Canada, 26,800 from the United States, 25,600 from Norway, 17,500 tons from the Soviet Bloc (14,100 tons from U.S.S.R. and the remainder from other countries). The Board of Trade decided against the Canadian request to impose an antidumping duty on Soviet aluminum upon assurance from the Soviet Union in September that not more than 16,500 short tons of aluminum would be exported to the United Kingdom during the next 12 months.

Late in 1958 Alcoa and Reynolds were obtaining a financial interest in British Aluminium Co., Ltd. Alcoa agreed to purchase 4.5 million shares of authorized but unissued stock, whereas Reynolds in conjunction with Tube Investments, Ltd., purchased stock on the open market. By the end of December it appeared that the Reynolds-Tube Investments group would gain control of British Aluminium.

Yugoslavia.—Preparatory work on the aluminum plant to be built at Titograd was suspended in May, when the Soviet Union and East Germany postponed for 5 years the credit loan of $175 million.

The French aluminum producer, Compagnie Péchiney, agreed to assist in the modernization and expansion of the Kidricevo and Lozovac plants.

ASIA

China.—It was reported that two reduction plants were to begin producing in 1959. The Canton aluminum plant at Huangpu, a Canton suburb, was to begin partial operation during the first quarter, producing at the rate of 11,000 short tons per year. The Tsamkong aluminum plant in Kwantung Province was to begin producing at an annual rate of 1,100 short tons in the second quarter of 1959. A large plant was being built at Kweiyang, Kweichow Province.

A joint directive issued by the Central Committee of the Communist Party and the Chinese Cabinet called for construction of small-scale plants capable of operating within 2 to 4 months. Emphasis was

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[30] Gakner, Alexander, The Foreign Mineral Trade of the U.S.S.R. in 1956: Bureau of Mines Mineral Trade Notes, Spec. Supp. 55, vol. 47, No. 3, September 1958, 38 pp.
Gakner, Alexander, The Foreign Mineral Trade of the U.S.S.R. in 1957: Bureau of Mines Mineral Trade Notes, Spec. Supp. 56, vol. 48, No. 1, January 1959, 30 pp.

[31] Shabad, Theodore, The Soviet Aluminum Industry. Published by the American Metal Market, 18 Cliff Street, New York 38, N.Y., October 1958, 25 pp.

[32] Steel, Reds Make Aluminum War: Vol. 143, No. 3, July 21, 1958, p. 77.
Waste Trade Journal, The Threat of Red Aluminum: Vol. 105, No. 21, Aug. 9, 1958, pp. 16–18, 67.
Mining Engineering, Aluminum—Cold War Casualty?: Vol. 10, No. 8, August 1958, pp. 850–851.

to be placed on economy, simplicity, and production methods requiring the least electric energy.[33]

India.—The Indian Aluminium Company, Ltd., completed its new plant at Hirakud and expected to begin operating early in 1959. The plant, having a capacity of 11,000 short tons, was built at a cost of $10 million. Expansion of the plant to 22,000 tons was awaiting approval by the Government.

Hindustan Aluminium Corp. was formed by Birla Bros. (Indian) and Kaiser Aluminum & Chemical Corp., to build a 22,000-ton aluminum plant at Pirpi, near the Rihand Dam in Uttar Pradesh. Other projects included an 11,000-ton plant in the Salem district of Madras State to be built by Compagnie Péchiney (French) and Montecatini (Italian); a plant to be sponsored by the Coimbatore Millowners' Association and built in the south of the country; and a plant to be built at Kolhapur, sponsored by Indian and Italian interests.

Japan.—Aluminum output reached a postwar high as a result of partial reactivation of the Niigata plant of Japan Light Metals Co., expansion of the Kitagata plant, and completion of a new 5,500-short-ton plant near the Kitagata plant of Showa Denko Co. The Niigata plant, which had been idle since the end of World War II, has a capacity of 13,500 short tons. This capacity, added to the 35,000-ton capacity of the Kambara plant, brought total capacity of the Japan Light Metals Co. to 48,500 tons.

Sumitomo Chemical Co. announced that it was planning to increase capacity of its plant to 25,000 tons in 1959.

Export shipments in 1958 totaled 5,000 tons compared with only 260 tons in 1957.

AFRICA

Several proposed aluminum projects in western Africa were described.[34] Although only one plant in Cameroon produced aluminum in Africa in 1958, the vast untapped hydroelectric power potential and large bauxite deposits of Africa led to the formation of a number of companies that were investigating the possibility of producing alumina or aluminum.

French aluminum producers announced that a new company, Cie Holding pour l'Aluminium Africain, would be formed by Péchiney, Ugine, and Cofimer, an investment company, with a capital of 1 billion francs, to invest in companies producing and marketing alumina and aluminum in Africa.

Angola.—Construction of a 50,000-ton aluminum plant was to be undertaken by Compagnie Péchiney of France and Aluminio Portugues (SARL) of Angola. The plant, with an initial capacity of 25,000 tons, was expected to be completed by 1961. Power was to be supplied by a hydroelectric plant under construction on the Mid-Quanza Falls at Cambambe.

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[33] E&MJ Metal and Mineral Markets, Copper, Aluminum Output Falling Behind in Red China: Vol. 29, No. 49, Dec. 4, 1958, p. 10.

[34] Modern Metals, American, European Firms Invest Millions in Africa's Booming Aluminum Industry: Vol. 15, No. 2, March 1959, pp. 68–69.

Henin, Louis, L'Industrie de l'aluminium en Afrique noire [Aluminum Industries in Dark Africa] (in French): Classe des sciences techniques—memoires in 8°, nouvelle series, vol. 8, Rue de Livourne, 80A, Brussels, 5, Belgium, 1958, 63 pp.

TABLE 15.—Present and tentative African aluminum projects

Country and company	Location	Tentative capacity (short tons per year)	Participants
Angola: Portuguese and French companies.	Cambambe	[1] 50,000	Aluminio Portugues (SARL) (Angola), Péchiney (French).
Belgian Congo: ALUMINGA Syndicate.	Inga	200,000	Syndicat Belge de l'Aluminium (Belgian), Péchiney-Ugine (French), Aluminium-Industrie A.G. (AIAG) (Swiss), Montecatini (Italian), Vereinigte Aluminiumwerke A.G. (German), Aluminium Ltd. (Canadian), British Aluminium Co. Ltd. (British), Reynolds Metals Co. (American).
Cameroon: Compagnie Camerounaise de l'Aluminium Péchiney-Ugine (ALUCAM).	Edea	[2] 100,000	Péchiney-Ugine (French), Caisse Centrale de la France d'Outre-mer (French), Cameroon Government, Syndicat Belge de l'Aluminium (Belgian).
Ghana: Foreign interests	Volta River	80,000–250,000	Several companies and Governments have expressed interest in the project.
Guinea, Republic of:			
1. FRIA Compagnie Internationale pour la Production de l'Alumine.	Fria	150,000	Vereinigte Aluminiumwerke A.G. (German), Olin-Mathieson Chemical Corp. (American), Péchiney-Ugine (French), British Aluminium Co. Ltd. (British), Aluminium Industrie A.G. (Swiss).
2. Bauxites du Midi	Boké	(3)	Aluminium Ltd. (Canadian).
3. French and Guinean Governments and Société Européene pour l'Etude de l'Aluminium en Afrique (AFRAL).	Konkouré	155,000	Péchiney-Ugine (French), Aluminium-Industrie A.G. (Swiss), Montecatini (Italian), Vereinigte Aluminiumwerke A.G. (German), Aluminium Ltd. (Canadian).
Central African Republic (formerly French Equatorial Africa): French Government and private interests.	Kouilou	125,000	Several companies have been contracted by the French Government.

[1] Initial capacity of 25,000 tons expected to be completed in 1961.
[2] Operating at 50,000 tons capacity in 1958.
[3] Current bauxite producer and potential alumina producer.

Cameroon.—Aluminum output increased 314 percent in 1958. During the year 30,700 short tons of aluminum was exported, principally to France.

Guinea.—After Guinea decided to become an independent country, it was stated that the project at Fria for producing alumina would proceed as planned. In 1958 Vereinigte Aluminiumwerke (VAW) acquired a 5-percent interest in the capital of the company. Participation in the company at the end of the year was Olin-Mathieson Chemical Corp. (American) 48.5 percent, Péchiney-Ugine (French) 26.5 percent, British Aluminum Co. (British) and AIAG (Swiss) each 10 percent, and VAW (German) 5 percent.

OCEANIA

Australia.—The Commonwealth and Tasmanian Governments, pending approval of the Tasmanian Parliament, decided to double capacity of the Bell Bay aluminum plant to 29,000 short tons a year.

TECHNOLOGY

In 1958 the aluminum industry spent more than $25 million on research and product development. This expenditure included research on bauxite and alumina production and utilization.

An article summarized the literature on research and technical progress in the United States and Great Britain on the extraction, fabrication, properties, and standardization of aluminum and its alloys. An extensive bibliography was included.[35]

The development of improvements in electrolytic reduction continued to receive attention.[36] Problems of the reduction operation, especially with respect to lowering costs, were described, and avenues of attack on the problems were proposed.[37] Literature on the electrolysis of aluminum from cryolite melts and on the structure of these melts was surveyed critically, and theories of electrolysis were examined in the light of the data obtained.[38] A study was made of the electromagnetic forces present in the electrolysis of aluminum.[39]

Two United States patents on the reduction of alumina (U.S. Patent 2,829,961 on the use of carbon or aluminum carbide at 1,800° to 2,000° C. for the reduction and U.S. Patent 2,843,475 on the use of aluminum sulfide and carbon at 1,200° C.) were discussed in an article.[40]

Research had continued for several years on the use of aluminum powder containing 5 to 17 percent Al_2O_3 in the production of sintered aluminum powder (SAP) and aluminum-powder metallurgical products (APM). This research was extended to include the study of parts fabricated from atomized aluminum-alloy powders. Such powders differed from SAP and APM in that they contained intentionally added alloying ingredients and less than 1 percent of oxide. High-temperature properties of the powder alloys were compared with those of the aluminum-aluminum oxide type powder.[41]

Articles discussing the use of aluminum alloys as materials of construction were summarized.[42] Architectural and atomic-energy applications were described, also the corrosion properties of aluminum in contact with different chemicals.

Sheet steel, coated on both sides with aluminum by a hot-dip process, possesses the surface characteristics of aluminum and the physical and mechanical properties of steel. Methods of forming, joining, and finishing aluminum-coated steel were discussed.[43]

The wide acceptance of aluminum in architectural applications, especially curtain walls, stimulated an interest in methods of coating and finishing aluminum. Mechanical finishes, chemical treatments, conversion coatings, anodizing and coloring, organic coatings, and porcelain enameling were evaluated as to their advantages and limi-

[35] Elliott, E., Aluminium and Its Alloys in 1958, Some Aspects of Research and Technical Progress Reported: Metallurgia (Manchester), vol. 59, No. 352, February 1959, pp. 79–85; No. 353, March 1959, pp. 109–116.

[36] Ginsberg, H., [Present Day Status of the Industrial Electrolysis of Aluminium and the Foreseeable Trends of Its Development] (in German): Metall (Berlin), vol. 12, No. 3, March 1958, pp. 173–175.

[37] Johnson, Arthur F., Metallurgical Problems Affecting the Economics of Aluminum Production: Jour. Metals, vol. 10, No. 1, January 1958, pp. 31–34.

[38] Stokes, John J., Jr., Interpretation of the Literature on the Mechanism of the Hall Process: Trans. Met. Soc. AIME, vol. 212, No. 1, February 1958, pp. 75–79.

[39] Bockman, O. Chr., and Wleügel, J., Electromagnetic Forces in Large Aluminum Furnaces: Jour. Electrochem. Soc., vol. 105, No. 7, July 1958, pp. 417–420.

[40] Chemical Week, Will Thermal Reduction Replace Electrolysis for Aluminum Production?: Vol. 83, No. 7, Aug. 16, 1958, pp. 55–56.

[41] Towner, R. J., Atomized Powder Alloys of Aluminum: Metal Progress, vol. 73, No. 5, May 1958, pp. 70–76, 176.

[42] Industrial and Engineering Chemistry, Materials of Construction, Aluminum Alloys: Vol. 50, No. 9, pt. 2, September 1958, pp. 1427–1432.

[43] McFee, W. E., How to Work Aluminum-Coated Steel: Iron Age, vol. 181, No. 6, Feb. 6, 1958, pp. 95–97.

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tations.[44] Although anodized aluminum panels costing about 20 cents per square foot were cheaper than porcelainized aluminum, it was reported that the difficulty of matching and the higher rejection rate for anodized panels virtually eliminated the cost differential. Primarily because of the high rejection rate, colored anodized panels cost about 40 percent more than uncolored panels.[45] Methods of anodizing aluminum were reviewed and typical cycles and operating conditions shown.[46]

Methods of machining aluminum-alloy castings were tabulated, and a guide for selecting casting alloys was published.[47] The continuous casting of billets in the United States and Europe was compared. It was noted that in the United States the problem has been approached from a practical and mechanical standpoint, whereas in Europe prime attention is paid to the metallurgy of casting.[48]

Three new methods of welding aluminum were developed. One method added chlorine to the inert gas (helium or argon) in the contact tube, a second method used a buried-arc technique, and the third used a low flow of shielding gas in addition to the chlorine and inert gas surrounding the arc. Improved welds and lower costs were claimed for these new methods.[49] Methods of producing high-quality welds of aluminum were described.[50] Recent developments in welding, brazing, and soldering aluminum also were reported.[51] Joining aluminum with aluminum rivets, bolts, or screws was said to result in a better product at lower cost. Such fasteners increase corrosion resistance, are easy to work, and result in aluminum products having a uniform appearance.[52]

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[44] Hafer, R. F., Finishes for Aluminum in Architecture: Modern Metals, vol. 14, No. 2, March, 1958, pp. 64, 66, 68–70.

[45] Engineering News-Record, What Price Colored Buildings?: Vol. 161, No. 26, Dec. 25, 1958, pp. 29–31, 33.

[46] Cummings, Guy A., Opportunities Abound in Anodizing Aluminum: Modern Metals, vol. 14, No. 4, May 1958, pp. 32, 34, 36, 38, 41.

[47] Iron Age, How to Get More for Your Nonferrous Dollar, Aluminum Processes, Properties Make Selection Critical: Vol. 182, No. 24, pt. 1, Dec. 11, 1958, pp. 122–125.

[48] Sinason, H. Henry, Aluminum Billet Casting: Light Metal Age, vol. 16, Nos. 11 and 12, December 1958, pp. 12–17.

[49] Baysinger, F. R., Three New Pore-Free Ways to Weld Aluminum: Iron Age, vol. 181, No. 11, Mar. 13, 1958, pp. 112–115.

[50] Correy, Thomas B., High Quality Fusion Welding of Aluminum: Light Metal Age, vol. 16, Nos. 5 and 6, June 1958, pp. 8–12; Nos. 7 and 8, August 1958, pp. 12–14, 16, 22, 24–26; Nos. 9 and 10, October 1958; pp. 8–13.

[51] Burgess, N. T., Progress in the Joining of Aluminum: Metallurgia (Manchester), vol. 57, No. 347, March 1958, pp. 117–121.

[52] Lemis, Floyd A., Aluminum Rivets Upgrade Parts Made of Aluminum: Steel, vol. 143, No. 22, Dec. 1, 1958, pp. 86–88; For Aluminum Fabricating Jobs . . . Aluminum Bolts Work the Best: No. 23, Dec. 8, 1958, pp. 130–131; Aluminum Screws Cut Costs: No. 24, Dec. 15, 1958, p. 131.

Antimony

By H. M. Callaway [1] and Edith E. den Hartog [2]

SUPPLY of antimony and demand for the metal were in equilibrium in 1958. Declines in industrial consumption and Government purchases were balanced by curtailed smelter output and restricted acceptance of import offerings. Shipments to Government account, although less than in recent years, were sufficient to prevent industry stock buildups.

TABLE 1.—Salient antimony statistics, in short tons

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Production:						
Primary:						
Mine	2,027	766	633	590	709	705
Smelter [1]	12,086	10,007	10,414	11,855	11,400	8,557
Secondary	21,863	22,358	23,702	24,106	22,565	19,515
Imports [2]	14,224	9,566	14,417	13,577	15,265	11,579
Ore and concentrates	9,014	4,722	7,514	6,572	8,198	5,185
Metal	2,960	2,825	3,671	4,693	5,052	4,672
Oxide	1,048	1,225	1,834	1,236	1,571	1,065
Sulfide	22	23	32	32	27	12
Antimonial lead	1,180	771	1,366	1,044	417	645
Exports of ore, metal and alloys	198	44	212	65	68	86
Consumption [3]	18,275	14,907	15,870	16,006	12,389	11,880
Average price of antimony at New York (cents per pound)	38.45	30.47	32.15	34.97	35.09	31.76
World: Production	48,000	44,000	51,000	53,000	50,000	44,000

[1] Revised figures; includes primary content of antimonial lead produced at primary lead smelters.
[2] General; antimony content of ore, oxide, sulfide, antimonial lead, and type metal.
[3] Revised figures; includes primary content of antimonial lead produced at primary lead smelters and antimony content of alloys imported.

LEGISLATION AND GOVERNMENT PROGRAMS

Although Government inventories for the national stockpile substantially equaled the current procurement priority level, domestic primary antimony producers continued deliveries in fulfillment of prior contract commitments.

Antimony remained on the list of eligible commodities for which Commodity Credit Corporation continued to barter domestic agricultural surpluses. Deliveries to Government resulting from barter contracts amounted to approximately 670 tons.

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

DOMESTIC PRODUCTION

MINE PRODUCTION

Domestic antimony mines produced 28 tons of antimony in 1958. Although many domestic ores contain minor quantities of antimony that are recovered as a byproduct at domestic smelters, data on the quantities recovered from individual deposits are lacking. The tetrahedrite-rich ores of 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 1958, Sunshine Mining Co. produced 677 tons.

TABLE 2.—Antimony concentrates shipped in the United States, in short tons

Year	Gross weight	Average percent antimony	Net weight antimony content	Year	Gross weight	Average percent antimony	Net weight antimony content
1949-53 (average)	5,713	33.2	2,027	1956	3,505	16.8	590
1954	4,686	16.3	766	1957	4,192	16.9	710
1955	3,967	16.0	633	1958	4,292	16.7	716

SMELTER PRODUCTION

Primary.—Domestic smelters produced 25 percent less primary antimony in 1958. Sharply curtailed metal output was attributed to declining Government acquisitions. Decreases in output of oxide, sulfide, and byproduct antimonial lead were less significant. Foreign antimony ores and concentrates supplied 50 percent of the source material from which domestic smelter production was derived. Approximately 45 percent of the total smelter output was byproduct metal, oxide, and antimonial lead derived from refining intermediate smelter products derived from both foreign and domestic concentrates. The portion of byproduct antimony that originated in domestic ores is estimated at 1,650 tons, or 19 percent of the total domestic primary smelter output. The remaining 5 percent of the total smelter output was derived from domestically mined antimony concentrates.

Companies that reported primary antimony production in 1958 were American Smelting & Refining Co., Foote Mineral Co., Harshaw Chemical Co., Hummel Chemical Co., McGean Chemical Co., National Lead Co., and Sunshine Mining Co.

Secondary.—Secondary antimony recovered in 1958 totaled 19,500 short tons, valued at $12.4 million compared with 22,600 tons, valued at $15.8 million recovered in 1957. All secondary antimony was recovered from lead and tin alloys and was produced as an element of lead and tin alloys, largely by secondary smelters.

Smelters recovered 10,800 tons of antimony from battery-plate scrap, chiefly in production of antimonial lead. From type-metal scrap, 3,500 tons of antimony was recovered, from drosses 2,700 tons, from bearing metals 1,300 tons, and from antimonial-lead scrap 1,000 tons.

In addition to scrap, secondary lead smelters consumed 1,600 tons of primary metallic antimony in making lead and tin alloys. No secondary metallic antimony was made in the United States in 1958.

However, antimony was removed from battery-plate scrap as a dross high in antimony oxide, and was then added in that form to antimonial-lead blast-furnace charges.

TABLE 3.—Antimony recovered from scrap processed in the United States, by kind of scrap and form of recovery, in short tons

Kind of scrap	1957	1958	Form of recovery	1957	1958
New scrap:					
Lead-base	2,531	2,631	In antimonial lead [1]	15,722	11,997
Tin-base	50	44	In other lead alloys	6,808	7,490
Total	2,581	2,675	In tin-base alloys	35	28
Old scrap:			Grand total	22,565	19,515
Lead-base	19,933	16,794	Value (millions)	$15.8	$12.4
Tin-base	51	46			
Total	19,984	16,840			
Grand total	22,565	19,515			

[1] Includes 1,149 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1957 and 1,307 tons in 1958.

TABLE 4.—Smelter production of primary antimony in the United States, in short tons, antimony content

Year	Class of material produced					Total
	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	
1949-53 (average)	2,914	6,027	90	578	2,477	12,086
1954	2,178	4,925	124	[1] 824	1,956	[1] 10,007
1955	2,138	5,390	92	[1] 762	2,032	[1] 10,414
1956	4,291	4,731	129	[1] 639	2,065	[1] 11,855
1957	4,658	4,210	107	[1] 510	[1] 1,915	[1] 11,400
1958	2,833	3,825	84	319	1,496	8,557

[1] Revised figures.

TABLE 5.—Antimony metal, alloys, and compounds produced in the United States, 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) [4]
		Gross weight	Antimony content					
			From domestic ores [2]	From foreign ores [3]	From scrap	Total		
						Quantity	Percent	
1949-53 (average)	12,086	57,840	1,805	672	1,770	4,247	7.4	21,863
1954	[1] 10,007	59,873	1,299	657	1,563	3,521	5.9	22,358
1955	[1] 10,414	64,044	1,307	725	1,523	3,555	5.6	23,702
1956	[1] 11,855	66,826	1,320	745	1,283	3,348	5.0	24,106
1957	[1] 11,400	67,786	1,300	615	1,149	3,064	4.5	22,565
1958	8,557	50,246	811	685	1,307	2,803	5.6	19,515

[1] Revised figures.
[2] Includes primary residues and small amount of antimony ore.
[3] Includes foreign base bullion and small quantities of foreign antimony ore.
[4] Includes antimony content of antimonial lead produced at lead refineries from scrap.

CONSUMPTION AND USES

Industrial consumption of primary antimony dropped 4 percent in 1958 to 11,900 tons—the lowest quantity recorded since 1949. The decline was confined to metallic products such as battery grids and antifriction bearings. Quantities of primary antimony used in chemical preparations such as paints, ceramic glazes, plastics, and pyrotechnics remained practically unchanged in 1958.

TABLE 6.—Industrial consumption of primary antimony in the United States, in short tons, antimony content

Year	Class of material consumed						Total
	Ore and concentrates	Metal	Oxide	Sulfide	Residues	Byproduct antimonial lead	
1949-53 (average)	2,484	6,152	6,446	138	578	2,477	18,275
1954	768	[1] 5,380	5,885	94	824	1,956	[2] 14,907
1955	491	[1] 5,407	7,051	127	762	2,032	[2] 15,870
1956	1,149	[1] 5,198	6,843	112	639	2,065	[2] 16,006
1957	677	[1] 4,055	5,129	103	[2] 510	[2] 1,915	[2] 12,389
1958	515	4,179	5,283	88	319	1,496	11,880

[1] Revised; includes antimony in imported alloys.
[2] Revised figures.

TABLE 7.—Industrial consumption of primary antimony in the United States, by class of material produced, in short tons, antimony content [1]

Product	1949-53 (average)	1954	1955	1956	1957	1958
Metal products:						
Ammunition	5	5	5	14	12	(2)
Antimonial lead [3]	8,085	5,456	5,234	5,494	4,233	3,698
Bearing metal and bearings	1,164	816	831	1,077	944	644
Cable covering	88	156	146	190	183	208
Castings	83	70	67	57	106	82
Collapsible tubes and foil	29	47	24	12	20	37
Sheet and pipe	205	238	157	300	258	273
Solder	157	148	131	144	90	100
Type metal [3]	1,267	998	1,281	1,050	607	877
Other	150	118	161	137	153	147
Total [3]	11,233	8,052	8,037	8,475	6,606	6,066
Nonmetal products:						
Ammunition primers	18	22	20	13	14	10
Fireworks	21	27	32	37	37	33
Flameproofing chemicals and compounds	1,593	1,266	1,218	1,082	760	758
Ceramics and glass	1,755	1,469	2,048	2,188	1,611	1,570
Matches	31	15	17	18	26	18
Pigments	1,146	1,418	1,283	1,471	1,085	1,047
Plastics	635	620	767	976	748	841
Rubber products	53	49	78	156	284	265
Other	1,790	1,969	2,370	1,590	1,218	1,272
Total	7,042	6,855	7,833	7,531	5,783	5,814
Grand total [3]	18,275	14,907	15,870	16,006	12,389	11,880

[1] In 1957, consumption components were reclassified and previous years' figures have been revised to make all quantities of the table directly comparable.
[2] Included in "Other" to avoid disclosing individual company confidential data.
[3] Revised to include antimony content of imported antimonial lead consumed.

STOCKS

Industry stocks remained essentially unchanged in 1958. During the year, a considerable decline in oxide stocks and lesser declines in metal, sulfide, and residue stocks were nearly offset by increases in stocks of concentrates and primary antimonial lead.

TABLE 8.—Industry stocks of primary antimony in the United States at end of year, in short tons, antimony content

	1954	1955	1956	1957	1958
Ores and concentrates	2,421	3,568	2,474	2,337	3,052
Metal	1,577	1,267	2,236	1,300	1,232
Oxide	2,751	3,234	2,638	2,510	1,889
Sulfide	135	94	159	160	143
Residues and slags	522	445	598	746	565
Antimonial lead [1] [2]	499	307	314	329	371
Total [2]	7,905	8,915	8,419	7,382	7,252

[1] Inventories from primary sources at primary lead smelters only.
[2] Revised figures.

PRICES

On February 14 the quoted price of RMM brand antimony metal was reduced from 33.00 cents to 29.00 cents per pound, in bulk, f.o.b., Laredo, Tex. and remained at the lower price throughout the rest of the year. On the same date prices of foreign metal were reduced 2 cents per pound to a range of 23 to 25 cents, duty-paid delivery in New York. Toward the end of the year, foreign prices increased ½ to 1 cent per pound for several purity classes. Quoted prices for oxide and ore remained virtually unchanged.

TABLE 9.—Antimony price ranges in 1958

Type of antimony:		*Price*
Domestic metal [1]	cents per pound	29.00–33.00
Foreign metal [2]	do	23.00–26.00
Antimony oxide [3]	do	24.00–26.00
Antimony ore,[3] 50–55 percent	dollars per short-ton unit	2.25– 2.40
Antimony ore, minimum 60 percent	do	2.40– 2.60
Antimony ore, minimum 65 percent	do	3.00– 3.20

[1] RMM brand, f.o.b., Laredo, Tex.
[2] Duty-paid delivery, New York.
[3] Quoted in E&MJ Metal and Mineral Market.

FOREIGN TRADE [3]

Imports of antimony fell 24 percent in 1958 to 11,600 tons for all categories of antimonial materials. Approximately 12,300 tons of imported ores and concentrates supplied one-half the total source material that entered domestic primary antimony production in 1958. Imports of metal, oxide, and antimonial lead, as well as 515 tons of concentrates, were consumed directly in industry. The United Kingdom and Yugoslavia were the larger contributors of metal, supplying 45 and 30 percent, respectively. Mexico supplied 38 percent of the

[3] Based on company reports to the Bureau of Mines.

ores and concentrates; Union of South Africa supplied 26 percent, and Bolivia 22 percent. Shipments were also received from the United Kingdom, Turkey, and Guatemala.

Exports of antimony in 1958, as in prior years, were nominal.

Tariff on antimony and antimonial products remained unchanged in 1958. Ores and concentrates were admitted duty free. Metal was dutiable at 2 cents per pound and oxide at 1 cent.

TABLE 10.—Antimony imported by the United States in 1958

Country	Antimony ore			Needle or liquated antimony		Antimony metal		Antimony oxide	
	Short tons (gross weight)	Antimony content: Short tons	Antimony content: Value (thousands)	Short tons (gross weight)	Value (thousands)	Short tons	Value (thousands)	Short tons (gross weight)	Value (thousands)
North America:									
Guatemala	71	46	$11						
Mexico	7,057	1,983	297			307	$197		
Total	7,128	2,029	308			307	197		
South America: Bolivia	1,800	1,154	211						
Europe:									
Belgium				2	$1	637	264	140	$57
France						167	60		
Germany								150	49
Italy						33	12		
Netherlands								35	14
Turkey	466	250	83						
United Kingdom	608	405	269	15	6	2,117	895	958	379
Yugoslavia						1,411	601		
Total	1,074	655	352	17	7	4,365	1,832	1,283	499
Africa: Union of South Africa	2,260	1,347	306						
Grand total	12,262	5,185	1,177	17	7	4,672	2,029	1,283	499

WORLD REVIEW

Bolivia.—According to the Bolivian Department of Statistics, concentrates containing 5,820 short tons of antimony valued at $1¼ million were exported in 1958. United States and Argentina were the only recipients. Output of antimony was totally confined to the privately owned mines.

Mexico.—Production and exports of antimony ores and concentrates in Mexico declined markedly, reflecting the decreased demand for metal in the United States. Excepting a small shipment of refined antimony to West Germany, all Mexican exports of antimony ore, concentrate, and metal were shipped to the United States. Mines in Oaxaca and San Luis Potosi supplied the ore, and the refinery at Monterrey produced the metal.

TABLE 11.—World production of antimony (content of ore except as indicated), by countries,[1] in short tons[2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Canada [3]	1,132	651	1,011	1,070	680	463
Guatemala					15	
Mexico [4]	6,099	4,610	4,209	5,022	5,732	3,028
United States	2,027	766	633	630	709	705
Total	9,258	6,027	5,853	6,722	7,136	4,196
South America:						
Argentina	[5] 45	13	7	2	2	
Bolivia (exports) [4]	10,243	5,751	5,907	5,635	7,026	5,818
Peru [4]	947	933	960	1,068	920	872
Total	11,235	6,697	6,874	6,705	7,948	6,690
Europe:						
Austria	511	429	493	489	430	514
Czechoslovakia [5]	1,940	1,800	1,800	1,800	1,800	1,800
France	470		90	251		
Greece	408	[5] 60				
Italy	650	326	402	314	138	130
Portugal	43	10			11	([6])
Spain	246	120	210	250	220	240
Yugoslavia (metal)	1,637	1,711	1,769	1,767	1,950	1,835
Total [1] [5]	6,200	4,600	4,900	4,900	4,600	4,600
Asia:						
Burma [4]	110	55	65	90	70	90
China [5]	7,700	12,000	13,000	14,300	15,400	16,500
Iran [7]	200	50	63	44	([6])	([6])
Japan	243	291	357	619	474	320
Thailand	117	78	28	41	2	
Turkey	1,498	1,080	1,841	1,063	1,232	[8] 1,687
Total [5]	9,900	13,600	15,400	16,200	17,200	18,700
Africa:						
Algeria	1,552	2,845	1,328	2,370	1,547	1,106
Morocco:						
Northern Zone	262	330	397	330	360	203
Southern Zone	771	434	327			
Rhodesia and Nyasaland, Fed. of: Southern Rhodesia	55	72	223	72	83	151
Union of South Africa	8,503	9,528	15,640	15,689	11,021	7,904
Total	11,143	13,209	17,915	18,461	13,011	9,364
Oceania:						
Australia	290	131	344	322	543	[5] 770
New Zealand	4					
Total	294	131	344	322	543	[5] 770
World total (estimate) [1]	48,000	44,000	51,000	53,000	50,000	44,000

[1] 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.
[2] This table incorporates a number of revisions of data published in previous Antimony chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Antimony content of smelter products exclusively from mixed ores.
[4] Includes antimony content of smelter products derived from mixed ores.
[5] Estimate.
[6] Data not available; estimate by author of chapter included in total.
[7] Year ended March 20 of year following that stated.
[8] Exports.

Union of South Africa.—Consolidated Murchison (Transvaal) Goldfields & Development Co., Ltd., South Africa's sole antimony producer, curtailed exploration and development because of reduced demand for antimony. The company reported that development of antimony ore in the Gravelotte section was several years ahead of mill requirements and that stocks of concentrate were sufficient to fulfill any anticipated improvement in the market. During the year 14,545 tons of concentrate containing 61.47 percent antimony was exported.

United Kingdom.—Imports of antimony ores and concentrates in 1958 totaled 12,650 tons. Exports of the metal from the United Kingdom dropped considerably. The United Kingdom consumed 5,300 tons of primary antimony in 1958, including 1,350 tons in battery grids, 400 tons in antifriction bearings, and 1,500 tons in white oxide pigment. On April 1, the House of Commons imposed a duty of 25 percent ad valorem or £40 per ton, whichever is greater, on foreign antimony. The domestic industry had previously petitioned the Board of Trade to consider a more protective tax owing to excessive competition from low-priced foreign antimony, particularly Chinese metal.

Yugoslavia.—Approximately 82,000 tons of antimony ore was mined in a belt running eastward from Zajaca to Bujonovac in southern Serbia. Three-fourths of the Yugoslavian production in 1958 entered the United States as refined metal.

TECHNOLOGY

Consolidated Mining & Smelting Co. of Canada, Ltd., announced the production of indium antimonide for the electronics industry. Reported impurity tolerance of this semiconductor material is of the order of 1 part in 100 million.[4] Extremely high electron mobility and attendant Hall effect of InSb make it a valued material for components of electronic control circuits.

Phase relations of the system antimony-zirconium were published.[5] The dilute alloys of zirconium, such as those having zero to 5 atomic percent antimony, have somewhat better corrosion resistant properties than pure zirconium.

The Bureau of Mines continued research aimed at finding more economic methods of treating base-metal ores containing near-economic quantities of antimony. Laboratory-scale pressure leaching of tetrahedrite concentrates to remove copper was followed by chlorination of the antimonial residue and reduction of the volatile chloride to metal. Technologic and economic evaluations of the results are yet to be made.

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[4] Consolidated Mining & Smelting Co. of Canada, Trail, British Columbia, Cominco Magazine, April 1959, pp. 2–5.

[5] Betterton, J. O., Jr., and Spicer, W. M., The Antimony-Zirconium System, Trans. Metallurgical Soc. of AIME, August 1958, vol. 212, No. 4, pp. 456–457.

Arsenic

By A. D. McMahon [1] and Gertrude N. Greenspoon [2]

PRODUCTION of white arsenic in the United States in 1958 totaled 11,500 tons compared with 10,500 tons in 1957. Shipments dropped 15 percent to the lowest point since 1952. Ship- for consumption fell 6 percent, and the total available for domestic consumption was 11 percent less than in 1957.

TABLE 1.—Salient statistics of white arsenic, 1949–53 (average) and 1954–58, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production	13,761	13,167	10,780	12,201	10,493	11,508
Shipments	12,484	11,523	11,673	18,876	12,785	10,931
Imports	8,638	4,848	7,222	6,422	10,135	9,524
Producers' stocks at end of year	7,344	12,464	11,571	4,827	2,535	3,112
Apparent consumption [1]	21,122	16,371	18,895	25,298	22,920	20,455
Price [2] cents per pound	6	5½	5½	5½	5½	5½
World: Production	49,000	38,000	46,000	47,000	[3] 43,000	40,000

[1] Producers' shipments, plus imports, minus exports; no exports were reported by producers, 1949–58.
[2] Refined white arsenic, carlots, as quoted by E&MJ Metal and Mineral Markets.
[3] Revised figure.

DOMESTIC PRODUCTION

Domestic white arsenic output advanced 10 percent in 1958. As in 1957 the entire production was a byproduct of smelting complex copper and lead ores at 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). There was no output of arsenic metal in 1958.

TABLE 2.—Production and shipments of white arsenic by United States producers, 1949–53 (average) and 1954–58

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
1949–53 (average)	13,014	11,713	$740,389	747	771	$64,629	13,761	12,484	$805,018
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
1958	11,121	10,544	421,777	387	387	37,884	11,508	10,931	459,661

[1] Excludes crude consumed in making refined.

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

CONSUMPTION AND USES

In 1958 most of the output of white arsenic was consumed in manufacturing lead and calcium arsenate insecticides. Apparent consumption of white arsenic totaled 20,500 tons, an 11-percent decrease from 1957.

Consumption of white arsenic varies with the severity of boll-weevil infestations of cotton in the southern cotton-producing States.

Arsenic compounds were also used in weedkillers, glass manufacture, cattle and sheep dips, dyestuffs, and wood preservatives.

TABLE 3.—Production of arsenical insecticides and consumption of arsenic wood preservatives in the United States, 1949–53 (average) and 1954–58, 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)
1949–53 (average)	11,020	11,715	730
1954	7,810	1,379	983
1955	7,388	1,885	1,067
1956	5,878	13,553	1,005
1957	5,960	9,739	1,068
1958	(3)	(3)	[4] 1,082

[1] Bureau of the Census, U.S. Department of Commerce.
[2] Forest Service, U.S. Department of Agriculture.
[3] Data not available.
[4] Preliminary figures.

STOCKS

Producers' stocks of white arsenic were 3,100 tons on December 31, 1958, an increase of 23 percent over those at the end of 1957. Year-end inventories of calcium arsenate and lead arsenate are not available.

PRICES

White arsenic was quoted at 5½ cents per pound (powdered, in barrels, carlots) throughout 1958. According to the Oil, Paint and Drug Reporter, calcium arsenate, in carlots, was quoted at 9–9½ cents per pound from the beginning of 1958 until mid-September. It was reduced slightly to 9–9¼ cents and remained there through the end of the year. The price for lead arsenate, carlots (3-pound bags), of 27½ cents per pound, unchanged for more than 5 years, was lowered to 26½ cents in early November. 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 (equivalent to 5.00 to 5.63 cents per pound) throughout 1958, and for arsenic metal, per long ton, £400 (50.00 cents per pound).

FOREIGN TRADE[3]

Imports.—White arsenic imported for consumption in 1958 totaled 9,500 short tons, 6 percent below the 1957 receipts. Mexico continued to be the principal supplier with 64 percent of the total imports. Sweden furnished 15 percent; France, 13 percent; and Canada, 8 percent.

Thirty-one tons of metallic arsenic was received in 1958, of which 15 tons came from Sweden, 11 tons from the United Kingdom, and 5 tons from Poland-Danzig. Imports of arsenic sulfide totaled 63 tons, of which 58 tons came from Belgium-Luxembourg and 5 tons from France. Of the 87 tons of imported sodium arsenate, 60 tons came from the United Kingdom, 17 tons from France, and 10 tons from West Germany.

TABLE 4.—White arsenic (As_2O_3 content) imported for consumption in the United States, 1949–53 (average) and 1954–58, by countries

[Bureau of the Census]

Country	1949-53 (average)		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	286	$27,507	592	$48,690	683	$43,048
Mexico	7,340	809,312	4,212	493,681	6,431	713,911
Total	7,626	836,819	4,804	542,371	7,114	756,959
South America: Peru	12	1,294				
Europe:						
France	515	60,887	44	2,597	75	5,880
Sweden	204	20,601			33	2,413
Other countries [1]	226	11,463				
Total	945	92,951	44	2,597	108	8,293
Asia: Japan	55	7,836				
Grand total	8,638	938,900	4,848	544,968	7,222	765,252

Country	1956		1957		1958	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	540	$49,387	1,508	$119,427	800	$63,353
Mexico	5,831	691,354	6,851	604,932	6,052	541,795
Total	6,371	740,741	8,359	724,359	6,852	605,148
South America: Peru						
Europe:						
France	12	927	981	34,770	1,201	49,532
Sweden	33	2,954	779	34,317	1,471	64,932
Other countries [1]	6	575	16	989		
Total	51	4,456	1,776	70,076	2,672	114,464
Asia: Japan						
Grand total	6,422	745,197	10,135	794,435	9,524	719,612

[1] Includes Belgium-Luxembourg, Germany, Poland-Danzig, Portugal, and the United Kingdom.

[3] Figures on imports and exports compiled by Mae D. 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.—No direct foreign sales of white arsenic were reported by U.S. producers. Exports of calcium arsenate were 637 tons, valued at $80,751, and were less than half those in 1957. Peru received 452; Nicaragua, 143; Canada, 31; and West Germany, 11 tons.

Exports of lead arsenate totaled 1,050 tons, valued at $412,411. Of the total, 947 tons went to Peru, 59 to Canada, 31 to Costa Rica, and the remainder (in lots of less than 5 tons each) to five 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 2.7 cents per pound at the beginning of 1958 and was lowered to 2.5 cents per pound on June 30, 1958. Compounds of arsenic not specified in the Tariff Act were subject to duty at 12½ percent of their foreign market value.

TABLE 5.—Arsenicals imported into and exported from the United States, by classes, 1949–53 (average) and 1954–58, in pounds

[Bureau of the Census]

Class	1949–53 (average)	1954	1955	1956	1957	1958
Imports for consumption:						
White arsenic (As_2O_3 content)	17,275,555	9,695,722	14,443,828	12,843,816	20,270,069	19,048,920
Metallic arsenic	121,052	117,085	228,960	88,666	136,745	61,660
Sulfide	71,893		93,717	84,894	42,094	126,354
Sheepdip	69,990	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	86,987	173,565	172,175	229,616	328,049	173,337
Paris green	25,979					
Exports:						
Calcium arsenate	4,551,648	1,975,894	1,885,582	628,020	2,779,954	1,274,000
Lead arsenate	617,022	709,752	1,080,498	2,563,176	1,216,158	2,099,960

WORLD REVIEW

Canada.—The Deloro Smelting & Refining Co., the only producer of white arsenic in Canada, recovered, 1,100 tons in 1958 from treating gold and silver-cobalt ores.

Southern Rhodesia.—At the Que Que roasting plant the average monthly output of crude white arsenic (80 percent As) was reported [4] to be 80 short tons. Arsenic was obtained as a byproduct of gold mining. Output in 1958, however, was 23 percent less than in 1957.

Sweden.—The entire output of white arsenic in Sweden was produced by the Boliden Mining Co., which continued to be the leading world producer. Exports in 1957 totaled 9,700 tons, of which 3,300 tons went to the Union of South Africa, 2,000 tons to the United Kingdom, and 1,000 tons to the United States.

[4] Bramson, Bernard A. (regional minerals officer), Annual Minerals Report—Federation of Rhodesia and Nyasaland: State Dept. Dispatch 128, Johannesburg, Union of South Africa, Oct. 28, 1958, 31 pp.

TABLE 6.—World production of white arsenic, by countries,[1] 1949–53 (average), and 1954–58, in short tons[2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	679	590	786	895	1,849	1,125
Mexico	6,657	2,675	3,256	2,913	5,075	3,411
United States	13,760	13,167	10,780	12,201	10,493	11,508
South America:						
Brazil	1,055	1,273	1,077	819	99	[3] 110
Peru	3	105	----------	28	22	[3] 22
Europe:						
Belgium (exports)	1,210	1,979	2,281	3,056	2,280	[3] 440
France	5,115	812	6,369	6,608	5,622	[3] 6,200
Germany, West (exports)	1,418	239	635	334	216	205
Greece	57	----------	42	45	11	[3] 11
Italy	1,506	1,243	1,166	1,173	1,087	[3] 1,100
Portugal	946	1,196	1,973	1,109	898	[3] 880
Spain	175	22	----------	----------	----------	----------
Sweden	12,813	10,762	13,803	13,437	11,130	[3] 11,000
Asia:						
Iran	[4] 23	----------	----------	----------	----------	----------
Japan	1,661	1,584	1,910	1,833	1,521	[3] 1,540
Africa:						
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	271	459	508	1,084	883	683
Oceania:						
Australia	147	----------	----------	----------	----------	----------
New Zealand	7	----------	----------	----------	----------	----------
World total (estimate)[1] [2]	49,000	38,000	46,000	47,000	43,000	40,000

[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 United Kingdom.
[2] This table incorporates a number of revisions of data published in previous Arsenic chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Years ended March 20 of years following those stated.

TECHNOLOGY

The development of crystal rectifiers from arsenic-tellurium alloys was reported.[5] The new rectifiers were said to be less costly to manufacture than other rectifiers, and could withstand exceptionally high voltages and currents.

A study[6] of arsenical compounds showed that three organic arsenicals indicated considerable bactericidal or fungicidal activity in controlling slime formation in the pulp and paper industry.

[5] Chemistry, Arsenic Tellurium Alloys: Vol. 32, No. 3, November 1958, p. 14.
[6] Zabel, Robert A., and O'Neil, Frederic W., The Toxicity of Arsenical Compounds to Microorganisms: TAPPI, vol. 40, No. 11, November 1957, pp. 911—914.

Asbestos

By D. O. Kennedy[1] and James M. Foley[2]

THE UNITED STATES continued to be the leading consumer of asbestos in 1958 but ranked fifth in world production after Canada, U.S.S.R., Union of South Africa, and Southern Rhodesia. Domestic output was 2 percent of world production and supplied 6 percent of United States requirements.

TABLE 1.—Salient statistics of the asbestos industry

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Production (sales)...short tons..	49,157	47,621	44,568	41,312	43,653	43,979
Value (thousand dollars).......	3,804	4,698	4,487	4,742	4,918	5,127
Imports (unmanufactured) short tons..	675,682	678,390	740,423	689,910	682,732	644,331
Value (thousand dollars).......	52,221	[1] 55,857	[1] 60,958	[1] 61,939	[1 2] 60,104	[1] 58,314
Exports (unmanufactured) [3] short tons..	14,252	1,894	2,787	2,950	2,893	3,026
Value (thousand dollars).......	3,032	291	268	375	350	424
Apparent consumption short tons..	710,587	724,117	782,204	728,272	723,492	685,284
Exports of asbestos products (thousand dollars) [3]...........	11,158	11,485	12,859	14,181	15,223	13,233
World: Production......short tons..	1,445,000	1,670,000	1,950,000	1,980,000	2,070,000	2,020,000

[1] Owing to changes in tabulating procedures by the U.S. Department of Commerce, data known to be not strictly comparable with earlier years.
[2] Revised figure.
[3] Includes material that has been imported and subsequently exported without change.

LEGISLATION AND GOVERNMENT PROGRAMS

Government purchases of Arizona fiber, crudes Nos. 1, 2, and 3, under Public Law 733, continued until December 31, 1958, the termination date of Public Law 733. Funds were made available in the United States Department of Interior Appropriation Bill for 1959 for purchases from July 1, 1958, to the end of the year. Virtually all the longer fibers (crudes Nos. 1, 2, and 3) produced were sold to the Government.

DOMESTIC PRODUCTION

Asbestos production in the United States increased less than 1 percent in 1958 compared with 1957. Although no figures are available

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Supervisory statistical assistant.

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on quantity of ore mined, it has been estimated that the 44,000 tons of fiber sold was recovered from 1 million tons of rock mined.

The Vermont Asbestos Mines Division of the Ruberoid Co. at Belvedere Mountain near Hyde Park, Vt., was the one large asbestos producer in the United States. A small percentage of spinning fiber was produced, which was used in electrolytic cells rather than in textiles.

The following firms and individuals produced chrysotile in the Globe district of Arizona in 1958: American Fiber Corp., Arizona Asbestos, Inc., Jaquays Mining Corp., Kyle Asbestos Mines of Arizona, Metate Asbestos Corp., Moore and Phillips, Phillips Asbestos Mines, Reynolds Falls Asbestos, Inc., and Vesta Asbestos Corp.

The Jaquays Mining Corp. and the Metate Asbestos Corp. began constructing new asbestos mills at Globe—a 30-ton-per-day and a 15-ton-per-day crude ore capacity, respectively. Each mill was reported to have modern equipment of the type used in Canadian mills to separate the fibers of grades 4 through 7.

A small output of short-fiber chrysotile was reported by the Tabor Mining Co., from the Phoenix mine, Napa County, Calif. Amphibole asbestos was produced in small quantities by Huntley Industrial Minerals, Inc., at Lone Pine, Inyo County, Calif., and by Powhatan Mining Co., Transylvania County, N.C.

The Jefferson Lake Sulfur Co. began a diamond-drilling campaign to explore the asbestos deposits of the American Asbestos Mining Corp. in Calaveras County, Calif.[3]

The Bureau of Mines did some exploratory drilling in Northern California to encourage development by private enterprise.

CONSUMPTION AND USES

Consumption of chrysotile asbestos in the United States decreased from 685,000 tons in 1957 to 643,000 tons in 1958. Over 96 percent of the chrysotile consumed was short fiber of less than spinning length and was used in large part by the construction industry. Increases in the number of operating mines in Canada, from which most of this fiber came, indicated that the decline in consumption was the result of decreased demand by the construction industry, not of a shortage in supply. Less than 7 percent of the chrysotile consumed was supplied by domestic mines, which were unaffected by the decrease in demand, as a large percentage of the domestic production came from captive mines.

Consumption of crocidolite, represented by imports, continued to increase through 1958. From 1953 to 1958 the consumption of crocidolite was as follows: 8,000, 11,000, 15,000, 19,000, 24,000, and 26,000 tons, respectively. Most of the crocidolite was used in making asbestos cement pipe, an industry that has expanded rapidly in recent years.

[3] Wall Street Journal, Jefferson Lake Sulphur to Develop Asbestos Deposits: Vol. 153, No. 31, Feb. 13, 1959, p. 15.

PRICES

The 1957 prices of asbestos in Canada remained unchanged during 1958 and were as follows:

Grade:	*Price per ton*
Crude No. 1	$1,520–$1,900
Crude No. 2—Crude run-of-mine and sundry	810– 1,230
No. 3—Spinning fiber	380– 670
No. 4—Shingle fiber	185– 250
No. 5—Paper fiber	125– 155
No. 6—Plaster fiber	89
No. 7—Shorts	40– 80

Prices of British Columbia chrysotile asbestos, quoted in the E&MJ Metal and Mineral Markets reports, were unchanged in 1958 as follows: Per short ton f.o.b. Vancouver, British Columbia, effective October 1, 1957, crude No. 1 $1,568, AAA $811, AA $703, A $509, AC $335, AK $227. 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.

The prices of Vermont asbestos rose in December 1957 and remained there during the first 7 months of 1958. Prices were decreased in August 1958 per short ton, f.o.b. Hyde Park or Morrisville as follows:

Group 3 (spinning and filtering)	$370–$428
Group 4 (shingle)	181– 200
Group 5 (paper)	120– 152
Group 6 (plaster)	86
Group 7 (shorts)	41– 75

The 1957 Arizona prices remained unchanged during 1958 as follows:

	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
Filter Fibre (soft)	250– 475
No. 1 crude (semisoft)	1,200– 1,500
No. 2 crude (semisoft)	900
No. 3 crude (semisoft)	400

The 1957 increases in prices were not paid by the Government during 1958 for stockpile grades, because prices were fixed by law at those of January 1956.

Market quotations are not 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 values per short ton for imports in 1957 and 1958:

	1957	*1958*
Imports:		
Amosite	$145.56	$150.44
Crocidolite:		
Bolivia	75.61	70.00
Australia	230.59	213.57
Union of South Africa	197.12	192.45

FOREIGN TRADE [4]

Imports.—During 1958 imports of amosite and crocidolite increased 18 and 5 percent, respectively, compared with 1957; however, imports of chrysotile decreased 7 percent resulting in a net decrease of 6 percent in total imports of asbestos in 1958. Almost the entire quantity of chrysotile fiber imported (94 percent) was short fiber of less than spinning length. Imports of low-iron chrysotile of spinning length from British Columbia decreased from 5,764 tons in 1957 to 4,779 tons in 1958.

Imports from Bolivia and Australia consisted solely of crocidolite. The Union of South Africa supplied crocidolite and chrysotile and was the only source of amosite. Only chrysotile asbestos was imported from all other countries.

[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 2.—Asbestos (unmanufactured) imported for consumption in the United States, 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
1957								
North America: Canada	590	$239,627	136,505	$24,886,273	489,055	[1] $25,031,526	626,150	[1] $50,157,426
South America:								
Bolivia	28	2,117					28	2,117
Venezuela	17	5,672	2	475			19	6,147
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
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 [4]	34,721	5,998,997	315	60,233	406	54,723	35,442	6,113,953
Oceania: Australia	6,592	1,520,019					6,592	1,520,019
Total	55,460	[5] 9,841,896	137,331	[5] 25,079,399	489,941	[1, 5] 25,182,520	682,732	[1, 5] 60,103,815
1958								
North America: Canada	707	277,934	134,190	24,452,416	450,527	23,643,514	585,424	48,373,864
South America:								
Bolivia	11	770					11	770
Venezuela	6	824	17	2,160	25	3,870	48	6,854
Europe:								
Finland	7	313			55	1,500	62	1,813
Italy			2	2,940			2	2,940
Portugal	4	560			14	1,455	18	2,015
Yugoslavia	4,090	196,251					4,090	196,251
Asia: Japan					6	1,653	6	1,653
Africa:								
British East Africa			9	706	50	6,266	59	6,972
Rhodesia and Nyasaland, Federation of [3, 6]	7,178	1,221,092	660	132,035	294	42,470	8,132	1,395,597
Union of South Africa [4]	38,837	6,760,670	491	86,630	1,074	180,572	40,402	7,027,872
Oceania: Australia	6,077	1,297,860					6,077	1,297,860
Total	56,917	9,756,274	135,369	24,676,887	452,045	23,881,300	644,331	58,314,461

[1] Revised figure.
[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] Includes 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. 1958; 51 tons ($10,800) blue crocidolite, and 39 tons ($5,312) amosite crude credited by the Bureau of the Census to Mozambique; 1 ton ($405) amosite crude credited by the Bureau of the Census to West Germany; 880 tons ($125,723) blue crocidolite and 314 tons ($46,365) amosite crude credited by the Bureau of the Census to the Federation of Rhodesia and Nyasaland; 259 tons ($55,950) short fibers credited by the Bureau of the Census to the United Kingdom, and 42 tons ($5,475) credited to Mozambique.
[5] Data known to be not comparable with 1958.
[6] Includes 2 tons ($787) crysotile crudes credited by the Bureau of the Census to the United Kingdom, and 4 tons ($589) credited to Mozambique; 206 tons ($47,167) mill fibers credited by the Bureau of the Census to the United Kingdom.

TABLE 3.—Asbestos imported for consumption in the United States, from specified countries, by grades, in short tons

[Bureau of the Census]

Grade	1957			1958		
	Canada	Southern Rhodesia [1]	Union of South Africa	Canada	Southern Rhodesia [1]	Union of South Africa
Chrysotile, crudes:						
No. 1	44	[2] 255		56	[3] 418	20
No. 2	162	56		190	65	
Other	384	[2] 10,772	2,704	461	[3] 6,695	2,133
Blue crocidolite			[4] 17,820			[4] 19,690
Amosite			14,197			[4] 16,994
Spinning or textile	21,222	344	[4] 275	18,915	460	466
Shingle	67,833	87	40	68,890	200	25
Paper	47,450			46,385		
Short fibers	489,055	202	[4] 406	450,527	294	[4] 1,074
Total	626,150	11,716	35,442	585,424	8,132	40,402

[1] Reported by the Bureau of the Census as Federation of Rhodesia and Nyasaland. All believed to be from Southern Rhodesia.
[2] Revised figure.
[3] Includes countries adjusted by Bureau of Mines. See table 2, footnote 6, for explanation.
[4] Includes countries adjusted by Bureau of Mines. See table 2, footnote 4, for explanation.

Exports.—Exports of unmanufactured asbestos increased slightly in 1958. Compared with imports they are insignificant.

TABLE 4.—Exports (domestic [1] and foreign [2]) of asbestos and asbestos products from the United States, by kinds

[Bureau of the Census]

Products	1957 Quantity	1957 Value	1958 Quantity	1958 Value
Domestic:				
Unmanufactured:				
Crude and spinning fibers ---- short tons	333	$90,826	278	$85,979
Nonspinning fibers ---- do	334	60,918	514	88,907
Waste and refuse ---- do	2,108	188,179	2,145	232,143
Total unmanufactured ---- do	2,775	339,923	2,937	407,029
Products:				
Brake lining and blocks—Molded, semimolded and woven	(3)	5,117,533	(3)	4,612,458
Clutch facing and lining ---- number	1,350,181	1,044,234	1,340,622	1,091,636
Construction materials, n.e.c ---- short tons	17,489	4,034,530	[4] 13,961	[4] 2,758,785
Pipe covering and cement ---- do	3,522	1,091,419	3,054	1,032,879
Textiles, yarn, and packing ---- do	1,449	3,238,557	1,166	2,965,097
Manufactures, n.e.c	(5)	682,170	(5)	764,740
Total products	----	15,208,443	----	13,225,595
Foreign:				
Unmanufactured:				
Crude and spinning fibers ---- short tons	69	7,024	----	----
Nonspinning fibers ---- do	----	----	30	6,252
Waste and refuse ---- do	49	2,655	59	11,045
Total unmanufactured ---- do	118	9,679	89	17,297
Products:				
Brake lining and blocks—Molded, semimolded and woven	(3)	592	(3)	740
Construction materials, n.e.c ---- short tons	57	9,235	[4] 56	[4] 7,101
Pipe covering and cement ---- do	7	4,389	----	----
Total products	----	14,216	----	7,841

[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.
[3] Values have been summarized; quantities not shown.
[4] Not strictly comparable with earlier years.
[5] Quantity not recorded.

WORLD REVIEW

NORTH AMERICA

Canada.—Canadian output of asbestos decreased in 1958. During the year 22.4 million tons of rock was mined and 972,123 tons of fiber recovered from 13.1 million tons of ore milled.

TABLE 5.—World production of asbestos by countries,[1] in short tons[2]

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

Country[1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada (sales)[3]	852,803	924,116	1,063,802	1,014,249	1,046,086	925,331
United States (sold or used by producers)	49,157	47,621	44,568	41,312	43,653	43,979
Total	901,960	971,737	1,108,370	1,055,561	1,089,739	969,310
South America:						
Argentina	254	168	1,380	238	319	[4] 330
Bolivia (exports)	411	33		62	121	
Brazil	1,348	2,816	3,124	3,739	2,654	1,703
Chile	235					
Venezuela	266	743	1,757	5,041	8,390	9,152
Total	2,514	3,760	6,261	9,080	11,484	11,185
Europe:						
Bulgaria	[4] 440	1,213	1,323	1,102	[4] 1,100	[4] 1,100
Finland[5]	12,041	7,853	18,674	8,282	10,031	7,977
France	5,115	14,449	10,913	9,370	11,298	20,503
Greece	22	2	3	6	9	
Italy	23,726	26,217	35,385	36,459	37,797	39,627
Portugal	206	30	56	35	64	[4] 70
Spain	33	176				
U.S.S.R.[4]	250,000	375,000	450,000	500,000	500,000	550,000
Yugoslavia	2,170	3,598	4,305	4,165	6,128	5,960
Total[4]	295,000	430,000	520,000	560,000	565,000	625,000
Asia:						
China[4]	5,500	15,000	23,000	26,000	33,000	39,000
Cyprus	16,687	15,309	15,306	15,375	15,028	[6] 14,693
India	550	435	1,564	1,378	1,910	[4] 1,650
Iran[7]	12		110	[4] 165	[4] 165	[4] 165
Japan	5,320	6,916	6,932	9,914	13,330	11,179
Korea, Republic of		233	66	54	96	22
Taiwan	151	161	403	118	268	47
Turkey	127	50	259	634	99	[4] 70
Total[4]	28,000	38,000	48,000	54,000	64,000	67,000
Africa:						
Bechuanaland	224	1,011	1,426	1,356	1,582	1,734
Egypt	416				22	
Eritrea		55			55	28
Kenya	403	224	152	170	109	120
Madagascar	7					
Morocco: Southern zone	581	597	631	379	132	
Mozambique		196	301	202	152	[4] 110
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	80,280	79,962	105,261	118,973	132,124	127,115
Swaziland	33,294	30,142	32,613	29,875	30,727	25,261
Uganda		6	2	2		
Union of South Africa	98,871	109,151	119,699	136,520	157,474	175,366
Total	214,076	221,344	260,085	287,477	322,377	329,734
Oceania:						
Australia	3,326	5,279	5,993	10,874	16,430	[4] 16,000
New Zealand	344		172	368	230	[4] 220
Total	3,670	5,279	6,165	11,242	16,660	[4] 16,220
World total (estimate)[1] [2]	1,445,000	1,670,000	1,950,000	1,980,000	2,070,000	2,020,000

[1] In addition to countries listed, asbestos is produced in Czechoslovakia, North Korea, and Rumania; no estimates are included in the total as production is believed to be negligible.
[2] This table incorporates a number of revisions of data published in previous Asbestos chapters. Data do not add exactly to totals shown because of rounding, where estimated figures are included in the detail.
[3] Exclusive of sand, gravel and stone (waste rock only), production of which is reported as follows: 1949–53 (average)—35,568 tons; 1954—26,429 tons; 1955—28,582 tons; 1956—45,427 tons; 1957—13,652 tons; 1958—18,450.
[4] Estimate.
[5] Includes asbestos flour.
[6] Exports.
[7] Year ended March 20 of year following that stated.

TABLE 6.—Sales of asbestos in Canada, by grades

[Dominion Bureau of Statistics]

Grades	1957			1958		
	Short tons	Value		Short tons	Value	
		Total (thousands)	Average per ton		Total (thousands)	Average per ton
Crude No. 1, 2, and other	622	$615	$988	605	$617	$1,020
Milled group:						
3	34,320	14,820	432	24,900	10,852	436
4	259,268	47,815	184	215,670	40,717	189
5	110,428	13,726	124	101,992	13,025	128
6	159,098	12,747	80	138,747	11,325	82
7	460,539	18,816	41	427,665	18,208	43
8	21,811	434	20	15,752	324	21
Total, all grades	1,046,086	108,973	104	925,331	95,068	103
Waste rock	13,652	19	1	18,450	24	1

The formal dedication of the $36 million, Black Lake 100,000-ton-per-year operation of Lake Asbestos of Quebec, Ltd., a subsidiary of the American Smelting and Refining Co., took place in October. The 4-year project included diverting the Becancour River, building four dams, draining a 2½-mile lake, and constructing a $9.2-million, 14-story mill, operating on 11 floors.[5] It was expected that the plant would increase the free world production of asbestos 7 percent.[6] Several articles were written describing its development, mining, and milling facilities.[7]

Advocate Mines, Ltd., of Quebec, Johns-Manville, Patino, Ltd., of Canada, and two European firms signed an agreement to develop an asbestos prospect to which Advocate Mines, Ltd., held the mineral rights in northern Newfoundland. The estimated reserve of the chrysotile deposit was set at 23 million tons of asbestos rock, valued at $10 a ton.[8]

The Carey-Canadian Mines[9] and the National Gypsum Co. were reported to have started production at their new asbestos mills near Thetford Mines in the Eastern Township. A large part of the National Gypsum production from this mill was shipped to its materials plants in St. Louis, Mo., New Orleans, La., and Millington, N.J., for processing of shingles, corrugated panels and wallboard.[10]

Exploration was being conducted by Derogan Asbestos Corp. at Melbourne Township,[11] by Golden Age Mines in the Beauceville area

[5] Engineering and Mining Journal, ASARCO-Lake Asbestos Dedicate Black Lake Mine: Vol. 159, No. 11, November 1958, pp. 18, 19, 186.
Mining World, ASARCO Opens New Mine and Plant in Quebec: Vol. 20, No. 13, December 1958, pp. 32–34.

[6] Chemical Age, Metal Traders Become U. K. Sales Agents for Canadian Asbestos Producer: Vol. 79, No. 2015, Feb. 22, 1958, p. 362.

[7] Chemical and Engineering News, Asbestos From the Lake: Vol. 36, No. 43, Oct. 27, 1958, pp. 22–24.
Pit and Quarry, Lake Asbestos of Quebec Operations: Vol. 51, No. 6, December 1958, pp. 78–84.

[8] Northern Miner (Toronto), Johns-Manville, European Group Take Over Advocate Asbestos: Vol. 44, No. 28, Oct. 2, 1958, pp. 1, 16.

[9] Canadian Mining Journal, Carey-Canadian Mines: Vol. 79, No. 9, September 1958, p. 186.

[10] Northern Miner (Toronto), National Asbestos Starts Production at Thetford Mines: Vol. 44, No. 17, July 17, 1958, p. 17.

[11] Northern Miner (Toronto), Derogan Asbestos Resumes: Vol. 44, No. 22, Aug. 21, 1958, p. 2.

of Quebec,[12] and by Asbestos Crude and Fibre Mines in the Thetford Mines district.[13]

Development at Cassiar Asbestos in British Columbia extended the southern limit of the ore body. Three asbestos prospects were explored, but most work was concentrated in the Clinton Creek property, northwest of Dawson.[14]

EUROPE

Greece.—Kennecott Copper Corp. continued to explore and began to construct a small pilot plant at an asbestos deposit in Koganic Province, Western Macedonia.[15]

Ireland.—Emerald Isle Mining Co. was reported to have reopened the Mountain Mine at Allihies, where an asbestos vein was examined.[16]

United Kingdom.—Turner Brothers Asbestos Co., Ltd., began to produce asbestos textiles from the new south block at its Hindley Green Factory near Wigan.[17]

Five British companies with 13 factories were reported to be manufacturing asbestos-cement products in Britain.[18]

ASIA

China.—Szechwan Bureau of Geology was reported to have found a 20-million-ton deposit of asbestos in the Szechwan Province.[19] The growth of the asbestos industry in China was described. It was reported that in addition to chrysotile, crocidolite was produced in Honan Province and amosite in Shensi Province. Occurrences, mining, and milling methods and production statistics were included.[20]

India.—Asbestos deposits were reported in the Singbhum district.[21]

AFRICA

Rhodesia and Nyasaland, Federation of.—Increased production was reported following the waiver of royalties on grades 6 and 7 asbestos fiber by the Southern Rhodesia Government.[22]

Union of South Africa.—Increased reserves and the sinking of a vertical shaft in the amosite deposits were reported at the annual general meeting of the Cape Asbestos Co. New deposits of crocidolite were being explored.[23]

Two asbestos mines were reported to have been opened in the Pietersburg District of Northern Transvaal by W. & B. Asbestos Co., (Pty.) Ltd., and by Consolidated Asbestos.[24]

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[12] Northern Miner (Toronto), Golden Age to Build Asbestos Test Mill: Vol. 44, No. 19, July 31, 1958, p. 22.
[13] Northern Miner (Toronto), Asbestos Crude and Fibre to Resume Exploration: Vol. 44, No. 7, May 8, 1958, p. 20; vol. 44, No. 37, Dec. 4, 1958, p. 13.
[14] Northern Miner (Toronto), Cassiar's Year Shaping Into the Best Yet: Vol. 44, No. 18, July 24, 1958, pp. 1, 13.
[15] Mining World, Greece: Vol. 20, No. 5, May 1958, p. 88.
[16] Mining World, Eire: Vol. 20, No. 8, July 1958, p. 8.
[17] Quarry Managers' Journal (London), Asbestos Factory at Work: Vol. 41, No. 10, April 1958, p. 384.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 5, May 1958, p. 21.
[19] Mining World, China: Vol. 20, No. 10, September 1958, p. 118.
[20] Yi-ming, Sun, Characteristics of Chinese Asbestos and Its Production: Canadian Min. Jour., vol. 79, No. 12, December 1958, pp. 62–64.
[21] Indian Mining Journal (Calcutta), Asbestos: Vol. 5, No. 10, October 1957, p. 50.
[22] South African Mining and Engineering Journal, Asbestos: Vol. 69, No. 3394, Feb. 28, 1958, pp. 359, 361.
[23] Mining Journal (London), Asbestos in South Africa: Vol. 250, No. 6406, May 30, 1958, p. 638.
[24] Engineering and Mining Journal, vol. 159, No. 10, October 1958, p. 198.

TABLE 7.—Asbestos produced in Southern Rhodesia

Year	Short tons	Value (thousands)	Year	Short tons	Value (thousands)
1954	79,962	$16,635	1957	132,124	$25,185
1955	105,261	19,684	1958	127,115	24,147
1956	118,973	23,832			

TABLE 8.—Asbestos produced in the Union of South Africa, by varieties and sources, in short tons

Variety and source	1954	1955	1956	1957	1958
Amosite (Transvaal)	45,922	50,137	50,097	56,798	69,773
Chrysotile (Transvaal)	19,373	20,535	24,336	25,646	27,403
Blue (Transvaal)	15,610	13,964	14,399	15,303	16,670
Blue (Cape)	28,136	34,878	47,688	59,549	61,520
Anthophyllite (Transvaal)	110	185			
Tremolite (Transvaal)				178	278
Total	109,151	119,699	136,520	157,474	175,644

TABLE 9.—Asbestos produced in and exported from the Union of South Africa

Year	Production (short tons)			Exports	
	Transvaal	Cape Province	Total	Short tons	Value (thousands)
1954	81,015	28,136	109,151	94,322	$15,259
1955	84,821	34,878	119,699	114,056	18,625
1956	88,832	47,688	136,520	122,867	20,432
1957	97,925	59,549	157,474	142,799	25,278
1958	114,124	61,520	175,644	145,796	25,420

OCEANIA

Australia.—Australian Blue Asbestos, a subsidiary of Colonial Sugar Refinery Co., opened an $800,000 treatment plant in the Hamersley Ranges of Western Australia, with a capacity of 25,000 tons of fiber a year.[25]

TECHNOLOGY

Complex marketing problems faced the asbestos producers throughout the world as the supply of spinning fiber began to outstrip the demand for these long fibers. The demand for shorter fibers caused the industry to improve mining and milling techniques to such an extent that the extraction of short fibers was increased by over 40 percent. Canadian productive capacity has increased more rapidly than the demand for asbestos fibers.[26] Even in Southern Rhodesia the market for the lower grades was so great that the Southern Rhodesia Government waived royalties on the lower grades as an incentive to potential producers to meet competition in world markets.[27]

[25] Mining Journal (London), Asbestos in Australia: Vol. 251, No. 6414, July 25, 1958, p. 106.

[26] Mining Journal (London), The Canadian Asbestos Industry: Vol. 251, No. 6424, Oct. 3, 1958, pp. 360–362.

[27] The Annual Report of the Chief Government Mining Engineer and Chief Inspector of Mines for 1957, Mar. 6, 1958, p. 5.

The use of roof bolts as a means of preventing contamination of asbestos ore by wood splinters from mine timbers was discussed, and methods used in Canadian mines were described.[28]

A symposium of articles on asbestos presented over the last 10 years at annual meetings of the Canadian Institute of Mining and Metallurgy was published.[29] One article discussed the filterability of asbestos fibers used in wet processes. The manufacture of some products involves the use of asbestos in combination with water, cement, and granular fillers. Tests showed that fibers from different types of asbestos and from different deposits had considerable diversity in filtration characteristics. Soft, silky fibers were difficult to filter; semiharsh to harsh fibers filtered easily. Knowledge of the filtration characteristics of different fibers made it possible to obtain filtration results by blending fibers to fit the manufacturing process concerned. The role of asbestos in plastics was studied, and the author stressed the use of fiber of constant texture and quality so that the molder can set up a working plastic formula and not be forced to make repeated changes.

Asbestos in thermal insulation was discussed and compared with other insulating materials.[30] A master table summarizing the significant properties of each major type of insulation helped in evaluating each material.

The search for insulating materials for jet engines and missiles has led to the study of asbestiform minerals and synthetic fibrous materials. Fundamental research by one company led to the synthesis of a crystalline fibrous potasium titanate that showed promise as a versatile high temperature insulating material.

Unofficial reports from another research laboratory indicated other synthetic asbestiform materials were being investigated, and high hopes were expressed for successful results.

A laminate of an asbestos mat base impregnated with a special phenolic resin and of nylon fabric was reported to have withstood tests at 2,000° F. This material had promise of usefulness in missiles.

The use of woven asbestos, special bonding compounds, and wire reinforcement as bridge bearing pads was described.[31]

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[28] Sinclair, W. E., Roof Bolting in Asbestos Mines: South African Min. and Eng. Jour., vol. 69, Part 2, No. 3435, Dec. 12, 1959, pp. 1197, 1199, 1201, 1203.
[29] Badollet, M. S., Asbestos, A Symposium of Articles: The Quebec Asbestos Min. Assoc., 1958, 49 pp.
[30] Fabian, Robert J., Thermal Insulation Materials: Materials in Design Eng., vol. 47, No. 3, March 1958, pp. 119–138.
[31] Engineering News Record, Asbestos Bearing Pads Withstand High Loading: Vol. 161, No. 24, Dec. 11, 1958, p. 72.

Barite

By Albert E. Schreck [1] and James M. Foley [2]

BARITE production, consumption, and imports in 1958 declined substantially from the record levels established in 1956 and 1957. Antitrust charges were filed against two major barite producers, and the Tariff Commission ruled that barium chloride producers were not suffering injury as a result of increased imports of that compound.

TABLE 1.—Salient statistics of the barite and barium-chemical industries

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Primary barite:						
Mine or plant output short tons	840,629	926,036	1,114,117	1,351,913	1,304,542	486,287
Sold or used by producers:						
Short tons	831,886	883,283	1,108,103	1,299,888	1,152,882	605,402
Value	$7,607,570	$8,508,177	$10,809,119	$13,497,972	[1] $12,799,470	$7,509,797
Imports for consumption:						
Short tons	115,994	317,093	359,636	589,053	832,626	526,561
Value	$896,421	$2,274,834	$2,181,119	$3,601,504	$5,864,124	$3,733,423
Consumption short tons [2]	927,972	1,215,678	1,459,671	2,035,389	1,670,720	1,195,669
Ground and crushed sold by producers:						
Short tons	717,982	1,037,590	1,232,176	1,503,010	1,467,117	1,026,865
Value	$14,606,469	$24,219,785	$30,613,095	$41,623,390	$42,352,525	$28,351,885
Barium chemicals sold by producers:						
Short tons	79,532	86,193	105,171	106,739	89,757	75,372
Value	$10,134,060	$11,633,014	$14,490,048	$13,855,058	$12,253,526	$10,685,392
Lithopone sold or used by producers:						
Short tons	80,219	44,011	42,845	38,434	(3)	(3)
Value	$10,395,194	$5,929,789	$6,002,832	$5,630,991	(3)	(3)
World: Production short tons	1,850,000	2,300,000	2,700,000	3,100,000	3,500,000	2,500,000

1 Revised figure.
2 Includes some witherite.
3 Figure withheld to avoid disclosing individual company confidential data.

LEGISLATION AND GOVERNMENT PROGRAMS

The United States Tariff Commission, at the request of Barium Reduction Corp., conducted an investigation on barium chloride, under section 7 of the Trade Agreements Extension Act of 1951, as amended. The purpose was "to determine whether barium chloride, classifiable under paragraph 12 of the Tariff Act of 1930, is as a result in whole or in part of the duty or other customs treatment reflecting the concession granted thereon under the General Agreement on

1 Commodity specialist.
2 Supervisory statistical assistant.

Tariffs and Trade, being imported into the United States in such increased quantities, either actual or relative, as to cause or threaten serious injury to the domestic industry producing like or directly competitive products."[3]

A public hearing was held July 15, 1958. As a result of the hearing and other investigative work, the Commission found that imports were not causing or threatening serious injury to the domestic industry and that there was not sufficient reason for a recommendation for relief.[4]

Antitrust charges were filed against the Nation's two major barite producers, National Lead Co. and Magnet Cove Barium Corp., a subsidiary of Dresser Industries, by the Federal Trade Commission. Complaints issued in March of the year charged both firms with violation of Section 5 of the Federal Trade Commission Act (15 U.S.C., sec. 45) and Section 7 of the Clayton Act (15 U.S.C., sec. 18). Hearings on the complaint had not been held by the close of 1958.[5]

DOMESTIC PRODUCTION

Output of primary barite declined 63 percent compared with 1957 and was at its lowest level in 15 years. This drastic decline in production was due to a reduction in demand for finished barium products and accumulated stocks. As a result many mines were operated on a limited scale, and others reported no production—only shipments from stocks.

Arkansas remained the leading producing State with Missouri second, although production in both States was less than half their 1957 output. Production in Georgia and Nevada, in third and fourth place, was also below 1957 levels.

Crushed and ground barite production was about 400,000 tons less than in 1957, and production of barium chemicals and lithopone also declined.

The deposit of an active barite producer in Montana and 12 other deposits in the State were described in a publication.[6] A paper on the history and development of barite in Washington County, Mo., was presented at the St. Louis meeting of the AIME in October.[7] Production began soon after the Civil War, and the barite was used primarily in the paint and rubber industries. The transition from the early exploration and hand-mining operations to more advanced methods of mining and beneficiation is discussed.

The Sunshine Mining Co. received a contract from North Star Uranium, Inc., to explore and develop the latter's barite property on Queen of Sheba Mountain, near Colville, Stevens County, Wash.

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[3] Federal Register, vol. 23, No. 47, Mar. 7, 1958, pp. 1635, 1636.

[4] United States Tariff Commission, Barium Chloride: Report on Escape-Clause Investigation No. 68, Under the Provisions of Section 7 of the Trade Agreements Extension Act of 1951, as Amended; Washington, October 1958, 19 pp.

[5] Federal Trade Commission, Docket No. 7095, In the Matter of Dresser Industries, Inc., a Corporation, and Magnet Cove Barium Corporation, a Corporation: Mar. 26, 1958; Docket No. 7096, In the Matter of National Lead Company, a Corporation: Mar. 26, 1958.

[6] De Munck, Victor C., and Ackerman, Walter C., Barite Deposits in Montana: Montana Bureau of Mines and Geol., Inf. Circ. 22, April 1958, 30 pp.

[7] Sackett, E. L. H., Barite in Washington County, Mo., History and Development: Presented at St. Louis meeting, AIME, Oct. 24, 1958, 9 pp.

Lenses of barite as much as 25 feet in width and ranging from 67 to 90 percent $BaSO_4$ have been uncovered.

Barium Reduction Corp., South Charleston, W. Va., was acquired by Pittsburgh Plate Glass Co. in October 1958. Management and operation of the plant will be conducted by Columbia-Southern Chemical Corp., a subsidiary of Pittsburgh Plate Glass Co.

TABLE 2.—Domestic barite sold or used by producers in the United States

State	1949–53 (average)		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas	384, 584	$3, 534, 103	370, 621	[1] $3, 488, 483	462, 986	[1] $3, 755, 094
Georgia, South Carolina, Tennessee	78, 010	889, 467	75, 492	1, 062, 016	130, 396	1, 829, 141
Missouri	263, 273	2, 475, 579	312, 791	3, 047, 436	363, 692	4, 003, 842
Nevada	69, 794	415, 649	83, 833	517, 492	[1] 113, 694	[1] 708, 804
Other States [3]	36, 225	292, 772	40, 546	392, 750	37, 335	512, 238
Total	831, 886	7, 607, 570	883, 283	8, 508, 177	1, 108, 103	10, 809, 119

State	1956		1957		1958	
	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas	486, 254	[1] $4, 255, 982	477, 327	[1 2] $4, 536, 827	182, 779	$1, 668, 039
Georgia, South Carolina, Tennessee	174, 139	2, 946, 839	175, 072	2, 982, 195	108, 511	2, 284, 561
Missouri	381, 642	4, 461, 955	317, 350	3, 938, 486	199, 268	2, 666, 496
Nevada	178, 440	1, 066, 930	109, 663	720, 806	59, 407	405, 636
Other States [3]	79, 413	766, 266	73, 470	621, 156	55, 437	485, 065
Total	1, 299, 888	13, 497, 972	1, 152, 882	[2] 12, 799, 470	605, 402	7, 509, 797

[1] Partly estimated.
[2] Revised figure.
[3] Includes Arizona (1949–55), California, Idaho (1949–58), Montana (1951–58), New Mexico (1949–58), and Washington (1953–55, 1957–58).

TABLE 3.—Ground (and crushed) barite produced and sold by producers in the United States

Year	Plants	Production (short tons)	Sales: Short tons	Sales: Value (thousands)	Year	Plants	Production (short tons	Sales: Short tons	Sales: Value (thousands)
1949–53 (average)	25	719, 789	717, 982	$14, 606	1956	30	1, 625, 879	1, 503, 010	$41, 623
1954	29	1, 038, 649	1, 037, 590	24, 220	1957	33	1, 480, 585	1, 467, 117	42, 353
1955	29	1, 314, 810	1, 232, 176	30, 613	1958	34	1, 014, 133	1, 026, 865	28, 352

CONSUMPTION AND USES

The decline in consumption and sales of barite which began in 1957 continued throughout 1958. The quantity of domestic barite sold or used by producers declined 47 percent. The quantity of crude barite, both domestic and imported, used in manufacturing crushed and ground barite, lithopone, and barium chemicals declined 28 percent.

Crushed and ground barite manufacture comprised about 90 percent of crude barite consumption, and lithopone and barium chemicals made up the remainder.

Overall sales of crushed and ground barite declined 30 percent, mostly owing to reduced consumption by the oil- and gas-well drilling industry, in which barite is used as a drilling-mud constituent. Although this industry received 95 percent of the total ground barite sold, the tonnage was some 400,000 less than in 1957, which could be attributed to a 9-percent drop in the number of domestic wells and an 11-percent drop in footage drilled. Sales of crushed and ground barite to the glass, rubber, and paint industries were also below 1957 levels. Barium-chemical and lithopone sales followed the downward trend.

TABLE 4.—Crude barite (domestic and imported) used in the manufacture of ground barite and barium chemicals in the United States, in short tons

Year	In manufacture of—			Total
	Ground barite [1]	Lithopone	Barium chemicals [2]	
1949-53 (average)	727,955	78,363	121,654	927,972
1954	1,044,094	35,866	135,718	1,215,678
1955	1,256,361	45,898	157,412	1,459,671
1956	1,839,770	31,065	164,554	2,035,389
1957	1,501,415	(3)	169,305	1,670,720
1958	1,063,297	(3)	142,372	1,195,669

[1] Includes some crushed barite.
[2] Includes some witherite.
[3] Included with "Barium chemicals" to avoid disclosing individual company confidential data.

TABLE 5.—Ground (and crushed) barite sold by producers, by consuming industries

Industry	1949-53 (average)		1954		1955		1956		1957		1958	
	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	631,011	88	968,429	94	1,142,309	93	1,421,033	95	1,392,394	95	977,255	95
Glass	24,328	3	23,208	2	28,737	2	32,661	2	27,595	2	9,890	1
Paint	25,000	4	22,000	2	25,633	2	20,602	1	16,179	1	14,641	1
Rubber	17,400	2	20,000	2	25,104	2	22,101	2	21,782	1	18,387	2
Undistributed	20,243	3	3,953	(1)	10,393	1	6,613	(1)	9,167	1	6,692	1
Total	717,982	100	1,037,590	100	1,232,176	100	1,503,010	100	1,467,117	100	1,026,865	100

[1] Less than 1 percent.

TABLE 6.—Barium chemicals produced and used or sold by producers in the United States, 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]					
1949-53 (average)	12	128,299	127,371	595	$40,406
1954	11	116,246	112,863	1,020	73,902
1955	9	135,455	134,202	1,943	165,502
1956	10	131,006	129,969	6,356	524,359
1957	9	112,048	110,900	1,087	79,474
1958	8	93,539	81,861	1,351	126,050
Carbonate (synthetic):					
1949-53 (average)	4	55,532	17,878	37,581	3,082,071
1954	4	65,319	25,307	43,325	3,985,674
1955	4	78,946	27,273	53,274	5,021,001
1956	5	82,043	31,022	50,524	4,783,453
1957	6	74,160	31,056	42,937	4,335,469
1958	6	56,706	26,811	35,307	3,753,712
Chloride (100 percent $BaCl_2$):					
1949-53 (average)	4	13,937	3,454	10,378	1,363,238
1954	3	9,940	45	10,181	1,441,431
1955	3	11,852	120	11,601	1,689,252
1956	3	11,746	130	11,174	1,706,683
1957	3	9,715	----------	9,373	1,538,809
1958	4	8,527	----------	8,122	1,328,413
Hydroxide:					
1949-53 (average)	5	9,894	268	9,415	1,977,965
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
1958	4	9,892	68	10,093	1,853,900
Oxide:					
1949-53 (average)	3	9,538	6,188	3,398	800,224
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
1958	(5)	(5)	(5)	(5)	(5)
Sulfate (synthetic):					
1949-53 (average)	7	14,533	----------	14,239	1,507,329
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
1958	3	6,581	----------	6,628	844,940
Other barium chemicals: [6]					
1949-53 (average)	(7)	6,817	2,349	3,926	1,362,827
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
1958	(7)	18,549	3,213	13,871	2,778,377
Total: [8]					
1949-53 (average)	18	----------	----------	79,532	10,134,060
1954	17	----------	----------	86,193	11,633,014
1955	16	----------	----------	105,171	14,490,048
1956	17	----------	----------	106,739	13,855,058
1957	14	----------	----------	89,757	12,253,526
1958	13	----------	----------	75,372	10,685,392

[1] Of any barium chemical.
[2] Includes purchased material.
[3] Exclusive of purchased material and exclusive of sales by 1 producer to another.
[4] Black-ash data include lithopone plants.
[5] Included with "Other Barium chemicals" to avoid disclosing individual company confidential data.
[6] Includes barium acetate, oxide (1958 only), nitrate, peroxide, sulfide and other unspecified compounds. Specific chemical 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

The 1958 market prices of barite as quoted in E&MJ Metal and Mineral Markets were unchanged from 1957.

TABLE 7.—Quotations on barium chemicals in 1958

[Oil, Paint and Drug Reporter]

	Jan. 6	Dec. 29
Barium carbonate, precipitated, bags, carlots, works .... short tons	$111.50	Unchanged.
Smaller lots, works .... do	126.50	Do.
Barium chlorate, drums, works .... pound	.32-.41	Do.
Barium chloride, anhydrous, bags, carlots, works .... short tons	176.00	Do.
Less carlots, works .... do	196.00	Do.
Barium chromate, bags, freight equaled .... pound	.35	[1] $0.38.
Barium dioxide (peroxide), drums, freight equaled .... do	.20	Unchanged.
Barium hydrate, crystals, bags, carlots, ton lots, freight equaled .... short tons	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 tons	275.00	[2] $265.00.
Less carlots, less ton lots, freight equaled .... do	285.00	[2] $275.00.
Blanc fixe, direct process, bags, carlots, works .... do	115.00	[3] $145.00.
Less carlots, works .... do	125.00	[3] $155.00.
New York warehouse .... do	165.00	[3] $195.00.
Lithopone, ordinary, bags, carlots, delivered .... pound	.08⅜ E	[4] Unchanged.
Less carlots, delivered .... do	.09⅛ E	Do.
Titanated (high strength), bags, carlots, delivered .... do	.11	Do.
Less carlots, delivered .... do	.12	Do.

[1] Increase published Mar. 17, 1958.
[2] Decrease published Dec. 15, 1958.
[3] Increase published Oct. 6, 1958.
[4] E=East.

FOREIGN TRADE [8]

Imports of crude barite were some 300,000 tons less than in 1957. Mexico for the second consecutive year was the principal supplier, with Canada second and Peru third.

For the fourth consecutive year imports of ground barite increased. Mexico supplied almost 75 percent of the total. Canada, West Germany, Italy, and Algeria contributed the remainder.

Crude witherite imports, all from the United Kingdom, were less than in 1957; however, imports of crushed and ground witherite increased substantially. Of the 202 tons of crushed and ground witherite imported, 152 tons came from France and 50 tons from Belgium-Luxembourg.

Overall barium-chemical imports decreased, although imports of some compounds increased. More than half of the chemical imports were from West Germany. France, Netherlands, Belgium-Luxembourg, United Kingdom, Italy, and Switzerland, in descending order, supplied the remainder.

Canada and Cuba were the recipients of most of the decreased exports of lithopone. In addition, Salvador, Iceland, and Mexico received small tonnages.

[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 8.—Barite imported for consumption in the United States, by countries

[Bureau of the Census]

	1957		1958	
	Short tons	Value	Short tons	Value
Crude barite:				
North America:				
Canada	109,180	$745,394	114,299	$870,862
Cuba	33,172	305,992	7,467	65,467
Mexico	406,193	2,200,907	211,250	1,225,815
Total	548,545	3,252,293	333,016	2,162,144
South America: Peru	124,440	1,253,167	74,924	750,557
Europe:				
Greece	79,528	443,097	45,569	253,887
Italy	25,490	231,166	19,156	175,724
Yugoslavia	54,623	684,401	53,896	391,111
Total	159,641	1,358,664	118,621	820,722
Grand total	832,626	[1] 5,864,124	526,561	3,733,423
Ground barite:				
North America:				
Canada			10	658
Mexico	297	6,530	743	11,539
Total	297	6,530	753	12,197
Europe:				
Germany, West	53	1,618	128	4,326
Italy	73	2,473	107	3,691
Total	126	4,091	235	8,017
Africa: Algeria			22	1,120
Grand total	423	10,621	1,010	21,334

[1] Data known to be not comparable with other years.

TABLE 9.—Barium chemicals imported for consumption in the United States

[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
1949–53 (average)	410	$68,076	221	$14,334	200	$23,019	99	$21,068
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	[1] 120,080	113	18,905
1958	69	9,307	1,573	103,865	1,376	129,159	161	25,832

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Short tons	Value	Short tons	Value	Short tons	Value
1949–53 (average)	258	$41,653	1,160	$85,763	135	$33,974
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
1958	701	107,724	322	23,350	38	26,415

[1] Data known to be not comparable with other years.

TABLE 10.—Lithopone exported from the United States

[Bureau of the Census]

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1949-53 (average)	11,640	$1,799,950	$154.63	1956	1,387	$239,892	$172.96
1954	3,013	454,461	150.83	1957	991	177,891	179.51
1955	1,892	300,960	159.07	1958	613	122,462	199.77

TABLE 11.—Witherite, crude, unground, imported for consumption in the United States

[Bureau of the Census]

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1949-53 (average)	3,264	$105,854	1956 [2]	2,934	$110,039
1954	4,415	153,139	1957 [2]	3,029	138,494
1955	2,363	77,867	1958 [2]	2,240	108,119

[1] Valued at port of shipment.
[2] In addition, crushed or ground witherite was imported as follows: 1957, 8 tons ($533); 1958, 202 tons ($15,610). Class established June 1, 1956; no transactions.

TABLE 12.—World production of barite, by countries,[1] in short tons [2]

[Compiled by Liela S. Price and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	121, 131	221, 472	253, 736	320, 835	228, 048	201, 329
Cuba (exports)	981	----------	----------	----------	37, 842	9, 407
Mexico (exports)	16, 558	56, 871	117, 654	235, 792	429, 537	[3] 211, 000
United States	840, 629	926, 036	1, 114, 117	1, 351, 913	1, 304, 542	486, 287
Total	979, 299	1, 204, 379	1, 485, 507	1, 908, 540	1, 999, 969	908, 023
South America:						
Argentina	17, 065	25, 329	22, 481	19, 152	18, 679	[3] 18, 700
Brazil	7, 542	13, 402	3, 950	16, 197	55, 349	62, 655
Chile	1, 662	3, 546	3, 466	476	[3] 1, 100	[3] 1, 100
Colombia	3, 135	9, 921	6, 614	8, 378	6, 963	14, 330
Peru	12, 575	12, 348	9, 410	11, 601	95, 388	117, 802
Total	41, 979	64, 546	45, 921	55, 804	[3] 177, 500	[3] 214, 600
Europe:						
Austria	7, 739	4, 802	4, 365	3, 413	3, 902	4, 709
France	39, 872	52, 361	70, 507	60, 627	71, 650	[3] 72, 000
Germany:						
East [3]	2, 900	27, 600	27, 600	27, 600	27, 600	27, 600
West	[4] 318, 393	422, 589	456, 710	453, 836	448, 144	409, 105
Greece	25, 218	24, 249	21, 451	28, 843	143, 549	165, 347
Ireland	4, 597	3, 080	6, 232	7, 729	8, 624	11, 283
Italy	68, 584	81, 931	114, 635	103, 075	113, 083	102, 729
Poland	([5])	([5])	11, 574	12, 346	[3] 12, 400	[3] 12, 400
Portugal	487	385	357	346	853	[3] 770
Spain	13, 454	11, 740	9, 833	8, 505	20, 287	29, 586
Sweden	248	108	137	----------	----------	----------
U.S.S.R.[3]	107, 000	110, 000	110, 000	110, 000	110, 000	130, 000
United Kingdom [6]	98, 652	81, 967	92, 906	84, 670	87, 280	70, 825
Yugoslavia	45, 629	114, 640	109, 129	[3] 71, 000	103, 969	151, 016
Total [1] [3]	756, 000	940, 000	1, 040, 000	980, 000	1, 160, 000	1, 190, 000
Asia:						
India	14, 110	21, 048	8, 537	7, 072	14, 462	15, 481
Japan	15, 998	20, 815	20, 374	20, 578	27, 513	16, 403
Korea, Republic of	417	336	933	744	8	----------
Philippines	----------	----------	----------	5, 045	6, 367	[3] 5, 500
Turkey	----------	----------	----------	----------	2, 111	6, 035
Total [1] [3]	40, 900	53, 000	52, 000	61, 000	84, 000	76, 000
Africa:						
Algeria	19, 672	21, 341	33, 720	32, 843	37, 724	47, 415
Egypt	24	35	67	88	294	[3] 300
Morocco: Southern Zone	2, 565	10, 246	27, 170	32, 622	16, 276	47, 060
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	298	----------	----------	----------	----------	34
Swaziland	406	362	449	516	351	480
Tunisia	152	----------	----------	----------	----------	----------
Union of South Africa	2, 237	2, 342	1, 892	2, 713	3, 369	2, 721
Total	25, 354	34, 326	63, 298	68, 782	58, 014	98, 010
Oceania: Australia	6, 316	7, 696	7, 016	6, 730	10, 951	8, 201
World total (estimate)[1] [2]	1, 850, 000	2, 300, 000	2, 700, 000	3, 100, 000	3, 500, 000	2, 500, 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. Date do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Beginning in 1950, marketable production is shown.
[5] Data not available; no estimate included in the total.
[6] Includes witherite.

WORLD REVIEW

NORTH AMERICA

Canada.—Giant Mascot Mines began recovering barite from mill tailings at its worked-out lead mine at Spillimacheen, British Columbia. The tailings pond was estimated to contain about 700,000 tons of material averaging 49 percent barite.[9] Output was shipped to McPhail Engineering Co., Tacoma, Wash.

Magnet Cove Barium Corp. continued production from its Hants County (Nova Scotia) operation. Conversion from an open-pit to an underground operation continued. Levels were established at 350, 520, 690, and 850 feet from the new 1,000-foot, five-compartment shaft. The reserve underground was estimated at 1.8 million tons, and the ore will be mined by block caving.[10] A beneficiation plant was completed earlier in the year.[11]

Mexico.—Two firms comprised Mexico's barium chemical industry. Nitromex, S.A., manufactured barium compounds, such as the carbonate, chlorate, chloride, and nitrate, and Pigmentos de Mexico, S.A., manufactured lithopone.[12]

SOUTH AMERICA

Argentina.—Argentina's lithopone industry consisted of two firms with a total capacity of approximately 14,000 short tons. Production in 1955 and 1956 averaged about 10,500 short tons, of which approximately 80 percent was consumed in paint manufacture and the remainder by the rubber industry. A small tonnage of lithopone was exported to Brazil in 1956.[13]

EUROPE

Austria.—A deposit estimated to contain more than 100,000 tons of barite was discovered near Graz, Styria Province.[14] The deposit, in an old, inactive silver mine, was uncovered by geologists studying the formations in the mine. Mining was expected to begin after clarification of claims and titles.

ASIA

India.—Field work by the Geological Survey of India uncovered several promising barite deposits in the Anantapur and Cuddapah districts of Andhra Pradesh State. Three deposits in the area were estimated to contain 111,500 tons of barite. Barite also occurs in the Kurnool and Khammameth districts.[15]

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[9] Northern Miner, Giant Mascot Mines Barite Production Short of Objective. Vol. 44, No. 5, Jan. 29, 1959, p. 2.
[10] Northern Miner, vol. 44, No. 5, Apr. 24, 1958, pp. 17–18.
[11] Northern Miner, Magnet Cove Barium: Vol. 44, No. 31, Oct. 23, 1958, p. 22.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, p. 26.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 27.
[14] E&MJ Metal and Mineral Markets, vol. 29, No. 7, Feb. 13, 1958, p. 11.
[15] Indian Mining Journal, Barytes Deposits in Andhra Pradesh: Vol. 6, No. 11, November 1958, p. 17.

Philippines.—The Pan-Philippine Corp. produced barite at its mine near Municipality of Lobo, Batangas Province, Luzon Island. Output was consumed primarily by local well-drilling companies. The mine, originally operated for its copper values, began producing barite in 1956, when the low tenor of the copper in the ore made it impractical to recover it. Installation of a flotation mill was planned to recover the copper values in the ore.[16]

Turkey.—A recent article described the barite deposits of Türk Barit, Ltd., in Elo lu Township, Maraş Province.[17] The barite occurs as veins or lenses in quartzite. The deposits were estimated to contain 80,000 tons of recoverable ore. The article also describes the geology of the deposits and gives location and geologic maps.

Barite was first produced commercially in Turkey in 1957, reportedly by Portmetal Mining & Trading Co. from a deposit near Alanya.[18]

Another barite deposit, estimated to contain 7 million tons of ore, occurs near Biler in Muş Province.

RESERVES

Domestic barite resources were discussed in a bulletin issued by the Federal Geological Survey.[19] The measured plus indicated reserve was estimated at approximately 285 million tons of ore containing about 46 million tons of barite. The inferred reserve was estimated to exceed 365 million tons containing about 67 million tons of barite. The occurrence, geology, mining, beneficiation, and exploration for barite were also discussed. An index map of barite mines and prospects accompanied the bulletin.

TECHNOLOGY

Barium Reduction Corp., at its South Charleston (W. Va.) plant, began using a new fluid-bed process developed and patented by Columbia-Southern Chemical Corp. for manufacturing barium oxide. It was reported that the output of barium oxide averaged 97–99 percent pure, or about 8 percent higher than the arc-furnace product. Temperatures necessary for reduction were also 500° to 800° F. less than arc-furnace temperatures. The process begins with barium carbonate, formed by carbonating black-ash solution with either Na_2CO_3 or CO_2, which is dewatered and then washed. The carbonate, having a specified moisture content, goes to a pugmill for mixing with carbon black. The mixture from the mill is pelletized, and the pellets are fed to the surface of the fluidized bed. Temperature of the bed is held at about 1,680° F. Nitrogen, having a low moisture content and free of CO_2 and oxygen, enters the bottom of the reactor to fluidize the bed and remove gases formed during reaction. Barium oxide pellets are discharged manually from the bottom of the reactor

[16] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, pp. 22–23.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, January 1959, pp. 24–27.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 25.
[19] Brobst, Donald A., Barite Resources of the United States: U.S. Geol. Survey Bull. 1027–B, 1958, 66 pp.

after several hours. The discharge is sent to a "whitener," where excess carbon is burned off.[20]

A reportedly large deposit of barite was uncovered early in the year in the Big Horn Mountains, south of Aguila, Ariz. The deposit, on a mountain top, contains barite veins as much as 10 feet in width.[21]

A method for concentrating barite by flotation was patented.[22] Ground barite ore is treated with mahogany petroleum sulfonate to render the barite particles floatable, and the material is subjected to froth flotation. A concentrate with a specific gravity of 4.20 or higher is obtained.

The barium titanates continued to be the object of increased interest and research. A method to produce high-purity barium metatitanate was patented.[23] Barium oxide and titanium dioxide are calcined at temperatures of approximately 1,035° C., and the calcined product is dissolved in hydrochloric acid. The insoluble impurities are then removed, and barium titanyl oxalate is precipitated. The precipitate is calcined to form barium metatitanate.

Results of studies on the effect of several processing variables on the electrical properties of barium titanates were published.[24]

The Naval Research Laboratory published the results of an evaluation of five samples of barium titanate.[25] The samples, although chemically pure and determined by X-rays to have only one crystal phase, exhibited poor electrical properties. Differential thermal analysis indicated that compounds other than the desired $BaTiO_3$ were present, also unreacted materials, which could account for the poor electrical properties.

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[20] Chemical Engineering, Lower Process Temperature Ups BaO Quality: Vol. 65, No. 20, Oct. 6, 1958, pp. 56, 58.

[21] Zipf, M., Arizona Barite Is Late Discovery in $1,000,000 Ore Find: Min. Record, vol. 69, No. 36, Sept. 4, 1958, p. 3.

[22] Vincent, K. C. (assigned to National Lead Co., New York, N.Y.), Flotation of Barite: U.S. Patent, 2,834,463, May 13, 1958.

[23] Blumenthal, Warren B. (assigned to National Lead Co., New York, N.Y.), Manufacture of High Purity Barium Metatitanate: U.S. Patent 2,827,360, Mar. 18, 1958.

[24] Murray, J. F., Some Causes and Effects of Phases Other than Tetrogonal $BaTiO_3$ in Barium Titanate: Bull. Am. Ceram. Soc., vol. 37, No. 11, November 1958, pp. 476–479.

Rosenthal, J. J., and Stoddard, S. D., A Study of Process Variables in Barium Titanate Ceramics: Bull. Am. Ceram. Soc., vol. 37, No. 8, August 1958, pp. 370–375.

[25] Skinner, K. G., Evaluation of Five Chemically Pure Barium Titanate Samples by Their Differential Thermal Analysis Characteristics: Naval Research Laboratory Rept. 5105, Mar. 19, 1958, 6 pp.

Bauxite

By Richard C. Wilmot,[1] Arden C. Sullivan,[2] and Mary E. Trought [3]

WORLD production of bauxite increased 3 percent in 1958. United States imports increased 12 percent and composed 86 percent of the domestic supply of new bauxite. Jamaica continued as the leading world producer of bauxite and supplied 62 percent of the United States imports. Commercial production began in Sarawak during 1958.

In the United States about 3.2 million short tons of alumina and aluminum oxide products was produced from bauxite. Production of aluminum consumed 87.5 percent of the bauxite used.

Construction of new alumina capacity continued. Ormet Corp. completed and began operation of a plant at Burnside, La., with an annual capacity of 345,000 short tons of alumina. Additional annual alumina capacity totaling 800,000 tons was scheduled for completion in the first part of 1959.

Aluminum is discussed in the Aluminum chapter of this volume.

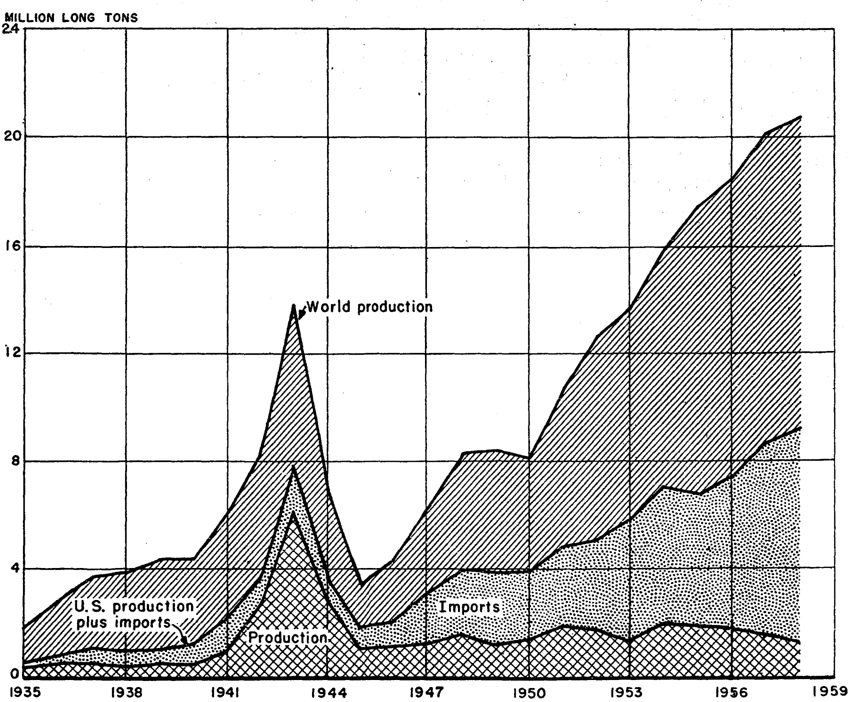

FIGURE 1.—United States supply and world production of bauxite, 1935–58.

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

TABLE 1.—Salient statistics of the bauxite industry, thousand long tons

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Crude-ore production (dry equivalent)	1,516	1,995	1,788	[1] 1,744	1,416	1,311
Value, thousands	$10,233	$16,403	$14,543	[1] $15,109	[1] $12,868	$11,898
Imports [2]	3,143	4,988	4,882	5,670	7,098	7,919
Exports (as shipped)	48	16	14	15	61	12
Consumption (dry equivalent)	3,961	6,428	6,989	7,751	7,633	7,034
World: Production	11,100	[1] 15,900	[1] 17,500	[1] 18,500	[1] 20,100	20,700

[1] Revised figure.
[2] Import figures adjusted to dry equivalent for Jamaican and Haitian bauxite. Other imports are on an as shipped basis.

DOMESTIC PRODUCTION

Production of crude bauxite in the United States was 1.3 million long tons, dry equivalent, a 7-percent decrease from 1957. On a dry basis shipments of ore from domestic mines and processing plants to consumers showed a 20-percent decrease from 1957. The domestic production of bauxite was 14 percent of the new supply, obtained by adding United States production to imports, compared with 17 percent in 1957.

The American Cyanamid Co. in Georgia, the R. E. Wilson Mining Co. and the D. M. Wilson Bauxite Co. in Alabama mined a total of 53,000 tons, dry equivalent, a 10-percent decrease from 1957. Crude ore was processed at the R. E. Wilson Mining Co. drying plant near Eufaula, Ala., and the American Cyanamid Co. plant at Adairsville, Ga. D. M. Wilson Bauxite Co. shipped crude ore.

TABLE 2.—Mine production of bauxite and shipments from mines and processing plants to consumers in the United States, thousand long tons

State and year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dried-bauxite equivalent	Value (thousands)[1]	As shipped	Dried-bauxite equivalent	Value (thousands)[1]
Alabama and Georgia:						
1949-53 (average)	55	45	$345	46	45	$432
1954	56	46	410	58	55	706
1955	89	67	516	73	67	714
1956	94	75	665	74	68	728
1957	77	59	554	67	62	672
1958	67	53	504	61	58	630
Arkansas:						
1949-53 (average)	1,740	1,471	9,888	1,638	1,493	11,704
1954	2,297	1,949	15,993	1,979	1,711	15,239
1955	2,050	1,721	14,027	1,939	1,660	14,845
1956	1,967	[2] 1,669	[2] 14,444	[2] 1,817	[2] 1,568	[2] 14,644
1957	1,625	1,357	[2] 12,314	2,004	1,696	[2] 16,476
1958	1,517	1,258	11,394	1,586	1,340	13,091
Total United States:						
1949-53 (average)	1,795	1,516	10,233	1,684	1,538	12,136
1954	2,353	1,995	16,403	2,037	1,766	15,945
1955	2,139	1,788	14,543	2,012	1,727	15,559
1956	2,061	[2] 1,744	[2] 15,109	[2] 1,891	[2] 1,636	[2] 15,372
1957	1,702	1,416	[2] 12,868	2,071	1,758	[2] 17,148
1958	1,584	1,311	11,898	1,647	1,398	13,721

[1] Computed from selling prices and values assigned by producers and estimates of the Bureau of Mines.
[2] Revised figure.

Of the total bauxite produced in the United States, 96 percent was from Arkansas. The two leading producers were the Aluminum Company of America (Alcoa) and Reynolds Metals Co., each of which shipped ore to its own alumina plant. Four companies mined smaller quantities of bauxite in Arkansas: American Cyanamid Co., Dulin Bauxite Co., Dickinson McGeorge, Inc., and Consolidated Chemical Industries, a division of Stauffer Chemical Co. American Cyanamid, Dulin, Consolidated Chemical Industries, Campbell Bauxite Co., and Porocel Corp. operated plants for the production of dried and activated bauxite. The Norton Co. mine and plant were both inactive.

The Coe mine was restored to production by Consolidated Chemical Industries. The crushing and drying plant of the American Cyanamid Co. at Berger was sold to Porocel Corp. and the new American Cyanamid Co. calcining and concentrating plant at Benton, Ark., designed specifically to treat bauxite from its Quapaw mine for the chemical industry, commenced production.

Kaiser Aluminum and Chemical Corp. stopped procuring options to prospect for aluminum ore near Greenville, S.C.

A geological study described in detail the bauxite deposits of Pulaski and Saline Counties of Arkansas.[4]

TABLE 3.—Recovery of dried, calcined, and activated bauxite in the United States, in long tons

Year	Crude ore treated	Processed bauxite recovered: Dried	Calcined or activated	Total: As recovered	Total: Dried-bauxite equivalent
1949–53 (average)	618,476	433,108	62,665	495,773	529,736
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
1958	184,094	92,111	42,203	134,314	143,569

CONSUMPTION AND USES

Domestic consumption of bauxite decreased 8 percent compared with 1957. The proportion of domestic ore consumed to total consumption decreased from about 24 to 19 percent. Consumption of bauxite for uses other than the production of alumina decreased 21 percent to 523,000 tons.

Shipments of domestic ore containing less than 8 percent silica increased from 8 percent in 1957 to 14 percent in 1958. In a year when the tonnage shipped was the lowest since 1949, the shipments of this grade of ore increased 64,000 tons over 1957. The proportion of ore containing 8 to 15 percent silica decreased from 66 percent in 1957 to 57, and the proportion of the ore containing more than 15 percent silica increased slightly to 29.

[4] Gordon, Mackenzie, Jr., and others, Geology of the Arkansas Bauxite Region: Geol. Survey Prof. Paper 299, 1958, 268 pp.

TABLE 4.—Bauxite consumed in the United States by industries, in long tons

(Dried-bauxite equivalent)

Industry	Domestic	Percent	Foreign	Percent	Total	Percent
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	----------
1958						
Alumina	1,184,420	87.8	5,326,115	93.7	6,510,535	92.6
Abrasive [1]	323	----------	185,171	3.2	185,494	2.6
Chemical	96,876	7.2	122,848	2.2	219,724	3.1
Refractory	14,317	1.1	46,043	.8	60,360	.9
Other	52,952	3.9	4,833	.1	57,785	.8
Total [1]	1,348,888	100.0	5,685,010	100.0	7,033,898	100.0
Percent	19.2	----------	80.8	----------	100.0	----------

[1] Includes consumption by Canadian abrasives industry.

TABLE 5.—Bauxite consumed in the United States in 1958, by grades, in long tons

(Dried-bauxite equivalent)

Grade	Domestic origin	Foreign origin	Total	Percent
Crude	1,195,001	73,188	1,268,189	18.0
Dried	98,117	5,397,485	5,495,602	78.1
Calcined	44,016	214,337	258,353	3.7
Activated	11,754	----------	11,754	.2
Total	1,348,888	5,685,010	7,033,898	100.0
Percent	19.2	80.8	100.0	----------

The six domestic alumina plants operated by the aluminum companies produced 3,188,000 short tons of calcined alumina and aluminum oxide products calculated on the basis of the calcined equivalent. This represented a 7-percent decrease from the 1957 production. The gross weight of the calcined alumina and aluminum oxide products was 3,234,000 tons, of which, calcined alumina was 3,074,000 tons and the other forms of alumina 160,000 tons. Of the shipments, 94 percent went to aluminum production plants and about 6 percent was shipped as commercial trihydrate or as activated, calcined, or tabular alumina for use primarily by the chemical, abrasive, ceramic, and refractory industries.

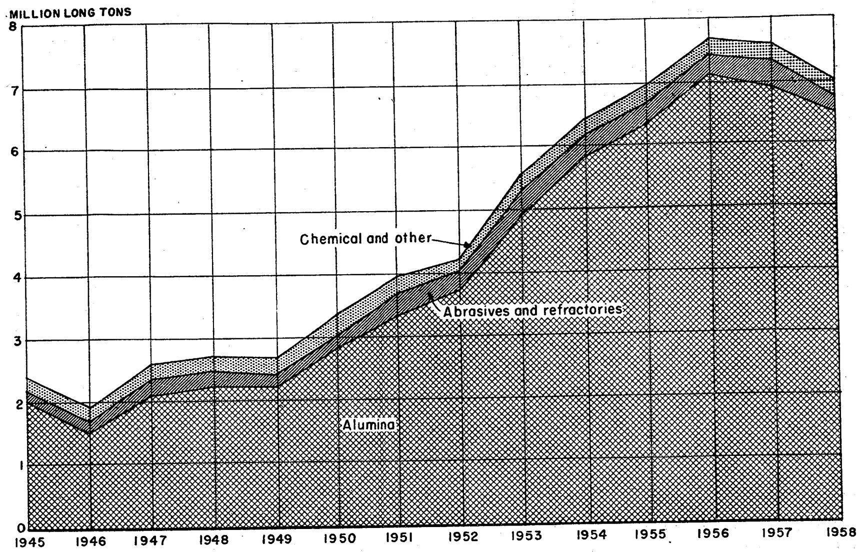

FIGURE 2.—Domestic consumption of bauxite, by uses, 1945–58.

TABLE 6.—Capacities of domestic alumina plants in operation and under construction

Company and plant	Capacity (short tons per year) as of December 31, 1958	
	Operating plants	Plants under construction
Aluminum Company of America:		
Mobile, Ala	985,500	
Bauxite, Ark	420,000	
Point Comfort, Tex		750,000
Total	1,405,500	750,000
Reynolds Metals Co.:		
Hurricane Creek, Ark	730,000	
La Quinta, Tex	547,500	182,500
Total	1,277,500	182,500
Kaiser Aluminum & Chemical Corp.:		
Baton Rouge, La	850,000	
Gramercy, La		430,000
Total	850,000	430,000
Ormet Corp.:		
Burnside, La	345,000	
Grand total	3,878,000	1,362,500

At the end of 1958 the annual rated alumina plant capacity in the United States was 3.9 million short tons. The 10-percent increase in capacity during the year was due to completion of a 345,000-ton-a-year alumina plant at Burnside, La., by Ormet Corp., jointly-owned by Olin Mathieson Chemical Corp. and Revere Copper and Brass, Inc. The plant, which employed about 500 people, cost $55 million. About 700,000 tons a year of bauxite from Surinam was to be treated and the alumina shipped by 23,000-ton barge tows up the Mississippi River to the company reduction plant at Hannibal, Ohio.

The caustic- and chlorine-producing facilities of the Kaiser Aluminum and Chemical Corp. 430,000-ton-a-year alumina plant at Gramercy, La., went on stream in March. The alumina plant at Gramercy and the fourth 182,500-ton unit of Reynolds Metals Co. Sherwin plant at La Quinta, Tex., were scheduled to begin operation in the first part of 1959. The first of the four 187,500-short-ton-a-year units at the Aluminum Company of America alumina plant at Point Comfort, Tex., was scheduled to treat ore from the Dominican Republic in early 1959. Alcoa refined the products of its alumina-from-bauxite plants to special aluminas at East St. Louis, Ill.

Calcined alumina consumed by the 20 aluminum-reduction plants in the United States totaled 3,010,000 short tons, a 4-percent decrease from that of 1957. An average of 2.042 long dry tons of bauxite was required to produce 1 short ton of alumina and an average of 1.922 tons of alumina was required to produce 1 short ton of aluminum metal. The overall ratio was 3.925 long dry tons of bauxite to 1 short ton of aluminum.

TABLE 7.—Production and shipments of selected aluminum salts in the United States, 1957

Type of salt	Production (short tons)	Number of plants producing	Shipments and interplant transfers: Quantity (short tons)	Shipments and interplant transfers: Value f.o.b. plant (thousands)
Aluminum sulfate:				
General:				
Commercial (17 percent Al_2O_3)	821,825	48	798,164	$28,831
Municipal (17 percent Al_2O_3)	10,052	6		
Iron-free (17 percent Al_2O_3)	25,073	10	24,466	1,635
Sodium aluminate (62.2 percent Al_2O_3)	11,356	6	(1)	(1)
Aluminum chloride:				
Liquid (32° B.)	15,280	11	11,304	837
Crystal (32° B.)	(1)	(1)	(1)	(1)
Anhydrous (100 percent $AlCl_3$)	34,555	10	28,975	9,075
Aluminum fluoride, technical	60,947	4	58,821	13,028
Aluminum trihydrate (100 percent $Al_2O_3.3H_2O$)	130,755	8	107,128	6,985
Other aluminum salts				[2] 12,870
Total				73,261

[1] Included with "Other aluminum salts."
[2] Includes cryolite, sodium-aluminum sulfate, sodium-aluminate, potassium-aluminum sulfate, ammonium-aluminum sulfate, aluminum hydroxide (light or litho), and other aluminum compounds.

SOURCE: Data are based upon report Form MA-28E.1, Annual Report on Shipments and Production of Inorganic Chemicals and Gases, Bureau of the Census.

STOCKS

Bauxite stocks in the United States on December 31, 1958, had declined 188,000 long dry tons from the stocks held a year earlier. On a dry basis consumers' inventories of crude and processed bauxite declined 4 percent, and those at mines and processing plants declined 13 percent. There were no withdrawals from the Government-held nonstrategic 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, in long tons[1]

Year	Producers and processors		Consumers		Government	Total	
	Crude	Processed[2]	Crude	Processed[2]	Crude	Crude and processed[2]	Dried-bauxite equivalent
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	[3] 1,143,392	5,812	483,173	1,605,262	2,204,674	[3] 5,442,313	[3] 4,898,229
1957	[3] 739,836	6,313	488,564	2,364,206	2,204,674	[3] 5,803,593	[3] 5,329,014
1958	637,349	6,605	606,643	2,163,120	2,204,674	5,618,391	5,140,744

[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 average value in 1958 of bauxite as shipped and delivered to the domestic alumina plants was estimated at $11.37 per long ton, dry equivalent, for domestic ore and $15.37 per ton for imported ore. The year-end prices quoted in the E&MJ Metal and Mineral Markets were the same as those quoted at the end of 1957, except for an increase of $1.20 per ton on imported Refractory-grade bauxite.

During 1958 the average value of calcined alumina shipped was $0.03410 per pound as determined by producer reports. The value of imported calcined alumina at the port of shipment was comparable.

TABLE 9.—Average value of domestic bauxite in the United States[1]

Type	Shipments f.o.b. mines or plants (per long ton)		Type	Shipments f.o.b. mines or plants (per long ton)	
	1957	1958		1957	1958
Crude (undried)	[2] $7.75	$7.66	Calcined		([3])
Dried	10.83	10.88	Activated	$61.34	$59.48

[1] Calculated from reports to the Bureau of Mines by bauxite producers.
[2] Revised figure.
[3] Figure withheld to avoid disclosing individual company confidential data.

TABLE 10.—Market quotations on bauxite in the United States on December 4, 1958

[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 [2]	[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		26.60

[1] F.o.b. Arkansas mine or mill.
[2] F.o.b. shipping point.
[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, in long tons

[Bureau of the Census]

Type and country	Average value, port of shipment [1]		Type and country	Average value, port of shipment	
	1957	1958		1957	1958
Crude and dried:			Calcined: [2]		
British Guiana	$6.92	$6.99	British Guiana	$22.66	$24.30
Haiti	9.05	8.73	Surinam	26.97	19.62
Jamaica	9.28	9.44	Average	22.66	24.30
Surinam	[3] 7.85	7.85	Bauxite and bauxite concentrate exported	79.47	81.57
Average	8.58	8.86			

[1] Dry tons used for computation.
[2] For refractory use.
[3] Revised figure.

TABLE 12.—Market quotations on alumina and aluminum compounds

[Oil, Paint and Drug Reporter]

Compound	Dec. 30, 1957	Dec. 29, 1958
Alumina, calcined, bags, carlots, works ... pound	$0.0475	[1] $0.050
Aluminum hydrate, heavy, bags, carlots, freight equalized ... pound	.0335	[1] .035
Aluminum sulfate, commercial ground bulk, carlots, works, freight equalized ... ton	[2] 40.00	40.00
Aluminum sulfate, iron free, bags, carlots, works, freight equalized ... 100 pounds	3.55	[3] 3.80

[1] First quoted Aug. 1, 1958.
[2] Revised figure.
[3] First quoted Sept. 22, 1958.

FOREIGN TRADE [5]

United States imports exceeded those of 1957 by 12 percent. The increase was almost entirely due to the 36 percent increase in Jamaican imports which, on a dry basis, compose 62 percent of total imports. Surinam supplied 31 percent, and British Guiana and Haiti supplied

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

the balance, except for 20 tons imported from the United Kingdom. Imports include bauxite acquired by the United States Government.

On a dry basis, 48 percent of the bauxite imports entered through the New Orleans (La.) customs district, 27 percent through Galveston (Tex.) customs district, 24 percent through the Mobile (Ala.), customs district, and 1 percent through the other districts. On an "as shipped" basis, with no corrections for moisture content, bauxite imports were 8,748,000 long tons.

Except for 54 tons, all calcined bauxite imported for refractory uses (shown in table 14) came from British Guiana. Calcined alumina for producing aluminum was imported in major quantities for the first time during 1958. Of the 52,000 short tons imported, 37,000 tons came from Japan and the balance from Canada.

Other aluminum compounds imported into the United States totaled 6,983 short tons; 40 percent came from Canada and the remainder from the countries of Western Europe.

TABLE 13.—Bauxite (crude and dried [1]) imported for consumption in the United States, in thousand long tons

[Bureau of the Census]

Country	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Haiti (dry equivalent) [2]					318	336
Jamaica (dry equivalent) [2]	249	1,717	2,178	2,573	3,622	4,933
Trinidad and Tobago	8					
Other North America	(3)					
Total	257	1,717	2,178	2,573	3,940	5,269
South America:						
British Guiana	120	175	242	269	[4] 391	225
Surinam	2,482	3,096	2,462	2,798	[4] 2,767	2,425
Other South America	1					
Total	2,603	3,271	2,704	3,067	[4] 3,158	2,650
Europe	2					(3)
Asia	281					
Africa				30		
Grand total [2]	3,143	4,988	4,882	5,670	[4] 7,098	7,919
Value, thousands	$20,531	$36,289	$36,656	$44,414	[4] $60,933	$70,142

[1] Only small quantities of undried bauxite were imported.
[2] Bureau of the Census import figures adjusted by the Bureau of Mines to dry equivalent by deducting 13.6 percent free moisture for Jamaican, and 14.6 percent in 1957 and 13.6 in 1958 for Haitian bauxite.
[3] Less than 1,000 tons.
[4] Revised figure.

TABLE 14.—Calcined bauxite imported for consumption in the United States, in long tons

[Bureau of the Census]

	Refractory purposes		Other uses	
	1957	1958	1957	1958
British Guiana	67,112	29,360		
Other countries	60	54	204	100
Total	67,172	29,414	204	100
Value, thousand	$1,522	$715	$4	$2

TABLE 15.—Bauxite (including bauxite concentrate [1]) exported from the United States, in long tons

[Bureau of the Census]

Country	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	46,840	14,777	13,115	13,337	58,654	9,548
Other North America	652	1,014	606	800	1,015	1,341
Total	47,492	15,791	13,721	14,137	59,669	10,889
South America	39	27	70	80	121	37
Europe	210	133	326	378	403	601
Asia	152	172		295	764	309
Africa	6	51		31	36	32
Grand total as exported	47,899	16,174	14,117	14,921	60,993	11,868
Dried-bauxite equivalent [2]	74,959	25,070	21,881	23,128	[3] 94,539	18,395
Total value, thousands	$1,124	$666	$528	$834	$4,847	$968

[1] Classified as "Aluminum ores and concentrates" by the Bureau of the Census.
[2] Calculated by Bureau of Mines.
[3] Revised figure.

On May 16, Public Law 415 was approved. It extended the suspension of duty on alumina used for the production of aluminum and on crude or calcined bauxite until July 16, 1960. Duties on imports of aluminum hydroxide and alumina not used for aluminum production remained at 0.25 cent a pound.

Exports of bauxite and bauxite concentrate in 1958 decreased to about one-fifth of the relatively large exports of 1957. Shipments to Canada were 80 percent of the total.

Approximately three-fifths of the 9,864 short tons of aluminum sulfate exported went to Canada, Colombia, and Venezuela. Of the other exported aluminum compounds, totaling 32,803 short tons, 71 percent went to Norway.

The international flow of bauxite for 1956 is shown in table 16. Total exports (11.3 million tons) increased 7 percent over 1955. Gains in exports of more than 100,000 tons a year were shown by Jamaica, Surinam, and Greece. Hungary was the only country with large exports to show a major decrease in 1956 compared with 1955. Its exports of bauxite declined 33 percent.

In 1956 six countries received 97 percent of the world exports: United States and Canada, 74 percent; Japan, West Germany, and United Kingdom, 17 percent; and U.S.S.R., 6 percent.

TABLE 16.—Production and trade of bauxite in 1956, by major countries, in thousand long tons

[Compiled by Corra A. Barry and Berenice B. Mitchell]

Exports, by countries of origin	Production	Exports	Exports, by countries of destination: North America: Canada	North America: United States	Europe: Germany, West	Europe: Italy	Europe: Norway	Europe: U.S.S.R.	Europe: United Kingdom	Europe: Other Europe	Asia: Japan	All other countries
Surinam	3,430	3,428	469	2,918	40	--	--	--	--	--	--	1
Jamaica	3,141	2,575	(1)	2,575	--	--	--	--	--	--	--	--
British Guiana	2,481	2,107	1,585	441	16	3	(1)	--	19	28	11	4
Yugoslavia	868	669	--	--	541	124	--	--	--	4	--	--
Greece	687	659	--	--	263	--	35	287	42	32	--	--
French West Africa	444	450	330	40	79	--	--	--	--	1	--	(1)
Hungary	879	365	--	--	--	--	--	[2] 365	--	--	--	--
France	1,443	320	--	--	201	--	--	--	111	8	--	--
Indonesia	299	308	--	--	131	--	--	--	--	--	177	--
Malaya	264	252	--	--	--	--	--	--	--	--	201	[3] 51
Ghana	[4] 138	138	--	--	--	--	--	--	138	--	--	--
Other	4,422	46	14	--	7	--	--	--	--	--	--	25
Total	[5] 18,500	11,317	2,398	5,974	1,278	127	35	652	310	73	389	81

[1] Less than 500 tons.
[2] Including Czechoslovakia, East Germany, and Poland.
[3] Formosa received 41,000 long tons.
[4] Exports.
[5] Estimate.

WORLD REVIEW

Compared with previous years, the increase in world bauxite production was small and exceeded that of 1957 by only 3 percent. Jamaica remained the world's largest producer of bauxite and furnished 28 percent of the world total. A new bauxite producer, Sarawak, in British Borneo, began commercial shipments to Japan. Construction of 1,285,000 tons a year of new alumina capacity in Guinea, British Guiana, and Jamaica continued, but completion dates on some projects were postponed because of decreased demand for alumina.

Free world output was estimated at 82 percent of the total world production.

TABLE 17.—Relationship of world production of bauxite and aluminum, in million long tons

Commodity	1949–53 (average)	1954	1955	1956	1957	1958
Bauxite	11.1	[1] 15.9	[1] 17.5	[1] 18.5	[1] 20.1	20.7
Aluminum	1.8	2.8	3.1	3.3	3.3	3.5
Ratio of bauxite to aluminum production	6.2	[1] 5.7	[1] 5.6	[1] 5.6	[1] 6.1	5.9

[1] Revised figure.

NORTH AMERICA

Costa Rica.—Four United States companies explored for bauxite in Costa Rica. Resources of 50 million tons of bauxitic material averaging less than 50 percent alumina were indicated.

Dominican Republic.—Construction of mining and dock facilities was completed during the year by Alcoa, and commercial production was planned for 1959.

Haiti.—Reynolds Haitian Mines, Inc., which began shipping bauxite in April 1957 from its property near Miragone, operated below capacity in 1958, and a gain of only 6 percent in production was reported.

TABLE 18.—World production of bauxite, by countries, in thousand long tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America (dried equivalent of crude ore):						
Haiti					263	280
Jamaica	[2] 747	2,044	2,645	3,141	4,643	5,722
United States	1,516	1,995	1,788	1,744	1,416	1,311
Total	2,263	4,039	4,433	4,885	6,322	7,313
South America:						
Brazil	17	27	44	69	63	[3] 41
British Guiana	2,001	2,310	2,435	2,481	2,202	1,586
Surinam	2,639	3,309	3,074	3,430	3,324	2,941
Total	4,657	5,646	5,553	5,980	5,589	4,568
Europe:						
Austria	10	17	19	22	22	23
France	987	1,267	1,470	1,443	1,657	1,788
Germany, West	5	4	4	5	5	[3] 5
Greece	178	348	492	687	820	787
Hungary	884	1,240	1,221	879	903	1,036
Italy	191	289	322	271	257	294
Rumania [3]	7	15	16	16	16	20
Spain	10	6	6	7	8	6
U.S.S.R.[3]	840	1,390	2,030	2,190	2,410	2,710
Yugoslavia	422	676	779	868	874	721
Total [3]	3,534	5,252	6,359	6,388	6,972	7,390
Asia:						
India	62	75	81	91	97	115
Indonesia	321	171	260	299	238	338
Malaya	35	166	222	264	326	262
Pakistan			1	3	3	2
Sarawak						136
Taiwan (Quemoy)	3					
Total	421	412	564	657	664	853
Africa:						
Guinea	90	424	485	444	360	325
Ghana (exports)	116	164	116	138	185	207
Mozambique	3	2	3	4	5	[3] 5
Total	209	590	604	586	550	537
Oceania: Australia	5	5	8	10	8	[3] 5
World total (estimate)	11,100	15,900	17,500	18,500	20,100	20,700

[1] This table incorporates a number of revisions of data published in previous Bauxite chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] Average for 1952–53.
[3] Estimate.

Jamaica.—A 23-percent increase was reported in the output of bauxite. During the year, 5,590,000 (4,799,000 dried basis) long tons of bauxite was exported to the United States and Canada. In addition Alumina Jamaica, Ltd., produced 1,131,000 (923,000 dried basis) tons of bauxite for local production of alumina at its Kirkvine plant. The company exported 418,000 short tons of alumina. Production of bauxite was expected to reach 6 million long tons in 1959.[6]

Construction of the 270,000-short-ton alumina plant at Ewarton by Alumina Jamaica, Ltd., slowed, but at the end of the year the plant was near completion.

Prospecting for bauxite on the island was continued by Harvey Aluminum, Inc., and Caribex, Ltd., a subsidiary of the American Metal Climax, Inc.

Panama.—Kaiser Exploration Co. ceased geological investigations on its concessions in western Panama, where the company had been exploring near the Costa Rica border. Alcoa continued reconnaissance in the area.

SOUTH AMERICA

British Guiana.—Exports of bauxite decreased 32 percent in 1958.

TABLE 19.—Bauxite exported from British Guiana, in long tons

Country of destination	1957		1958	
	Dried ore	Calcined ore	Dried ore	Calcined ore
Canada	1,326,990	142,540	922,170	66,740
France		18,933		21,952
Germany, West		10,208		(1)
Japan	6,000	18,040	(1)	8,180
United Kingdom	9,730	11,860	6,605	15,220
United States	390,449	60,209	232,786	48,305
Other countries	895	25,340	7,076	35,252
Total	1,734,064	287,130	1,168,637	195,649
Value, BWI$ [2]	19,572,750	9,946,478	13,392,778	7,169,410

[1] Breakdown not available; probably included in other countries.
[2] 1 BWI$=US$0.58.

The Demerara Bauxite Co. operated at 65 percent of capacity. Progress was made on the company $60 million alumina plant at Mackenzie. The 245,000-ton plant was first scheduled to be completed in 1959, but the beginning of operations was postponed until early 1961. An article described the bauxite deposits and operating methods of the Demerara Bauxite Co.[7]

French Guiana.—Two permits for exploring for bauxite were granted to the Bureau Minier Guyanais for a period of 3 years. The first covered a triangular area between the coastline, Iracouba, and the Maroni River, and the second included an area along the coast east of Cayenne from the Cayenne River to the Brazilian border.

Surinam.—An agreement between Alcoa and the Surinam Government to develop the Brokopondo project was signed in January. By

[6] Bracewell, Smith, Jamaican Bauxite in the West Indies Economy: Min. Eng., vol. 10, No. 10, October 1958, pp. 1079–1080.
[7] Mine and Quarry Engineering, The Bauxite Mining and Alumina Industry in British Guiana: Vol. 24, No. 5, June 1958, pp. 234–241.

this agreement the Suriname Aluminum Co. (Suralco), which was incorporated in Delaware to replace the Surinam Bauxite Co., was to receive additional bauxite concessions and an extension of time on existing concessions to the year 2033. Suralco also was to build a hydroelectric plant, aluminum smelting facilities, and, eventually, an alumina plant.

Alcoa contracted for the sale and shipment of 600,000-long tons of bauxite to the U.S. Government.

Shipments of bauxite declined 14 percent compared with 1957. Of the 2,702,000 long tons of Metal-grade ore shipped, 2,520,000 tons went to the United States and the Trinidad transfer station, 182,000 tons to Canada, and the remainder to other countries. All of the 56,500 tons of Chemical-grade ore exported was sent to the United States. Of the 57,000 tons of calcined ore shipped, 49,000 tons went to the United States, 6,000 tons to the Netherlands, and 2,000 tons to other countries.

EUROPE

Greece.—Under a 3-year trade agreement signed in July, Greece was to deliver to the U.S.S.R. 492,000 long tons of bauxite in 1958, 541,000 tons in 1959, and 591,000 tons in 1960.

Exports of bauxite during the year included 280,000 long tons to West Germany, 441,000 to the U.S.S.R., 37,000 to the United Kingdom, 34,000 to Norway, 16,000 to Spain, and 15,000 tons to other countries.

Hungary.—More than £4 million was to be spent during 1958–60 in developing two new bauxite mines, which would have a combined annual output of over 490,000 long tons of bauxite. This increase in output would enable the alumina plants to raise annual production to 220,000 short tons by 1960.

A 3-year expansion program emphasized the extraction of byproducts from alumina manufacture. An experimental plant was being built at Ajka to extract 33 pounds of gallium a year, and a new plant was being built at Almasfüzito to recover iron oxide from 440,000 short tons of red mud a year. These plants were scheduled to begin operations in 1959.[8]

Intensive study of the Hungarian bauxite deposits during the last decade revealed new data on their geology, tectonics, composition, and structure.[9]

Norway.—Imports of bauxite increased 28 percent to 36,000 long tons, but imports of alumina showed only a 1-percent increase to 216,800 short tons. A new barter agreement between Aardal og Sunndal Verk A/S and Aluminium Ltd. was signed on August 25. Aluminium, Ltd., was to supply Aardal with 4.1 million short tons of alumina up to 1978 and would receive aluminum in exchange.

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[8] Metal Industry (London), Aluminium in Hungary: Vol. 93, No. 6, Aug. 8, 1958, p. 119.

[9] Bardosi, D., [The Geology of the Bauxite Deposits in Hungary]: Isvestiya Akademii Nauks SSR (News of the Academy of Sciences U.S.S.R.), Geol. Series, vol. 22, No. 9, September 1957, pp. 3–18; dist. by Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C.

U.S.S.R.—A report on the Soviet aluminum industry[10] stated that there is a trend to increased use of nonbauxitic materials, such as nephelite, alunite, kyanite, and sillimanite. The report also described the bauxite mine at Arkalyk which will supply the alumina-aluminum plant being built in Kazakhstan.

Large deposits of calcite-nepheline ore (tuvinite) were discovered at the Balyktya-Khem River in Siberia.[11] Among the alumina resources in East Siberia are the Tatar bauxite deposit in Krasnoyarsk, the Bokson bauxite deposits in Buriat Mongolian Autonomous Soviet Socialist Republic, and the Uzhmur nepheline-syenite ore in Krasnoyarsk. An article on the Bokson deposits was published by the U.S.S.R. Academy of Science.[12]

Yugoslavia.—Bauxite reserves in the vicinity of Novigradesko More near Zadar were increased to 35 million tons. Of the 583,000 long tons of bauxite exported, 398,000 went to West Germany. Compagnie Péchiney agreed to assist in expanding the Kidricevo alumina plant from 49,500 short tons to 99,000 and then to 154,000 tons. A continuous Bayer process was being introduced at the plant.

The $175 million loan by the U.S.S.R. and East Germany to develop bauxite deposits in Montenegro to support a proposed 55,000-short-ton aluminum plant was postponed for 5 years.

ASIA

China.—Output of diaspore shale and bauxite in 1958 was reported at about 196,000 long tons. Alumina output during the last 5 years reportedly increased from 7,700 short tons in 1954 to 26,000 in 1955, 50,000 in 1956, 55,000 in 1957, and 66,000 tons in 1958.

Indonesia.—Greater Japanese demand for bauxite was largely responsible for the 42-percent increase in production and 52-percent increase in exports during 1958. Exports to Japan increased 130 percent to 222,500 long tons, to Argentina 199 percent to 14,000 tons, and to Australia 59 percent to 79,800 tons, but exports to Europe showed a decline of 30 percent to 69,300 tons.

Under contracts with the leading Japanese aluminum producers Indonesia will ship 210,000 long tons of bauxite to Japan in 1959.

Sarawak (Borneo).—The Sematan Bauxite Company, owned by Aluminium, Ltd., E. Ott & Company (M), Ltd., Nippon Light Metal, Ltd., Sumitomo Chemical Company, and Showa Denko K. K., began mining operations in May and by the end of 1958 had produced 136,000 long tons of bauxite. Exports of bauxite totaling 99,900 long tons all went to Japan.

Malaya.—Bauxite output in Malaya was 20 percent less than in 1957. Of the 247,000 long tons exported, 231,600 was shipped to Japan and 16,000 was sent to Taiwan.

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[10] Shabad, Theodore, The Soviet Aluminum Industry: Publ. by Am. Metal Market, 18 Cliff St., New York 38, N.Y., October 1958, 25 pp.

[11] Engineering and Mining Journal, vol. 159, No. 10, October 1958, p. 201.

[12] Ustinova, O. A., [Conditions of Industrial Utilization of the Bauxitic Formation of the Bokson Deposit] (Usloviia promyshlennogo osvoenniia boksitoobraznykh porod Boksonskogo mestorozhdeniia): Akademiia Nauk SSSR. Trudy Vostochno-Sibirskogo Filiala (Moskva), 1–(12), pts. I and II, 1958, pp. 65–70.

Ramunia Bauxite Co. estimated that 50,000 tons of commercial-grade bauxite, enough for 5 years of operation at present rate of production, remained in its deposit. The reserve of the South Asia Bauxite Co. property was estimated at 10 million tons.

Taiwan.—Imports of bauxite during the year totaled 40,600 long tons—a slight decrease from 41,300 long tons imported in 1957. Malaya and Singapore supplied 39,800 tons and India the remaining 800 tons.

AFRICA

Belgian Congo.—Prospecting for bauxite in the Congo near the Inga power project was reported to have had some success, but facts concerning the extent and content of the deposits were not released.

Guinea.—It was announced by newly independent Guinea that construction of the 530,000-short-ton alumina plant in the Badi-Konkouré region would continue. During 1958, Vereinigte Aluminiumwerke, A.G. (VAW) bought a 5-percent interest in the FRIA Cie. Internationale pour la production d'Alumine. Participants at the end of the year were Olin Mathieson Chemical Corp. (American), 48.5 percent; Péchiney-Ugine (French), 26.5 percent; British Aluminium Co., Ltd. (British) and Aluminium Industries, A.G. (AIAG) (Swiss), each 10 percent; and VAW (German), 5 percent.

Development of the Fria bauxite deposits was to be accompanied by lengthening and improving highways between Conakry and Fria, building a 96-mile railroad between Fria and Conakry harbor, building a town for workers, and doubling capacity of Conakry harbor.[13]

Bauxites du Midi continued work on a 75-mile railroad to the Atlantic coast and on the port facilities, as part of developing a mine and building a 240,000-short-ton alumina plant scheduled at Bokée.

OCEANIA

Australia.—Exploration by the Commonwealth Aluminium Corporation Pty., Ltd., in the Weipa area of the Cape York Peninsula, Queensland, has developed about 600 million tons of ore. Another concession, known to contain bauxite, has been obtained by the company at Gove, Northern Territory.

Reynolds Pacific Mines Pty., Ltd., reported the discovery of a large bauxite deposit on Croker Island off Arnhem Land, Northern Territory.

Aluminium Laboratories, Ltd., discovered additional bauxite on Cape York Peninsula. These deposits are considered an extension of the Weipa deposits. Prospecting has centered south of Mapoon Mission (Port Musgrave) in the Wenlock-Duvie River area to the north and in the Archer River area to the south of Weipa.

A 6,250-square-mile reservation extending from New Norica to Bridgetown in the Darling Ranges was granted to Western Mining Corporation, Ltd. A new company, Western Aluminium, N.L., was formed to undertake preliminary prospecting in the area.

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[13] Modern Metals, Corporation Will Develop French Guinea Bauxite: Vol. 14, No. 8, September 1958, pp. 86–87.

WORLD RESERVES

World bauxite reserves, as estimated in 1958 by the Federal Geological Survey and Federal Bureau of Mines, are shown in table 20. The world reserve and the rate of mining have both more than doubled since 1950. Part of the reserve increase must be attributed to technical improvements in processing and transportation that have permitted the economic treatment of aluminous material previously classed as submarginal rather than as reserve. In the United States the lowest average grade considered commercial has gradually declined from the 60-percent Al_2O_3 used in 1930 to the 47-percent Al_2O_3 available for use in 1959.

Since 1950 the worldwide search for bauxite has resulted in an increase in the reserve of Guinea from 6 to 600 million tons and in the reserve of Australia from 21 to 600 million tons. During the same period, reserves have increased 230 million tons in Jamaica and 150 million tons in Surinam.

The bauxite reserves of the U.S.S.R. include the Tikhvin deposits near Leningrad, ores in several districts occurring along the flanks of the Ural Mountains, bauxite in Kazakhstan near Arkalyh, and deposits in the Ukraine. In addition, the Bokson bauxite deposits have been found in the Buriat-Mongol Republic. Other aluminous materials not included as bauxite reserves are the nepheline syenites of the Kola Peninsula, near Uzhur in Central Siberia and the Tezhar deposits in Armenia. Also being tested as sources of alumina are the alunite deposits near Zaglik and the sillimanite deposits of the Kola Peninsula and near Kyakhta, Siberia.

The Chinese reserves, containing diaspore as the principal mineral, are grouped in the Provinces of Liaoning, Hopeh, and Shantung in the northeast and of Kweichow in the southwest. Deposits in Yunnan Province contain boehmite, and gibbsitic material is found in Fukien Province. The potential resources of China are estimated at ½ billion tons or more of bauxitic ores, but the deposits have not been well explored. In addition, 280 million tons of alunite has been reported in Chekiang and Anhwei Provinces.

TECHNOLOGY

The Ormet Corp. completed a new Bayer-process alumina plant at Burnside, La. Ore from ocean steamers is unloaded by gantry cranes and transferred by conveyors, first to the crushers, then to the storage area, and finally to the rodmills, where caustic soda and starch are added. The slurry is digested in autoclaves for approximately 40 minutes at 290° F. and a pressure of 60 p.s.i. and is then pumped to pressure filters which remove the red mud. The filtrate is held in the precipitators for 30 to 40 hours. The precipitated alumina is thickened by countercurrent decantation, and the coarser fractions of the alumina are removed on pan filters. The fine alumina is returned to seed the precipitators, and the caustic solution is recirculated. The auxiliary water-treatment plant has a capacity of 800,000 gallons of pure water per day.

TABLE 20.—Estimate of world bauxite reserves as of December 1958

Country	Million long tons	Country	Million long tons
North America:		Asia:	
Dominican Republic	40	China	50
Haiti	23	Federation of Malaya	10
Jamaica	550	India	58
United States	50	Indonesia	15
		Sarawak	5
Total	663	Turkey	10
		Viet-Nam	(1)
South America:			
Brazil	30	Total	148
British Guiana	80		
Surinam	200	Africa:	
		Ghana	229
Total	310	Guinea	600
		Mozambique	(1)
Europe:			
Austria	1	Total	829
France	70		
Greece	84	Oceania:	
Hungary	250	Australia	600
Italy	11	Palau Islands, Ponape, Manus	3
Rumania	20		
Spain	7	Total	603
U.S.S.R.	100		
Yugoslavia	128	Grand total	3,224
Total	671		

1 Less than 1 million tons.

The Anaconda Aluminum Co. 50-ton pilot plant at Anaconda, Mont., for extracting alumina from Idaho clay began operations. By the yearend the program concerned testing construction materials to determine the most suitable equipment for use in the process.

In France Compagnie Péchiney changed its alumina-producing plants from batch to continuous operation. By an elaborate series of heat exchangers, the consumption of steam was reduced from 9 tons to less than 4 tons per ton of alumina produced.[14]

In the U.S.S.R. the combination process was used to treat high-silica bauxite containing as low as 36 percent Al_2O_3. The lime-soda-sinter process was adapted to treating nepheline concentrate containing about 30 percent Al_2O_3. In addition to alumina, gallium, sodium and potassium compounds, a base for Portland cement was recovered. The estimated cost of alumina from the Uzhur nepheline syenites of Siberia was only 8 percent more than that of producing alumina from high-grade bauxite from the Urals.[15]

The genesis of bauxite was discussed in a paper that described various stages of alteration from the olivine basalt to nodular bauxitic clay that occurred on the island of Kauai in the Territory of Hawaii.[16]

Another paper covered the chemical and geological factors that influence the formation of bauxite. The effect of the pH of the weathering solutions on the solubility of silica and alumina was described and related to the formation of the bauxite minerals.[17]

[14] Starratt, F. Weston, Aluminum and France: Jour. Metals, vol. 10, No. 1, January 1958, pp. 38–43.
[15] Works cited in footnotes 10 and 12, page 15.
Polutoff, N., [Production of Aluminum From Nepheline] (in German): Aluminium, Düsseldorf, vol. 34, No. 4, April 1958, pp. 192–193.
[16] Abbott, Agatin T., Occurrence of Gibbsite on the Island of Kauai, Hawaiian Islands: Econ. Geol., vol. 53, No. 7, November 1958, pp. 842–853.
[17] Keller, W. D., Argillation and Direct Bauxitization in Terms of Concentration of Hydrogen and Metal Cations at the Surface of Hydrolyzing Aluminum Silicates: Bull. Am. Assoc. Petrol. Geol., vol. 42, No. 2, February 1958, pp. 233–245.

The geology and genesis of the different types of bauxite deposits occurring in the Arkansas area were described in a detailed report.[18]

The Federal Geological Survey placed on open file a preliminary report on the geology and resources of the bauxitic laterites of the Hawaiian Islands.[19]

Results of preliminary metallurgical tests by the Federal Bureau of Mines on bauxitic samples from the islands of Kauai, Maui, and Hawaii were reported. Samples contained 20- to 45-percent Al_2O_3 and 2- to 25-percent silica. In wet screening and magnetic concentration tests, significant improvements in grade were accompanied by low alumina recoveries. Although none of the concentrates obtained were economically competitive with products from commercial deposits, the large tonnages available justify additional investigations.[20]

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[18] Gordon, Mackenzie, Jr., and others, Geology of the Arkansas Bauxite Region: Geol. Survey Prof. Paper 299, 1958, 268 pp.

[19] Cathcart, James B., Bauxite Deposits of Hawaii, Maui, Kauai, Territory of Hawaii: Geol. Survey Prelim. rept., October 1958, 72 pp., open file, University of Hawaii; Wash., D.C.; Denver, Colo.; Menlo Park, Calif.; Spokane, Wash.; San Francisco, Calif.

[20] Calhoun, W. A., Preliminary Sampling and Beneficiation of the Hawaiian Bauxite Deposits: Bureau of Mines open-file rept., August 1958, 43 pp., Wash., D.C.; Rolla, Mo.; San Francisco, Calif.; Honolulu, Hawaii.

Beryllium

By Donald E. Eilertsen [1]

THE SEARCH for beryllium ore deposits was accelerated in 1958, and research workers delved deeper into many other complex problems ranging from ore dressing to producing ductile beryllium for possible use in aircraft, missiles, and nuclear reactors.

LEGISLATION AND GOVERNMENT PROGRAMS

In 1958 the Government bought 449 short tons of beryl under its purchase program to encourage domestic production, making a cumulative total of 2,144 tons purchased under the program. Only clean beryl crystals, cobbed free of waste (not flotation concentrates), were accepted for purchase. The date to apply for participation in the Government's purchase program for domestically produced beryl was extended from June 30, 1958, to December 31, 1961. The program is scheduled to terminate June 30, 1962, or when 4,500 short tons of beryl has been delivered, whichever occurs first.

Government financial assistance for beryl exploration was available through Defense Minerals Exploration Administration (DMEA) until June 30 and thereafter through its successor agency, the Office of Minerals Exploration (OME). Government participation in

TABLE 1.—Salient statistics of beryllium, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Beryl, approximately 10–12 percent BeO:						
Domestic mine shipments	557	669	500	[1] 445	521	463
Value	$214,545	$303,649	$267,927	[1] $231,126	$275,855	$238,017
Imports	5,393	5,816	6,037	12,371	7,290	4,599
Consumption	2,712	1,948	3,860	4,341	4,309	6,002
Approximate price per unit BeO, domestic [2]	$39	$45	$49	$47	$48	$47
Approximate price per unit BeO, imported (10 percent BeO)	$36	$44	$37	$36	$35	$34
World: Beryl production, 10–12 percent BeO	6,800	7,700	8,900	12,900	[1] 11,900	7,000

[1] Revised figure.
[2] 10 percent BeO, 1949–54, and 11 percent BeO, 1955–58.

[1] Commodity specialist.

beryl exploration was 75 percent through DMEA and 50 percent through OME. No new contracts or certifications were made in 1958.

DOMESTIC PRODUCTION

Mine Production.—A total of 463 tons of beryl was produced by 175 operators in 9 States. Individual shipments of beryl ranged from a few pounds to 114 tons. The Boomer Lode mine in Park County, Colo., was again the leading producer.

South Dakota produced about 52 percent of the total domestic beryl; Colorado, 29 percent; New Mexico, 6 percent; and six other States, 13 percent.

Refinery Production.—The Beryllium Corp., at its plants near Reading and Hazelton, Pa., and The Brush Beryllium Co., Elmore, Ohio, produced beryllium metal, beryllium-copper master alloy, other beryllium-copper alloys, beryllium-aluminum beryllium-nickel, and beryllium oxide.

The 5-year contracts awarded in 1956 to The Beryllium Corp. and The Brush Beryllium Co. for annual delivery of 100,000 pounds of beryllium ingot by each firm to the Atomic Energy Commission (AEC) were amended, and the new delivery level of each contract was set at 37,500 pounds annually.

Beryl Ores Co., Arvada, Colo., produced specialized beryl materials for the ceramic industry. A. O. Smith Corp., Milwaukee, Wis., Lapp Insulator Co., LeRoy, N.Y., and the Ceramics Division, Champion Spark Plug Co., Detroit, Mich., used beryl in manufacturing ceramic articles.

Data on production were not available for publication.

CONSUMPTION AND USES

Domestic consumption of beryl was 6,000 tons in 1958, the largest quantity ever recorded. Output of beryllium metal and beryllium-copper in 1958 exceeded that in 1957; however, less beryllium-aluminum and beryllium-nickel were produced than in 1957.

Use of beryllium in test reactors and power reactors, such as the gas-cooled type being developed in England, increased. Beryllium was also consumed in research and development of potential applications of the metal for aircraft, missiles, and nuclear reactors. Recently developed uses include inertial guidance gyroscope and gimbal parts. Beryllium was also used to harden copper and nickel and to contribute ease of casting and thermal stability to aluminum.

Beryllium-copper alloys resist fatigue, corrosion, heat, and wear, and these alloys were used as parts for machines and electrical equipment, and in nonsparking tools.

Hot-pressed and machined beryllium oxide shapes were used in the nuclear, aircraft, missile, and electronic industries.[2] Beryllium oxide was also used in crucibles and coatings for crucibles.

Beryl was used in the form of ground-coat frit (glass) and in manufacturing electrical insulators and spark plugs.

[2] American Metal Market, Machined Beryllium Oxide Shapes Now Used in Atom, Aircraft, Missile Work: Vol. 65, No. 173, p. 7.

TABLE 2.—Beryl shipped from mines in the United States, by States, in short tons [1]

States	1949-53 (average)	1954	1955	1956	1957	1958
Colorado	93	59	46	[2] 163	182	134
New Hampshire	(3)	12	20	(3)	4	14
New Mexico	(3)	117	106	31	29	27
South Dakota	219	337	294	195	268	240
Other [4]	245	144	34	[2] 56	38	48
Total: Short tons	557	669	500	[2] 445	521	463
Value	$214,545	$303,649	$267,927	[2] $231,126	$275,855	$238,017

[1] Estimated 10-12 percent BeO.
[2] Revised figure.
[3] Included with "Other" to avoid disclosing individual company confidential data.
[4] Arizona 1949-51, 1953-58; Connecticut 1953-58; Georgia 1952-57; Idaho 1953-54, 1957; Maine 1949-58; Maryland 1954, 1957; New Hampshire 1949-53, 1956; New Mexico 1949-53; New York 1954; North Carolina 1949, 1951, 1953-58; Virginia 1954-56; and Wyoming 1956-58.

STOCKS

End-of-year consumer stocks of beryl totaled 4,529 tons. Stocks of beryllium metal and beryllium-copper master alloy exceeded those of 1957, but stocks of beryllium-aluminum and beryllium-nickel were smaller.

No imported beryl or domestically produced beryllium-copper was added to the national stockpile. Some domestically produced beryllium-copper containing imported raw materials was acquired as a result of the U.S. Department of Agriculture barter program in which the Commodity Credit Corporation exchanges surplus commodities for strategic materials.

PRICE AND SPECIFICATIONS

The price quoted for domestically produced beryl containing 10–12 percent BeO was $46–$48 per short-ton unit of BeO, f.o.b. mine. The price of imported beryl per short-ton unit, based on 10–12 percent BeO, c.i.f. United States ports, was $36–$37 until February 27, $34–$35 until July 24, $31–$33 until August 14, unquoted until October 2, and $28–$35 for the rest of the year.[3] The General Services Administration bought domestically produced beryl at depots located at Franklin, N.H., Spruce Pine, N.C., and Custer, S. Dak. Purchases were made on the basis of a short-ton unit (20 pounds) of contained BeO, and prices per unit were as follows: 8 to 8.9 percent, $40; 9 to 9.9 percent, $45; and 10 percent and over, $50.

The price of beryllium metal, 97 percent pure, lump or beads, f.o.b. Cleveland, Ohio, and Reading, Pa., was $71.50 per pound. Beryllium-copper master alloy was quoted f.o.b. Reading, Pa., Elmore, Ohio, and Detroit, Mich., at $43 per pound of contained beryllium, with the balance paid as copper at the market price on date of shipment. Beryllium-aluminum was quoted f.o.b. Reading, Pa., Elmore, Ohio, and Detroit, Mich., at $74.75 per pound of contained beryllium, with aluminum paid at the market price, for 5-pound ingot. Prices

[3] E&MJ Metal and Mineral Markets: Vol. 29, Nos. 1–52, January–December 1958.

of beryllium-copper strip ranged from $1.80 to $1.885 per pound and remained steady at $1.885 after October 24. Beryllium-copper rod, bar, and wire was quoted at prices ranging from $1.78 to $1.865 per pound; after October 24, it remained at $1.865 per pound.[4]

FOREIGN TRADE [5]

Imports.—Table 3 shows beryl imported for consumption, 1955–58. Other imports in 1958 were 8,050 pounds of beryllium oxide or carbonate valued at $51,828.

Exports.—Exports were 13,195 pounds of beryllium and beryllium-alloy powders (except beryllium-copper) valued at $17,776, 200 pounds of beryllium and beryllium alloys in semifabricated forms valued at $28,280, and 44,241 pounds of beryllium metal and alloys (except beryllium-copper) in crude form and scrap valued at $201,110.

TABLE 3.—Beryllium ore (beryl concentrate) imported for consumption in the United States, by countries, in short tons

[Bureau of the Census]

Country	1955	1956	1957	1958
South America:				
Argentina	441	2,330	1,545	772
Brazil	1,735	2,607	2,165	888
Total	2,176	4,937	3,710	1,660
Europe:				
Norway	-	-	-	3
Portugal	283	242	33	-
Total	283	242	33	3
Asia:				
Hong Kong	-	1	-	-
India	845	3,360	1,256	600
Korea, Republic of	6	-	-	-
Pakistan	-	15	69	-
Total	851	3,376	1,325	600
Africa:				
Belgian Congo	128	992	222	1,188
British East Africa (principally Uganda)	93	264	56	30
British Somaliland	-	29	-	-
British West Africa, n.e.c.	-	22	-	-
Madagascar	28	212	43	-
Morocco	-	26	-	-
Mozambique	620	1,110	965	284
Nigeria	3	-	-	-
Rhodesia and Nyasaland, Federation of	861	559	266	135
Union of South Africa (includes South-West Africa)	994	602	670	699
Total	2,727	3,816	2,222	2,336
Grand total: Short tons	6,037	12,371	7,290	4,599
Value	$2,226,068	$4,459,387	$2,526,068	$1,547,466

[4] American Metal Market, vol. 65, Nos. 1–250, January–December 1958.
[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

World production of beryl declined more than 40 percent.

Belgium.—The Centre d'Etude de l'Energie Nucleaire (CEN) awarded a $1.2 million contract to The Brush Beryllium Co., Cleveland, Ohio, for making two beryllium core matrices for Belgian reactor No. 2.[6]

Japan.—Beryllium-copper was reported to have been produced by Nippon Gaishi Kaisha (insulator manufacturers) of Nagoya.[7]

TABLE 4.—World production of beryl, by countries,[1] in short tons [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America: United States (mine shipments)	557	669	500	445	521	463
South America:						
Argentina	325	705	1,488	1,722	1,571	[3] 1,100
Brazil	2,431	1,581	1,954	2,321	[4] 2,136	[5] 888
Surinam	[6] 2	10	----------	----------	----------	----------
Total	2,758	2,296	3,442	4,043	3,707	1,988
Europe: [1] Portugal	138	368	337	244	191	[3] 45
Asia:						
Afghanistan	[7] 4	30	33	30	15	----------
India [5]	169	392	845	3,360	1,256	600
Korea, Republic of	1	[5] 4	[5] 6	----------	(8)	----------
Total	174	426	884	3,390	1,271	600
Africa:						
Belgian Congo (including Ruanda-Urundi)	[6] 8	50	362	1,905	1,771	[3] 1,100
British Somaliland	----------	----------	19	17	----------	----------
Kenya	[9] 1	----------	----------	----------	6	4
Madagascar	421	648	316	169	297	[3] 80
Morocco: Southern Zone	114	17	2	----------	----------	----------
Mozambique	240	1,002	960	944	1,871	1,134
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	[7] 6	1	21	13	5	13
Southern Rhodesia	1,005	1,077	963	606	572	332
South-West Africa	601	564	472	454	385	246
Uganda	35	77	110	98	78	[4] 83
Union of South Africa	554	203	137	133	711	462
Total	2,985	3,639	3,362	4,339	5,696	3,362
Oceania: Australia	78	166	230	356	442	[3] 300
World total (estimate)[1]	6,800	7,700	8,900	12,900	11,900	7,000

[1] In addition to the countries listed, beryl has been produced in the U.S.S.R.; however, production data are not available. 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 exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Experts.
[5] United States imports.
[6] One year only, as 1953 was first year of commercial production.
[7] Average for 1950–53.
[8] Less than 0.5 ton.
[9] Average for 1952–53.

[6] Modern Metals, Largest Commercial Beryllium Contract: Vol. 14, No. 5, June 1958, p. 78.
[7] Bureau of Mines Mineral Trade Notes, Copper: Vol. 46, No. 4, April 1958, p. 8.

United Kingdom.—The Atomic Energy Authority announced that contracts had been placed with various firms for constructing an advanced gas-cooled nuclear reactor at Windscale. Beryllium cans are to be used to hold the uranium oxide fuel.

The press reported that Imperial Chemical Industries, Ltd., made plans for a beryllium fabrication plant.[8]

TECHNOLOGY

The Bureau of Mines intensified its search for beryllium ore, particularly beryl, and its research on recovering low-grade beryl from pegmatites and developing methods of extracting and purifying beryllium. Many pegmatite and nonpegmatite deposits in South Dakota, Wyoming, California, Nevada, Utah, Colorado, Arizona, New Mexico, and in Maine, New Hampshire, Vermont, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, and Maryland were examined for beryllium minerals and some deposits were selected for further investigation. Plans were also made to begin examining similar deposits in Washington, Oregon, Idaho, and Montana. The Bureau continued its research on developing flotation methods to recover low-grade beryl from pegmatites. Some beryl occurrences responded to concentration by using one or another (or modifications) of Bureau-developed flotation methods.[9] However, some occurrences yielded beryl concentrate too low in quantity and quality to be practical and may require entirely new processing methods. Other research on beryllium was directed toward developing methods of recovering beryllium oxide from beryl concentrate by using liquid-liquid extraction methods and extracting beryllium from ores by chlorination. Experiments were also begun on producing beryllium with a Kroll-type reaction, using beryllium chloride and magnesium, and on making high-purity beryllium by fused-salt electrorefining methods. Field tests for detecting small quantities of beryllium in minerals were under development. A spectrographic method for determining 0.002 to 5 percent beryllium in a variable matrix was developed.[10]

The U.S. Air Force research on beryllium included work on purification, electron-beam melting, casting, extraction, forging, joining, sheet rolling, surface effects, alloy development, and toxicity.

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[8] Metal Bulletin (London), Beryllium: No. 4324, Sept. 2, 1958, p. 26.

[9] Lamb, Frank D., Beneficiation of New England Beryllium Ores: Bureau of Mines Rept. of Investigations 4040, 1947, 9 pp.

Snedden, H. D., and Gibbs, H. L., Beneficiation of Western Beryl Ores: Bureau of Mines Rept. of Investigations 4071, 1947, 18 pp.

Runke, S. M., Petroleum Sulfonate Flotation of Beryl: Bureau of Mines Rept. of Investigation 5067, July 1954, 19 pp.

A recently developed flotation method for separating spodumene and beryl, by J. S. Browning and B. H. Clemmons of the Bureau's Southern Experiment Station, Tuscaloosa, Ala., is to be patented and followed by publication of a Report of Investigations.

[10] Creitz, E. E., Spectrographic Determination of Beryllium in a Variable Matrix: Bureau of Mines Rept. of Investigations 5407, 1958, 10 pp.

Comprehensive evaluations were made of problems relating to beryllium-ore resources and use of the metal in airframes of airplanes and missiles [11] and of the toxicity of beryllium and its compounds.[12]

A report on the sources, extraction, and properties of beryllium was published.[13]

A portable field instrument, the Berylometer, was developed and marketed.[14] This instrument shows promise of being of much assistance in the exploration and examination of beryllium deposits.

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[11] Materials Advisory Board, Report of the Panel on Beryllium (MAB–129–M): Nat. Academy of Sciences Nat. Research Council, Washington 25, D.C., June 25, 1958, 90 pp.

[12] Materials Advisory Board, Report of the Panel on Toxicity of Beryllium (MAB–135–M): Nat. Academy of Sciences, Nat. Research Council, Washington 25, D.C., July 31, 1958, 22 pp.

Breslin, A. J., and Harris, W. B., Health Protection in Beryllium Facilities, Summary of Ten Years of Experience: U.S. Atomic Energy Comm., Rept. HASL–36, May 1, 1958, 58 pp. (Available from Office of Tech. Services, U.S. Dept. of Commerce, Washington 25, D.C.)

[13] Hodge, Webster, Beryllium for Structural Applications, A Review of the Unclassified Literature: Defense Metals Inf. Center, Battelle Memorial Inst., DMIC Rept. 106, Aug. 15, 1958, 178 pp. (Available from Office of Tech. Services, U.S. Dept. of Commerce, Washington 25, D.C., Rept. PB 121648.)

[14] Brownell, George M., A Beryllium Detector for Field Exploration, paper presented at meeting of Soc. of Econ. Geol. at St. Louis, Mo., Nov. 7, 1958. 11 pp. (Instrument obtainable from Nuclear Enterprises, Ltd., 1750 Pembine Highway, Winnipeg 9, Manitoba, Canada, and from Isotopes Specialties Co., Inc., 170 W. Providencia Street, Burbank, Calif.

Bismuth

By H. M. Callaway[1] and Edith E. den Hartog[2]

A SHARP DECLINE in consumption and an attendant rise in consumer inventories characterized bismuth metal in 1958. However, problems of oversupply were averted by decreased domestic refinery production, curtailed imports, accelerated exports, and increased shipments to Government account.

DOMESTIC PRODUCTION

Reversing a 3-year upward trend, the domestic output of bismuth metal declined 17 percent in 1958. As in previous years, production came almost exclusively from metallurgical byproducts of lead refining. The bismuth-enriched byproducts, in turn, were derived from both foreign and domestic ores. Companies reporting production in 1958 were American Smelting and Refining Co., The Anaconda Co., and United States Smelting Lead Refinery, Inc.

TABLE 1.—Salient statistics of bismuth metal, 1949–53 (average) and 1954–58, in pounds

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Consumption	[1] 1,693,333	1,439,000	1,548,000	1,513,000	1,615,100	1,242,700
Imports	637,445	644,300	595,600	918,200	[2] 849,000	[2] 751,800
Exports	(3)	(3)	(3)	(3)	[2] 24,300	[2] 63,700
Price per pound, New York, ton lots	$2.25	$2.25	$2.25	$2.25	$2.25	$2.25
Consumers' and dealers' stocks Dec. 31	[1] 191,200	252,800	234,300	229,000	[4] 375,300	546,100
World: Production	4,100,000	3,700,000	4,400,000	5,700,000	5,500,000	4,900,000

[1] Data not available for 1949 and 1950.
[2] As reported to Bureau of Mines by respondent companies.
[3] Comparable data not available.
[4] Revised figure.

Bismuth recovered from alloy scrap and reclaimed in alloy products was estimated to have totaled 130,000 pounds in 1958.

CONSUMPTION AND USES

In 1958 users of bismuth in the United States consumed 1.2 million pounds of metal—23 percent less than the 1957 quantity. The decline was attributed to two factors: (1) the lower level of industrial activity that persisted throughout the first 9 months of the year; and (2) larger

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

imports of bismuth in intermediate smelter products that directly entered untabulated industrial end uses.

STOCKS

Stocks of metallic bismuth held by consumers and dealers rose 46 percent to 546,000 pounds—a record stock for the 8 years the Bureau of Mines has assembled data on bismuth stocks. However, producer stocks declined 25 percent, indicating the abnormally high consumer inventories represented a shift in stocks rather than a surplus metal buildup.

TABLE 2.—Bismuth metal consumed in the United States, 1957–58, by uses, in pounds

Use	1957	1958	Uses	1957	1958
Fusible alloys	756,100	488,400	Experimental uses	80,400	87,000
Other alloys	354,800	208,400	Other uses	17,100	36,300
Pharmaceuticals [1]	406,700	422,600	Total	1,615,100	1,242,700

[1] Includes industrial and laboratory chemicals.

PRICES

In 1958 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. Bismuth ore, also listed in The Metal Bulletin, was quoted at $1.19 per pound of contained bismuth in 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 through 1958.

FOREIGN TRADE [3]

Imports of refined metal declined 11 percent in 1958, reflecting the diminished industrial demand. Metal imports were augmented by substantial quantities of bismuth that entered the United States as a minor constituent of concentrates and base bullion and as impure bismuth-lead bars. The economically recoverable bismuth content of imported concentrates and bullion entered the market as domestically refined bismuth. Most of the bismuth-lead bars, however, were consumed directly in alloy fabrication. The statistics presented herein exclude this category of imported bismuth which was estimated to have been 275,000 pounds in 1958.

Responding to the continued high level of demand in Europe, domestic producers and dealers exported 64,000 pounds of bismuth metal in 1958—a threefold increase from the 1957 quantity.

[3] Based on company reports to the Bureau of Mines.

TABLE 3.—General imports of bismuth metal into the United States, 1957–58, in pounds

Country	1957	1958
Mexico	210,325	180,195
Peru	580,316	496,982
Yugoslavia	58,387	74,574
Total	849,028	751,751

TABLE 4.—Exports of bismuth metal from the United States, 1957–58, in pounds

Country	1957	1958
Canada	4,250	4,250
Chile		3,500
India	11,595	
Sweden	4,885	
Switzerland	2,600	
United Kingdom		51,311
Other countries	1,000	4,670
Total	24,330	63,731

WORLD REVIEW

Bolivia.—The Tasna Chorolque Telamayu properties were reopened in early 1958. Companies in the United States, previously dealing only in metal and alloys, showed increased interest in purchasing the concentrate that customarily is smelted in Europe. Comibol planned further expansions and more efficient milling processes. In November, the Bolivian Government imposed a 3-percent royalty tax on the value of bismuth concentrate but exempted the first year's production from newly developed mines.

Canada.—Output in Canada rose 43 percent in 1958. Refined bismuth metal was produced at Trail, British Columbia, by the Consolidated Mining & Smelting Co. of Canada, Ltd. Semirefined bismuth was produced by Molybdenite Corp. of Canada, Ltd., at La Corne in western Quebec, and Gaspe Copper Mines, Ltd., at Murdochville, Quebec. In addition, a small quantity of bismuth was recovered by Deloro Smelting & Refining Co., Ltd., Deloro, Ontario, in refining silver-cobalt ores from the Cobalt-Gowganda area of Northern Ontario.

Japan.—Mitsui Mining & Smelting Co., Ltd., produced bismuth as a byproduct of smelting lead-zinc ore from its Kamioka mine in Gifu Prefecture. Furukawa Mining Co. was the second largest Japanese bismuth producer.

Korea.—The Korea Tungsten Mining Co., the country's only bismuth producer, recovered bismuth from its Sang Dong mine. The 30-percent bismuth concentrate was smelted at Seoul and exported to United Kingdom.

Mexico.—In 1958 Mexico exported 310,000 pounds of bismuth metal and impure lead-bismuth bars. Netherlands was the leading recipient, followed by United States and United Kingdom. American Smelting and Refining Co. produced semirefined high-bismuth bars at Monterrey, and Cia. Metalurgica Penoles, S.A., a subsidiary of American

Metal Climax, Inc., produced high-purity metal at its refinery at Penoles.

TABLE 5.—World production of bismuth, by countries,[1] 1949–53 (average), and 1954–58 in pounds[2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country[1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada (metal)[3]	160,914	258,675	265,896	285,861	319,941	457,088
Mexico[3]	683,796	795,900	773,800	1,391,100	780,200	417,700
South America:						
Argentina:						
Metal	[4] 220		16,300			
In ore[4]	490	10,140	20,700	20,000	47,800	59,300
Bolivia[5]	79,330	101,467	113,000	74,800	90,600	106,200
Peru[3]	580,306	691,731	734,714	634,757	804,800	895,200
Europe:						
France (in ore)	169,754	24,300	69,500	142,200	119,000	[4] 110,000
Spain (metal)	37,059	32,985	48,234	71,650	190,500	[6] 110,000
Sweden[4]	52,900	110,000	145,500	88,000	120,000	110,000
Yugoslavia (metal)	167,237	241,842	229,516	245,039	219,805	169,670
Asia:						
China (in ore)	[4] 72,750	(7)	(7)	(7)	(7)	(7)
Japan (metal)	85,821	118,610	142,364	156,859	144,800	[4] 143,000
Korea, Republic of (in ore)	241,148	254,000	287,000	401,000	240,000	198,000
Africa:						
Belgian Congo (in ore)	840	2,000	70			
Mozambique	4,658	1,905	4,145	785	6,975	2,141
South-West Africa (in ore)	3,461	2,500	2,360	310	670	680
Uganda	7,324	400	3,100	660	2,700	[4] 2,600
Union of South Africa (in ore)	8,441	1,080	228	360	145	[4] 2,500
Oceania:						
Australia (in ore)	2,015	1,345	3,000	5,150	1,340	[4] 1,000
World total (estimate)[1][2]	4,100,000	3,700,000	4,400,000	5,700,000	5,500,000	4,900,000

[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, Germany, 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 exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Refined metal plus bismuth content of bullion exported.
[4] Estimate.
[5] 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.

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 of refined metal and a large portion of the impure bismuth bars were shipped to the United States.

TECHNOLOGY

Developments in thermoelectric and nuclear devices relating to bismuth continued in 1958. Bismuth telluride remained the most popular thermoelectric element in experimental cooling devices based on the Peltier effect, although researchers expanded knowledge of the thermoelectric responses of many previously unconsidered materials in an attempt to bypass a supply bottleneck and increase efficiency of nonmechanical cooling appliances.

Babcock & Wilcox Co., under contract with the Atomic Energy Commission, continued experiments preparatory to constructing a liquid metal thermal reactor to generate mechanical power from the nuclear fission of uranium suspended in molten bismuth.

Boron

By Henry E. Stipp [1] and James M. Foley [2]

EXPLORATION for boron mineral deposits was greatly accelerated in 1958 and the discovery of deposits in the United States (southern California), Turkey, and China was announced. Domestic demand for boron products was expected to double by 1969. A substantial market for boron oxide was expected to develop rapidly as a result of the U.S. Government boron high-energy-fuels program. Expansion of domestic industrial boron production capacity continued in 1958.

TABLE 1.—Salient statistics of boron minerals and compounds in the United States

	1949-53 (average)	1954	1955	1956	1957	1958
Sold or used by producers:						
Short tons:						
Gross weight [1]	655,436	790,449	[2] 522,466	[2] 546,815	[2] 541,124	528,209
B_2O_3 content	190,720	230,500	[2] 246,226	[2] 267,864	[2] 269,251	265,613
Value	$15,841,000	$26,714,000	[2] $30,739,000	[2] $32,848,000	[2] $38,041,000	$38,310,000
Imports for consumption (refined):						
Pounds	1,004		22,046			47,368
Value	$374		$2,400			$133,000
Exports:						
Short tons	141,625	205,614	222,588	243,725	214,497	235,584
Value	$8,836,000	$12,904,000	$14,533,000	$16,596,000	$15,975,000	$18,292,000
Apparent consumption:						
Short tons	513,812	584,835	[1 2] 299,889	[1 2] 303,090	[1 2] 326,627	[1] 292,649

[1] Gross weight reported for 1949–54 included a higher proportion of crude ore to finished products than in 1955–58.
[2] Revised figure.

DOMESTIC PRODUCTION

Boron minerals were produced by American Potash & Chemical Corp. from the brines 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.; West End Chemical Division of Stauffer Chemical Co. recovered boron minerals from the brine of Searles Lake at Westend, Calif.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

An official of U.S. Borax & Chemical Corp. predicted that growing demand for boron products would cause production to double within 10 years.[3] Another representative of U.S. Borax & Chemical Corp. advocated an increase in the depletion allowance on borax from 15 to 23 percent.[4]

U.S. Borax & Chemical Corp. increased boric acid production at Wilmington, Calif. Its subsidiary, U.S. Borax Research Corp., which completed construction of a laboratory at Anaheim, Calif., in 1958, was granted an Air Force contract to study high-temperature inorganic polymers. An agreement between U.S. Borax Research Corp. and Dow Chemical Co. to conduct research on an economic process for manufacturing boron trichloride was announced.[5]

Stauffer Chemical Corp. and Aerojet-General Corp. formed a joint partnership, known as the Stauffer-Aerojet Co., to conduct research and development on high-energy fuels.[6] Stauffer increased capacity of its San Francisco boric acid plant by 50 percent.

The Atomic Energy Commission announced a revised plan for sale of the boron-10 isotope. Boron, enriched to 92 percent, will be distributed by the Chicago Operations Office. Small quantities of boron, enriched to greater concentration, may be obtained from the Oak Ridge National Laboratory.[7]

Exploration for boron minerals was greatly accelerated. The Kern County Land Co., announced the discovery of a deposit estimated to contain approximately 40 million tons of colemanite in the Mojave Desert near the Kern County-San Bernardino County line.[8]

Kerr-McGee Oil Industries, Inc. leased 14,885 acres in Kern and San Bernardino Counties from South Pacific Land Co.[9]

Milton L. Kane, of Los Angeles, Calif., reported the discovery of a boron deposit in Ventura County, Calif. Sodium borate deposits of southern Harney County, Oreg., were the object of increased interest, as numerous prospecting applications were filed in 1958.[10]

CONSUMPTION AND USES

Borax, sodium tetraborate decahydrate, pentahydrate and dehydrated borax comprised the greatest portion of sales of boron products in 1958. Large quantities of borax were consumed in the glass and ceramics industries, where it was used in porcelain enamel, ceramic glazes, heat-resistant glass, and glass wool. Soaps, detergents, and disinfectants consumed large quantities of borax. Borax in small quantities was added to fertilizers to supply an element essential for growth of vegetation. In large concentrations borax is toxic to

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[3] Oil, Paint and Drug Reporter, Boron Has Doubled Output, Is Seen Doubling It Again: Vol. 174, No. 14, Sept. 29, 1958, p. 7.

[4] Mining Engineering, Aid For Boron: Vol. 10, No. 3, March 1958, p. 321.

[5] Metal Industry (London), Boron Trichloride: Vol. 93, No. 25, Dec. 19, 1958, p. 519.

[6] Oil, Paint and Drug Reporter, Boron Compounds Bringing Stauffer, Aerojet-General Together: Vol. 173, No. 3, Jan. 20, 1958, pp. 4, 63.

[7] U.S. Atomic Energy Commission, Washington 25, D.C., No. A-145, June 17, 1958.

[8] Mining World, Large Boron Discovery in California Desert: Vol. 20, No. 4, April 1958, p. 61.

[9] Engineering and Mining Journal, vol. 158, No. 12, December 1957, p. 166.

[10] Western Mining and Industrial News, Borax Development in South Oregon: Vol. 26, No. 9, September 1958, p. 16.

plants; consequently it was used in weed-killing products. Other uses for borax were in welding, brazing, and soldering fluxes, paper, glue, and paint.

Large quantities of boric acid, a compound produced from borax, were consumed in ceramic, pharmaceutical, and cosmetic products.

A Stauffer Chemical Co. official characterized borax and boric acid as good basic chemicals with excellent prospects for future growth.[11]

Elemental boron was used in shielding material for atomic energy applications, fuses for rockets and flares, igniters in rectifier and control tubes, deoxidizers and grain-refining alloys in nonferrous metals, and solar batteries. Extremely small quantities of boron, in the form of boron compounds, were added to low- and medium-carbon and low-alloy steels to increase hardenability and save alloying metals. Boron-bearing carbon steel was used in sprockets for tractors. Boron was added to stainless steels and related alloys to control corrosion and heat resistance, reduce hot shortness, increase product yield, and serve as control rods and shields in atomic reactors. During 1958, 12.8 short tons of boron metal (189 tons gross weight of alloying compounds) was consumed in producing steel in the United States as compared with 64 short tons (461 tons gross weight of alloying compounds) in 1957.[12]

Recent interest in boron carbide was reported to be motivated by rapid technological strides in the fields of hard materials, nuclear energy, and exotic fuels.[13] The extreme hardness of boron carbide has led to its use in solid shapes for nozzles and gage parts and in a variety of specialized uses such as in ultrasonic machining. As a shielding or control-rod material for the absorption of thermal neutrons in nuclear reactors boron carbide has a unique combination of advantages. It has become important as a feed material for the production of boron trichloride, which in turn is a potential starting material for other boron compounds.

Boron compounds were used as intermediate materials in many chemical processes. Three boron compounds, reported used as intermediates in producing high-energy fuels, were sodium borohydride, boron trichloride, and boron trifluoride. Sodium borohydride was used also as a reducing agent in manufacturing paper, pharmaceuticals, and fine chemicals. Boron trichloride was employed as a catalyst in producing silicones and as an extinguishing agent for magnesium fires. Boron trifluoride was used as a catalyst in producing coal and petroleum products. It was employed also in recovering the boron-10 isotope for use in atomic energy applications. Boron carbide was used as a chemical intermediate, a neutron-control material in atomic reactors, and as an abrasive. Compounds of boron, oxygen, and carbon, such as borate esters, were used in dehydrating agents, synthesis intermediates, insecticides, solvents, catalysts, pharmaceuticals, plasticizers, hydraulic fluids, stabilizers in plastics, paints and enamels, soldering and brazing fluxes, and gasoline additives. Triethylborane and tri-

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[11] American Metal Market, Stauffer Sees Coming Growth in Special Metals: Vol. 65, No. 83, Apr. 30, 1958, p. 8.

[12] American Iron and Steel Institute, Annual Statistical Report: New York, N.Y., 1958, p. 24.

[13] The Carborundum Co., Advanced Materials Technology, Boron Carbide Sparks New Opportunities for Progress in Many Fields: Vol. 1, No. 3, May 1958, pp. 4, 5.

butylborane were used as catalysts to promote the polymerization of vinyl chloride, methacrylic esters, acrylic esters, and acrylonitrile. Amine boranes were used for reduction of aldehydes and ketones, stabilization against color formation, preparation of diborane, as polymerization catalysts, and as petroleum additives. Trimethoxyboroxine was used as a fire-extinguishing fluid on metal fires, and as a polymerization agent for glycidyl ethers. Methyl borate served as a catalyst for condensation of ketenes with aldehydes or ketones to form B-lactones. It forms azetropes with many other liquids and has been used to separate various types of hydrocarbons. It has also been used in neutron-absorbing and -detecting.

Two processing areas of the Callery Chemical high-energy-boron fuel plant at Muskogee, Okla., began operating during the first quarter of the year. The Callery plant at Lawrence, Kans., began operating in April.[14]

A $31 million contract was awarded Callery Chemical by the U.S. Navy for production of boron fuels at the Callery plant in Muskogee, Okla.[15] Sample quantities of triethylborane were offered by Callery Chemical Co. for experimental studies. The colorless liquid catalyzes polymerization of unsaturated monomers and also can be used as a jet fuel.[16] Callery made research quantities of the following alkyl boric acids in 1958: Chloropropyldihydroxyborane, dihydroxynonylborane, and dihydroxydodecylborane.

Olin Mathieson Chemical Corp. began producing boron-based high-energy fuel for the U.S. Navy at Model City, N.Y.

In the same vicinity Girdler Construction Division was awarded a subcontract to design and build a hydrogen plant to serve a second high-energy fuel plant under construction by Olin Mathieson for the U.S. Air Force.[17]

AFN, Inc., began operating a high-energy fuel pilot plant at Henderson, Nev., for the U.S. Air Force.[18]

It was estimated that one group of high-performance bombers (approximately 30 planes), operating 25 percent of the time on boron fuel, would require about 105,000 tons of fuel per year.[19] An annual market for 150,000 tons B_2O_3, equivalent to 45 percent current U.S. production, could develop.

PRICES

The price of most grades of borax and boric acid increased about 5 percent January 1, 1958. The following prices were quoted by Oil, Paint and Drug Reporter:

[14] Chemical and Engineering News, Callery Chemical Will Start to Operate: Vol. 36, No. 16, Apr. 21, 1958, p. 17.
[15] Chemical Engineering Progress, First Major High-Energy Fuel Contract to Callery: Vol. 54, No. 5, May 1958, p. 22.
[16] Chemical and Engineering News, Triethylborane: Vol. 36, No. 20, May 19, 1958, p. 40.
[17] Chemical and Engineering News, New Facilities: Vol. 36, No. 20, May 19, 1958, p. 20.
[18] Chemical and Engineering News, AFN, Inc.: Vol. 36, No. 26, June 30, 1958, p. 25.
[19] Gibbons, D. R., Chemical Fuels and Other Organometallic Compounds: Their Impact on the Mineral Industry: Arthur D. Little, Inc., Cambridge 42, Mass. (pres. at AIME meeting Feb. 20, 1958).

	Jan. 6–13	*Jan. 13–December*
Borax, tech., anhydrous, bags, carlots, works, ton	$87.50	Unchanged.
Ton lots, bags, exwarehouse, New York or Chicago, ton	143.75	Do.
Bulk, carlots, works, ton	78.50	Do.
Granular, decahydrate, 99½ percent, bags, carlots, works, ton	47.50	Do.
Ton lots, bags, exwarehouse, New York or Chicago, ton	103.75	Do.
Bulk, carlots, works, ton	41.00	Do.
Pentahydrate, 99½ percent, bags, carlots, works, ton	63.00	Do.
Ton lots, bags, exwarehouse, New York or Chicago, ton	119.25	Do.
Bulk, carlots, works, ton	56.50	Do.
Powder, 99½ percent, bags, carlots, works, ton	68.00	$52.50
Ton lots, bags, exwarehouse, New York or Chicago, ton	124.25	108.75

U.S.P. borax is $15 per ton higher than technical.

	January–December
Boric acid, tech., anhydrous, 99.9 percent, bags, carlots, works, ton	$335.00
Ton lots, bags, exwarehouse, New York or Chicago, ton	390.00
Crystals, 99.9 percent, bags, carlots, works, ton	133.50
Ton lots, bags, exwarehouse, New York or Chicago, ton	190.75
Granular, 99.9 percent, bags, carlots, works, ton	108.50
Ton lots, bags, exwarehouse, New York or Chicago, ton	165.75
Powder, 99.9 percent, bags, carlots, works, ton	113.50
Ton lots, bags, exwarehouse, New York or Chicago, ton	170.75

U.S.P. boric acid $25 per ton higher than technical.

FOREIGN TRADE [20]

The United States exported boron minerals and compounds to many countries throughout the world.

In 1958, 47,000 pounds of boron carbide valued at $133,000 was imported into the United States. There were no imports of boron minerals.

WORLD REVIEW

The United States produced a large part of the world supply of boron minerals in 1958; several other countries produced smaller quantities. Worldwide attention was focused on deposits of boron minerals in many countries, stimulated by the use of boron in high-energy fuels.

SOUTH AMERICA

Argentina.—Production of borates in 1957 totaled 22,898 short tons valued at $3.5 million.[21] Control of borax exports from Argentina was initiated in September. Submitting end-use information with export applications was required.[22] Borax production in Argentina was limited by the capacity of the refining plants, and by the transportation capacity of the Belgrano Railway. Boric acid production varied between 220 and 275 short tons a month and was used by

[20] 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.

[21] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 1259: Feb. 26, 1959, p. 2.

[22] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 404: Sept. 9, 1958, p. 2.

TABLE 2.—Boric acid, borates, and compounds [1] exported from the United States, by countries of destination

[Bureau of the Census]

Country	1957 Short tons	1957 Value	1958 Short tons	1958 Value
North America:				
Canada	12,805	$1,321,831	14,056	$1,524,517
Costa Rica	273	22,821	295	32,201
Cuba	529	47,410	521	43,578
Mexico	4,023	381,325	4,348	415,177
Nicaragua	36	9,104	12	4,305
Trinidad and Tobago	18	1,328	18	1,453
Other North America	145	15,578	70	10,613
Total	17,829	1,799,397	19,320	2,031,844
South America:				
Brazil	4,267	347,839	5,171	430,204
Columbia	739	73,606	424	46,072
Peru	475	32,233	473	34,256
Uruguay	239	31,404	80	8,868
Venezuela	355	29,531	235	24,792
Other South America	30	3,734	57	12,054
Total	6,105	518,347	6,440	556,246
Europe:				
Austria	3,275	161,298	3,277	160,724
Belgium-Luxembourg	3,348	223,508	2,944	253,068
Denmark	1,178	74,289	927	107,990
Finland	945	65,162	590	41,643
France	22,377	1,562,266	29,191	2,153,625
Germany, West	42,884	2,859,976	48,427	3,180,397
Greece	518	26,766	579	30,496
Ireland	1,111	70,617	1,128	69,441
Italy	10,797	632,982	10,338	675,557
Netherlands	12,063	1,015,408	11,358	994,803
Norway	3,495	327,135	3,585	329,382
Poland			1,968	114,719
Portugal	165	16,490	1,522	116,547
Spain	30	5,468	1,239	61,544
Sweden	3,640	258,865	2,935	207,681
Switzerland	4,834	335,895	4,989	380,038
United Kingdom	44,369	3,121,024	44,431	3,338,888
Yugoslavia	1,685	127,992	1,103	100,044
Other Europe			28	2,145
Total	156,714	10,885,141	170,559	12,318,732

Country	1957 Short tons	1957 Value	1958 Short tons	1958 Value
Asia:				
Ceylon	39	$3,220	125	$7,605
Hong Kong	2,551	189,581	4,137	346,772
India	4,819	362,579	4,507	328,964
Indonesia	329	20,261	877	52,456
Iran	156	11,714	276	17,965
Israel	476	35,282	485	36,209
Japan	11,862	893,854	14,505	1,150,356
Korea, Republic of	238	16,008	192	21,264
Lebanon	65	4,654	57	3,459
Malaya, Federation of	45	2,658	20	1,673
Singapore, Colony of			75	5,531
Pakistan	497	48,437	599	44,857
Philippines	509	53,491	596	63,645
Taiwan	321	24,664	844	55,439
Thailand	177	14,242	467	36,278
United Arab Republic (Syria Region) [2]	66	6,201	55	5,298
Viet Nam, Laos, and Cambodia	956	74,828		
Other Asia	21	3,860	121	7,745
Total	23,127	1,765,534	27,938	2,185,516
Africa:				
Rhodesia and Nyasaland, Federation of	266	19,298	151	13,891
Union of South Africa	2,790	274,961	1,437	149,366
United Arab Republic (Egypt Region) [2]	119	9,858	216	20,335
Other Africa	122	12,448	180	20,279
Total	3,297	316,565	1,984	203,871
Oceania:				
Australia	5,155	490,602	6,530	684,249
New Zealand	2,270	199,698	2,813	311,625
Total	7,425	690,300	9,343	995,874
Grand total	214,497	15,975,284	235,584	18,292,083

[1] Effective Jan. 1, 1958, classified by the Bureau of the Census as boric acid and borates, crude, refined, and compounds (including borate esters and other boron compounds), n.e.c. data not strictly comparable with 1957.
[2] Effective July 1, 1958.

domestic industry. Refined borax production varied between 1,653 and 1,874 short tons a month; 551 to 772 short tons was used for domestic consumption.[23]

Chile.—Production of ulexite totaled 9,292 short tons as compared with 6,379 short tons in 1957.[24] Borax Consolidated, Ltd., a subsidiary of Borax Consolidated, Ltd., of England, mined ulexite at Salar Ascotan, near the "Cebollar Station of the Antofagasta and Bolivia Railway." This 24 miles long by 6 miles wide dry lake, is in the Calama district, department of El Loa, province of Antofagasta. Cristalerias de Chile, the leading glass manufacturer in Chile, built a plant for the production of borax, boric acid, and various other chemicals at Padre Hurtado, 15 miles from Santiago. Plant capacity was about 220 short tons of borax and 40 tons of boric acid.[25]

EUROPE

Austria.—The duty on crude boric acid was raised to equal that on refined boric acid. Domestic, chemically refined boric acid could not compete with the high-purity foreign crude.[26]

France.—The French firm Quartz et Silice began producing boron-10 isotope at a plant near Paris. The production process included fractional distillation of a boron trifluoride-diethyl ether complex in a single column containing 1,200 plates one-half inch apart.[27]

Germany, West.—Production of boron and boron compounds during 1957 totaled 50,400 short tons.[28]

Italy.—Boric acid production totaled 4,000 short tons in 1957.[29]

United Kingdom.—United Kingdom Atomic Energy Authority signed a 10-year agreement with 20th Century Electronics, New Addington, Croydon, on production and supply of boron-10. The firm is licensed to use Authority patents and to sell surplus boron-10 and boron-11.[30] Sixteen boron compounds in two grades, 99.8 and 99 percent, were marketed in 1957.[31] The new sodium perborate plant of Laporte Chemicals, Ltd., at Warrington had ample capacity to meet foreseeable demand at home and from abroad.[32]

ASIA

China.—Deposits of boron and other minerals reportedly were discovered in Yunnan and Chinghai and in the Inner Mongolian autonomous region of China.[33]

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[23] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 23.
[24] U.S. Embassy, Santiago, Chile, State Department Dispatch 1106: May 6, 1959, p. 1. U.S. Embassy, Santiago, Chile, State Department Dispatch 620: Dec. 17, 1958, p. 3.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, pp. 25–27.
[26] U.S. Embassy, Vienna, Austria, State Department Dispatch 963: Apr. 1, 1958, p. 6.
[27] Chemical Engineering, Close Spacing Gets Close Fractionation: Vol. 65, No. 21, Oct. 20, 1958, p. 64.
[28] U.S. Embassy, Düsseldorf, Germany, State Department Dispatch 196: Apr. 30, 1958, p. 3.
[29] U.S. Embassy, Rome, Italy, State Department Dispatch 1360: Apr. 30, 1958, p. 1.
[30] Chemistry and Industry (London), British Production of Boron-10: No. 38, Sept. 20, 1958, p. 1239.
[31] Chemical Age (London), Borax Introduce Metallic Borides: Vol. 79, No. 2010, Jan. 18, 1958, p. 164.
[32] Chemical Age (London), vol. 80, No. 2054, Nov. 22, 1958, p. 858.
[33] Mining Journal (London), Mining Miscellany: Vol. 251, No. 6416, Aug. 8, 1958, p. 152.

Turkey.—Estimated production of boron minerals and compounds totaled 56,506 short tons valued at $2 million.[34] The boron industry was reviewed, with emphasis on the geology of borate deposits and mining operations. A conservative estimate of the ore reserve was given as 3 million tons of proved ore, 10 million tons of probable ore, and 15 million tons of possible ore.[35] Private U.S. investment for developing a boron-mineral concession and establishing a plant for manufacturing borax and boric acid was sought by a Turkish mining firm.[36] The boron mineral deposit near Hisarcik, south of Emet, Kutahya, was opened July 10. The deposit was believed to contain more than 7 million tons of colemanite.[37]

TECHNOLOGY

A patent was granted for recovering boric acid and calcium chloride from colemanite or other crude calcium borate ore by treating the ore with hydrochloric acid.[38]

The primary borate minerals in nonmarine bedded borate deposits were said to be borax, ulexite, inderite, and inyoite.[39]

A composition was patented for spraying combustible materials in the path of a fire to retard its progress.[40] The composition is an aqueous suspension of a finely divided calcium borate, such as colemanite or ulexite, and a small amount of bentonite.

Several reports were written on the use of boron material in glass and ceramics. The addition in glass of up to 12 percent boric acid was said to reduce expansion of the glass when it was subjected to heat.[41] Values for the specific heat of Pyrex glass was obtained and compared with values in literary sources.[42]

In Costa Rica small quantities of boron added to soils deficient in that element increased yields of coffee by several hundred percent. The failure of plants to blossom, locally called cafe mocha, was found to result from excess manganese. Applications of boron, lime, magnesium and zinc corrected the situation.[43]

A patent was issued on a method of coating metal with metallic boride by passing a metallic borohydride vapor over the surface of the metal at a temperature of 400° to 800° C.[44]

[34] U.S. Embassy, Ankara, Turkey, State Department Dispatch 671: Apr. 28, 1959, p. 1.
[35] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 5, Special Supplement No. 53, May 1958, 47 pp.
[36] Foreign Commerce Weekly, Boron Project in Turkey Planned: Vol. 59, No. 15, Apr. 14, 1958, p. 20.
[37] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 25–27.
[38] May, F. H., and Levasheff, V. V. (assigned to Callery Chemical Co., Pittsburgh, Pa.), Recovery of Boric Acid From Crude Borate Ores: U.S. Patent 2,855,276, Oct. 7, 1958.
[39] Muessig, Siegfried, Primary Borates in Playa Deposits: Minerals of High Hydration: Econ. Geol., vol. 53, No. 7, November 1958, p. 925.
[40] Connell, G. A., (assigned to U.S. Borax & Chemical Corp., Los Angeles, Calif.), Methods and Compositions for Controlling Fires: U.S. Patent 2,858,895, Nov. 4, 1958.
[41] Mining Journal (London), Borates: Vol. 250, No. 6398, Apr. 4, 1958, p. 382.
[42] Moore, J., and Sharp, D. E., Note on Calculation of Effect of Temperature and Composition on Specific Heat of Glass: Jour. Am. Ceram. Soc., Ceram. Abs., vol. 41, No. 11, November 1958, p. 462.
[43] U.S. Borax & Chemical Corp., Boron-O-Gram: NS–43, May–June 1958, p. 1.
[44] Reid, M. H., and Brenner, Abner (assigned to the United States of America as represented by the Secretary of Commerce), Method of Producing Boride Coatings on Metal: U.S. Patent 2,849,336, Aug. 26, 1958.

An instrument designed to measure continuously the boron content of process streams was said to be accurate to ±1 percent by volume.[45]

A silver fluoroborate scrubbing solution was used in a process designed to separate olefins from a mixture of cracked gases.[46] The silver fluoroborate solution dissolved more olefin per unit volume than any other salt solution tested, and the process could be used to produce polymerization-grade ethylene and propylene.

X-ray techniques were used for product development and quality control of boron materials.[47]

Discovery of a new class of boron compounds was reported.[48] The boron-carbon ring compounds, 1-n-butylboracyclopentane and 1-n-butylboracyclohexane, were isolated during attempts to prepare 1,4-bis(di-n-butlyboryl)-butane and 1,5-bis(di-n-butylboryl)-pentane.

Boron trichloride was reported to be a valuable reagent for degrading cyclic acetals and ketals of hexitols to the parent hexitols.[49] It also was effective in demethylation and deacylation of sugar derivatives and in degrading certain polysaccharide derivatives.

Bellevue Laboratories applied for patents on a new process for producing boron trichloride.[50]

BBB-tri(chloromethyl)borazole was obtained in 60 percent yield when trichloroborazole was added to diazomethane in ether solution at −65° C.[51]

A process was patented for preparing alkyl esters of oxygen acids of boron.[52]

A patent was issued for producing a potassium perborate from aqueous solutions of potassium metaborate and hydrogen peroxide.[53]

Organic acids were prepared by reacting an inorganic acid catalyst and an olefin-acting material in the presence of carbon monoxide and a saturated hydrocarbon. An acid phase containing a reaction product was separated from the reaction mixture and the product hydrolyzed to form an organic acid.[54]

Boric acid was prepared from a mixture of trimethyl borate and methanol by hydrolyzing the trimethyl borate with a saturated aqueous solution of boric acid.[55] The boric acid that precipitated during

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[45] Chemical Engineering, Stream Analyzer: Vol. 65, No. 26, Dec. 29, 1958, p. 40.

[46] Chemical Engineering, New Solution for Separating Olefins: Vol. 65, No. 19, Sept. 22, 1958, p. 82.

[47] Engineering Mining Journal, X-ray Is Key Tool in PCB Laboratory: Vol. 158, No. 11, November 1957, p. 124.

[48] Chemical and Engineering News, The Boron-Carbon Ring: Vol. 36, No. 17, Apr. 28, 1958, pp. 56, 57.

[49] Chemistry and Industry (London), Boron Trichloride As a Degradative Reagent for Carbonhydrates and Their Derivatives: No. 21, May 24, 1958, p. 630.

[50] Chemical and Engineering News, Claims for a New Boron Trichloride Process: Vol. 36, No. 3, Jan. 20, 1958, p. 23.

[51] Chemistry and Industry (London), Preparation of Chloromethyl Derivatives of Boron by the Diazomethane Method: No. 43, Oct. 25, 1958, p. 1405.

[52] Buls, Vernon W., and Thomas, Richard I. (assigned to Shell Development Co., New York, N.Y.), Preparation of Esters of Boronic and Borinic Acids: U.S. Patent 2,835,693, May 20, 1958.

[53] Bretschneider, Gunther (assigned to Deutsche Gold-und-Silber-Scheideanstalt, Frankfurt-am-Main, Germany), Process for the Production of a Potassium Perborate Product Containing a High Active Oxygen Content: U.S. Patent 2,851,334, Sept. 9, 1958.

[54] Schneider, Abraham (assigned to Sun Oil Co., Philadelphia, Pa.), Preparation of Organic Acids Having a Quaternary Alpha Carbon Atom: U.S. Patent 2,864,858, Dec. 16, 1958.

[55] May, Frank H., Levasheff, Vladimir V., and Hammar, Howard N. (assigned to Callery Chemical Co., Pittsburgh, Pa.), Recovery of Boric Acid From Trimethyl Borate: U.S. Patent 2,833,623, May 6, 1958.

hydrolysis was recovered. Methanol was then distilled from the hydrolysis mixture crystallizing boric acid, which was recovered.

Boron carbide powders of desired particle size were produced by heating carbon, boric oxide, or alkali metal tetraborate, or an alkali earth-metal tetraborate and a reducing agent such as metallic magnesium to a temperature of 930° to 2,000° C.[56] Boron carbide was separated by leaching with hot dilute hydrochloric and nitric acids.

A number of patents were issued for the production of boron nitride. Boron nitride was reported to have outstanding chemical properties in addition to its more widely known mechanical and electrical properties.[57] The hot-pressed material resisted molten iron, silicon, aluminum, cryolite, copper, and zinc. It resisted chlorine up to 1,300° F., but showed noticeable hydrolysis in hot aqueous solutions.

All attempts to build a polymer chain containing boron and nitrogen resulted in a hydrolytically unstable material or a cyclic material in which chain formulation was nil.[58] Electrochemical and gaseous reactions promoted by silent electric discharge may provide fruitful approaches for solving these problems.

Borides of the metals of the fourth, fifth, and sixth periodic groups of elements were said to have high melting points, extreme hardness, and high conductivity at all temperatures.[59] Borides showed marked corrosion resistance and high stability. Fabrication techniques for metal borides, such as pressing by powder metallurgy and forming coatings on metals or alloys, are being investigated.

A small quantity of boron was added to a molybdenum-silicon coating for metal to increase resistance to oxidation.[60]

A characteristic of boron alloys when used for brazing was said to be a tendency to dissolve and diffuse into steels.[61] This made them useful for joining large sections but difficult for joining thin sections. If boron alloys are used for brazing it is necessary to control accurately the amount of brazing alloy used, the temperature, and the time. Nickel-boron-chromium (NiB_7Cr) and nickel boride (NiB) alloys were important because they had constant flow points from batch to batch, and flow was obtained at much lower temperatures.

Extremely small quantities of boron and zirconium increased the durability of nickel-base alloys.[62]

Boron was used to produce nonaging low-carbon sheet steel.[63] Semikilled practice gave good yields of ingots and satisfactory surface

[56] Gray, Edgar G. (Longford, England), Process for the Production of Boron Carbide: U.S. Patent 2,834, 651, May 13, 1958.

[57] Chemical Engineering, Above 2,500° F. What Material to Use?: Vol. 65, No. 13, June 30, 1958, pp. 105–109.

[58] Evans, R. N., Insulation and Dielectric Materials: Air Research and Development Command, Materials Symposium, Dallas, Tex., July 9–10, 1958.

[59] Chemical Age (London), Metal Boride Developments: Vol. 79, No. 2012, Feb. 1, 1958, p. 226.

[60] Yntema, L. F., Beidler, E. A., and Campbell, I. E. (assigned to Fansteel Metallurgical Corp., North Chicago, Ill.), Highly Refractive Boron Bodies: U.S. Patent 2,823,151, Feb. 11, 1958.

[61] Metal Progress, Brazing Alloys for Guided Missiles: Vol. 74, No. 3, September 1958, pp. 99–104.

[62] Hartley, Charles B., Superalloys: Air Research and Development Command, Materials Symposium, Dallas, Tex., July 9–10, 1958.

[63] Metallurgical Society, American Institute of Mining and Metallurgical Engineers, A Boron Steel for Deep Drawing: trans., vol. 212, No. 3, June 1958, pp. 402—405.

quality. Good drawability was indicated. Some problems with hot-tearing and boron-analysis procedures were solved.

The properties of low-carbon tungsten and titanium steels containing boron were described.[64]

Several patents were issued for the production of elemental boron. Boron, substantially free of boron suboxide, was prepared by fusing in a nonoxidizing atmosphere a mixture of boron oxide and magnesium.[65] The product formed was treated with acid and the crude boron separated. The crude boron was leached with molten boric oxide.

Elemental boron was prepared by electrolyzing a molten bath of boron trioxide, potassium chloride, and potassium fluoride.[66]

A patent was issued on a method of preparing elemental boron by electrolyzing a fused mixture of boric oxide, alkali metal fluoborate, and alkali metal oxide.[67]

A continuous electrolytic process for making hydrides of boron and silicon has been developed.[68] The reaction was completed in a double U-tube containing a molten mixture of lithium chloride, potassium chloride, and lithium hydride.

High-Energy Boron Fuels.—The National Advisory Committee for Aeronautics disclosed that a ramjet test missile flew more than three times the speed of sound using boron fuel.[69]

The U.S. Government program for producing high-energy fuels was reviewed.[70]

Production of boron high-energy fuel at the U.S. Navy $38 million plant at Muskogee, Okla., reportedly consisted of the following steps:[71] Methyl borate was produced by reacting methanol with boric acid; sodium was reacted with hydrogen to make sodium hydride; methyl borate and sodium hydride were reacted to make diborane; and diborane was alkylated with ethylene and polymerized to yield the liquid fuel.

Callery Chemical Co. synthesized a solid boron-based fuel.[72] Highly promising test firings were reported, although the fuel was still undergoing development.

Thiokol Chemical Corp. and Callery Chemical Co. announced development of new superefficient rocket engines using a solid boron-based high-energy fuel.[73] Engines of greatly improved performance, lower weight, and greater power can be built because the solid fuel

[64] Metal Progress, Tungsten and Titanium Steels Containing Boron: Vol. 73, No. 3, March 1958, pp. 182, 184, 186, 188.
[65] Mazza, H., Sawyer, D. L., and Baier, R. W. (assigned to American Potash & Chemical Corp., Wilmington, Del.), Process for Producing Amorphous Boron of High Purity: U.S. Patent 2,866,688, Dec. 30, 1958.
[66] Nies, N. P., Fajans, E. W., Thomas, L. L., Hiebert, L. E., and Morgan, V. (assigned to U.S. Borax & Chemical Corp.), Electrolytic Production of Elemental Boron: U.S. Patent 2,832,730, Apr. 29, 1958.
[67] Murphy, N. F., and Tinsley, R. S. (assigned to Callery Chemical Co., Pittsburgh, Pa.), Electrochemical Preparation of Boron: U.S. Patent 2,848,396, Aug. 19, 1958.
[68] Chemical Week, Processes: Vol. 83, No. 21, Nov. 22, 1958, p. 87.
[69] Rock Products, Boron Base High-Energy Fuels: Vol. 60, No. 12, December 1957, p. 12.
[70] Chemical Engineering, High-Energy Fuels Head for Stratosphere: Vol. 65, No. 1, Jan. 13, 1958, pp. 141, 142.
[71] Chemical Engineering, Boron Fuels Head for Volume Output: Vol. 65, No. 24, Dec. 15, 1958, p. 76.
[72] Chemical Engineering, Boron Propellants Get Solid Backing: Vol. 65, No. 1, Jan. 13, 1958, p. 73.
[73] American Metal Market, Trend Toward Boron Compound Solid Rocket Fuels: Vol. 65, No. 10, Jan. 15, 1958, pp. 1, 5.

burns more efficiently on the exposed inner surface of a shaped propellant.

The history of boron hydrides and their structural formulas and selected chemical and physical properties were published.[74] Heating values of the boron hydrides and hydrogen were compared with those of conventional fuels.

The chemical and structural properties of boron hydrides and some of their potential uses were reviewed.[75]

Olin Mathieson Chemical Corp. reportedly used a three-step process in producing liquid boron-based high-energy fuel for the U.S. Navy.[76]

An article reported that sodium borohydride and anhydrous aluminum chloride might be slurried individually with toluene and both slurries fed to a reactor, where boron trichloride would be reduced to diborane.[77] Diborane pyrolyzed to pentaborane could be reacted with a chlorinated hydrocarbon to produce H.E.F.–2 fuel.

The capacity of the U.S. Air Force and Navy boron fuel plants was estimated in a publication to total about 3,400 tons per year. This is only enough fuel to keep a bomber in the air about 140 hours.[78]

P. A. Stranges, of Olin Mathieson Chemical Corp., hinted that progress had been made in producing boron-based fuels by more direct routes.[79] Eliminating intermediate processing steps would help to reduce the high cost of the fuel and thereby facilitate its use commercially.

A new method of producing boron trialkyls from aluminum trialkyls was developed.[80]

A method for producing an alkali metal borohydride by reacting an alkali metal hydride and boron orthophosphate at 200° to 400° C., in an inert petroleum liquid was patented.[81] Four instruments, designed for use in the high-energy fuel industry, were displayed by Mine Safety Appliances Co.[82] They comprised a boron analyzer, a continuous borane analyzer, a portable borane analyzer, and an ionization detector.

Extreme reactivity, moisture and air sensitivity, and toxicity were reported to create most problems in developing large-scale commercial processes for production of boron fuels.[83] Operating units usually were isolated and operated remotely or through protective barricades because spontaneous-ignition temperatures of boron hydrides caused fires or explosions. This complicated and hindered development programs; however, most problems now have been solved.

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[74] Major, Coleman, J., Boron Hydrides: Chem. Eng. Prog., vol. 54, No. 3, March 1958, pp. 49–54.

[75] Chemical Age (London), Boron Hydrides and Potential Uses: Vol. 79, No. 2016, Mar. 1, 1958, p. 394.

[76] Chemical and Engineering News, Exotic Fuels—Now Commercial Scale: Vol. 36, No. 20, May 19, 1958, pp. 15–16.

[77] Chemical Engineering, Borane Fuel Process Brought Into Focus: Vol. 65, No. 13, June 30, 1958, p. 56.

[78] Missiles and Rockets, Boron Fuel Yet a Trickle: Vol. 111, No. 6, May 1958, p. 152.

[79] Chemical Engineering, Bright Prospects for New Jet Fuels: Vol. 65, No. 13, June 30, 1958, p. 50.

[80] Chemical and Engineering News, New Way to B-Trialkyls: Vol. 36, No. 32, Aug. 11, 1958, pp. 52, 53.

[81] Bronaugh, H. J. (assigned to Thiokol Chemical Corp., Trenton, N.J.), Preparation of Alkali Metal Borohydrides: U.S. Patent 2,849,276, Aug. 26, 1958.

[82] American Metal Market, Boron Analyzer is at Instrument Show: Vol. 65, No. 183, Sept. 20, 1958, p. 7.

[83] Barry, L. A., Chemical Engineering in the Industrial Development of Boron Hydrides: Chem. Eng. Prog., vol. 54, No. 10, October 1958, pp. 152–154, 156, 158.

Bromine

By Henry E. Stipp[1] and James M. Foley[2]

PRODUCTION of bromine (as measured by sales) decreased for the second consecutive year. The price of most bromine products was constant throughout 1958. New uses for bromine compounds as catalysts in the hydrogenation of petroleum fractions and as high-temperature lubricants in aircraft and missiles were reported.

DOMESTIC PRODUCTION

Sales of bromine and bromine compounds (bromine content) in 1958 decreased 8 percent from sales reported by producers in 1957. The reduction in sales resulted chiefly from decreased requirements for ethylene dibromide in gasoline antiknock mixtures. Domestic production of bromine in 1958 was from sea water, well brines, and saline-lake brines. Bromine was recovered from sea water at Freeport, Tex., by the Ethyl-Dow Chemical Co. Westvaco Chemical Division of Food Machinery & Chemical Corp. extracted bromine from sea water bittern at Newark, Calif. In Michigan, The Dow Chemical Co. plants at Midland and Ludington, Great Lakes Chemical Corp. at Manistee, Michigan Chemical Corp. at East Lake and St. Louis, and Morton Salt Co. at Manistee recovered bromine from well brines. The Westvaco Chemical Division also treated well brines at South Charleston, W. Va. Michigan Chemical Corp. and Murphy Corp. recovered bromine from oilwell brines at their El Dorado, Ark., plant. American Potash & Chemical Corp. extracted bromine from the brine of Searles Lake at Trona, Calif.

Great Lakes Oil and Chemical Co. will establish a research department at Lafayette, Ind., to develop bromine products. Ethyl Corp. produced antiknock compounds at its new plant in Pittsburg, Calif.

TABLE 1.—Total sales of bromine and bromine compounds (bromine content) by primary producers in the United States, 1949–53 (average) and 1954–58

Year	Pounds (thousand)	Value (thousand)	Year	Pounds (thousand)	Value (thousand)
1949–53 (average)	127,427	$25,451	1956	196,730	$47,434
1954	187,399	41,313	1957	191,971	48,038
1955	184,454	39,856	1958	176,397	46,689

[1] Commodity specialist.
[2] Supervisory statistical assistant.

TABLE 2.—Bromine and bromine compounds sold by primary producers in the United States, 1957–58

	Gross weight (thousand pounds)	Bromine content [1] (thousand pounds)	Value (thousand)
1957			
Elemental bromine	9,179	9,171	$2,193
Potassium bromide	3,032	2,036	971
Other, including ethylene dibromide, sodium bromide, and ammonium bromide	213,175	180,764	44,874
Total	225,386	191,971	48,038
1958			
Elemental bromine	14,404	14,404	3,346
Other, including ethylene dibromide, sodium bromide, ammonium bromide, and potassium bromide	194,606	161,993	43,343
Total	209,010	176,397	46,689

[1] Calculated as theoretical bromine content present in compound.

CONSUMPTION AND USES

Ethylene dibromide and other bromine compounds supplied 92 percent of the total bromine consumed in 1958. Fumigation mixtures used to control insects and other pests in seeds and soil contained ethylene dibromide. It was used also as an intermediate in the synthesis of dyes and pharmaceuticals, a nonflammable solvent for resins, gums, and waxes, and as an antispasmodic and external anesthetic in medicine.

Elemental bromine ranked second (8 percent), in consumption. It was used chiefly as a laboratory reagent and a bleaching and disinfecting agent, and also in brominated dyes and lachrymators, shrinkproofing wool, and in many inorganic and organic bromine compounds.

Sodium, potassium, and ammonium bromides were used in the pharmaceutical and photography industries, and as process and laboratory reagents. Sodium and potassium bromates were used as flour additives and components of hair-wave compounds.

Fire-extinguishing materials, such as bromochloromethane, and methyl bromide, consumed some bromine. Methyl bromide was used chiefly as an active ingredient in fumigants.

In addition, bromine compounds were used as catalysts, dehumidifying agents, hydraulic liquids, flameproofing agents, a flotation medium for recovering minerals, lithography chemicals, and effervescent mineral waters.

PRICES

Prices for most bromine and bromine compounds were firm throughout 1958. According to Oil, Paint and Drug Reporter the following prices were quoted: Bromine, purified, cases, carlots, delivered east of the Rocky Mountains, 32 cents a pound; cases, less than carlots, same basis, 34 to 39 cents a pound; drums, lead-lined carlots, delivered east of the Rocky Mountains, 31 cents a pound; ammonium bromide, N.F., granular, barrels, 45 cents a pound; ethylene dibromide, drums, carlots, freight equaled, 30½ cents a pound; drums, less than carlots, freight equaled, 31½ cents a pound; tanks, freight equaled, 28½ cents a pound; potassium bromide, U.S.P., granular, barrels, kegs, 39 to 40 cents a pound; potassium bromate, drums, 1,000 pound lots or more, 50 cents a pound; sodium bromide, U.S.P., granular, drums, works, 40 cents a pound.

FOREIGN TRADE [3]

Exports of bromine, bromide, and bromates decreased slightly from the 10.5 million pounds valued at about $3 million in 1957 to 10 million pounds valued at $3 million in 1958. Canada and Brazil received the largest shipments, 6.7 million pounds valued at $1 million and 2 million pounds valued at $1 million, respectively; smaller quantities were sent to 38 other countries.

The United States imported 10.4 thousand pounds of bromine and bromine compounds (n.s.p.f) in 1958 valued at $37 thousand, chiefly from United Kingdom and West Germany. Eight pounds of potassium bromide valued at $366 and 1,400 pounds of sodium bromide valued at $1,200 also were imported.

WORLD REVIEW

France.—Production of bromine in France during 1957 totaled 3.3 million pounds, compared with 2.6 million pounds in 1956.[4]

Germany, West.—Bromine and bromine compounds produced in 1957 totaled 3.5 million pounds valued at $171,000.[5]

Israel.—Production of bromine in 1957 totaled 1.4 million pounds. Two additional units of the Dead Sea Bromine Co., Ltd., plant at Sodom operated in 1958. Production was expected to exceed 4 million pounds in 1958 and 8 million pounds in a few years. Exports of liquid bromine totaled 932,000 pounds valued at $150,000 f.o.b. Haifa in 1957. Ethylene dibromide exports in 1957 were 310,000 pounds valued at $65,000.[6]

Italy.—In 1957 production of bromine compounds totaled 68,000 pounds.[7]

Japan.—Elemental bromine produced during 1957 totaled 2.5 million pounds.[8]

TECHNOLOGY

Studies of the smog-forming potential of gasolines indicated that there was no significant difference between an unleaded fuel and fuel containing tetraethyl lead-ethylene dibromide antiknock compound.[9]

Two booklets were published in 1958 to give research and manufacturing chemists basic information on bromine.[10]

Several new bromine compounds for flame-proofing plastics, protective coatings, fluids, textiles, paper, and wood were made available on a commercial basis.[11]

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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 95, July 30, 1958, p. 1.
[5] U.S. Embassy, Dusseldorf, Germany, State Department Dispatch 196, Apr. 30, 1958, p. 1.
[6] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 4, October 1958, p. 42.
[7] U.S. Embassy, Rome, Italy, State Department Dispatch 1360, Apr. 30, 1958, p. 1.
[8] U.S. Embassy, Tokyo, Japan, State Department Dispatch 1214, Apr. 11, 1958, p. 2.
[9] Hesselberg, H. E., Smog-Chamber Studies of Unleaded Versus Leaded Fuels: Ethyl Corp., Mar. 25, 1957, 5 pp.
[10] Michigan Chemical Corporation, St. Louis, Mich., Bromine, Its Properties and Uses, 1958, 62 pp.; How to Handle Bromine, 1958, 34 pp.
[11] Chemical Engineering, New Brominated: Vol. 65, No. 2, Jan. 27, 1958, p. 78.

Operations of the new bromine plant at El Dorado, Ark., were described.[12] Brine from the Smackover oilfield, which contained 4,200 p.p.m. of bromine, flowed through a network of pipes into a central tank. After residual oil was removed, the brine was discharged into an 800,000 gallon storage pond, pumped through brush-packed, wooden towers to remove dissolved gases such as hydrogen sulfide, sent through a heat exchanger that used stripped end brine, into an overhead Monel metal tank. Through the ceramic and porcelain plate packing of four granite towers, brine descended and was stripped of bromine by ascending steam and chlorine.

Bromine, water vapor, and traces of chlorine passed through glass lines to tantalum condensers and then into glass gravity separators, where water was removed. The bromine was fractionated to remove all traces of chlorine and distilled in a glass-lined column, where nonvolatile materials were removed. Moisture was removed by sulfuric acid in a packed, glass-lined column and bromine was stored in tanks with 200,000 pounds capacity. Stripped brine was cooled, limed, treated with chemical, settled, and injected into a shallow rock formation.

The use of zinc bromide solution as windows in radiation-filled laboratories was reported.[13] The solution transmits light in a straight line but holds back gamma rays.

An organoaluminum bromide with a bromine-aluminum ratio of 2.2 or less was used effectively at 350° C. for the hydrogenation of aromatics.[14] It decomposed to form a bromine-aluminum solid that was thought to be the hydrogenation catalyst.

The discovery of an organic manganese compound to supplement tetraethyl lead-ethylene dibromide antiknock fluid was announced. Its use was said to add 20 percent to the power output of gasoline engines.[15]

Two bromine gases, dibromodifluoromethane and monobromotrifluoromethane were suggested for use as high temperature lubricants in aircraft and missiles.[16]

An analytical technique for determining olefinic unsaturation by use of ozone instead of bromine was developed.[17]

To learn what happened when a silver emulsion is exposed to light, researchers photographed a silver bromide grain using an electron microscope.[18] The picture showed that electrons gathered on the positive side of the grain and triggered formation of metallic silver.

Highly flame-resistant, potentially cheap polymers have been prepared by the noncatalytic addition of trichlorobromomethane to olefins.[19]

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[12] Chemical Engineering, New Bromine Plant Taps Rich Oil-Field Brine: Vol. 65, No. 11, June 2, 1958, pp. 51–52.

[13] Chemical Engineering News, News Triggers Chemical Processing Progress: Vol. 36, No. 27, July 7, 1958, pp. 46–47.

[14] Industrial and Engineering Chemistry, Organoaluminum Halides as Hydrogenation Catalysts: Vol. 50, No. 8, August 1958, pp. 1139–1142.

[15] The Chemical Digest (Foster D. Snell, Inc.), vol. 24, No. 1, 1958, p. 1.
Chemical Engineering News, New World of Chemicals: Vol. 36, No. 30, July 28, 1958, p. 48.

[16] Chemical Engineering News, Freons—Potential Greases: Vol. 36, No. 38, Sept. 22, 1958, p. 48.

[17] Chemical Engineering News, O_3 Pegs Double Bond: Vol. 36, No. 42, Oct. 20, 1958, p. 41.

[18] Chemical Engineering News, New Clues in Silver Bromide Mystery: Vol. 36, No. 42, Oct. 20, 1958, p. 41.

[19] Chemical Engineering News, New, Potentially Cheap Approach: Vol. 36, No. 48, Dec. 1, 1958, p. 19.

Cadmium

By Arnold M. Lansche[1]

CADMIUM supply exceeded apparent consumption in 1958. Production and shipments were lowest in the second quarter; the rate of increase in metal stocks was largest in the first quarter and smallest in the last quarter. The value of cadmium barter contracts negotiated by the Commodity Credit Corporation in the calendar year 1958 was $302,060.

DOMESTIC PRODUCTION

The combined production of primary and secondary cadmium in 1958 declined about 8 percent from 1957. The decline was directly related to the reduced output of primary slab zinc; electrolytically produced zinc decreased approximately 20 percent and distilled zinc 21 percent. Other sources of primary cadmium were foreign and domestic flue dust, fume from thermal reduction of zinc concentrates and lead and copper concentrates containing zinc and associated cadmium, and the purification of zinc sulfate solutions used to make lithopone. A small quantity of secondary cadmium was recovered in 1958 by processing scrap alloys.

Of the 9.7 million pounds of cadmium metal produced in 1958 about 11 percent was obtained from foreign flue dust. Except for the small quantity of secondary production, an estimated 47 percent of the remainder was obtained from domestic zinc ore and 53 percent from

TABLE 1.—Salient statistics of cadmium, 1949–53 (average) and 1954–58, in thousand pounds of contained cadmium

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Primary production	8,813	9,552	[1] 9,754	[2] 10,614	[2] 10,549	[2] 9,673
Metal imported for consumption	782	402	927	3,116	1,586	1,002
Exports	422	999	1,394	1,284	693	580
Apparent consumption	8,556	7,499	10,684	12,711	[2] 10,999	[2] 8,177
Price (average per pound)	$2.23	$1.73	$1.70	$1.70	$1.70	$1.52
World: Production	13,400	16,100	18,460	[3] 20,100	[3] 21,070	19,850

[1] Primary cadmium metal only.
[2] Primary and secondary cadmium metal.
[3] Revised figure.

[1] Commodity specialist.

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.

Changes in 1958: Cadmium oxide production was begun by the Blackwell Zinc Co. at its Blackwell, Okla., plant; American Smelting and Refining Co. added cadmium-mixing and calcining equipment at its Globe plant, Denver, Colo.; Harshaw Chemical Co. purchased Kentucky Color and Chemical Co. of Louisville, Ky., October 1, 1958; and E. I. duPont de Nemours & Co. discontinued production of cadmium at its Electrochemicals Department on July 1, 1958.

The production of cadmium sulfide, including cadmium lithopone and cadmium sulfoselenide (cadmium content), declined 6 percent in 1958 to about 983,000 pounds, the lowest since 1952. Statistics were not available on cadmium-mercury lithopone.

CONSUMPTION AND USES

The apparent consumption of cadmium metal, as computed by adding production, net imports, and net stock changes at producers, compound manufacturers and distributors, was 23 percent below total new supply in 1958 and 26 percent below apparent consumption in 1957. Reduced barter acquisitions of cadmium by the Commodity Credit Corporation and less production of manufactured goods using the metal were factors that affected cadmium consumption.

Statistics were not available on the quantity of cadmium consumed in making nickel-cadmium batteries. Cadmium requirements are

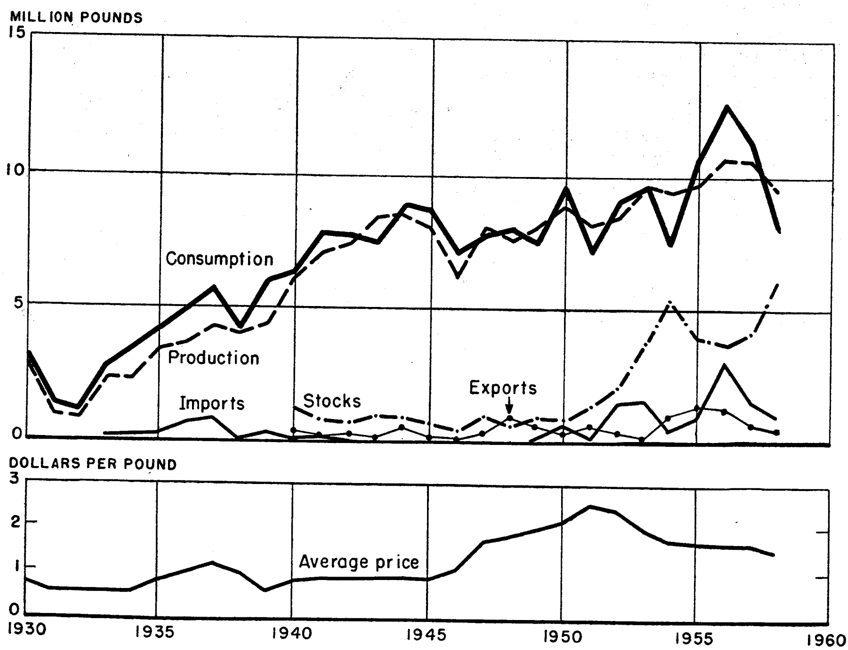

FIGURE 1.—Trends in production, consumption, year-end stocks, imports, exports and average price of cadmium metal in the United States, 1930–58.

TABLE 2.—Cadmium produced and shipped in the United States, 1949–53 (average) and 1954–58, in thousand pounds of contained cadmium

	1949–53 (average)	1954	1955	1956	1957	1958
Production:						
Primary:						
Metallic cadmium	8,612	9,416	9,754	[1] 10,614	[1] 10,549	[1] 9,673
Cadmium compounds [2]	201	136	(3)	(3)	(3)	(3)
Total primary production	8,813	9,552	9,754	[1] 10,614	[1] 10,549	[1] 9,673
Secondary (metal and compounds) [2,4]	226	138	286	(3)	(3)	(3)
Shipments by producers:						
Primary:						
Metallic cadmium	8,074	7,922	11,167	[1] 10,936	[1] 10,091	[1] 7,921
Cadmium compounds [2]	201	136	(3)	(3)	(3)	(3)
Total primary shipments	8,275	8,058	11,167	[1] 10,936	[1] 10,091	[1] 7,921
Secondary (metal and compounds) [2,4]	216	149	286	(3)	(3)	(3)
Value of primary shipments:						
Metallic cadmium	$16,899	$11,925	$15,729	[5] $16,283	[5] $14,921	[5] $10,067
Cadmium compounds [6]	424	204	(3)	(3)	(3)	(3)
Total value	17,323	12,129	15,729	[5] 16,283	[5] 14,921	[5] 10,067

[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 metallic cadmium shipments, including secondary.
[6] Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

TABLE 3.—Cadmium oxide and cadmium sulfide produced in the United States, 1949–53 (average) and 1954–58, in thousand pounds

Year	Oxide		Sulfide [1]	
	Gross weight	Cadmium content	Gross weight	Cadmium content
1949–53 (average)	692	604	3,344	1,131
1954	959	838	3,470	1,046
1955	(2)	(2)	4,191	1,348
1956	(2)	(2)	3,937	1,258
1957	(2)	(2)	3,198	1,041
1958	(2)	(2)	2,884	983

[1] Includes cadmium lithopone and cadmium sulfoselenide.
[2] Figure withheld to avoid disclosing individual company confidential data.

known to be about 0.008 pound per a.-hr./cell and such batteries are used successfully in civil and military aircraft, guided missiles, and refrigerator railway cars. The companies reported making the batteries in various sizes were Sonotone Corp., Elmsford, N.Y.; Gould-National Batteries, Inc., St. Paul, Minn.; and Gulton Industries, Inc., Metuchen, N.J.

Cadmium was consumed in electroplating such items as automobile-engine parts, aircraft parts, radio and television parts, and nuts and bolts. Cadmium was also used in bearing alloys, fusible alloys, pigments, dentistry, photography, and dyeing. Cadmium metal and cadmium nitrate were used in nuclear reactors to control the rate of nuclear fission and as reactor poisoning agents.

STOCKS

Stocks of cadmium metal (metal producers, compound manufacturers, and distributors) totaled about 5.6 million pounds, a 52-percent increase over 1957. Stocks of cadmium compounds (cadmium content) held by compound manufacturers and distributors totaled 559,000 pounds, a 12-percent increase over 1957.

Commodity Credit Corporation barter contracts amounted to $302,060 in the calendar year 1958.

TABLE 4.—Industry stocks at end of year, 1957–58, in thousand pounds of contained cadmium

	1957 [1]			1958		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Metal producers	3,359		3,359	5,367		5,367
Compound manufacturers	98	446	544	75	508	583
Distributors [2]	220	51	271	153	51	204
Total stocks	3,677	497	4,174	5,595	559	6,154
Consumers' stocks	(3)	(3)	[4] 1,000	(3)	(3)	[4] 1,000

[1] Partly revised.
[2] Comprises principally 8 largest dealers and producers of plating salts; approximately 130,000 pounds of metal and 19,000 pounds of oxide were estimated in the hands of other dealers and distributors at the end of 1957. Comparable figures for 1958 were 76,000 pounds of metal and 14,000 pounds of oxide.
[3] Data not available.
[4] Estimate.

PRICE

The quoted price for cadmium delivered in 1- to 5-ton lots declined September 24 from $1.55 to $1.45 a pound, where it remained until the year ended. Oversupply, competition, and lower foreign quotations were factors in the price decline. The price of zinc, one of cadmium's chief competitors, on the other hand, increased from 10 cents to 11.5 cents a pound, East St. Louis, during October and November without affecting the price of cadmium. Large quantities of cadmium were sold, both in the domestic and export markets, at prices considerably below the quoted price. High-purity cadmium (99.99+ percent) was quoted at $3.50 per pound. Quoted price in France remained at 1,500 francs per kilogram during the year ($1.63 per pound on the basis of $0.0024 per franc).

The London quotation declined from 10s. per pound in lots of a hundredweight ($1.40 on the basis of $2.80 per £) to 9s. 6d. ($1.33). The market for cadmium in Italy declined from 2,500 lire per kilogram to 2,150 lire or from $1.75 per pound to $1.50, on the basis of $0.00154 per lira.

Cadmium-selenium lithopone (sulfoselenide), orange (deepshade), was quoted[2] at $2.00 per pound in barrel lots until March 25, after which no quotation was given. Cadmium-mercury lithopone, orange (deepshade), was quoted initially at $1.70 per pound in barrel lots but declined to $1.61 in March at which it remained for the rest of the year.

[2] Oil, Paint and Drug Reporter, vol. 173, No. 13. Mar. 24, 1958, p. 12.

The price of scrap cadmium-bearing alloys, depending on the cadmium content, averaged 85 to 90 cents per pound; for pure cadmium scrap the price was about $1.05 per pound.

FOREIGN TRADE [3]

Imports.—General imports of cadmium metal in 1958 approximated 1.03 million pounds—3 percent above imports for consumption. General imports of the metal—down 35 percent from 1957—declined for the third consecutive year. Imports of the metal for consumption were down 37 percent to 1 million pounds. General imports exceeded imports for consumption from Italy, Netherlands, and Japan. The decline in price of cadmium metal was reflected in the lower value per pound of the imported metal, which was $1.53 in 1957 and $1.30 in 1958.

TABLE 5.—Cadmium metal and flue dust imported into the United States, 1957–58, by countries

[Bureau of the Census]

Country	General imports [1]				Imports for consumption [2]			
	1957		1958		1957		1958	
	Pounds (thousand)	Value (thousand)	Pounds (thousand)	Value (thousand)	Pounds (thousand)	Value (thousand)	Pounds (thousand)	Value (thousand)
METALLIC CADMIUM								
North America: Canada	1,042	$1,586	508	$682	1,042	$1,586	508	$682
South America: Peru	51	81	103	155	51	81	103	155
Europe:								
Belgium-Luxembourg	11	19	119	139	11	19	119	139
France	2	4	11	11	2	4	11	11
Italy	55	89	14	18	55	89	13	17
Netherlands	22	31	22	28	18	24	13	19
United Kingdom			(3)	(3)			(3)	(3)
Total	90	143	166	196	86	136	156	186
Asia: Japan	77	113	143	167	77	113	121	142
Africa:								
Belgian Congo	330	508	59	69	330	508	59	69
Rhodesia and Nyasaland, Federation of			10	15			10	15
Total	330	508	69	84	330	508	69	84
Oceania: Australia			45	63			45	63
Total metallic cadmium	1,590	2,431	1,034	1,347	1,586	2,424	1,002	1,312
FLUE DUST (CD CONTENT)								
North America: Mexico	1,550	1,092	1,218	661	1,400	837	1,218	661
Total flue dust	1,550	1,092	1,218	661	1,400	837	1,218	661
Grand total	3,140	3,523	2,252	2,008	2,986	3,261	2,220	1,973

[1] Comprises cadmium imported for immediate consumption plus material entering bonded warehouses.
[2] Comprises cadmium imported for immediate consumption plus material withdrawn from bonded warehouses.
[3] Less than 1,000.

[3] 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.

General imports and imports for consumption of flue dust (cadmium content) were the same in 1958. Mexico supplied the 1.2 million pounds of that material received—13 percent less than in 1957.

Tariff.—The import duty on cadmium metal remained 3.75 cents per pound in 1958—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.

Exports.—Exports declined 16 percent in 1958 (cadmium is the metal of chief value in the exports). The United Kingdom received the largest quantity—approximately 446,000 pounds. The average value of total exports was $1.33 a pound.

TABLE 6.—Cadmium metal, alloys, dross, flue dust, residues, and scrap exported from the United States, 1949–53 (average) and 1954–58

[Bureau of the Census]

Year	Pounds (thousand)	Value (thousand)	Year	Pounds (thousand)	Value (thousand)
1949–53 (average)	422	$1,072	1956	1,284	$1,932
1954	999	1,422	1957	693	1,060
1955	1,394	1,938	1958	580	771

WORLD REVIEW

World production of cadmium metal declined about 6 percent in 1958 to 19.9 million pounds. A decline of almost 880,000 pounds in U.S. production furnished more than half of the decrease.

NORTH AMERICA

The U.S. contribution to world cadmium-metal production reached a low in 1958 of 49 percent of the total output, the lowest since 1939.

Canada.—Cadmium production declined 22 percent. Exported zinc concentrate [4] from mines in eastern Canada averaged 0.2 percent cadmium.

SOUTH AMERICA

Argentina.—The Government-operated Fabricaciones Militares electrolytic zinc plant at Rio Tercero, Province of Cordoba, recovered cadmium.

EUROPE

United Kingdom.—The Government disposed of the remaining 12.5 tons of the cadmium rods in the United Kingdom strategic stocks in 1958.[5] Cadmium production approximated 278,000 pounds in 1958—22 percent above 1957. Consumption increased 6 percent to about 2.29 million pounds. Quantities (in thousand pounds) for various purposes were used as follows: Plating anodes, 1,167; plating salts, 177; cadmium-copper alloys, 104; other alloys, 76; alkaline batteries, 143; dry batteries, 5; solder, 115; colors, 457; miscellaneous uses, 46.

[4] Northern Miner, vol. 44, No. 24, Sept. 4, 1958, p. 14.
[5] Metal Bulletin (London), No. 4261, Jan. 14, 1958, p. 25; No. 4262, Jan. 17, 1958, p. 21.

TABLE 7.—World production of cadmium, by countries,[1] 1949–55 (average) and 1954–58, in thousand pounds[2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	1,018	1,087	1,919	2,339	2,368	1,841
Guatemala	----------	----------	----------	107	84	[3] 88
United States (primary):						
Metallic cadmium	[4] 8,612	[4] 9,416	9,754	[5] 10,614	[5] 10,549	[5] 9,673
Cadmium compounds (Cd content)	201	136	(6)	(6)	(6)	(6)
South America: Peru	13	66	138	107	104	[3] 110
Europe:						
Austria [3]	----------	----------	----------	22	24	22
Belgium [3]	874	1,100	1,433	1,488	1,488	1,488
France	190	313	397	240	388	390
Germany, West	112	618	709	645	611	703
Italy	293	458	433	403	485	450
Netherlands [3]	----------	22	34	36	36	36
Norway	182	178	255	278	244	240
Poland [3]	415	500	550	542	560	560
Spain	12	21	22	25	20	18
U.S.S.R.[3 7]	221	470	680	795	1,050	1,040
United Kingdom	308	315	337	251	228	278
Yugoslavia [3]	----------	----------	----------	----------	44	44
Asia: Japan	280	611	757	886	873	972
Africa:						
Belgian Congo	58	139	366	611	911	1,075
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	----------	----------	----------	117	125	38
Oceania: Australia	613	645	674	618	880	788
World total (estimate) [1 2]	13,400	16,100	18,460	20,100	21,070	19,850
Mexico [8]	1,803	1,130	2,855	1,892	1,673	1,695
South-West Africa [8]	1,349	1,620	1,402	2,328	2,838	2,698

[1] Data derived in part from bulletins of the World Non-Ferrous Metal Statistics and annual issues of Metal Statistics (Metallgesellschaft).
[2] This table incorporates a number of revisions of data published in previous Cadmium chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] In addition, secondary metal and compounds were as follows: 1949–53 (average), 236,000 pounds; and 1954, 138,000 pounds.
[5] Includes secondary.
[6] Bureau of Mines not at liberty to publish figures.
[7] Estimates based on an assumed average cadmium content of 0.1 percent in zinc concentrates.
[8] To avoid duplicating figures, data are not included in the world total. The cadmium content of flue dust from Mexico is exported for treatment elsewhere and represents in part shipments from stocks on hand. The cadmium content of concentrates from South-West Africa also exported for treatment elsewhere.

TECHNOLOGY

Hydrogen[6] entrapped in high-strength steel during cadmium plating was reported to be the explanation for embrittlement and failure of the steel when subjected to sustained load tests. An interruption in the plating process, when the coating reaches 1/10,000 inch thick, for baking the steel to drive out entrapped hydrogen, was said to eliminate hydrogen embrittlement and low-magnitude stress failure.

Capital Airlines reported that each of its Vickers Viscount aircraft was supplied with two 24-volt, 28-ampere-hour nickel-cadmium batteries. Use of these batteries reduced maintenance costs 80 to 90 percent. This commercial airline fleet was reportedly the first to switch from the conventional lead-acid batteries to the newer power supply.

[6] Business Week, Hydrogen Proves to be Culprit in Fractures of Plated Steels; No. 1492, Apr. 5, 1958, p. 74.

Wright Air Development Center, Ohio, was perfecting the cadmium sulfide electric generator,[7] which developed 50 milliwatts at 8 volts when exposed to direct sunlight. Ethyl Corporation reported that cadmium, believed to be in the form of diethylcadmium,[8] assists importantly in a new process for making tetraethyl lead. The lead is almost completely converted to tetraethyl lead, and the cadmium is recycled. Cadmium foil in various thicknesses, as low as 0.0025 inch, and 99.98 percent pure became available.

A patent[9] described a light-fast, atmospherically stable cadmium sulfide pigment with about 0.2 to 1.0 percent selenium incorporated in its lattice.

A process for producing bright cadmium electrodeposits was patented.[10]

A method for producing a red pigment composed of cadmium sulfide, and alkali sulfur, and mercury sulfide was patented.[11]

A patent[12] was issued for manufacturing cadmium niobate.

Bureau of Mines Information Circular 7881,[13] issued in 1958, provides comprehensive data on cadmium occurrence, reserves, recovery processes, properties, uses, compounds, substitutes, foreign and domestic supply and distribution, structure of the foreign and domestic industry, government controls, and a bibliography.

TOXICOLOGY

Toxicity tests[14] on white rats using aerosols of cadmium oxide were described in 1958. Inhalation of the poison was reported to cause adverse changes in the motor chronaxie and conditioned reflex activity of the animals. Hour exposure to concentrations of 0.063 milligram per liter of the oxide immediately developed changes in the chronaxie and disorders of the conditoned reflex activity were profound in character. No immediate changes were observed when concentrations less than threshold toxic concentration (0.02 milligram per liter) were used. Daily poisoning of the rats for 1 hour for 3 months at a concentration of cadmium in the air of 0.0018 to 0.002 milligram per liter caused progressive deterioration of the conditioned reflex activity and a rise and fall of the motor chronaxie.

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[7] American Metal Market, Eagle-Picher and Harshaw Progress on Solar Energy: Vol. 65, No. 136, July 16, 1958, p. 1; vol. 66, No. 20, Jan. 29, 1959, p. 7.

[8] Chemical and Engineering News, Toward Cheaper TEL: Vol. 36, No. 17, Apr. 28, 1958, p. 66.

[9] Flasch, Hehnut (assigned to Farben-fabriken Bayer Aktiengesellschaft, Leverkusen, Germany, a German corporation), New Cadmium Sulfide Yellow Pigments: U.S. Patent 2,819,175, July 7, 1958.

[10] Foulke, Donald Gardner, and Kardos, Otto (assigned to Hanson-Van Winkle-Mining Co., Red Bank, N.J.). Bright Cadmium Plating: U.S. Patent 2,848,393, Aug. 19, 1958.

[11] Hay, John (assigned to the Harshaw Chemical Co., Cleveland, Ohio), Mercury-Containing Cadmium Pigment Production Process: U.S. Patent 2,850,401, Sept. 2, 1958.

[12] McNeill, William, and Nordblom, George F. (assigned to the United States of America as represented by the Secretary of the Army). Method of Making Cadmium Niobate: U.S. Patent 2,854,390, Sept. 30, 1958.

[13] Mentch, Robert L., and Lansche, Arnold M., Cadmium: A Materials Survey: Bureau of Mines Inf. Circ. 7881, 1958, 43 pp.

[14] Mel' nikova, E. A. [The Toxicity of Highly Dispersed Aerosols of Cadmium Oxide]: Farmakologiiai i Toksikologiia (Moskva), vol. 21, No. 1, January 1958, pp. 179–184 (in Russian); (available in English from Consultants Bureau, Inc., 227 West 17th St., New York 11, N.Y.).

Calcium and Calcium Compounds

By C. Meade Patterson [1] and James M. Foley [2]

CALCIUM CHLORIDE output continued its climb to another record in 1958. The Federal aid program for a 41,000-mile interstate highway network costing about $40 billion by 1972 underway made prospects for calcium chloride consumption loom greater than ever before. Calcium chloride is needed to mix in concrete, to stabilize and maintain shoulders, to allay dust, and to melt snow and ice.

DOMESTIC PRODUCTION

Nelco Metals, Inc., subsidiary of the New England Lime Co., produced calcium at Canaan, Conn., by the thermal reduction of quicklime with aluminum in vacuum retorts. Calcium was also produced by Union Carbide Metals Co. (formerly Electro Metallurgical Co.), Division of Union Carbide Corp., at Niagara Falls, N.Y.

Both natural and synthetic calcium chloride and calcium-magnesium chloride comprised the total United States production indicated by shipment figures of the Bureau of the Census. Shipments of solid and flake calcium chloride and calcium-magnesium chloride (77–80 percent and 94–97 percent $CaCl_2$) were 536,000 short tons valued at $14.8 million in 1957, and shipments of brine (40–45 percent $CaCl_2$) were 182,000 short tons valued at $1.9 million in 1957.[3] Calcium chloride and calcium-magnesium chloride from natural brines sold by producers in the United States, 1949–53, averaged 303,000 short tons annually, valued at $4.2 million; and for 1954–58, 356,000 short tons valued at $6.7 million.

California companies produced natural chloride brine from the dry bed of Bristol Lake, San Bernardino County, Calif. Companies recovered calcium and magnesium chloride salts in Michigan by evaporating well brines from underground formations. Calcium-magnesium chloride was obtained from well brines near South Charleston, W. Va.

Dow Chemical Co. produced calcium chloride from natural brines and as a byproduct of sodium carbonate operations. Two other large

[1] Commodity specialist.
[2] Supervisory statistical assistant.
[3] U.S. Department of Commerce, Bureau of the Census, Industry Division, Inorganic Chemicals and Gases, 1957: Facts for Industry Series M28A–07, Oct. 16, 1958, p. 10.

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producers of synthetic calcium chloride were Columbia-Southern Chemical Corp., Pittsburgh, Pa., and Solvay Process Division of Allied Chemical & Dye Corp., New York, N.Y. About 60 calcium chloride distributors in 1958 included Wyandotte Chemicals Corp., Wyandotte, Mich., formerly a large producer.[4]

Metal Hydrides, Beverly, Mass., has been a leading producer of calcium hydride as a generator of hydrogen for Government meteorological balloons.[5]

Hummel Chemical Co., New York, N.Y., produced calcium-silicon powder for spun pipes, special alloys, and Thermit welding.[6]

CONSUMPTION AND USES

Bureau of Mines Northwest Electrodevelopment Experiment Station, Albany, Oreg., prepared tungsten-vanadium alloys of 5, 25, and 50 percent vanadium by coreduction of their oxides with redistilled calcium.

Chlorides of cobalt, iron, manganese, and nickel were produced by the exchange of chlorine between calcium chloride and oxides of these metals under high-temperature vacuum conditions in an inert atmosphere.[7]

The Federal Highway Act of 1956 required dustfree construction, and bids specified calcium chloride.[8] Bulk shipping, handling, and storing of calcium chloride received increasing attention.[9]

In Cass County, Mich., the most economical snow and ice control on roads in 1956 and 1957 was a mixture of calcium chloride and sodium chloride in the ratio 1:2 by weight.[10]

Flake 77–80 percent calcium chloride mixed with sand in the weight ratio 1:39 was spread on the 4.3-mile Chesapeake Bay bridge to provide immediate traction on snow and ice for an average wintertime traffic of 5,500 vehicles a day. The same treatment was applied to the Baltimore Harbor Tunnel Thruway, the Susquehanna River bridge at Havre de Grace, Md., and the Potomac River bridge at Newburg, Md.[11]

A table listed [12] tire size, percent of filling, weight of calcium chloride, and total weight as a guide to weighting tires. Hydroflating load-carrying vehicle tires with calcium chloride solutions improved traction, increased drawbar pull, and reduced slippage, tire wear, bounce, fuel consumption, and pressure loss.

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[4] Chemical and Engineering News, $CaCl_2$ Faces New Era: Vol. 36, No. 25, June 23, 1958, p. 34.

[5] Chemical and Engineering News, Hydrides Looks to New Markets: Vol. 36, No. 33, Aug. 18, 1958, pp. 24–25.

[6] Chemical and Engineering News, Calcium Silicon Powder: Vol. 36, No. 25, June 23, 1958, p. 46.

[7] Neumann, Norbert F., and Schlechten, A. W., The Effect of Additions on the Exchange of Chlorine Between Calcium Chloride and Metal Oxides: Trans. Metallurgical Society, AIME, vol. 212, No. 4, August 1958, pp. 445–451.

[8] Calcium Chloride Institute News, Where You Use Calcium Chloride, You Maintain Traffic During Construction: Vol. 8, No. 3, May–June 1958, p. 3.

[9] Calcium Chloride Institute News, vol. 8, No. 4, July–August 1958, pp. 2, 4–5, 9.

[10] Robillard, R. J., Efficient Use of Mixtures Can Be Worthwhile: Calcium Chloride Institute News, vol. 8, No. 5, September–October 1958, pp. 3–4.

[11] Webster, Johnson H., Maintaining Traffic on Bridges During Cold Weather: Calcium Chloride Inst. News, vol. 8, No. 5, September–October 1958, pp. 6–7.

[12] Horgan, Paul C., Liquid Filled Tires Improve Traction: Calcium Chloride Institute News, vol. 8, No. 1, January–February 1958, p. 8.

Ohio Turnpike Commission used 1:2 calcium chloride and salt for snow and ice removal. At 25° F. and colder 400 pounds of the mixture was spread each mile in snow or sleet and 200 pounds in freezing rain. Regardless of the type of precipitation, 400 pounds per mile was spread at 10° F. or below.[13]

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 1958.[14]

Nelco Metals quoted two grades of calcium per pound on a sliding scale in nonreturnable containers, f.o.b. Canaan, Conn. Commercial grade (over 99 percent): Full crowns, $2 to $0.95; broken crowns 5 inches and smaller, $2.10 to $1.05; 6-mesh nodules, $2.50 to $1.15; turnings, $3 to $2.50; ingots or waffles, $2.80 to $1.30. Redistilled grade (over 99.4 percent): Broken crowns 8 inches and smaller, $3.75 to $1.70; 6-mesh nodules, $4 to $1.80; and ⅛-inch nodules, $5 to $2.50.[15]

Union Carbide Metals Co. (formerly Electro Metallurgical Co.), Division of Union Carbide Corp., quoted two sizes of distilled grade (99.5 percent) on a sliding scale, f.o.b. Niagara Falls, N.Y.: Lump, $6.55 to $3.75, and crushed, $6.85 to $4.05 per pound.[16]

Average 1958 value of imported calcium was $1.53 a pound and of imported calcium-silicon 19.2 cents a pound, compared with 19.5 cents in 1957.

Price quotations[17] for calcium chloride in its various commercial forms were unchanged from those shown in the 1957 Calcium Yearbook chapter.

American Society for Testing Materials has designated regular calcium chloride (77 percent minimum) as Type 1 and concentrated calcium chloride (94 percent minimum) as Type 2. The Calcium Chloride Institute revised highway application charts for Types 1 and 2.[18]

FOREIGN TRADE[19]

Imports.—Calcium imports remained small in 1958, and Canada was the only source.

Calcium-silicon alloy imports in 1958 decreased 74 percent from 1957. France supplied 99.5 percent, and Canada, 0.5 percent.

In 1958 only 475 short tons of calcium chloride were imported; 52 percent came from Belgium-Luxembourg; 27 percent, from West Germany; and 21 percent, from United Kingdom.

[13] Calcium Chloride Institute News, OTC Procedures for Clear Pavement: Vol. 8, No. 6, November–December 1958, pp. 3–4; Roads and Streets, Winter Maintenance Data for Ohio Turnpike: Vol. 102, No. 2, February 1959, p. 92.

[14] E&MJ Metal and Mineral Markets, vol. 29, Nos. 1–52, Jan. 2–Dec. 25, 1958.

[15] Nelco Metals, Inc., Price Sheets, Calcium Metal, Commercial and Redistilled Grades and Some Properties of Calcium Metal: Nov. 15, 1958, 3 pp.

[16] Electro Metallurgical Co., Division of Union Carbide Corp., Product Price Sheet: Calcium Metal (Distilled Grade), Jan. 1, 1958, 1 p.

[17] Oil, Paint and Drug Reporter, vol. 173, Nos. 1–27; vol. 174, Nos. 1–27, Jan. 6–Dec. 29, 1958.

[18] Calcium Chloride Institute News, vol. 8, No. 3, May–June 1958, p. 5.

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

TABLE 1.—Calcium metal and calcium-silicon imported for consumption in the United States, 1949–53 (average) and 1954–58

[Bureau of the Census]

Year	Calcium metal		Calcium-silicon	
	Pounds	Value	Pounds	Value
1949–53 (average)	479,027	$498,260	120,728	$5,291
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
1958	15,694	24,084	130,866	25,111

TABLE 2.—Calcium chloride imported for consumption into and exported from the United States, 1949–53 (average) and 1954–58

[Bureau of the Census]

Year	Imports		Exports	
	Short tons	Value	Short tons	Value
1949–53 (average)	1,340	$44,425	17,224	$487,212
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
1958	475	17,137	37,632	1,325,460

Exports.—Ninety-seven percent of exported calcium chloride went to Canada, Mexico, Cuba, and the Philippines, in descending quantities; Canada received 91 percent of the total. The remaining 3 percent was distributed among 23 countries in Latin America, Europe, Asia, and Africa.

WORLD REVIEW

NORTH AMERICA

Canada.—Calcium was produced by thermal reduction of quicklime with high-quality aluminum by the leading world producer, Dominion Magnesium, Ltd., Toronto, at its Haley, Ontario, plant in 1958. Quicklime and aluminum were briquetted and charged into horizontal, high-temperature, vacuum retorts, which projected through the furnace wall. Calcium condensed in the cold ends of the retorts. Calcium production in 1957 was 66,341 pounds valued at Can$83,589, or Can$1.26 a pound.[20]

The United States was the principal purchaser of Canadian calcium in 1957.

EUROPE

Germany, East.—Weiss & Co., Döbeln, Saxony, developed calcium "Weiss" to decontaminate lead, mercury, and nickel.

Germany, West.—Dihydrated calcium chloride was prepared by E. Merck A. G. of Darmstadt. Crystalline, nondeliquescent dihydrate was better suited for preparing solutions than hexahydrate.[21]

[20] Dominion Bureau of Statistics, Preliminary Estimate of Canada's Mineral Production for 1957 (Ottawa): Jan. 2, 1958, p. 3.

United Kingdom.—Calcium chloride was supplied by Imperial Chemical Industries, Ltd., as an ammonia-soda byproduct. Confronted by a nation-wide shortage, which resulted in a 20-percent reduction in import duty, the company planned increased capacity. Calcium chloride was used principally in curing concrete and in ready mixed cements. December 1958 prices ranged from $37.10 per ton for solid (70 to 75 percent $CaCl_2$) in drums to $47.60 for flake or solid.[22]

ASIA

China.—A calcium plant was among 65 chemical factories planned for the Harbin district by 1962.[23]

India.—Mettur Chemical & Industrial Corporation, Ltd., Mettur Dam R. S., Madras State, was a leading manufacturer of bleaching powder and calcium chloride. Domestic demand exceeded production, and expansion was planned.[24]

Pakistan.—An exploratory borehole drilled at Dhariala on the eastern part of the Salt Range Plateau found saturated brine containing 6.1 percent $CaCl_2$ at the 3,939-foot horizon. Initial flow at the surface was 60,000 gallons an hour. Brine containing calcium chloride was also found at 4,418 feet.[25]

TECHNOLOGY

Patents.—Calcium was produced by the thermal dissociation of calcium carbide containing lime. Calcium carbide was heated to its dissociation temperature at which calcium vapor evolved. Calcium was collected after carbon monoxide and other extraneous gases had combined with calcium vapor to form solid reaction products, which were removed.[26]

A flux for uranium and uranium alloys consisted of 50 to 70 percent fluorspar, 20 to 40 percent calcium chloride, and 5 to 15 percent uranium tetrafluoride.[27]

Building.—Calcium chloride—up to 2 percent by weight of cement—was used in pouring most floors in the 42-story Southland Life Insurance Co. building and the 28-story Sheraton Dallas Hotel, Dallas, Tex., in the winter of 1957–58. Calcium chloride reduced the cost of finishing, permitted earlier removal of forms, and allowed pouring on days otherwise too cold.[28]

Strength development of precast concrete columns at Arizona State College, Tempe, Ariz., was so accelerated by calcium chloride that the columns could be stripped and lifted into position in 3 days.[29]

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[21] Chemical Trade Journal and Chemical Engineer (London), vol. 143, No. 3715, Aug 15, 1958, p. 375.
[22] Chemical Age (London), $CaCl_2$ Shortage: Vol. 80, No. 2059, Dec. 27, 1958, pp. 1051–1052.
[23] Chemical Age (London), vol. 80, No. 2040, Aug. 16, 1958, p. 266.
[24] U.S. Consulate, Madras, India, State Department Dispatch 462: May 23, 1958, pp. 1–2.
[25] U.S. Embassy, Karachi, Pakistan, State Department Dispatch 445: Nov. 25, 1957, p. 7.
[26] Jaffe, Sigmund, and Parks, John M. (assigned to Air Reduction Co., Inc., New York, N.Y.), Production of Calcium Metal: U.S. Patent 2,839,380, June 17, 1958.
[27] Foote, Frank (assigned to the United States of America as represented by the Chairman of the Atomic Energy Commission), Flux Composition and Method for Treating Uranium-Containing Metal: U.S. Patents 2,849,307 and 2,849,308, Aug. 26, 1958.
[28] Calcium Chloride Institute News, Cool Weather No Construction Hindrance on Dallas' New Southland Center: Vol. 8, No. 3, May–June 1958, p. 8.
[29] Riley, Walter E., Lift Slab Construction—Precast Concrete Columns, Slabs Strengthened With Calcium Chloride: Calcium Chloride Inst. News, vol. 8, No. 5, September–October 1958, p. 5.

A 500-gallon dilution tank supplied calcium chloride to batches of ready-mixed concrete to produce 350 cubic yards of concrete hourly at Anderson Concrete Corp., Columbus, Ohio.[30]

Stabilization.—Calcium chloride stabilized shoulders provided emergency parking, supported heavily loaded trucks, remained level with pavement edge, were dustfree, and required minimum maintenance along principal highways in New York, Ohio, Pennsylvania, and Virginia.[31]

Test sections of an Anne Arundel County, Md., highway base stabilized with calcium chloride remained firm and free of cracks over the 1957–58 winter.[32]

Tennessee Department of Highways and Public Works completed its first highway with 10-foot calcium chloride stabilized shoulders in Knox County in August 1957. To each ton of aggregate, 6 pounds of calcium chloride were added. After compaction, calcium chloride was applied to the surface at 3/4 pound per square yard. The stabilized shoulders remained flush with the pavement after 5 months of heavy rainfall and traffic.[33]

Calcium chloride has been used in stabilization since 1915, but lime has been used regularly only since 1945. Where 15 to 22 pounds of lime were used per square yard, only 2 pounds of calcium chloride were used per square yard.[34]

Research.—Ice-melting studies of calcium chloride and rock salt were sponsored by the Calcium Chloride Institute. University of Minnesota tests on the quantity of ice melted in 15 to 120 minutes at varying temperatures confirmed faster melting by calcium chloride at all temperatures and the greatly reduced effectiveness of salt at lower temperatures. Ohio State University research indicated that relative humidity must exceed 75 percent before sodium chloride readily absorbed water and melted ice. Calcium chloride, on the other hand, melted ice at relative humidities between 46 and 60 percent and temperatures between −15° and 32° F. Field studies in Michigan showed 25 percent more clear space on icy pavements after 1 hour of treatment with 1:3 calcium chloride-salt mixture. When calcium chloride dissolves, it releases the heat that salt requires to dissolve, which explained the greater effectiveness of the mixture in melting ice. It has demonstrated that premixed calcium chloride and salt could be stockpiled if dry and protected from rain. Underneath the protecting crust that formed, the saline mixture remained freeflowing.[35]

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[30] Modern Concrete, World's Largest Ready Mixed Concrete Plant Features Automatic Dual Batching: Vol. 22, No. 3, July 1958, pp. 34–37, 39.

[31] Dickinson, W. E., Stabilized Shoulders: Calcium Chloride Institute News, vol. 8, No. 2, March–April 1958, pp. 3–4.

[32] Calcium Chloride Institute News, Test Road Shows Benefit of Calcium Chloride in Base: Vol. 8, No. 2, March–April 1958, p. 8.

[33] Better Roads, Tennessee Builds All-Weather Shoulders: Vol. 28, No. 7, July 1958, p. 24.

[34] National Lime Association, Limeographs: Vol. 25, December 1958, p. 53.

[35] Dickinson, William E., Melt Ice Fastest Way With Mixtures Method—Storage Proves Practical: Calcium Chloride Inst. News, vol. 8, No. 4, July–August 1958, pp. 3–5.

Cement

By D. O. Kennedy [1] and Betty M. Moore [2]

AFTER a slow start caused by severe winter conditions in the Northern States the demand for cement rose rapidly to a new monthly record of nearly 37 million barrels shipped in October 1958. Total production fell just short of the peak established in 1956. Optimism for the future was supported by expected population increases in the next decade, particularly in metropolitan areas where concrete products—culverts, sewer pipes, highways, and sidewalks—are in greatest demand. Consumption of cement in highway construction in 1958 was estimated by the Bureau of Public Roads to be more than 74 million barrels and was expected to be over 160 million barrels annually when the Federal highway program is in full swing.

Although the annual productive capacity of the cement industry increased 35 percent, from 298 million barrels at the end of 1954 to 403 million at the end of 1958, further increases were scheduled. Seven companies announced their intentions of building new plants with a combined capacity of 8 million barrels and seven other companies announced intentions of adding over 13 million barrels capacity to their existing plants.

A contract for 3 million barrels of portland cement to be used in constructing Glen Canyon Dam in northern Arizona was awarded to the American Cement Corp. on its low bid of $3.2473 a barrel delivered at the damsite. A second contract was awarded to J. G. Shotwell for 220,000 tons of pozzolanic material from a natural deposit 20 miles north of Flagstaff, Ariz. The 700-foot-high Glen Canyon Dam is the major feature of the Colorado River Storage Project.

Three classes of hydraulic cement were produced in the United States in 1958—portland, natural, and slag cements. In addition, prepared masonry cements were produced at many portland cement plants and at all other cement plants.

LEGISLATION AND GOVERNMENT PROGRAMS

The Lehigh Valley Air Pollution Control, formed by several towns in eastern Pennsylvania, voted antipollution ordinances in 1958. Progress has been made by the cement companies in installing dust-collecting equipment, but the economic problem of replacing equipment is a serious one to most companies.[3] For many years dust from the cement plants in the valley was considered only an occupational hazard, but technical developments offering increased efficiency in

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[3] Bell, J. N., Air Pollution Laws Come to Lehigh Valley: Rock Products, vol. 61, No. 5, May 1958, pp. 80–83.

TABLE 1.—Salient statistics of the cement industry

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production:						
Portland ... thousand barrels	235,564	268,752	293,260	312,204	292,923	306,609
Prepared masonry ... do	(1)	(1)	16,519	15,906	14,701	14,361
Natural, slag, and hydraulic lime ... do	[2] 3,554	[2] 3,504	941	1,128	631	520
Total ... do	239,118	272,256	310,720	329,238	308,255	321,490
Capacity used at portland-cement mills ... percent	86.3	91.3	94.1	90.7	78.2	77.3
Shipments from mills:						
Portland ... thousand barrels	233,989	271,190	288,171	304,424	284,146	302,320
Prepared masonry ... do	(1)	(1)	16,526	15,898	14,381	14,451
Natural, slag, and hydraulic lime ... do	[2] 3,567	[2] 3,513	954	1,074	662	492
Total ... do	237,556	274,703	305,651	321,396	299,189	317,263
Value of shipments [3] ... thousands	$592,098	$763,413	$884,381	$989,234	$961,499	$1,038,672
Average value per barrel	$2.49	$2.78	$2.89	$3.08	$3.21	$3.27
Stocks at mills, Dec. 31 ... thousand barrels	16,309	16,569	17,485	22,412	[4] 28,748	30,434
Imports ... do	661	450	5,220	4,456	[4] 4,427	3,390
Exports ... do	3,128	1,859	1,795	1,981	1,331	641
Apparent consumption ... do	235,089	273,294	309,076	323,870	302,285	320,012
World: Production ... do	870,596	[4] 1,143,003	[4] 1,278,217	[4] 1,386,081	[4] 1,447,912	1,541,996

1 Not included in tabulation until 1955.
2 Includes masonry cement from natural, slag, and hydraulic-lime cement plants.
3 Value received f.o.b. mill, excluding cost of containers.
4 Revised figure.

dust control have made citizens in the cement communities less willing to accept ineffective control measures.

PORTLAND CEMENT

PRODUCTION AND SHIPMENTS

Production of portland cement increased from 298 million barrels in 1957 to 311 million in 1958. Ninety-two of the 164 plants producing cement in 1957 had larger outputs in 1958; of the 72 plants with less production 60 percent were in the northeast section of the United States. Four new plants reported production: Alpha Portland Cement Co., Lime Kiln, Md.; Arkansas Cement Co., Foreman, Ark.; General Portland Cement Co. and Lehigh Portland Cement Co., both of Miami, Fla. In addition, six new plants, one each in Arizona, Michigan, Mississippi, New Mexico, New York, and Texas, were under construction.

TABLE 2.—Finished portland cement produced, shipped, and in stock in the United States (and Puerto Rico) by districts

District	Active plants		Production			Shipments from mills								Stocks at mills on Dec. 31		
			Thousand barrels		Change from 1957 (percent)	1957			1958					Thousand barrels		Change from 1957 (percent)
						Thousand barrels	Value		Thousand barrels	Value		Change from 1957 (percent) in—				
	1957	1958	1957	1958			Total (thousand)	Average per barrel		Total (thousand)	Average per barrel	Barrels	Average value	1957	1958	
Eastern Pennsylvania, Maryland	21	22	37,293	36,976	−1	35,705	$117,585	$3.29	35,893	$119,956	$3.34	+1	+2	[1] 4,455	5,174	+16
New York, Maine	11	11	17,836	16,920	−5	17,259	56,509	3.27	16,229	53,907	3.32	−6	+2	[1] 1,754	2,293	+31
Ohio	10	10	16,291	15,191	−7	15,454	49,115	3.18	14,960	50,092	3.35	−3	+5	[1] 1,973	2,116	+7
Western Pennsylvania, West Virginia	7	7	13,306	11,508	−14	12,799	41,482	3.24	11,518	38,766	3.37	−10	+4	[1] 1,356	1,216	−10
Michigan	8	8	21,015	19,841	−6	20,590	65,996	3.21	19,691	65,738	3.34	−4	+4	[1] 2,204	2,342	+6
Illinois	4	4	8,794	9,433	+7	8,097	24,560	3.03	9,205	29,308	3.18	+14	+5	875	945	+8
Indiana, Kentucky, Wisconsin	7	7	17,681	20,269	+15	16,558	53,611	3.24	19,362	64,541	3.33	+17	+3	[1] 1,721	1,878	+9
Alabama	8	8	11,965	12,372	+3	11,382	34,238	3.01	11,915	36,562	3.07	+5	+2	905	981	+8
Tennessee	6	6	7,181	7,923	+10	6,776	20,592	3.04	7,678	23,969	3.12	+13	+3	684	665	−3
Virginia, South Carolina	4	4	7,643	6,851	−10	7,491	24,173	3.23	6,892	22,677	3.29	−8	+2	702	660	−6
Georgia, Florida	4	6	7,167	9,650	+35	7,079	23,348	3.30	9,208	29,940	3.25	+30	−2	452	853	+89
Louisiana, Mississippi	4	4	6,784	6,935	+2	6,599	19,700	2.99	6,849	21,230	3.10	+4	+4	431	473	+10
Iowa	5	5	10,502	12,306	+17	10,423	33,219	3.19	12,260	39,993	3.26	+18	+2	1,380	1,314	−5
Eastern Missouri, Minnesota, South Dakota	6	6	12,549	14,156	+13	12,524	39,926	3.19	13,816	45,621	3.30	+10	+3	1,339	1,623	+21
Kansas	6	6	8,118	9,244	+14	7,864	23,593	3.00	9,298	28,843	3.10	+18	+3	[1] 1,005	923	−8
Western Missouri, Nebraska, Oklahoma, Arkansas	6	7	10,488	11,908	+14	10,297	31,688	3.08	12,047	38,243	3.17	+17	+3	1,083	895	−17
Texas	14	14	21,845	25,465	+17	21,547	66,201	3.07	25,209	77,186	3.06	+17	−0.3	[1] 1,782	2,037	+14
Colorado, Arizona, Utah	6	6	8,740	9,895	+13	8,774	29,101	3.32	9,846	33,005	3.35	+12	+1	432	482	+12
Wyoming, Montana, Idaho	3	3	2,802	2,922	+4	2,788	9,756	3.50	2,956	10,536	3.56	+6	+2	294	261	−11
Northern California	5	5	16,718	16,829	+1	16,621	49,993	3.01	17,281	54,307	3.14	+4	+4	[1] 1,441	986	−32
Southern California	8	8	21,653	22,227	+3	21,110	67,859	3.21	22,302	70,060	3.14	+6	−2	[1] 1,515	1,440	−5
Oregon, Washington	9	9	6,552	7,788	+19	6,409	22,482	3.51	7,905	28,046	3.55	+23	+1	886	770	−13
Puerto Rico	2	2	5,501	4,862	−12	5,552	17,232	3.10	4,748	15,175	3.20	−14	+3	47	161	+243
Total	164	168	298,424	311,471	+4	[2] 289,698	921,959	3.18	307,068	997,701	3.25	+6	+2	[1] 28,716	30,488	+6
Pennsylvania	24	24	44,004	40,945	−7	42,519	140,100	3.29	40,148	135,118	3.37	−6	+2	[1] 5,075	5,634	+11
Missouri	5	5	10,866	12,143	+12	10,794	34,307	3.18	11,813	39,376	3.33	+9	+5	931	1,204	+29

[1] Revised figure.

[2] Does not include finished cement used in manufacturing prepared masonry cement, as follows: 1957, 2,542,000 barrels; 1958, 2,631,000 barrels.

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States (and Puerto Rico) in 1958, 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	2,529	1,358	1,849	3,220	3,484	3,482	3,163	3,912	3,744	3,757	3,429	2,946
New York, Maine	1,336	932	879	1,236	1,719	1,672	1,625	1,708	1,650	1,804	1,202	1,162
Ohio	649	401	633	1,165	1,487	1,328	1,626	1,612	1,873	2,061	1,445	909
Western Pennsylvania, West Virginia	874	535	695	1,048	1,129	1,204	1,168	1,079	1,146	1,167	878	574
Michigan	637	489	644	1,596	1,812	2,455	2,420	2,361	2,413	2,250	1,962	799
Illinois	694	417	555	707	984	926	936	907	887	913	761	746
Indiana, Kentucky, Wisconsin	888	859	1,229	1,615	2,141	2,034	2,078	2,160	2,208	2,355	1,564	1,141
Alabama	828	713	982	938	1,070	1,067	1,101	1,221	1,194	1,102	1,137	1,019
Tennessee	478	241	416	683	732	760	749	793	750	800	771	751
Virginia, South Carolina	289	311	529	571	600	707	495	650	723	706	744	526
Georgia, Florida	500	613	745	684	757	784	791	853	905	998	1,089	931
Louisiana, Mississippi	500	380	444	538	601	617	601	578	628	738	642	669
Iowa	727	568	771	630	1,187	1,210	1,293	1,312	1,257	1,183	1,085	1,083
Eastern Missouri, Minnesota, South Dakota	807	528	529	1,126	1,355	1,422	1,376	1,442	1,562	1,659	1,292	1,057
Kansas	352	386	532	742	840	806	824	969	974	1,086	954	781
Western Missouri, Nebraska, Oklahoma, Arkansas	575	413	569	824	1,089	1,292	1,128	1,327	1,175	1,322	1,207	942
Texas	1,577	1,553	1,785	2,043	2,324	2,288	2,332	2,436	2,241	2,485	2,343	2,053
Colorado, Arizona, Utah	661	561	713	800	902	864	882	983	942	913	842	839
Wyoming, Montana, Idaho	96	93	145	221	306	301	291	344	334	346	244	207
Northern California	914	641	1,014	1,165	1,629	1,665	1,684	1,776	1,624	1,674	1,552	1,492
Southern California	1,569	1,343	1,475	1,385	2,026	2,045	2,122	2,187	2,141	2,126	1,887	1,916
Oregon, Washington	369	386	476	694	695	731	737	683	809	985	595	625
Puerto Rico	381	404	429	370	405	418	411	382	417	417	406	422
Total: 1958	18,230	14,125	18,038	24,001	29,274	30,078	29,833	31,675	31,597	32,847	28,031	23,590
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
SHIPMENTS												
Eastern Pennsylvania, Maryland	1,546	859	2,052	3,443	3,788	3,524	3,929	3,949	4,086	3,925	3,085	1,704
New York, Maine	544	349	767	1,280	1,893	1,854	1,928	1,993	1,988	1,805	1,238	591
Ohio	392	311	702	1,172	1,315	1,472	1,634	1,932	2,069	2,297	1,288	376
Western Pennsylvania, West Virginia	453	300	640	1,045	1,111	1,190	1,235	1,290	1,376	1,457	1,006	415
Michigan	439	366	712	1,567	2,092	2,094	2,413	2,625	2,554	2,862	1,492	476
Illinois	241	208	529	915	1,280	997	1,136	1,040	1,043	1,013	568	233
Indiana, Kentucky, Wisconsin	633	514	1,125	1,712	2,053	1,864	2,165	2,305	2,363	2,629	1,417	582
Alabama	697	615	906	976	1,074	1,049	1,113	1,217	1,140	1,179	1,095	851
Tennessee	350	306	497	620	715	735	796	819	814	896	667	462
Virginia, South Carolina	353	292	488	606	679	658	555	660	767	757	686	392
Georgia, Florida	602	511	661	731	790	762	765	785	895	1,021	886	799
Louisiana, Mississippi	446	363	471	549	592	607	599	687	569	766	584	616

Iowa	214	177	403	917	1,391	1,552	1,582	1,753	1,766	1,474	696	334
Eastern Missouri, Minnesota, South Dakota	323	243	560	1,051	1,377	1,374	1,521	1,774	1,970	2,219	968	436
Kansas	325	300	472	815	937	885	785	1,019	1,069	1,402	776	513
Western Missouri, Nebraska, Oklahoma, Arkansas	423	362	556	1,021	1,186	1,175	1,173	1,552	1,524	1,508	928	634
Texas	1,572	1,470	1,892	1,962	2,242	2,311	2,495	2,403	2,165	2,566	2,093	2,039
Colorado, Arizona, Utah	598	574	605	809	903	936	955	1,020	1,008	971	727	737
Wyoming, Montana, Idaho	105	96	139	240	310	296	337	342	387	368	184	153
Northern California	906	662	976	1,252	1,596	1,738	1,932	1,775	1,669	1,875	1,417	1,483
Southern California	1,717	1,189	1,344	1,606	2,105	2,127	2,111	2,095	2,070	2,225	1,816	1,883
Oregon, Washington	345	395	581	665	686	661	717	780	1,050	995	524	506
Puerto Rico	369	392	408	364	410	401	405	373	425	405	387	408
Total: 1958	13,593	10,854	17,486	25,318	30,525	30,262	32,281	34,188	34,767	36,615	24,528	16,623
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
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	5,417	5,897	5,676	5,422	5,087	5,123	4,313	4,235	3,860	3,651	3,960	5,175
New York, Maine	2,535	3,111	3,221	3,160	2,972	2,773	2,455	2,158	1,799	1,776	1,731	2,292
Ohio	2,228	2,316	2,242	2,221	2,381	2,231	2,215	1,892	1,689	1,438	1,591	2,116
Western Pennsylvania, West Virginia	1,770	1,996	2,047	2,031	2,033	2,030	1,947	1,723	1,483	1,185	1,050	1,202
Michigan	2,402	2,526	2,457	2,484	2,204	2,563	2,571	2,306	2,166	1,553	2,019	2,342
Illinois	1,317	1,523	1,536	1,311	998	910	694	545	373	260	436	945
Indiana, Kentucky, Wisconsin	1,954	2,276	2,314	2,149	2,160	2,255	2,095	1,867	1,627	1,278	1,357	1,878
Alabama	1,006	1,090	1,138	1,062	1,024	1,009	960	931	950	832	843	981
Tennessee	796	727	627	670	662	660	590	535	439	317	396	665
Virginia, South Carolina	638	658	699	664	585	634	574	564	520	468	526	660
Georgia, Florida	351	446	528	477	438	457	481	547	553	526	724	853
Louisiana, Mississippi	483	497	464	453	459	463	461	348	399	368	423	473
Iowa	1,894	2,274	2,627	2,327	2,114	1,765	1,467	1,015	497	197	566	1,314
Eastern Missouri, Minnesota, South Dakota	1,815	2,100	2,068	2,138	2,114	2,154	2,004	1,670	1,257	697	1,017	1,623
Kansas	1,032	1,105	1,164	1,091	994	915	948	898	803	480	658	923
Western Missouri, Nebraska, Oklahoma, Arkansas	1,236	1,287	1,282	1,085	989	1,105	1,061	836	486	300	575	857
Texas	1,793	1,876	1,768	1,849	1,931	1,909	1,746	1,777	1,854	1,773	2,023	2,037
Colorado, Arizona, Utah	494	472	580	570	568	497	424	386	321	263	379	481
Wyoming, Montana, Idaho	278	274	281	262	258	264	218	221	167	146	206	261
Northern California	1,448	1,427	1,464	1,377	1,410	1,335	1,086	1,087	1,042	842	977	986
Southern California	1,382	1,537	1,668	1,447	1,369	1,287	1,298	1,391	1,461	1,361	1,433	1,467
Oregon, Washington	907	897	791	821	830	900	921	825	581	575	649	767
Puerto Rico	59	71	92	99	93	111	117	126	118	129	147	161
Total: 1958	33,235	36,383	36,734	35,170	33,673	33,350	30,646	27,883	24,445	20,415	23,686	30,459
1957	29,828	32,382	34,277	34,893	33,176	29,885	24,345	20,018	20,250	19,213	23,187	[2] 28,729

[1] Difference between monthly and annual reports not adjusted.
[2] Revised figure.

Descriptions were published of equipment installed as part of expansion plans or in new cement plants in Buffington, Ind., Lake Charles, La., Lime Kiln, Md., Union Bridge, Md., Cape Girardeau, Mo., and Lime and Oswego, Oreg.[4]

Permanente Cement Co. purchased the Bellingham (Wash.) plant of the Olympic Portland Cement Co., Ltd., and announced plans for increasing its size.

TYPES OF PORTLAND CEMENT

General-use and moderate-heat portland cements (types I and II) were produced at 167 of the 168 operating plants and comprised 94 percent of all the portland cement made. High-early-strength portland cement (type III) was produced at 120 plants, 9 more than in 1957, but the output was less than in 1957.

No portland-pozzolan cement was made. Ten plants reported production of portland-slag cement, and 94 percent of the 4-million-barrel output came from four plants. The total output dropped to less than that of 1955. Nine of 10 plants produced other types of portland cement in addition to slag cement.

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[4] Herod, Buren C., Universal Atlas' New Plant at Gary: Pit and Quarry, vol. 51, No. 2, August 1958, pp. 72–78, 80.
Meschter, Elwood, Built for Expansion: Rock Products, vol. 61, No. 3, March 1958, pp. 100–105, 132.
Herod, Buren C., Adds Lake Charles Plant to Far-Flung Operations: Pit and Quarry, vol. 50, No. 9, March 1958, pp. 78–89.
Rock Products, Alpha Opens New Cement Plant to Serve Baltimore Area: Vol. 61, No. 11, November 1958, pp. 108–109, 112.
Meschter, Elwood, Alpha Adds New Cement Plant With Low Investment: Rock Products, vol. 62, No. 1, January 1959, pp. 92–96, 151.
Meschter, Elwood, To Win a Market, Get There First With the Most: Rock Products, vol. 61, No. 9, September 1958, pp. 88–91, 152, 154.
Herod, Buren C., New Cape Girardeau Mill—No. 10 in Marquette Chain: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 154–160.
Utley, Harry F., Capacity Up 75 Percent as Oregon Portland Cement Expands Two Plants: Pit and Quarry, vol. 50, No. 11, May 1958, pp. 88–90.

TABLE 4.—Portland cement produced and shipped in the United States,[1] by types

Type and year	Active plants	Production (thousand barrels)	Shipments: Thousand barrels	Value: Total (thousand)	Value: Average per barrel
General-use and moderate-heat (types I and II):					
1949–53 (average)	153	201,114	199,847	$492,221	$2.46
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
1958	167	[2] 291,688	287,377	922,921	3.21
High-early-strength (type III):					
1949–53 (average)	93	7,213	7,065	20,351	2.88
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
1958	120	[3] 12,161	12,274	45,107	3.67
Low-heat (type IV):					
1949–53 (average)	4	367	327	987	3.02
1954	1	84	48	194	4.02
1955	0				
1956	2	14	3	9	3.29
1957	2	21	5	16	3.23
1958	2	7	9	35	3.90
Sulfate-resisting (type V):					
1949–53 (average)	4	57	84	303	3.62
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
1958	9	244	205	767	3.75
Oil-well:					
1949–53 (average)	17	1,751	1,763	4,887	2.77
1954	16	1,641	1,665	5,059	3.04
1955	16	1,898	1,851	6,429	3.47
1956	16	1,655	1,705	5,687	3.33
1957	16	1,511	1,482	5,161	3.48
1958	15	983	1,058	3,739	3.54
White:					
1949–53 (average)	4	1,116	1,103	5,648	5.12
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	1,087	1,024	6,595	6.44
1958	4	[4] 1,377	1,237	8,001	6.47
Portland-pozzolan:					
1949–53 (average)	5	1,800	1,805	4,505	2.50
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
1958	11	[5] 4,096	3,977	13,632	3.43
Miscellaneous:[6]					
1949–53 (average)	23	864	862	2,692	3.12
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
1958	22	[4] 915	931	3,499	3.76
Grand total:					
1949–53 (average)	153	239,042	237,447	591,489	2.49
1954	[7] 157	272,353	274,872	759,862	2.76
1955	[7] 157	297,453	292,765	837,526	2.86
1956	[7] 160	316,438	308,678	940,020	3.05
1957	[7] 164	298,424	289,698	921,959	3.18
1958	[7] 168	311,471	307,068	997,701	3.25

[1] Includes Puerto Rico.
[2] Includes air-entrained portland cement as follows (in thousand barrels): 1954, 31,204; 1955, 31,588; 1956, 35,458; 1957, 32,791; 1958, 31,470.
[3] Includes air-entrained portland cement as follows (in thousand barrels): 1954, 2,651; 1955, 3,378; 1956, 3,444; 1957, 3,497; 1958, 4,382.
[4] Includes a small amount 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; 1958, 2,164.
[6] Includes hydroplastic, plastic, and waterproofed cements.
[7] Includes number of plants making air-entrained portland cement as follows: 1954, 99; 1955, 99; 1956, 104; 1957, 112; 1958, 113.

CAPACITY OF PLANTS

The estimated annual capacity of all portland-cement plants on December 31, 1958, as reported to the Bureau of Mines by producers, was 6 percent greater than on December 31, 1957. The capacity of 397 million barrels for the continental United States was 5 million barrels greater than forecast by the cement industry in December 1955. The increase of 22 million barrels in 1958 was due to expansions at 20 of the 163 plants in operation in 1957 and the addition of 4 new plants.

Number of portland-cement plants in the United States (including Puerto Rico) in 1958, by size groups

Estimated annual capacity, Dec. 31, million barrels:	*Number of plants*	*Percent of total capacity*
Less than 1	10	1.8
1 to 2	59	22.2
2 to 3	58	34.4
3 to 4	24	19.4
4 to 5	9	9.3
5 to 11	7	12.9
Total	[1] 167	100.0

[1] Does not include clinker-grinding plants.

TABLE 5.—Portland-cement-manufacturing capacity of the United States (and Puerto Rico), by districts

District	Estimated (thousand barrels)		Percent utilized	
	1957	1958	1957	1958
Eastern Pennsylvania, Maryland	49,473	52,406	75.4	70.6
New York, Maine	22,401	23,586	79.6	71.7
Ohio	18,023	21,245	90.4	71.5
Western Pennsylvania, West Virginia	15,998	16,160	83.2	71.2
Michigan	25,581	25,742	82.2	77.1
Illinois	9,977	9,880	88.2	95.5
Indiana, Kentucky, Wisconsin	24,010	23,666	73.6	85.6
Alabama	15,029	14,869	79.6	83.2
Tennessee	8,520	8,520	84.3	93.0
Virginia, South Carolina	9,270	9,270	82.4	73.9
Georgia, Florida	9,512	14,500	75.3	66.6
Louisiana, Mississippi	8,525	8,525	79.6	81.3
Iowa	13,000	14,050	80.8	87.6
Eastern Missouri, Minnesota, South Dakota	16,514	17,686	76.0	80.0
Kansas	11,750	12,148	69.1	76.1
Western Missouri, Nebraska, Oklahoma, Arkansas	12,865	16,157	81.5	73.7
Texas	32,063	35,776	68.1	71.2
Colorado, Arizona, Utah	8,880	9,850	98.4	100.5
Wyoming, Montana, Idaho	3,150	3,150	89.0	92.8
Northern California	18,335	18,435	91.2	91.3
Southern California	31,815	31,070	68.1	71.5
Oregon, Washington	9,695	10,095	67.6	77.1
Puerto Rico	6,000	6,000	91.7	81.0
Total	380,386	402,786	78.5	77.3

TABLE 6.—Capacity of portland-cement plants in the United States,[1] by processes

Process	Capacity, Dec. 31						Percent of capacity utilized			Percent of total finished cement produced		
	Thousand barrels			Percent of total								
	1956	1957	1958	1956	1957	1958	1956	1957	1958	1956	1957	1958
Wet	203, 522	217, 114	234, 130	58. 2	57. 1	58. 1	89. 3	77. 9	71. 3	57. 4	56. 7	53. 6
Dry	145, 920	163, 272	168, 656	41. 8	42. 9	41. 9	92. 3	79. 2	84. 4	42. 6	43. 3	46. 4
Total	349, 442	380, 386	402, 786	100. 0	100. 0	100. 0	90. 6	78. 5	77. 3	100. 0	100. 0	100. 0

[1] Includes Puerto Rico.

CLINKER PRODUCTION

Production of clinker rose 3 percent over 1957 and in October reached a record of 29.9 million barrels per month. At the end of 1958 stocks of clinker on hand were 4 percent greater than at the end of 1957.

TABLE 7.—Portland-cement clinker produced and in stock at mills in the United States,[1] by processes, in thousand barrels [2]

Process	Plants		Production		Stocks on Dec. 31—	
	1957	1958	1957	1958	1957 [3]	1958 [4]
Wet	98	100	175, 062	179, 853	7, 878	7, 830
Dry	66	68	129, 266	132, 954	6, 975	7, 599
Total	164	168	304, 328	312, 807	14, 853	15, 429

[1] Includes Puerto Rico.
[2] Compiled from monthly estimates of producers.
[3] Revised figures.
[4] Preliminary figures.

TABLE 8.—Production of portland-cement clinker at mills in the United States (and Puerto Rico) in 1958, by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,936	2,021	2,065	3,166	3,479	3,438	3,005	3,654	3,408	3,677	3,542	3,294
New York, Maine	1,638	1,298	1,312	1,367	1,716	1,560	1,591	1,554	1,517	1,638	1,225	1,322
Ohio	1,239	871	953	1,224	1,507	1,381	1,518	1,373	1,583	1,683	1,413	1,216
Western Pennsylvania, West Virginia	1,110	848	764	920	1,029	1,068	1,145	827	841	944	744	630
Michigan	1,439	1,394	1,576	1,617	1,609	2,054	2,069	1,732	1,832	1,874	1,905	1,634
Illinois	792	696	747	787	802	781	776	795	814	878	774	786
Indiana, Kentucky, Wisconsin	1,373	1,327	1,665	1,741	1,847	1,868	1,945	1,842	1,797	1,916	1,461	1,745
Alabama	911	834	999	941	1,133	1,064	1,025	1,123	1,132	1,090	1,075	1,073
Tennessee	558	300	416	648	721	705	757	755	738	772	810	759
Virginia, South Carolina	520	402	587	559	668	709	449	461	636	663	660	615
Georgia, Florida	585	649	742	747	832	755	833	891	961	1,056	1,134	1,081
Louisiana, Mississippi	503	493	516	533	652	600	640	515	590	657	625	644
Iowa	790	694	899	584	1,077	1,141	1,213	1,162	1,180	1,187	1,126	1,152
Eastern Missouri, Minnesota, South Dakota	1,051	701	600	1,025	1,210	1,155	1,006	1,115	1,247	1,346	1,206	1,275
Kansas	439	527	628	703	791	724	840	868	883	989	947	859
Western Missouri, Nebraska, Oklahoma, Arkansas	728	666	661	764	1,007	1,037	1,089	1,041	1,079	1,118	1,099	837
Texas	1,550	1,753	2,047	2,100	2,157	2,216	2,343	2,385	2,278	2,315	2,277	2,246
Colorado, Arizona, Utah	731	619	788	770	825	795	869	923	888	903	836	848
Wyoming, Montana, Idaho	200	172	165	188	294	294	294	271	215	287	296	297
Northern California	1,230	1,067	1,253	1,232	1,337	1,433	1,467	1,440	1,390	1,554	1,464	1,487
Southern California	1,584	1,350	1,502	1,608	1,807	1,968	2,175	2,155	2,148	2,159	2,050	2,060
Oregon, Washington	525	457	524	601	733	723	757	714	601	775	665	724
Puerto Rico	441	398	444	346	341	456	434	311	366	424	335	445
Total: 1958	22,873	19,537	21,853	24,171	27,574	27,925	28,240	27,907	28,124	29,905	27,669	27,029
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

RAW MATERIALS

Since 1943 approximately 70 percent of the domestic output of portland cement has been made from limestone and clay or shale. Argillaceous limestone (cement rock) or a mixture of cement rock and limestone was used for 23 percent of the portland cement made in 1958. Four plants used marl in place of limestone, and nine plants used shells.

Blast-furnace slag was used as a raw material in the production of portland cement at 24 plants, 10 of which used approximately 310,000 tons of slag to produce portland slag cement.

Fluorspar added to the raw materials at a few plants helped to reduce the alkali content of the finished portland cement. It was reported that the alkali in the mixture was more easily volatilized when fluorspar was present.

TABLE 9.—Production and percentage of total output of portland cement in the United States,[1] by raw materials used

Year	Cement rock and pure limestone		Limestone and clay or shale [2 3]		Blast-furnace slag and limestone	
	Thousand barrels	Percent	Thousand barrels	Percent	Thousand barrels	Percent
1949–53 (average)	49,139	20.6	172,846	72.3	17,057	7.1
1954	57,173	21.0	195,693	71.8	19,487	7.2
1955	71,764	24.1	206,763	69.5	18,926	6.4
1956	72,722	23.0	221,948	70.1	21,768	6.9
1957	64,776	21.7	211,743	71.0	21,905	7.3
1958	71,681	23.0	225,495	72.4	14,295	4.6

[1] Includes Puerto Rico.
[2] Includes output of 4 plants using marl and clay in 1949–53 (average); and 4 plants in 1954–58.
[3] Includes output of 7 plants using oystershell and clay in 1949–53 (average); 8 plants in 1954–56; 9 plants in 1957–58.

TABLE 10.—Raw materials used in producing portland cement in the United States[1]

Raw material	1956	1957	1958
Cement rock ....thousand short tons..	19,463	17,152	20,799
Limestone (including oystershell) ....do....	66,117	63,903	62,306
Marl ....do....	1,421	1,565	1,487
Clay and shale [2] ....do....	9,095	9,044	9,400
Blast-furnace slag ....do....	1,706	1,455	1,279
Gypsum ....do....	2,449	2,366	2,507
Sand and sandstone (including silica and quartz) ....do....	1,011	973	1,121
Iron materials [3] ....do....	494	516	535
Miscellaneous [4] ....do....	220	222	107
Total	101,976	97,196	99,541
Average total weight required per barrel (376 pounds) of finished cement ....pounds..	645	651	639

[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

Less coal and oil were used in producing cement than in 1957; coal and oil had supplied 62.5 percent of the British thermal units used in 1957, compared with 58 percent in 1958. The cubic feet of natural gas consumed increased 13 percent compared with 1957. The 167 plants used an average of 1.26 million B.t.u. per barrel of cement produced. Although several plants had one or more preheaters in operation, in most instances no figures were available indicating separation of either fuel consumption or cement production in these special kilns. The only available figures indicated an average of 700,000 B.t.u. per barrel of cement in modern kilns equipped with preheaters.

TABLE 11.—Finished portland cement produced and fuel consumed by the portland-cement industry in the United States,[1] by processes

Process	Finished cement produced			Fuel consumed		
	Plants	Thousand barrels	Percent of total	Coal (thousand short tons)	Oil (thousand barrels of 42 gallons)	Natural gas (M cubic feet)
1957						
Wet	97	169,109	56.7	4,340	4,320	103,852,885
Dry	67	129,315	43.3	4,513	1,095	42,312,794
Total	164	298,424	100.0	[2] 8,853	5,415	[3] 146,165,679
1958						
Wet	100	167,044	53.6	4,122	3,714	114,863,171
Dry	68	144,427	46.4	4,305	761	50,131,796
Total	168	311,471	100.0	[4] 8,427	4,475	[5] 164,994,967

[1] Includes Puerto Rico.
[2] Comprises 221,075 tons of anthracite and 8,632,090 tons of bituminous coal.
[3] Includes 55,606 M cubic feet of byproduct gas and 2,502,631 M cubic feet of coke-oven gas.
[4] Comprises 182,707 tons of anthracite and 8,244,485 tons of bituminous coal.
[5] Includes 39,895 M cubic feet of byproduct gas and 858,725 M cubic feet of coke-oven gas.

TABLE 12.—Portland cement produced in the United States,[1] by kinds of fuel

Fuel	Finished cement produced			Fuel consumed		
	Plants	Thousand barrels	Percent of total	Coal (thousand short tons)	Oil (thousand barrels of 42 gallons)	Natural gas (M cubic feet)
1957						
Coal	63	[2] 113,221	37.9	6,150	------	------
Oil	8	[2] 14,543	4.9	------	2,706	------
Natural gas	22	[2] 36,626	12.2	------	------	[3] 47,915,347
Coal and oil	20	39,728	13.3	1,687	1,205	------
Coal and natural gas	23	35,440	11.9	837	------	[4] 29,871,334
Oil and natural gas	20	47,603	16.0	------	1,461	[5] 55,667,109
Coal, oil, and natural gas	8	11,263	3.8	179	43	[5] 12,711,889
Total	164	298,424	100.0	[6] 8,853	5,415	146,165,679
1958						
Coal	62	[2] 112,075	36.0	5,928	------	------
Oil	8	[2] 11,737	3.8	------	2,178	------
Natural gas	29	[2] 57,128	18.3	------	------	69,893,357
Coal and oil	21	40,162	12.9	1,629	1,591	------
Coal and natural gas	23	39,169	12.6	685	------	[7] 33,606,380
Oil and natural gas	16	35,942	11.5	------	601	45,001,254
Coal, oil, and natural gas	9	15,258	4.9	185	105	16,493,976
Total	168	311,471	100.0	[8] 8,427	4,475	164,994,967

[1] Includes Puerto Rico.
[2] Average consumption of fuel per barrel of cement produced as follows: 1957—coal, 108.6 pounds; oil, 0.1861 barrel; natural gas, 1,308 cubic feet. 1958—coal, 105.8 pounds; oil, 0.1856 barrel; natural gas, 1,223 cubic feet.
[3] Includes 2,502,631 M cubic feet of coke-oven gas.
[4] Includes 55,606 M cubic feet of byprodust gas.
[5] Revised figure.
[6] Comprises 221,075 tons of anthracite and 8,632,090 tons of bituminous coal.
[7] Includes 858,725 M cubic feet of coke-oven gas and 39,895 M cubic feet of byproduct gas.
[8] Comprises 182,707 tons of anthracite and 8,244,485 tons of bituminous coal.

TABLE 13.—Electric energy used at portland-cement-producing plants in the United States,[1] by processes

Process	Electric energy used: Generated at portland-cement plants: Active plants	Generated at portland-cement plants: Million kilowatt-hours	Purchased: Active plants	Purchased: Million kilowatt-hours	Total: Million kilowatt-hours	Total: Percent	Finished cement produced (thousand barrels)	Average electric energy used per barrel of cement produced (kilowatt-hours)
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			
1958								
Wet	26	691	95	3,226	3,918	56.0	167,044	23.5
Dry	33	1,407	63	1,671	3,078	44.0	144,427	21.3
Total	59	2,098	158	4,897	6,996	100.0	311,471	22.5
Percent of total electric energy used		30.0		70.0	100.0			

[1] Includes Puerto Rico.

TRANSPORTATION

The trend toward shipping cement in bulk rather than in bags continued. Over 79 percent of all cement was shipped in bulk and the remainder in paper and cloth bags. For several years cement shipments by truck increased more than 2 percent annually, but in 1957 and 1958 the percentages shipped by truck were about the same. Most shipments by boat were confined to Puerto Rico, Louisiana, Alabama, California, and Kentucky, where 32, 22, 10, 4, and 3 percent, respectively, of the total shipments were by boat. The tabulations in this chapter represent only shipments from producing companies to consumers and do not include shipments between producing plants or from plants to distribution centers.

TABLE 14.—Shipments of portland cement from mills in the United States,[1] in bulk and in containers, by types of carriers

Type of carrier	In bulk: Thousand barrels	In bulk: Percent	In containers: Bags: Paper (thousand barrels)	In containers: Bags: Cloth (thousand barrels)	In containers: Other containers [2] (thousand barrels)	In containers: Total (thousand barrels)	Total shipments: Thousand barrels	Total shipments: Percent
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	
1958								
Truck	84,527	34.8	21,917	(4)		21,917	106,444	34.7
Railroad	150,897	62.1	41,838	(4)		41,838	192,735	62.8
Boat	7,334	3.0	154			154	7,488	2.4
Used at plant	330	.1	71	(4)		71	401	.1
Total	243,088	100.0	63,980	(4)		63,980	307,068	100.0
Percent of total	79.2		20.8	(4)		20.8	100.0	

[1] Includes Puerto Rico. [2] Includes steel drums and iron and wood barrels. [3] Less than 0.05 percent.
[4] Figure included with bags to avoid disclosing individual company confidential data.

CONSUMPTION

Net shipments of cement into a State afford a fair index of consumption. Shipments were higher to 33 States and the District of Columbia than in 1957 and lower to 15 northeastern States. Shipments of high-early-strength cement were greatest to New York, New Jersey, Pennsylvania, and Michigan.

All sections of the United States except the northeastern section showed increases in consumption over 1957, resuming the upward trends held from 1945 through 1956.

TABLE 15.—Destination of shipments of finished portland and high-early-strength cement from mills in the United States, by States, in thousand barrels

Destination	Finished portland		High-early-strength	
	1957	1958	1957	1958
Alabama	4,665	4,727	535	483
Alaska [1]	(2)	(2)	(2)	(2)
Arizona	2,773	3,575	2	1
Arkansas	1,694	2,129	16	27
Northern California	33,388	13,408	92	20
Southern California	(3)	20,824	(3)	156
Colorado	4,026	4,183	18	8
Connecticut [1]	5,185	3,207	348	291
Delaware [1]	904	853	67	81
District of Columbia [1]	1,171	1,525	74	99
Florida	9,950	11,409	786	865
Georgia	4,676	5,741	226	249
Hawaii [1]	(2)	(2)	(2)	(2)
Idaho	956	1,453	3	2
Illinois	16,236	19,388	569	664
Indiana	7,044	7,328	409	346
Iowa	5,813	7,755	142	187
Kansas	4,981	6,397	116	102
Kentucky	3,281	3,071	54	80
Louisiana	7,585	8,048	83	96
Maine	965	956	62	70
Maryland	5,127	4,558	136	258
Massachusetts [1]	4,922	4,762	440	435
Michigan	[4] 14,499	13,997	[4] 1,291	1,139
Minnesota	5,480	6,197	285	338
Mississippi	[4] 2,188	2,778	[4] 20	12
Missouri	6,851	7,636	135	164
Montana	1,378	1,394	10	8
Nebraska	2,649	3,833	35	124
Nevada [1]	568	580	10	6
New Hampshire [1]	635	584	52	42
New Jersey [1]	7,943	7,900	1,257	1,203
New Mexico [1]	2,207	2,430	72	76
New York	19,182	19,196	1,292	1,215
North Carolina [1]	4,646	4,451	162	177
North Dakota [1]	1,930	1,657	1	5
Ohio	17,338	16,186	392	400
Oklahoma	4,886	5,131	57	22
Oregon	2,533	2,594	3	5
Pennsylvania	14,354	15,276	955	1,010
Rhode Island	[4] 763	819	[4] 64	66
South Carolina	2,011	2,212	75	49
South Dakota	1,072	1,392	13	41
Tennessee	4,156	4,288	77	91
Texas	18,891	22,323	600	738
Utah	1,790	2,119	20	13
Vermont [1]	302	353	21	16
Virginia	5,435	5,180	313	331
Washington	5,088	6,545	315	332
West Virginia	2,325	2,009	7	7
Wisconsin	6,758	6,751	40	62
Wyoming	688	962	24	21
Unspecified	24	0	1	0
Total United States	283,912	302,070	11,777	12,233
Other countries	[4 5] 5,786	[5] 4,998	[4 6] 90	[6] 41
Total shipped from cement plants	289,698	307,068	11,867	12,274

[1] Non-cement-producing State.
[2] Included with "Other countries" to avoid disclosure of individual company operations.
[3] Included with northern California.
[4] Revised figure.
[5] Direct shipments by producers to foreign countries, the States of Alaska and Hawaii, and Puerto Rico, including distribution from Puerto Rican mills.
[6] Direct shipments by producers to other countries and the States of Alaska and Hawaii.

STOCKS

Stocks of finished portland cement and clinker at portland-cement plants on December 31, 1958, were 6 and 4 percent higher, respectively, than on December 31, 1957. Changes in stocks during the period 1950–58 are shown in figure 1.

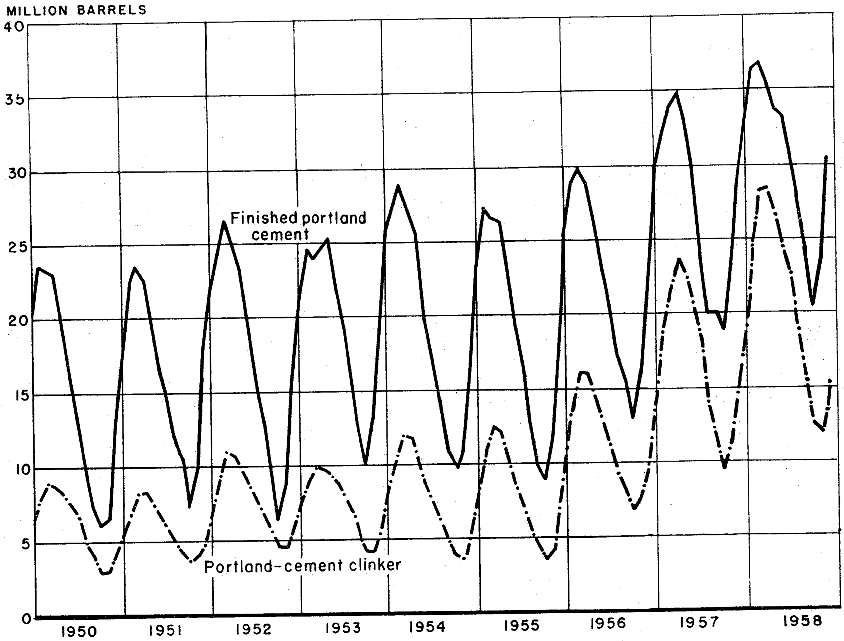

FIGURE 1.—End-of-month stocks of finished portland cement and portland-cement clinker, 1950–58.

TABLE 16.—Stocks of finished portland cement and portland-cement clinker at mills in the United States [1] on Dec. 31, and yearly range in end-of-month stocks

		Dec. 31 (thousand barrels)	Range			
			Low		High	
			Month	Thousand barrels	Month	Thousand barrels
1954	Cement	16,533	October	9,667	March	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	22,395	do	13,007	do	29,868
	Clinker	9,443	do	6,874	do	16,151
1957	Cement	[2] 28,716	do	19,213	April	34,893
	Clinker	[2] 14,853	do	9,444	do	23,620
1958	Cement	30,488	do	20,415	March	36,734
	Clinker	15,429	November	12,124	April	28,409

[1] Includes Puerto Rico.
[2] Revised figure.

PREPARED MASONRY CEMENTS

PRODUCTION AND SHIPMENTS

Prepared masonry cements were produced at 126 portland-cement plants, 3 natural-cement plants, 2 slag-cement plants, and 1 hydraulic-lime plant.

Prepared masonry cements vary in composition and bulk density. Statistics have been converted to equivalent 376-pound barrels for comparability. Production of prepared masonry cements was nearly the same in 1957 and 1958 as in 1954. Shipments in 1958 were greatest to Florida, Ohio, Pennsylvania, and Michigan.

TABLE 17.—Destination of shipments of prepared masonry cement from mills in the United States, by States, in thousand barrels

Destination	1957	1958
Alabama	1,151	357
Alaska [1]	([2])	([2])
Arizona	7	5
Arkansas	119	139
California	----------	----------
Colorado	185	206
Connecticut [1]	93	86
Delaware [1]	21	22
District of Columbia [1]	205	185
Florida	921	1,111
Georgia	266	632
Hawaii [1]	----------	----------
Idaho	11	13
Illinois	685	605
Indiana	491	452
Iowa	144	153
Kansas	186	170
Kentucky	309	321
Louisiana	106	253
Maine	49	46
Maryland	332	355
Massachusetts [1]	203	186
Michigan	1,070	913
Minnesota	286	298
Mississippi	104	202
Missouri	143	147
Montana	24	24
Nebraska	55	57
Nevada [1]	----------	----------
New Hampshire [1]	45	41
New Jersey [1]	443	385
New Mexico [1]	72	89
New York	903	858
North Carolina [1]	704	851
North Dakota [1]	38	37
Ohio	1,084	1,031
Oklahoma	151	163
Oregon	2	1
Pennsylvania	1,019	915
Rhode Island	21	24
South Carolina	265	427
South Dakota	38	39
Tennessee	466	554
Texas	553	637
Utah	17	16
Vermont [1]	29	27
Virginia	694	714
Washington	34	34
West Virginia	174	178
Wisconsin	439	415
Wyoming	6	8
Unspecified	2	55
Total United States	14,365	14,437
Other countries [3]	16	14
Total shipped from cement plants	14,381	14,451

[1] Non-cement-producing State.
[2] Included with "Other countries" to avoid disclosing individual company confidential data.
[3] Direct shipments by producers to other countries and to Alaska.

TABLE 18.—Prepared masonry cement produced and shipped in the United States (and Puerto Rico), by districts

District	Active plants		Production (thousand barrels)		Shipments from mills					
					1957			1958		
	1957	1958	1957	1958	Thousand barrels	Value (thousand)	Average	Thousand barrels	Value (thousand)	Average
Eastern Pennsylvania, Maryland	18	19	1,791	1,659	1,724	$6,093	$3.53	1,715	$5,997	$3.50
New York, Maine	12	13	1,037	952	997	3,599	3.61	970	3,355	3.46
Ohio	9	9	815	814	784	3,069	3.91	740	2,951	3.99
Western Pennsylvania, West Virginia	6	7	960	842	935	3,641	3.89	842	3,307	3.93
Michigan	5	5	1,529	1,137	1,455	5,610	3.85	1,221	4,694	3.84
Illinois	4	4	485	411	478	1,796	3.76	413	1,551	3.75
Indiana, Kentucky, Wisconsin	6	6	1,692	1,919	1,703	6,804	4.00	1,848	6,513	3.52
Alabama	7	8	1,643	1,637	1,618	6,041	3.73	1,673	6,368	3.81
Tennessee	5	5	643	693	639	2,214	3.47	697	2,439	3.50
Virginia, South Carolina	5	4	([1])	730	([1])	([1])	([1])	728	2,796	3.84
Georgia, Florida	3	4	799	952	787	3,239	4.12	935	3,737	4.00
Louisiana, Mississippi	3	3	180	197	173	611	3.53	194	689	3.54
Iowa	4	4	361	453	400	1,662	4.16	415	1,748	4.22
Eastern Missouri, Minnesota, South Dakota	6	6	470	362	436	1,798	4.12	437	1,834	4.19
Kansas	7	7	305	293	314	1,221	3.89	302	1,204	3.99
Western Missouri, Nebraska, Oklahoma, Arkansas	6	6	291	327	284	1,159	4.08	310	1,264	4.07
Texas	10	12	622	670	597	2,340	3.92	665	2,570	3.87
Colorado, Arizona, Utah	2	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	5	46	25	37	160	4.33	41	167	4.07
Puerto Rico	0	0	---	---	---	---	---	---	---	---
Undistributed	---	---	1,032	288	1,020	3,688	3.61	305	1,329	4.36
Total	125	132	14,701	14,361	14,381	54,745	3.81	14,451	54,513	3.77
Pennsylvania	21	21	2,231	1,912	2,161	8,030	3.72	1,967	7,281	3.70
Missouri	5	5	335	314	308	1,269	4.12	302	1,280	4.24

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.

NATURAL, SLAG, AND HYDRAULIC-LIME CEMENTS

Natural cement was produced for sale at three plants and slag cement at two. The output of these cements was small, as most productive capacity at the five plants was used for prepared masonry cement. A fourth natural-cement plant and a hydraulic-lime cement plant produced only prepared masonry cement in 1958. Producers reported using 112,000 short tons of limestone, 17,000 tons of slag, and 16,000 tons of lime and consuming 14,000 short tons of coal and 160 million cubic feet of natural gas in manufacturing these cements in 1958. The seven plants reported an annual capacity of 1.3 million barrels.

As all prepared masonry cements contained some portland cement, they were included in the tabulations of masonry cement prepared at portland-cement plants (tables 17 and 18). Figures on production of natural and slag cements in 1957 and 1958 are not entirely comparable with figures for preceding years because of changes in the method of reporting by some producers.

TABLE 19.—Natural, slag, and hydraulic lime cements produced, shipped and in stock at mills in the United States [1]

Year	Production		Shipments		Stocks on Dec. 31 (thousand barrels)
	Active plants	Thousand barrels	Thousand barrels	Value (thousand)	
1949–53 (average)	9	3,554	3,567	$9,712	153
1954	8	3,504	3,513	13,215	79
1955	6	941	954	3,019	66
1956	6	1,128	1,074	3,589	116
1957	5	631	662	2,027	[2] 79
1958	5	520	492	1,633	107

[1] Includes natural masonry cements through 1954.
[2] Revised figure.

PRICES

The average net realization of all shipments from cement plants was $3.27 a barrel compared with $3.21 in 1957.

Portland-cement prices at the cement plants increased from $3.18 a barrel in the last quarter of 1957 to $3.25 and $3.26 in the first and second quarters of 1958, respectively. The average price a barrel dropped to $3.24 in the third quarter and rose to $3.25 in the last quarter of 1958. The average price of types I and II portland cement (94 percent of all portland cement produced) increased from $3.19 a barrel in the first quarter to $3.20 in the second and third quarters and $3.21 in the fourth quarter.

Average prices of high-early strength cement decreased from $3.71 a barrel in the first quarter to $3.67, $3.66, and $3.67 in the last three quarters of 1958, respectively.

Prepared masonry cement decreased from $3.81 a 376-pound barrel in the first quarter of 1958 to $3.73 in the second and third quarters, but rose to $3.78 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 150.6 in 1958 compared with 146.9 in 1957.

TABLE 20.—Average mill value per barrel, in bulk, of cement in the United States [1]

Year	Portland cement	Natural, slag, and hydraulic-lime cements	Prepared masonry cement [2]	All classes of cement [3]
1949–53 (average)	$2.49	$2.63	$2.96	$2.49
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
1958	3.25	3.32	3.77	3.27

[1] Includes Puerto Rico.
[2] Includes masonry cements made at portland-, natural-, and slag-cement plants.
[3] Includes shipments of masonry for 1955–58.

FOREIGN TRADE [5]

Imports.—Imports of hydraulic cement decreased from 4½ million barrels in 1957 to 3⅓ million barrels in 1958. About 50 percent entered through Florida and came primarily from Belgium-Luxembourg, Colombia, and West Germany. Imports into New York and the New England States were largely from Canada, Belgium-Luxembourg, Norway, Sweden, and Denmark.

Imports of white cement decreased from 448,000 barrels in 1957 to 268,000 barrels in 1958. Nearly 70 percent entered through Florida. Belgium-Luxembourg supplied 30 percent of the white cement imported.

Exports.—Exports of hydraulic cement were less than 50 percent of 1957 exports. Exports to Africa increased, but exports to all other continents declined.

TABLE 21.—Hydraulic cement imported for consumption in the United States

[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
1949-53 (average)	646,362	$1,877,319	1,163	$6,882	13,232	$69,008	660,757	$1,953,209
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	[2] 448,949	[1] 2,710,781	[2] 4,427,047	[1] 14,819,470
1958	3,110,677	8,059,683	11,673	91,259	267,736	1,530,929	3,390,086	9,681,871

[1] Data known to be not comparable with other years.
[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 22.—Hydraulic cement imported for consumption in the United States (and Puerto Rico), 1958, by countries and customs districts, in barrels

[Bureau of the Census]

Customs district	Belgium-Luxembourg	Canada	Colombia	Denmark	France	Germany, West	Japan	Mexico	Poland-Danzig	Sweden	United Kingdom	Yugoslavia	Other countries [1]	Total
Alaska							14,776							14,776
Buffalo		54,861												54,861
Chicago				30,204										30,204
Connecticut		112		123,556						68,394			270,893	462,955
Dakota		574												574
El Paso								6,781						6,781
Florida	475,824		329,998	65,323	31,942	319,490			17,500	95,148	237,754		85,266	1,658,245
Galveston											260			260
Georgia											2,250			2,250
Hawaii							327							327
Laredo						167		7,267						7,434
Los Angeles	1,882			7,752	874	2,138	5,326				6,695			24,667
Maine and New Hampshire		18,588					140							18,728
Maryland						64								64
Massachusetts		523							27,501			30,255		58,279
Michigan		114,230				2,391								116,621
Minnesota				376										376
New Orleans	852													852
New York	777		10,565		162	21,612					4,257	176		37,549
Oregon	402													402
Philadelphia						5,472					3,500	17,003		25,975
Puerto Rico	5,109		158,418		11,589	1,924					302			177,342
Rhode Island	7,500								23,499	120,991				151,990
Rochester		261,612												261,612
St. Lawrence		164,687			8									164,695
San Diego				2,233			3,031							5,264
San Francisco				9,631	718						1,812			12,161
Vermont		27,323												27,323
Virginia										20,140			32,665	52,805
Washington		14,714												14,714
Total: Barrels	492,346	657,224	498,981	239,075	45,293	353,258	23,600	14,048	68,500	304,673	256,830	47,434	388,824	3,390,086
Value	$1,669,476	$2,092,253	$1,120,442	$730,130	$295,900	$867,851	$87,836	$48,226	$147,194	$649,078	$872,768	$139,945	$960,772	$9,681,871

[1] Includes Dominican Republic (Florida customs district) 7,513 barrels; Israel (Florida) 58,253 barrels; Norway (Connecticut) 270,893 barrels; Switzerland (Florida) 19,500 barrels; United Arab Republic—Egypt Region (Virginia) 32,665 barrels; total, 388,824 barrels.

TABLE 23.—Hydraulic cement exported from the United States, by countries of destination

[Bureau of the Census]

Country	1956		1957		1958	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Bermuda	----------	----------	1,355	$5,474	1,725	$10,028
Canada	628,049	$2,649,101	294,969	1,322,117	168,677	730,060
Central America:						
British Honduras	750	2,805	1,133	5,780	3,964	18,678
Canal Zone	2,622	13,146	2,382	9,756	----------	----------
Costa Rica	11,775	37,841	15,250	49,796	25,584	124,324
El Salvador	725	3,557	200	2,061	149	2,302
Guatemala	7,419	32,817	1,600	6,357	200	1,989
Honduras	9,297	33,337	16,776	62,806	16,626	66,565
Nicaragua	4,417	28,308	10,350	45,409	13,363	55,466
Panama	396	3,428	264	1,832	1,838	13,588
Greenland	----------	----------	----------	----------	125	500
Mexico	345,086	1,539,987	312,830	1,346,547	221,241	988,608
West Indies:						
British:						
Bahamas	6,225	36,667	13,092	64,246	14,520	84,617
Barbados	1,000	16,833	----------	----------	1,500	7,673
Jamaica	50	1,109	6,623	27,333	383	3,399
Leeward and Windward Islands	5,600	19,130	11,407	38,112	9,268	30,582
Trinidad and Tobago	464	2,421	1,472	8,146	1,750	8,928
Cuba	540,352	900,449	145,489	267,323	6,048	38,827
Dominican Republic	----------	----------	613	3,448	300	1,496
French West Indies	10,025	27,769	6,553	16,856	6,200	17,160
Haiti	96,266	263,620	50	1,180	----------	----------
Netherlands Antilles	842	3,145	989	3,109	3,082	8,712
Total	1,671,360	5,615,470	843,397	3,287,688	496,543	2,213,502
South America:						
Argentina	----------	----------	3,476	28,796	----------	----------
Bolivia	----------	----------	1,995	11,403	2,483	14,754
Brazil	21,230	93,195	20,059	89,569	6	104
British Guiana	1,958	10,016	1,056	4,776	264	1,194
Chile	3,894	34,199	6,013	41,460	2,110	22,406
Colombia	20,193	129,376	16,120	110,074	12,962	83,540
Ecuador	3,058	13,335	48	596	----------	----------
Peru	5,247	19,703	943	6,478	3,591	11,205
Surinam	132	1,494	1,264	5,113	187	1,580
Uruguay	----------	----------	----------	----------	444	9,187
Venezuela	126,727	596,590	353,106	1,055,444	64,962	205,947
Total	182,439	897,908	404,080	1,353,709	87,009	349,917
Europe:						
Belgium-Luxembourg	995	11,970	953	17,751	815	13,733
Denmark	100	3,670	427	10,041	14	778
France	1,442	8,831	1,893	12,544	3,355	21,907
Germany, West	473	7,442	1,003	25,617	124	3,454
Italy	140	6,694	252	6,436	37	942
Netherlands	----------	----------	367	10,854	213	5,480
Norway	774	12,978	795	26,928	234	6,576
Sweden	2,005	27,511	722	27,261	441	13,201
United Kingdom	369	9,697	300	7,400	----------	----------
Other Europe	663	10,766	1,098	20,208	----------	----------
Total	6,961	99,559	7,810	165,040	5,233	66,071
Asia:						
Arabia Peninsular States, n.e.c.	250	1,320	2,300	12,157	3,500	19,267
India	257	1,285	2,883	14,808	----------	----------
Indonesia	44,187	199,548	3,272	13,253	4,735	20,819
Iraq	4,490	23,728	1,100	6,314	6,453	34,415
Japan	3,442	98,970	6,281	144,039	2,711	82,381
Korea, Republic of	6,175	29,265	----------	----------	132	962
Kuwait	15,999	73,735	8,595	49,614	4,750	25,282
Malaya, Federation of	2,132	11,400	750	3,871	----------	----------
Pakistan	3,749	13,892	4,008	18,263	----------	----------
Philippines	2,000	22,310	2,924	23,579	1,608	14,386
Saudi Arabia	1,004	18,923	856	11,304	2,246	34,672
Turkey	1,000	6,019	2,600	10,348	625	3,269
Other Asia	2,301	21,539	783	4,155	50	1,400
Total	86,986	521,934	36,352	311,705	26,810	236,853

TABLE 23.—Hydraulic cement exported from the United States, by countries of destination—Continued

Country	1956		1957		1958	
	Barrels	Value	Barrels	Value	Barrels	Value
Africa:						
British East Africa	1,198	$6,908				
Liberia	13,111	51,172	13,156	$53,342	14,250	$57,400
Libya	894	4,685	1,250	6,905	6,612	31,520
Somaliland	1,575	7,409	1,813	8,257	661	3,870
Other Africa	864	5,242	465	5,628	135	1,713
Total	17,642	75,416	16,684	74,132	21,658	94,503
Oceania:						
Australia	507	4,546			93	2,508
British Western Pacific Islands	3,440	13,968	5,444	23,025	500	2,062
New Guinea	5,564	38,942	4,648	55,263	2,383	5,794
New Zealand	5,405	22,083	7,830	32,538	930	3,818
Trust Territory of the Pacific Islands			4,275	18,425		
Other Oceania	500	2,041				
Total	15,416	81,580	22,197	129,251	3,906	14,182
Grand total	1,980,804	7,291,867	1,330,520	5,321,525	641,159	2,975,028

WORLD REVIEW

NORTH AMERICA

Canada.—Two new plants began producing cement, Lake Ontario Portland Cement Co., Ltd., at Picton, Ontario, and Lafarge Cement of North America, Ltd., at Lulu Island, British Columbia, raising the annual productive capacity of the Canadian cement industry to 39.3 million barrels.[6] A large part of the output of the Picton plant was exported to its affiliate, Rochester Portland Cement Corp., in Rochester, N. Y.

The increase in productive capacity resulted in a 1.5-percent increase in cement shipments. The Canada Cement Co., Ltd., with eight plants and 56 percent of the Canadian productive capacity, accounted for more than half the total Canadian output of cement. Imports of cement decreased from 3.7 million barrels in 1956 to about 0.5 million barrels in 1957 and 1958.

The Imperial Cement Co., Ltd., of Edmonton, Alberta, planned to build a $12-million plant near Acheson using marl from deposits 12 miles west of Edmonton.

The British Columbia Cement Corp. moved its head office from Victoria to Vancouver in August.

[6] Department of Mines and Technical Surveys, Cement in Canada 1957: Rev. 35, Ottawa, April 1958, 7 pp.

TABLE 24.—World production of hydraulic cement, by countries, in thousand barrels [1]

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

Country	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Canada (sold or used by producers)	16,834	20,885	23,430	26,713	32,178	32,752
Cuba	2,152	2,468	2,492	2,445	3,917	4,227
Dominican Republic	580	938	1,372	1,448	1,642	1,583
Guatemala	299	364	463	469	575	692
Haiti	------	------	152	264	164	217
Jamaica	[3] 516	575	639	780	657	1,044
Mexico	8,795	10,261	11,815	13,310	15,010	15,127
Nicaragua	111	141	170	246	252	235
Panama	416	451	428	410	463	[3] 469
Salvador	[4] 211	287	334	405	498	510
Trinidad	------	141	709	815	780	879
United States	242,597	275,857	314,913	333,472	313,756	326,352
Total	272,511	312,368	356,917	380,777	369,892	384,087
South America:						
Argentina	9,141	10,020	10,959	11,961	13,861	14,494
Bolivia	221	193	221	188	141	170
Brazil	9,112	14,658	16,247	19,202	19,795	22,099
Chile	3,852	4,544	4,714	4,521	4,263	4,362
Colombia	3,829	5,640	6,133	7,153	7,194	7,200
Ecuador	434	557	856	891	909	938
Paraguay	[3] 23	41	70	82	70	41
Peru	2,111	2,832	3,195	3,237	3,201	3,588
Uruguay	1,753	1,741	1,560	1,988	2,445	2,539
Venezuela	3,805	7,112	7,517	8,508	10,243	9,475
Total	34,281	47,338	51,472	57,731	62,122	64,906
Europe:						
Albania	76	88	252	[3] 440	410	457
Austria	7,792	9,510	10,900	11,351	12,483	12,630
Belgium	23,002	25,652	27,493	27,346	27,587	23,787
Bulgaria	3,641	4,573	4,761	5,037	5,160	5,218
Czechoslovakia	12,114	15,022	16,957	18,458	21,530	24,063
Denmark	6,057	7,165	7,382	6,960	6,831	6,239
Finland	4,620	6,098	6,192	5,629	5,547	5,424
France	46,590	57,144	62,303	67,076	73,151	78,650
Germany:						
East	10,196	15,450	17,420	19,167	20,287	20,862
West	70,143	95,443	110,048	115,267	112,880	115,964
Greece	2,938	5,007	6,620	7,259	7,183	7,857
Hungary	5,177	5,553	6,889	5,834	5,799	7,270
Iceland	------	------	------	------	------	193
Ireland	2,621	3,471	3,940	4,175	2,650	2,533
Italy	34,441	51,333	62,509	66,472	69,592	75,179
Luxembourg	756	885	921	956	1,114	1,149
Netherlands	4,128	5,699	6,455	7,364	7,740	8,009
Norway	3,917	4,515	4,691	5,248	5,799	6,057
Poland	15,837	19,953	22,357	23,658	26,314	29,551
Portugal	3,788	4,591	4,568	6,004	5,740	6,004
Rumania	7,183	9,381	11,674	12,817	14,195	14,951
Saar	1,372	1,618	1,659	1,929	2,058	1,718
Spain	16,101	22,351	25,400	27,710	29,117	30,829
Sweden	11,902	14,453	14,951	14,629	14,342	14,623
Switzerland	7,429	10,654	12,413	13,945	13,931	12,899
U.S.S.R.	70,688	111,356	131,924	145,996	170,036	195,834
United Kingdom	61,424	71,274	74,581	76,059	71,274	68,601
Yugoslavia	7,335	8,168	9,164	9,117	11,627	11,533
Total	441,268	586,407	664,424	705,903	744,377	788,084
Asia:						
Burma	123	358	352	229	217	211
Ceylon	[5] 293	493	446	498	287	469
China	[3] 13,251	26,971	26,385	37,654	39,911	58,633
Cyprus	------	------	------	217	399	434
Hong Kong	387	586	686	709	610	891
India	18,147	26,203	26,731	29,358	33,362	36,341
Indonesia	645	862	874	850	1,472	1,741
Iran	334	381	774	1,342	1,642	2,568
Iraq	504	1,161	1,859	2,873	3,541	[3] 3,518
Israel	2,310	3,301	3,893	3,594	4,216	4,181
Japan	35,385	62,591	61,934	76,364	88,981	87,862
Jordan	------	369	[3] 498	463	627	668
Korea:						
North [3]	1,407	2,932	2,111	3,518	4,104	4,397
Republic of	147	364	328	270	539	1,736

See footnotes at end of table.

TABLE 24.—World production of hydraulic cement, by countries, in thousand barrels [1]—Continued

Country	1949–53 (average)	1954	1955	1956	1957	1958
Asia—Continued						
Lebanon	1,630	1,964	2,463	2,861	3,283	2,973
Malaya	[4] 188	504	639	610	668	633
Pakistan	2,932	4,010	4,063	4,609	6,409	6,391
Philippines	1,648	1,818	2,345	2,562	2,996	3,764
Syria	580	1,460	1,548	1,911	1,847	2,269
Taiwan	2,322	3,143	3,459	3,459	3,541	5,951
Thailand	1,237	2,252	2,263	2,334	2,357	3,025
Turkey	2,515	4,151	4,814	5,687	7,394	8,895
Viet-Nam	1,202	1,489	[3] 1,759	[3] 2,052	[3] 2,052	[3] 2,052
Total	87,187	147,363	150,224	184,024	210,455	239,603
Africa:						
Algeria	2,210	3,864	3,958	3,823	4,169	[3] 4,808
Angola	[4] 170	246	410	510	762	973
Belgian Congo	1,184	2,029	2,375	2,691	2,721	[3] 2,697
Egypt	5,963	7,828	8,039	7,921	8,596	8,865
Ethiopia	[3] 41	164	[3] 188	158	147	188
French Cameroons	------	------	29	76	64	64
French West Africa	352	487	756	850	926	874
Kenya	158	416	768	1,091	1,208	1,272
Morocco:						
Northern zone	------	29	258	[3] 293	[3] 293	[3] 293
Southern zone	2,351	3,835	4,016	3,436	2,556	2,298
Mozambique	405	598	803	885	973	[3] 973
Nigeria	------	------	------	------	------	663
Rhodesia and Nyasaland, Fed. of:						
Northern Rhodesia	[6] 287	393	534	663	3,858	4,667
Southern Rhodesia	950	1,935	2,363	2,732		
Sudan	------	------	375	393	352	[3] 381
Tunisia	1,126	1,665	2,246	2,111	2,351	2,023
Uganda	[4] 135	246	293	358	504	622
Union of South Africa	10,917	12,676	13,697	14,482	14,805	15,948
Total	26,249	36,411	41,108	42,473	44,285	47,609
Oceania:						
Australia	7,675	11,222	11,674	12,529	13,615	14,418
New Zealand	1,425	1,894	2,398	2,644	3,166	3,289
Total	9,100	13,116	14,072	15,173	16,781	17,707
World total (estimate) [1]	870,596	1,143,003	1,278,217	1,386,081	1,447,912	1,541,996

[1] This table incorporates a number of revisions of data published in previous Cement chapters.
[2] Average for 1952–53.
[3] Estimate.
[4] Average for 1 year only, as 1953 was first year of commercial production.
[5] Average for 1950–53.
[6] Average for 1951–53.

Descriptions were published of plants at Edmonton, Alberta,[7] Clarkson, Ontario,[8] Picton, Ontario,[9] and Regina, Saskatchewan.[10]

Costa Rica.—Bids were invited for constructing a 440,000-barrel cement plant by two Government agencies.[11]

[7] Rock Products, Simple Flexible Plant Features Few Units: Vol. 61, No. 5, May 1958, pp. 90–91.

[8] Lindsay, G. C., Cement Company Aids Ontario's Booming Economy: Rock Products, vol. 61, No. 2, February 1958, pp. 94–99, 162, 164.

Trauffer, W. E., Canadian Cement Review and Forecast: Pit and Quarry, vol. 50, No. 10, April 1958, pp. 134–136, 141.

Rock Products, Plant Called Most Efficient in North: Vol. 61, No. 5, May 1958, pp. 110–111.

[9] Herod, B. C., Lake Ontario Portland Cement Co.: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 106–114.

Meschter, E., Lake Ontario, Ships Cement and Stone to These Huge Markets: Rock Products, vol. 6, No. 10, October 1958, pp. 80–84, 142, 145.

[10] Rock Products, Look at This Raw Materials Handling System: Vol. 61, No. 5, May 1958, pp. 88–89.

[11] Foreign Commerce Weekly, Costa Rica Calls for Bids on Cement Plant: Vol. 59, No. 2, Jan. 13, 1958, p. 16.

Cuba.—The cement plant of Cemento Santa Teresa, S.A., at Artemisa, Pinar del Rio Province, was completed in September 1957 and contributed to Cuba's increased production during 1958.[12]

Guatemala.—The expansion program, completed in December 1957 at Guatemala's first cement plant, Cementos Novella, S. A., increased the annual capacity of the plant to 1,250,000 barrels. A new cement company, Cementos Cruz, S. A., incorporated in March 1957, planned to build a million-barrel plant 50 miles from Guatemala City.[13]

Mexico.—Expansions at the 19 cement plants in Mexico increased annual productive capacity from 16 million barrels in 1956 to nearly 20 million barrels at the end of 1958.[14]

SOUTH AMERICA

Argentina.—The 14 cement plants in Argentina had a total annual productive capacity of 16.4 million barrels in 1958. The cement industry began with a few plants using vertical kilns, but these have been replaced with rotary kilns. The 31 rotary kilns in use included kilns of American, German, and Danish design, such as a Lepol kiln, a Humboldt kiln, and a 558-foot kiln.[15]

Brazil.—Construction of a cement plant was begun at Matosinhos, Minas Gerais, to supply cement for a new dam in the State. The designed capacity of the mill was reported to be 1,200,000 barrels per year.[16]

Plans were announced for two new cement plants, one of 500,000 barrels annual capacity at Monte Alegre and the other at Capanema in the State of Para.[17]

Chile.—Addition of another kiln at the La Calera plant was announced. The new kiln, made in Germany, was expected to reduce fuel costs by 40 percent.[18] The three cement plants in Chile, Fabrica de Cemento de "El Melon," S. A., at La Calera; Cemento "Juan Soldado" Consolidada, S. A., at Coquimbo; and Cemento Cerro Blanco de Polpaico, S. A., near Santiago, had annual capacities of 3.5 million, 1.2 million, and 1.5 million barrels, respectively.

Colombia.—The combined annual capacity of Colombia's 12 cement plants was 9.4 million barrels. This included one new plant completed during the year. In addition, a 500,000-barrel plant was under construction at Neira.[19] A 340-foot kiln was shipped from Wisconsin for installation by Cementos El Cairo, S. A., in its plant near Medallion.[20]

Peru.—The Arequipa Cement Co., the sixth cement company to be formed in Peru, planned to construct a cement plant 12 miles from Arequipa. Two producing companies, Cía. Peruaña de Cemento

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[12] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, p. 27.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, pp. 28–29.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, pp. 26–29.
[15] Boiso, Jorge, La Evolucion Technologica y El Desarrollo de la Industria Argentina de Cemento Portland: Centro Argentino de Ingenieros, August 1958, p. 18.
[16] Chemistry and Industry (London), New Cement Plant in Brazil: No. 51, Dec. 20, 1958, p. 1701.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, p. 27; vol. 48, No. 5, May 1959, p. 24.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 25.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, pp. 23–24.
[20] Pit and Quarry, Colombian Cement Firm Purchases U.S. Made Kiln: Vol. 51, No. 3, September 1958, p. 30.

Portland and Cementos Chiclayo, S. A., with plants at Lima and Chiclayo, merged. Production was reported from Cía Cemento Portland del Norte, S. A., plant at Pacasmayo.[21]

Uruguay.—Cía. Uruguayo de Cemento Portland (Lone Star Cement Co.) at Sayago, Cía. Nacional de Cementos, S. A., at Pan de Azucar, and a Government plant operated by the Administracion Nacional de Combustibles, Acohol, y Portland at Minas produced cement in Uruguay. The combined annual capacity of the three plants was 2.5 million barrels.

EUROPE

The Organization for European Economic Cooperation adopted a questionnaire to be sent to the free countries of Europe to collect information on cement production, foreign trade, and manpower in 1958 and forecasts for 1959 and 1960.

Bulgaria.—Increased construction of dams, power stations, factories, and public buildings resulted in the erection of a cement plant in Dimitrovo and plans for two more plants, one at Devnya and the other near Vratsa.[22]

Iceland.—The first cement plant in Iceland was completed but produced only clinker owing to shortage of electric power to operate the clinker grinding mill. The capacity of the plant was 440,000 barrels per year.[23]

Netherlands.—The fifth cement plant of Cementfabriek IJmuiden began operating. The five plants of this company had a combined productive capacity of 3.5 million barrels per year. The new mill with an annual capacity of 1.1 million barrels was reported to be one of the largest on the European Continent.[24]

U.S.S.R.—Production of cement in the Soviet Union increased 11 percent from 1955 to 1956, 16 percent from 1956 to 1957, and 15 percent from 1957 to 1958. The Seven-Year Plan (1959–65) calls for a constant increase of at least 12 percent each year to a total of 440 million barrels in 1965.

A French firm announced plans to construct two kilns 574 feet long and 19 feet in diameter for a cement plant to be built in central Siberia. This plant would have a capacity of 10 million barrels per year.[25]

United Kingdom.—British standards for portland cement, portland blast-furnace cement, and low-heat portland cement were published. A semidry-process cement plant was described in an article.[26] In the semidry process the raw materials are dried and ground together to form a powder which is nodulized with 12 to 15 percent water before entering the kiln. In the wet process the slurry containing about 40 percent moisture is fed to the kiln.

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[21] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 24.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, pp. 27–28.
[23] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, p. 28.
[24] Chemistry and Industry (London), New Cement Plant: No. 40, Oct. 4, 1958, p. 1284.
[25] South African Mining and Engineering Journal (Johannesburg), Largest Cement Plant: Vol. 69, No. 3433, pt. 2, Nov. 28, 1958, p. 1105.
[26] Quarry Managers' Journal (London), Semidry Cement Process Inspected: Vol. 41, No. 12, June 1958, pp. 463–469.

ASIA

China.—It was reported that barter programs had been arranged between China and Poland and China and Rumania for raw materials from China in exchange for cement-plant equipment.

Cyprus.—The first cement plant on Cyprus was erected by the Cyprus Cement Co. at Limassol in 1956.[27]

India.—The Government of India approved construction of 26 new cement plants and expansion plans for the 29 existing plants. Completion of these plans will raise capacity from 50 to 90 million barrels per year.[28]

Indonesia.—The cement plant of the N. V. Pabrik Semen Gresik completed its first year of operation. Plans were made to increase its capacity by 50 percent to 2 million barrels.

Iran.—Until 1958 there were only three portland-cement plants in Iran: The Government-owned plant at Tehran (1,050,000 barrels capacity), Fars Cement Co. plant at Shirza (350,000 barrels capacity), and Tehran Cement Co. plant at Tehran (1,050,000 barrels capacity). In 1958 three new plants were opened: Isfahan Cement Co. at Isfahan (350,000 barrels), Sahemi Cement Co. at Meshed (130,000 barrels), and Shomal Cement Co. at Tehran (170,000 barrels). In addition, two Government plants, the Doroud plant at Arak (1,050,000 barrels) and the Manjil plant at the Sefid River Dam (520,000 barrels), were under construction. Plans were announced by two private companies for constructing two more plants, one at Tabriz and the other at Ahwaz. The average value of portland cement was $4.04 a barrel.[29]

Iraq.—Under the excise-tax law of 1958, the Minister of Finance could order a refund to exporters of the tax ($0.24 per barrel) on cement exported from Iraq.[30]

Israel.—Expansion plans were announced by Shimshon Cement, Ltd. (Hartuv plant) and Nesher Portland Cement Co., Ltd. (Ramla and Haifa plants) to increase annual capacity to 6.9 million barrels.[31] Shimshon Cement, Ltd., and Central Trade and Investment Co. (sole distributor for Nesher Portland Cement Co., Ltd.) entered into a joint marketing agreement with the approval of the Government of Israel.[32]

Korea, Republic of.—The Mungyong cement plant financed by the United Nations Korean Reconstruction Agency began producing cement in September 1957. The Samchok Cement Co., Samchock, the other cement plant in South Korea, operated at about 50 percent capacity because of technical difficulties and low-quality coal.[33]

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[27] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, pp. 27–28.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, pp. 29–30; vol. 47, No. 5, Nov. 28, 1958, pp. 27–28.
[29] U.S. Embassy, Tehran, Iran, State Department Dispatch 497: Jan. 24, 1959, 6 pp.
[30] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, pp. 28–29.
[31] Mining World, Israel Plans Increased Gypsum, Potash Production: Vol. 20, No. 5, May 1958, p. 85.
[32] International Cooperation Administration, Telaviv, Israel, Airgram Toica A-641, Dec. 12, 1958, 3 pp.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 28.

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Korea, North.—Rumania announced plans to build a cement plant in North Korea "within the framework of reciprocal economic aid."[34]

Lebanon.—New kilns were installed in the two cement plants in Lebanon, increasing the annual capacity of the older plant to 3.8 million barrels and that of the newer plant to 350,000 barrels. An application was made for construction of a third plant in south Lebanon.[35]

Pakistan.—The Pakistan Industrial Development Corporation completed an agreement with F. L. Smidth, of Denmark, for installing a third kiln at the Zeal-Pak cement plant at Hyderabad[36] and placed an order with a Czechoslovakian firm for machinery and equipment for expanding the Maple Leaf cement plant at Daukhel.[37]

The Pakistan Cement Industries, Ltd., began constructing a 500,000-barrel-annual-capacity cement plant at Hattar.[38]

Turkey.—The completion of four cement plants in Turkey in 1957 increased the annual capacity of the Turkish cement industry to 9.5 million barrels. Two plants, one at Corum and the other at Balikesir, began producing in 1958, further increasing the total capacity of the country to 10.5 million barrels. Four more plants were under construction at Elazig, Gaziantep, Konya, and Pinarhisar. When completed, the 16 plants in Turkey are expected to have an annual capacity of 15 million barrels.[39]

AFRICA

Belgian Congo.—A review of the cement industry in the Belgian Congo was published.[40] The industry, which started with two plants in the 1920's, was augmented in the 1950's by two clinker-grinding plants and two smaller cement plants. The four cement plants had an annual capacity of 3.5 million barrels at the end of 1958. Plans were announced to build a third clinker-grinding plant at Stanleyville.

Egypt.—A cement plant with a productive capacity of nearly 3 million barrels a year was under construction at Helwan near Cairo. The plant will make portland cement and portland-slag cement, using slag from the Egyptian Iron & Steel Co.[41]

Rhodesia and Nyasaland, Federation of.—The Rhodesia Cement, Ltd., planned to add a fifth kiln to its 1.6-million-barrel-a-year cement plant at Colleen Bawn.[42]

TECHNOLOGY

The growth of the cement industry from 1955 through 1958 has been characterized by installation of larger equipment and more

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[34] U.S. Legation, Bucharest, Rumania, State Department Dispatch 26: July 31, 1958.
[35] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 23.
[36] Pit and Quarry, Third Kiln Scheduled for Pakistan Cement Plant: Vol. 50, No. 11, May 1958, p. 41.
[37] Canadian Mining Journal, More Cement for Pakistan: Vol. 79, No. 11, November 1958, p. 103.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 5, May 1958, pp. 21–23.
[39] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 28–29.
[40] Bureau of Mines, Mineral Trade Notes: Vol. 44, No. 4, April 1957, pp. 19–25.
[41] Foreign Commerce Weekly, Egyptian Cement Plant Now Under Way: Vol. 59, No. 21, May 26, 1958, p. 35.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, p. 27.

efficient methods of controlling operations.[43] Plants from Pennsylvania to California have added large equipment for quarry operations,[44] longer kilns,[45] automatic systems to control fuel flow to kilns, and draft regulators, as well as systems to control speeds of feeders, kilns, and coolers.

At one plant audiovisual alarms warn operators when abnormal conditions need correction.[46] Closed-circuit television was installed in a California plant for simplified control of raw-materials crushing, grinding, and storage.[47] A nuclear density gage was ordered by another plant as part of a control system for maintaining the water content of slurry. Measurement is made through nuclear-energy absorption with control performed pneumatically.[48] The use of conveyor belts in place of cranes in one plant improved the output per man, resulting in lower production costs.[49] The need of adequate lubrication for efficient operation of the heavy equipment in cement plants was discussed.[50]

Improvements in analytical methods, through use of the spectrograph, diffractometer,[51] and flame photometry[52] and by substituting the method of the Federal Specification Board for the ASTM method of insoluble-residue determination,[53] were described as steps in automation of the cement-making process and a means of obtaining a more uniform final product. Differences in laboratory procedures[54] and factors affecting the quality of cement[55] were discussed.

Dewatering.—Tests at the Keystone Portland Cement Co. plant showed that deflocculation of the slurry with sodium tripolyphosphate and sodium carbonate increased the plant capacity and that the chemical cost was offset by fuel economies resulting from the treatment.[56] An apparatus and method for "rapid economical separation" of the fine and coarse fractions in cement slurries was patented.[57]

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[43] Rock Products, Cement Industry Needs More Large-Scale Modernization: Vol. 61, No. 5, May 1958, pp. 79, 134, 170; A New Era Begins: Vol. 61, No. 5, May 1958, pp. 84–86, 166, 168.

[44] Rock Products, Emphasis Here is on Big Equipment, No Standbys: Vol. 61, No. 5, May 1958, pp. 114–115.

[45] Rock Products, Hugh 450-ft. Kiln Really Boosts Production: Vol. 61, No. 5, May 1958, pp. 94–95; Vast Reserves Prompted Building of Plant: Vol. 61, No. 5, May 1958, pp. 106–107; Here Future Expansion Plans Were Built In: Vol. 61, No. 5, May 1958, pp. 98–99.

[46] Trauffer, W. E., Modernization at Lone Star's Nazareth Plant: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 120–127, 130, 153.

[47] Lenhart, W. B., One Man, 8 TV Cameras, Control Cement Making from Crusher to Raw Storage: Rock Products, vol. 61, No. 11, November 1958, pp. 74–77, 139.

[48] Utley, H. F., Nuclear Gauge Sees Through Slurry Pipe to Control Density: Pit and Quarry, vol. 51, No. 1, July 1958, p. 162.

[49] Rock Products, Small Plant's Boast—Few Men, High Output: Vol. 61, No. 5, May 1958, pp. 118–119.

[50] Clark, M. S., Cement Mill Lubrication: Pit and Quarry, vol. 50, No. 8, February 1958, pp. 82–83, 86–88; vol. 50, No. 9, March 1958, pp. 93, 96–98, 120.

[51] Lenhart, W. B., X-Rays—New Aid for Cement Process Control: Rock Products, vol. 61, No. 3, March 1958, pp. 90–93.

[52] Ford, C. L., The Successive Determination of Manganese, Sodium and Potassium in Cement by Flame Photometry: ASTM Bull., No. 233, October 1958, pp. 57–63.

[53] Halstead, W. J., and Chaiken, B., Insoluble Residue Determination in Portland and Portland-Slag Cements: ASTM Bull., No. 229, April 1958, pp. 60–65.

[54] Youden, W. J., Presentation for Action-Dual Reference for Cement Industry Illustrates Value of a Vivid Presentation of the Results of an Investigation: Ind. Eng. Chem., vol. 50, No. 8, August 1958, pp. 83A–84A.

[55] Rockwood, N. C., How Uniform Must Portland Cement Be?: Rock Products, vol. 61, No. 9, September 1958, pp. 17, 161, 164–165.

[56] Allen, J. P., and Lyons, J. W., Phosphate Slurry Thinner Used at Keystone Portland's Bath Plant: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 135–144.

[57] Bek, S. J. (assigned to F. L. Smidth & Co., New York, N. Y.), Method and Apparatus for Separating Slurry and Like Suspensions: U. S. Patent 2,858,020, Oct. 28, 1958.

Grinding.—Four methods for removing heat generated in clinker grinding were discussed: Water-cooled mills, injection of water in finish mills, air cooling, and removal of balls from mill for cooling.[58]

An article reviewed the following eight methods of wet grinding that have been used for preparing material for cement-kiln feed: (1) Open-circuit compartment mill, (2) compartment mill with peripheral screen, (3) ballmill in closed circuit with a vibrating screen and tubemill, (4) ballmill in closed circuit with a bowl classifier, (5) compartment mill in closed circuit with vibrating screen, (6) peripheral-discharge compartment mill in closed circuit with vibrating screen, (7) compartment mill in closed circuit with cone classifier, and (8) rodmill tubemill.[59] The advantages of designing millrooms to allow for future growth of the plant or to permit grinding during offpeak power periods were recommended as a means of providing maximum production for the least capital investment and lowest operating costs.[60] The use of rodmills for reducing limestone from minus-1-inch to minus-¼-inch for tubemill feed eliminated thickeners and filters commonly used in wet-process plants.[61] The Missouri Portland Cement Co. installed a 10-foot-diameter, 32-foot-long compartment ballmill for clinker grinding as part of its modernization program. The mill was reported to give high output with low circulating load, and the use of low lifter bars in the second compartment reduced heat, noise, and wear.[62]

A new method for wet grinding slurries in multicompartment mills in which the amount of water in the slurry was under close control was patented.[63]

Preheaters.—A suspension preheater installed at the Cementon (Pa.), plant of the Whitehall Cement Manufacturing Co. was reported to have reduced fuel consumption to 600,000 B.t.u. a barrel.[64] Two plants, Marquette Cement Manufacturing Co., Milwaukee, Wis., and Diamond Portland Cement Co., Middlebranch, Ohio, reported similar reductions in fuel consumption with ACL double-pass traveling grate preheaters.[65]

The Coplay Cement Manufacturing Co. reported reductions in fuel consumption to 680,000 B.t.u. per barrel after installation of a Gru-

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[58] Tonry, J. R., Removal of Heat in Cement Grinding: Soc. Min. Eng. AIME, Preprint 5817P17, Feb. 16, 1958, 8 pp.
[59] Rowland, C. A., Wet Grinding—Past, Present, Future: Rock Products, vol. 61, No. 8, August 1958, pp. 102, 104, 106, 108, 110, 119.
[60] Rowland, C. A., Factors in Design of Cement Plant Milling Rooms: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 163–165, 168–170.
[61] Rock Products, Rod Mill Crushes Limestone for Wet Process: Vol. 61, No. 5, May 1958, pp. 102–103.
[62] Wolfe, J. M., and Kester, B. E., A Cement Grinding Mill of Intermediate Length: Pit and Quarry, vol. 51, No. 2, August 1958, pp. 120–123, 126.
[63] Vester, B., and Olsen, T. B. (assigned to F. L. Smidth & Co., New York, N. Y.), Method of and Apparatus for Multiple Stage Wet Grinding: U.S. Patent 2,824,701, Feb. 25, 1958.
[64] Trauffer, W. E., Whitehall Preheater Installation: Pit and Quarry, vol. 50, No. 9, March 1958, pp. 122–126, 128–130, 142.
[65] Trauffer, W. E., Diamond Portland Completes Extensive Expansion Program: Pit and Quarry, vol. 50, No. 8, February 1958, pp. 90–91, 94, 97–99, 105–107.
Chemical Engineering, Two U.S. Cement Mills Now Save Fuel, Avoid Dust Losses with New ACL Calcining Systems: Vol. 65, No. 8, Apr. 21, 1958, pp. 60–62.
Meschter, E., Making Cement with Pellets: Rock Products, vol. 61, No. 5, May 1958, pp. 74–78, 164.
Rock Products, A New Process Goes In—Results Look Good: Vol. 61, No. 5, May 1958, pp. 122–123.
Trasler, F., and Irving, G., Grate and Kiln Combine for Efficiency: Precambrian (Winnipeg), vol. 31, No. 10, October 1958, pp. 58–60.

dex preheater—a helical-coil counter-flow heat exchanger.[66] Interest in the fuel savings reported by users of preheating equipment was reflected in the number of patents issued for various types of preheating methods and apparatus.[67]

Calcination.—Automatic control of kiln temperatures resulted from research by the Calaveras Cement Co. Signals from thermocouples in the kiln at the critical or burning zone act through instruments to control the fuel valve, fuel and primary air ratio, and secondary air ratio. Any change in the optimum temperature at the critical point causes an immediate response in fuel flow, resulting in increased fuel economy and uniform-quality clinker.[68]

Tests in Canada revealed that the SO_3 content of the clinker was directly correlated with the temperatures between the calcining zone and the chain section. Increases and decreases in temperature in this zone resulted in decreases and increases in SO_3, regardless of variations in the sulfur content of the coal used. It was also determined that fluctuations in SO_3 content in the clinker had to be compensated by adjustments in the addition of gypsum to avoid variations in the quality of the finished cement.[69]

One company overcame the problem of fine dust particles clogging its kiln-gas sampling probe by using live, superheated steam to draw the gas sample into the probe.[70] A study of kiln tire-roller supports was made to determine the relation between tire-roller placement and rotary-kiln performance.[71] A method used to repair a cracked tire by welding was described.[72]

A kiln burner consisting of multiple concentric jets of different velocities was described as tripling the length of the calcining zone

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[66] Chemical Engineering, Preheating Cement Kiln Feed Saves Btu's: Vol. 65, No. 19, Sept. 22, 1958, pp. 146–149; New Processes and Technology: Vol. 65, No. 9, May 5, 1958, p. 125.

[67] Rosa, J., and Petr, V., Countercurrent Recirculating Device for the Exchange of Heat Between a Gas and a Finely Granulated Material: U.S. Patent 2,819,890, Jan. 14, 1958.

Niemitz, G. (assigned to Kennedy-Van Saun Mfg. & Eng. Corp., New York, N.Y.), Suspension Type Heat Exchangers for Finely Divided Solids: U.S. Patent 2,824,384, Feb. 25, 1958.

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[68] Mining Congress Journal, Automation in Cement Production: Vol. 44, No. 3, March 1958, p. 88.

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[69] Stikker, A., The Role of Sulfur Trioxide in Burning—Its Influence on Cement Quality: Pit and Quarry, vol. 50, No. 9, March 1958, pp. 132–134, 137.

[70] Rock Products, Steam Licks Gas Sampling Problem: Vol. 61, No. 8, August 1958, pp. 82, 119.

[71] Wight, H. H., Tire-Roller Placement Determines Rotary Kiln Performance: Rock Products, vol. 61, No. 2, February 1958, pp. 120, 123, 126, 131, 176.

[72] Rock Products, Huge Rotary Kiln Tire Repaired by Squirt Welding: Vol. 61, No. 2, February 1958, p. 91.

and greatly increasing the thermal efficiency.[73] Patents were issued covering methods of firing, lining, cooling, and supporting rotary kilns.[74]

A method was patented for producing portland cement and sulfur simultaneously by burning anhydrite or gypsum in a reducing atmosphere and recalcining the calcine from the first kiln in a second kiln.[75] Various methods of cooling clinker were patented.[76]

Storage and Transportation.—A cement storage station, built in Montreal, used the latest pneumatic conveying equipment and dust-control machinery.[77] The Marquette Cement Manufacturing Co. added two more specially designed barges to its fleet for moving cement in bulk on the Mississippi and Illinois Rivers.[78]

Dust Control.—Basic dust-suppression factors were described and evaluated in a series of articles.[79] Dust generation in driers, coolers, and kilns was minimized by designing equipment to eliminate unnecessary entrance-impact shattering, sliding attrition, and impact breakage from heat-exchange units. Dust pickup by gases or air was decreased by avoiding, as far as possible, the fall of dusty material through rapidly moving gases. Incline pipes into kilns to shield the feed from the gas flow were examples of simple but effective methods to lower the pickup of dust within the kiln. The deposition of escape dust from stacks was at times influenced by stack height or forced draft, so that emission products were well dispersed and thinned out before contacting neighboring areas. Under adverse atmospheric conditions only dust-collection equipment was feasible and the system only had to be efficient enough to alleviate the nuisance, as the cost of the equipment and power needed is directly related to the amount of 2- to 10-micron dust to be retained.

With the increase in installation of dust-collection systems the problem of dust return became more important. The high alkali and sulfur content of some dust caused mud rings in many kilns, and partial calcination of the dust caused most operators to devise methods of destroying its cementitious properties before returning it to

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[73] Pit and Quarry, Unusual Features Patented in Rotary Kiln Design: Vol. 50, No. 11, May 1958, pp. 120, 140, 148.

[74] Niemitz, G. (assigned to Kennedy-Van Saun Mfg. & Eng. Corp., New York, N.Y.), Method of Firing Rotary Kilns and Gas Burner Therefor: U.S. Patent 2,857,148, Oct. 21, 1958.

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[76] Hartwig, W. J. (assigned to Allis-Chalmers Mfg. Co., Milwaukee, Wis.), Self-Cleaning Grizzly for Clinker Cooler: U.S. Patent 2,831,270, Apr. 22, 1958.

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Petersen L. (assigned to F. L. Smidth & Co., New York, N.Y.), Cooling Apparatus for Use with Rotary Kilns: U.S. Patent 2,859,955, Nov. 11, 1958.

Lellep, O. G. (assigned to Allis-Chalmers Mfg. Co., Milwaukee, Wis.), Apparatus for Cooling Granular Materials: U.S. Patents 2,861,353 and 2,861,356, Nov. 25, 1958.

[77] Rock Products, A New Wrinkle in Cement Loading Stations: Vol. 61, No. 11, November 1958, pp. 125–126.

[78] Pit and Quarry, Marquette Cement Mfg. Co. Adds Two Barges to Fleet: Vol. 50, No. 9, March 1958, p. 142.

[79] Bauer. W. G., Factors of Dust Suppression in Small to Medium-Size Rotary Kiln System: Pit and Quarry, vol. 50, No. 11, May 1958, pp. 134–135, 138–139; vol. 51, No. 1, July 1958, pp. 185–186, 190; vol. 51, No. 2, August 1958, pp. 108–110.

the kiln. A survey of 47 wet-process plants showed a wide variation in practice.[80] A new-type electrode was successfully tested at a California plant for use within the electrostatic precipitators.[81]

Air-Entrained Concrete.—Interest in the use of air-entrained concrete was reflected by studies made by the Federal Bureau of Reclamation.[82] The successful use of air-entrained cement for concrete pavements in test pavements after 15 years of service was discussed.[83] New reports were published on the design and specifications for concrete pavements.[84]

Heavy Concrete.—For constructing shielding structures in atomic-energy plants, special concretes meeting the requirements for gamma-ray absorption and neutron attenuation were described.[85]

Pozzolanic Concretes.—The use of pozzolanic materials to replace part of the cement in concrete for marine use and sewer construction was discussed.[86] A series of compressive tests of concrete containing Chicago fly ash showed that the weight required in mixes with fly ash was greater than the weight required in straight portland-cement mixes to obtain approximately equal compressive strengths at early ages (3 to 28 days).[87]

Prestressed Concrete.—Prestressed concrete was used for 85-foot panels in constructing a market in Salt Lake City, Utah; for 69-foot, modified I-beams in constructing a 21-story building in Seattle, Wash.; for columns, beams, and panels in constructing a baseball-park grandstand in Salt Lake City, Utah; and for 90 arches to carry prestressed beams and slabs forming the roof of a factory in Havana, Cuba.

Special Concretes.—Many patents were issued for adding chemicals to portland cement to impart special hardening, waterproofing, quick-setting, or acid-resisting qualities to the concrete made from the cement.

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[84] ACI Committee 325, Recommended Practice for Design of Concrete Pavements (ACI 325–58): Jour. Am. Concrete Inst., vol. 30, No. 1, July 1958, pp. 17–51.

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[85] Davis, H. S., High-Density Concrete for Shielding Atomic Energy Plants: Jour. Am. Concrete Inst., vol. 29, No. 11, May 1958, pp. 965–977.

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Chromium

By Wilmer McInnis [1] and Hilda V. Heidrich [2]

ALL DOMESTIC chromite mines, except one in Montana, ceased production during the first half of 1958 because the Government's purchase program for chromite was terminated.

Domestic consumption of chromite ores and concentrates was the least since 1954, and imports were the lowest in 9 years.

Production of chromite in several major producing countries was considerably less than in 1957, and prices quoted in the United States for foreign ores declined during the year. The historical production of chromite since 1900 is presented by countries in table 11.

TABLE 1.—Salient chromite statistics, short tons

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production (shipments)	17,600	163,400	153,300	[1] 207,700	166,200	143,800
Value (thousands)	[2] $1,149	$7,164	$6,644	$8,715	$7,815	$6,187
Imports for consumption	1,574,000	1,471,000	1,834,000	2,175,000	[3] 2,283,000	1,263,000
Total new supply	1,591,600	1,634,400	1,987,300	[1] 2,382,700	[3] 2,449,200	1,406,800
Exports	1,800	900	1,300	1,700	800	700
Consumption	1,078,000	914,000	1,584,000	1,847,000	1,760,000	1,221,000
Stocks Dec. 31 (consumers')	754,000	1,268,000	1,110,000	1,227,000	1,619,000	1,537,000
World production	[3] 3,345,000	[3] 3,700,000	[3] 4,020,000	[3] 4,570,000	[3] 5,125,000	4,050,000

[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.
[2] Partly estimated.
Revised figure.

LEGISLATION AND GOVERNMENT PROGRAMS

The purchase program for domestic chrome ore and concentrates at Grants Pass, Oreg., was terminated in May when General Services Administration announced that the 200,000-long-dry-ton limit had been reached. Termination of the program resulted in the closure of all domestic chromite mines and mills, except the American Chrome Co. operation at Nye, Mont., from which virtually the entire output was delivered to the Government under contract.

The Secretary of the Department of the Interior modified the Administration's long-range minerals program, which was submitted to the Senate in 1957 as Senate bill 2375. The modified proposal called

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

for a production bonus of $35 per long dry ton of chromite ore and concentrate containing 46 percent Cr_2O_3 for a maximum of 50,000 tons annually instead of the $21 per ton proposed originally.

Office of Minerals Exploration, the successor to Defense Minerals Exploration Administration, encouraged exploration for domestic chromite through the offer of financial assistance up to 50 percent of the allowable costs, but no applications for assistance were received.

The Commodity Credit Corp., Department of Agriculture, continued to acquire chromite ores, chromium ferroalloys, and chromium metal under the barter program.

DOMESTIC PRODUCTION

Chromite ores and concentrates were produced (shipped) from 90 mines and mills in 1958, but only the American Chrome Co. operation in Montana continued throughout the year. The 142,000 short dry tons shipped averaged 40.4 percent Cr_2O_3. Of this quantity, 6,000 tons was lumpy ore averaging 47.1 percent Cr_2O_3 with a Cr/Fe ratio of at least 2:1, 17,000 tons was fines and concentrates averaging 43.4 percent Cr_2O_3 with a Cr/Fe ratio of at least 2:1, and the rest averaged 38.5 percent Cr_2O_3 and its Cr/Fe was less than 2:1.

The Kenai Chrome Co. produced several hundred tons of chromite concentrate, which were not shipped, at its plant near Seldovia, Alaska. The firm reportedly was ready to load the material for shipment to Seattle, Wash., when it was notified the domestic purchase program had been terminated.

Producers in California and Oregon organized a cooperative known as the California-Oregon Chrome Producers Association. A prime objective of the association was to secure a ferrochromium plant for the area. The Bureau of Mines provided data for determining the technical feasibility of such a plant by smelting 12 tons of chromite ore for the association.

TABLE 2.—Chromite production (mine shipments) in the United States, by States, in short tons, wet weight

State	1954	1955	1956	1957		1958	
				Shipments	Value	Shipments	Value
Alaska	2,953	7,082	7,193	4,207	$431,000		
California	30,661	22,105	27,082	34,901	2,788,000	20,588	$1,646,000
Montana	123,096	118,703	118,780	119,149	3,921,000	119,057	[2] 4,539,000
Oregon	6,655	5,341	[1] 54,577	7,900	675,000	4,133	
Washington		22	30			17	2,000
Total	163,365	153,253	[1] 207,662	166,157	7,815,000	143,795	6,187,000

[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.
[2] Estimate.

CONSUMPTION AND USES

Domestic consumption of chromite ores and concentrates decreased 31 percent compared with 1957; owing largely to decreased production of alloy and stainless steels, in which most chromium ferroalloys are consumed, and to reduced output of chromium ferroalloys for delivery to the Federal Government.

The metallurgical industry consumed 766,000 short tons of chromite ores and concentrates in producing 313,000 tons of chromium ferroalloys and chromium metal, equivalent to 2.4 tons of ore per ton of ferroalloy output. In addition, the industry consumed 12,000 tons of ore in direct additions to steel. Of the quantity of ore and concentrate used in producing chromium ferroalloys and chromium metal, 82 percent was Metallurgical-grade ore averaging 48.0 percent Cr_2O_3, 14 percent Chemical-grade ore averaging 44.2 percent Cr_2O_3, and 4 percent was Refractory-grade ore averaging 35.6 percent Cr_2O_3. Sixty percent of the Metallurgical-grade ore and concentrate had a Cr/Fe ratio of at least 3:1, 38 percent had less than 3:1 but at least 2:1 Cr/Fe ratio, and 2 percent had less than 2:1 Cr/Fe ratio.

Chromite ore consumed by the refractories industry in making bricks, mortar, and other refractory products totaled 305,000 short tons, averaging 35.2 percent Cr_2O_3; 7,000 tons more was used directly in furnace repairs.

Producers of chromium chemicals consumed 131,000 short tons of chromite ore and concentrate averaging 45.6 percent Cr_2O_3 in making 97,000 tons of chromium chemicals, sodium bichromate equivalent.

Production of high- and low-carbon ferrochromium declined 49 and 20 percent, respectively, compared with 1957. The average chromium content of the high-carbon ferrochromium produced was 59.1 percent (6.7 percent lower than in 1957), and the average chromium content of the low-carbon ferrochromium was 67.3 percent, (about the same as in 1957). The lower chromium content of the high-carbon ferrochromium was due mainly to increased production of Charge-grade material that contained 50–55 percent chromium compared with 65–70 percent for most other grades.

Several chromium ferroalloy plants curtailed production because of reduced demand for the products. Pacific Northwest Alloys, Inc., announced early in the year that operation of its Mead, Wash., plant had been curtailed sharply because it had excessive stockpiles of ferrochromium. The ferrochromium plant at Vancoram, Ohio, built in 1957 by Vanadium Corp. of America was operated at a reduced rate, and little or no production was reported from several other ferroalloy plants during part of the year.

TABLE 3.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States, in thousand short tons

Year	Metallurgical		Refractory		Chemical		Total	
	Gross weight	Average Cr_2O_3 (percent)	Gross weight	Average Cr_2O_3 (percent)	Gross weight	Average Cr_2O_3 (percent)	Gross weight	Average Cr_2O_3 (percent)
1949–53 (average)	555	47.4	378	33.9	145	44.4	1,078	42.4
1954	502	46.3	278	34.3	134	44.6	914	42.4
1955	994	46.5	431	34.4	159	44.8	1,584	43.0
1956	1,212	46.8	475	34.4	160	45.4	1,847	43.5
1957	1,177	47.1	435	34.8	148	45.0	1,760	43.9
1958	778	46.9	312	35.2	131	45.6	1,221	43.8

Consumption data on chromium ferroalloys and chromium metal (table 4) are estimated to be 89 percent of actual consumption; many users of small quantities were not canvassed.

TABLE 4.—Consumption of chromium ferroalloys and metal in the United States in 1958 by major end uses

Alloy	Short tons		Percent consumed (gross weight) in—				
	Gross weight	Cr content	Stainless steel	High-speed steel	Other alloy steels	High-temperature alloys	Other uses
Low-carbon ferrochromium	86,408	58,350	78.1	0.3	15.3	5.7	0.6
High-carbon ferrochromium	53,671	31,498	56.3	.9	37.5	2.0	3.3
Low-carbon ferrochromium silicon	33,590	13,911	88.0	.5	9.9	1.0	.6
Other [1]	27,821	13,488	23.0		69.5	3.4	4.1
Total	201,490	117,247	66.4	.4	27.8	3.6	1.8

[1] Includes chromium briquets, exothermic chromium additives, chromium metal, and other chromium alloys.

TABLE 5.—End use of individual chromium ferroalloys and chromium metal in the United States, 1958, percent

Alloy	Stainless steel	High-speed steel	Other alloy steel	High-temperature alloys	Other uses
Low-carbon ferrochromium	78.1	0.3	15.3	5.7	0.6
High-carbon ferrochromium	56.3	.9	37.5	2.0	3.3
Chromium briquets	94.6		.4	1.0	4.0
Chromium metal	4.8		7.0	70.2	18.0
Exothermic ferrochrome-silicon	18.1		76.6	.6	4.7
Exothermic ferrochromium (low- and high-carbon)			97.4	.3	2.3
Low-carbon ferrochromium-silicon	88.0	.5	9.9	1.0	.6
Other chromium alloys [1]	58.3		32.1	1.1	8.5

[1] Includes miscellaneous chrome-silicon alloys.

STOCKS

Industry stocks of chromite ores and concentrates declined slightly during 1958, and at the yearend they were equivalent to a 15-month supply, based on the 1958 consumption rate.

Stocks of chromium ferroalloys and chromium metal at producers' and consumers' plants totaled 67,000 and 26,000 short tons, respectively, at the close of 1958.

Chromium chemicals at producers' plants on December 31, 1958, were 11,000 short tons, sodium bichromate equivalent.

PRICES AND SPECIFICATIONS

Domestically produced chromite ores and concentrates were sold to the Federal Government at incentive prices. Output in California, Oregon, and Washington was sold at fixed prices provided for in the regulations covering the purchase program for domestic chrome ores and concentrates at Grants Pass, Oreg.; output in Montana was sold under contract.

TABLE 6.—Stocks of chromite at consumers' plants, December 31, 1954–58, in thousand short tons

Grade	1954	1955	1956	1957	1958
Metallurgical	804	628	640	849	749
Refractory	257	313	432	610	612
Chemical	207	169	155	160	176
Total	1,268	1,110	1,227	1,619	1,537

Prices of most foreign chromite ores and concentrates declined approximately 10 to 20 percent, depending on source and grade, according to quotations by E&MJ Metal and Mineral Markets. Turkish and Pakistan ore prices were not quoted during the last half of the year, but it was reported that ore traders could sell Turkish chromite ore containing 48 percent Cr_2O_3 with a Cr/Fe ratio of 3:1 as low as $44 per ton f.o.b. cars United States ports.[3]

E&MJ Metal and Mineral Markets quoted both electrolytic and aluminothermic chromium metal at $1.15 to $1.19 a pound delivered at the end of 1958 compared with $1.29 at the end of 1957. Ferrochromium prices were unchanged during the year. Quoted prices in carload lots f.o.b. continental United States were: High-carbon ferrochromium (4 to 9 percent carbon, 65 to 70 percent chromium) 28.75 cents a pound of contained chromium; low-carbon ferrochromium (0.10 percent carbon, 67 to 72 percent chromium) 38.50 cents a pound of contained chromium; and special ferrochromium (0.01 percent carbon, 63 to 66 percent chromium) 37.75 cents a pound of contained chromium. Charge-grade ferrochromium (8 percent maximum carbon, 50 to 55 percent chromium) was priced by one producer at 25.75 cents a pound of contained chromium in carlots delivered.

TABLE 7.—Price quotations for various grades of foreign chromite in 1958

[E&MJ Metal and Mineral Markets]

Source	Cr_2O_3 (percent)	CrFe ratio	Price per long ton [1]	
			January 1	December 31
Pakistan	48	3:1	[2] $52–$53	([3])
Rhodesia	48	3:1	[2] 47–49	[2] $42–$44
Do	48	2.8:1	[2] 44–46	[2] 39–41
Do	48		[2] 37–39	29–31
South Africa (Transvaal)	48		36–37	30–32
Do	44		26–26.50	22–23
Turkey	48	3:1	[2] 55–57	[2 4] 51–55
Do	46	3:1	[2] 52–54	[2 4] 48–51

[1] Quotations are on a dry basis, subject to penalties if guarantees are not met, f.o.b. cars, east coast ports.
[2] Nominal.
[3] No quotation during 1958.
[4] Last quoted price, Aug. 7, 1958.

[3] E&MJ Metal and Mineral Markets, vol. 29, No. 33, Aug. 14, 1958, p. 12.

TABLE 8.—Chromite imported for consumption in the United States, by countries and grades

[Bureau of the Census]

Country	Metallurgical grade			Refractory grade			Total		
	Short tons		Value	Short tons		Value	Short tons		Value
	Gross weight	Cr_2O_3		Gross weight	Cr_2O_3		Gross weight	Cr_2O_3	
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	[1] 9,212	478,754	560	213	7,620	20,920	[1] 9,425	486,374
Philippines	147,290	71,305	3,726,248	426,438	[1] 141,706	7,428,221	573,728	[1] 213,011	11,154,469
Turkey	412,664	192,395	14,618,561				412,664	192,395	14,618,561
Total	580,314	[1] 272,912	18,823,563	426,998	[1] 141,919	7,435,841	1,007,312	[1] 414,831	26,259,404
Africa:									
Rhodesia and Nyasaland, Federation of	[1] 506,513	[1] 234,473	[1] 15,956,293	[1] 17,128	[1] 6,586	[1] 424,715	523,641	241,059	16,381,008
Union of South Africa	238,471	107,610	4,321,555	[1] 48,705	[1] 19,329	[1] 586,966	[1,2] 576,667	[1,2] 254,200	[1,2] 8,443,703
Total	[1] 744,984	[1] 342,083	[1] 20,277,848	[1] 65,833	[1] 25,915	[1] 1,011,681	[1,2] 1,100,308	[1,2] 495,259	[1,2] 24,824,711
Oceania: New Caledonia [3]	62,770	33,445	2,112,929				62,770	33,445	2,112,929
Grand total	[1] 1,408,160	[1] 657,695	[1] 42,036,553	[1] 585,070	[1] 198,536	[1] 10,102,632	[1,2] 2,282,721	[1,2] 983,492	[1,2] 55,674,367
1958									
North America: Cuba	10,255	4,359	282,908	28,809	9,623	548,721	39,064	13,982	831,629
Europe: Greece	2,800	1,422	144,950				2,800	1,422	144,950

Asia:									
India	22,024	11,018	597,840	7,382	2,958	92,400	29,406	13,976	690,240
Philippines	28,490	13,096	754,127	216,351	70,653	3,697,447	244,841	83,749	4,451,574
Turkey	340,086	155,074	10,965,304				340,086	155,074	10,965,304
Total	390,600	179,188	12,317,271	223,733	73,611	3,789,847	614,333	252,799	16,107,118
Africa:									
Rhodesia and Nyasaland, Federation of	196,064	93,555	4,543,308	16,622	5,894	386,092	212,686	99,449	4,929,400
Union of South Africa	102,693	46,591	1,816,954	36,137	14,976	419,205	[2] 349,253	[2] 153,863	[2] 5,070,526
Western Portuguese Africa, n.e.c.	1,685	809	21,063				1,685	809	21,063
Total	300,442	140,955	6,381,325	52,759	20,870	805,297	[2] 563,624	[2] 254,121	[2] 10,020,989
Oceania: New Caledonia [3]	43,616	22,123	1,100,923				43,616	22,123	1,100,923
Grand total	747,713	348,047	20,227,377	305,301	104,104	5,143,865	[2] 1,263,437	[2] 544,447	[2] 28,205,609

[1] Revised figure.
[2] Includes chemical grade 1957: 289,491 short tons, gross weight, 127,261 short tons Cr_2O_3, valued at $3,535,182; 1958 (country of origin adjusted by Bureau of Mines): 210,423 short tons, gross weight, 92,296 short tons Cr_2O_3, valued at $2,834,367.
[3] Assumed source; classified in import statistics under "French Pacific Islands."

FOREIGN TRADE [4]

Imports.—United States imports of chromite ores and concentrates were the lowest since 1949. Although the imports came from nine countries, Union of South Africa, Turkey, Federation of Rhodesia and Nyasaland, and the Philippines combined supplied 91 percent of the total. All chromite from Turkey and 92 percent of the quantity from Federation of Rhodesia and Nyasaland was Metallurgical-grade ore. Eighty-eight percent of the ore from the Philippines was Refractory-grade chromite. Sixty percent of the imports from the Union of South Africa was Chemical-grade ore, 29 percent Metallurgical-grade, and 11 percent was Refractory-grade ore.

Imports of chromium metal totaled 2,353 short tons valued at $4,767,655 of which 2,131 tons valued at $4,399,000 entered duty free for the United States Government. Other imports of chromium products include ferrochromium (table 9) and 1,650 short tons of chromate and bichromate valued at $336,378.

Exports.—Sodium bichromate and chromate exported from the United States totaled 4,273 short tons valued at $1,043,848. Exports of other chromium products included 58 tons of chromium metal and alloys in crude form and scrap valued at $123,696, 2 tons of semifabricated forms valued at $6,911, and 486 tons of chromic acid valued at $281,240. Re-exports of ferrochromium totaled 346 short tons valued at $140,215.

Tariff.—The United States had no import duty on chromite ores and concentrates. Duties on chromium products from countries except U.S.S.R. and other designated Communist countries and areas were: Ferrochromium containing under 3 percent carbon, and chromium meal, 10½ percent ad valorem; ferrochromium containing 3 percent or more carbon, ⅝ cents a pound of contained chromium, chromium-carbide, chromium-nickel, chromium-silicon, chromium-vanadium, chrome green and other colors containing chromium 12½ percent ad valorem.

The import duties on these chromium products from U.S.S.R. and other designated Communist countries and areas were: Ferrochromium containing under 3 percent carbon and chromium metal, 30 percent ad valorem; ferrochromium containing 3 percent or more carbon, 2½ cents a pound of contained chromium; 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.

[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 9.—Ferrochromium imported for consumption in the United States, 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	
1957 [1]						
North America: Canada				8,238	4,177	$1,709,224
Europe:						
France	[2] 3,757	[2] 2,676	[2] $1,637,327	228	165	60,015
Germany, West	[2] 6,854	[2] 4,730	[2] 2,454,590	3,845	2,737	1,089,148
Italy				4,034	2,658	1,223,147
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	16,353	11,367	6,304,912	31,316	19,543	8,155,493
1958						
North America: Canada				9,372	5,099	2,159,862
Europe:						
France	3,205	2,297	1,313,284	49	35	13,227
Germany, West	5,287	3,676	2,184,799			
Norway				372	258	92,494
Sweden	36	25	15,812	838	559	270,771
Yugoslavia	2,018	1,548	714,464	165	131	23,611
Total	10,546	7,546	4,228,359	1,424	983	400,103
Asia: Japan	1,536	1,052	493,700	1,422	949	335,626
Africa:						
Rhodesia and Nyasaland, Federation of	146	103	62,824			
Union of South Africa	277	196	126,207	56	37	11,520
Total	423	299	189,031	56	37	11,520
Grand total	12,505	8,897	4,911,090	12,274	7,068	2,907,111

[1] Changes in Minerals Yearbook 1957, p. 356, table 9, Netherlands revised to none.
[2] Revised figure.

Table 10.—Chromite ores and concentrates exported from the United States

[Bureau of the Census]

Year	Domestic [1]		Foreign [2]	
	Short tons	Value	Short tons	Value
1949-53 (average)	1,831	$82,244	10,956	$459,612
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
1958	717	48,829	52,303	2,157,966

[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

Although chromite has been produced since near the end of the eighteenth century, data on output before 1900 are not shown in table 11. The data in the table were compiled from various sources and contain many revisions of figures published in previous chromium chapters in the Minerals Yearbook series.

NORTH AMERICA

Canada.—Strannar Mines, Ltd., continued exploring chromite claims in the Cat Lake-Bird River area of southeastern Manitoba. The firm mined approximately 2,000 tons of material, containing about 10 percent chromium, for experimental smelting. The geology and chromite reserves of the Bird River area were discussed.[5]

Cuba.—Chromite production in Cuba declined compared with output in 1957. Exports during the first half of the year totaled 37,000 short tons.

EUROPE

U.S.S.R.—No precise information was available on chromite production in the U.S.S.R., but an estimate for the country is included in table 11. Exports of chromite ores from the Soviet Union during 1955–57 were published.[6]

ASIA

Iran.—The Plan Organization (an agency of the Government of Iran) formed two mixed companies during 1958 for exploiting chromite deposits in Iran. The first company formed was the Esfandaqeh Mining Co., which was controlled 51 percent by the Plan Organization and 49 percent by a private company. The company was organized to exploit a chromite area southwest of the village of Esfandaqeh, which is about 110 miles by air south of Kerman. The area was reported to be one of the most promising for chromite in Iran.[7]

[5] Davies, J. F., Chromite Deposits of Southeastern Manitoba: Canadian Min. Jour. (Gardenvale, Quebec) vol. 79, No. 4, April 1958, pp. 112–114.
[6] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, January 1959, pp. 7–10.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 4, October 1958, p. 6.

The other company (Forumad Chromite Mining Co.) was formed late in 1958 to develop chromite deposits in Northeastern Iran, about midway between Shahrud and Sabzewar.

Philippines.—Production of chromite ores and concentrates in the Philippines decreased 43 percent compared with 1957 despite a barter agreement that provided for the exchange of Refractory-grade chromite for rice. Approximately 93 percent of the chromite produced was Refractory-grade ore from the Masinloc property in Zambales Province. The Acoje Mining Co. was the principal producer of Metallurgical-grade ore. The sharp decrease in output was reported to have been due largely to the cancellation of orders by United States consumers.[8]

Turkey.—The Mining Credit Bank (Maden Kredi Bankasi), organized in 1957, was reported to have been opened officially on June 9, 1958, to increase the production and export of chromite and other mineral commodities.[9] A chromite production company (Krom-Isletmesi AO) was reported formed within the Bank to represent the interest of chromite mine owners.[10]

Another measure to aid the chromite producers was a premium payment of 2.10 Turkish liras on each dollar value of chromite export. The premium was allowed by the new foreign trade regime that became effective on August 25, 1958.

Exports of chromite ores and concentrates from Turkey in 1958 totaled 568,800 short tons.

AFRICA

Rhodesia and Nyasaland, Federation of.—Although chromite production in Southern Rhodesia declined slightly, activity along the Great Dyke south of Darwendale was reported to have increased as claims were made to cover deep level seams.[11]

The Maponzui Chrome mines (Pvt.), Ltd., exercised an option to mine chromite in the Belingwe Native Reserve in Southern Rhodesia.[12] Hard, lumpy ore that averaged 50 percent CR_2O_3, with a Cr/Fe ratio of 3:1 was mined near Shabani.[13] The high ratio was unusual for Rhodesian chromite ores because the chromite mineral in most deposits is higher in iron.

Union of South Africa.—Production of chromite ores and concentrates was about 20 percent less than in 1957 because the leading producers curtailed production and many of the small high-cost mines were closed during the last half of 1958 for lack of orders.

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8 Mining World, Republic of the Philippines: Vol. 20, No. 11, October 1958, p. 77.
9 Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, p. 40.
10 Mining Journal (London), vol. 250, No. 6393, Feb. 28, 1958, p. 245.
11 Mining Journal (London), vol. 250, No. 6390, Feb. 7, 1958, p. 152.
12 Mining Journal (London), vol. 251, No. 6435, Dec. 19, 1958, p. 699.
13 Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 2, February 1959, pp. 5–6.

TABLE 11.—World production of chromite, by countries, 1900–58, in short tons

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Year	World total [1]	North America			South America [3]	Europe					Asia	
		United States	Cuba	Other [2]		Albania	Greece	U.S.S.R.	Yugoslavia [4]	Other [5]	Cyprus	India
1900	58,600	157		2,335			6,173	21,105	110			
1901	99,400	412		1,274			5,346	24,437	557			
1902	94,000	353		899			12,875	21,666	298			
1903	105,200	168		3,509			9,345	18,101	162			287
1904	130,500	138		6,074			17,009	29,294	308			4,028
1905	158,600	25		8,575			9,811	29,819	205			3,032
1906	176,900	120		9,035			12,710	20,959	353			4,900
1907	123,500	325		7,196			12,930	29,052	181			8,147
1908	73,800	402		7,225			4,795	12,070	551			5,314
1909	118,700	670		2,470			10,582	24,480	366			10,360
1910	119,500	230		299			10,428	15,856	353			1,946
1911	89,400	134		157			5,087	1,323	276			4,260
1912	135,400	225					7,130	23,446	220			3,236
1913	162,100	285					6,991	[9] 16,500	336			6,357
1914	172,600	662		136			7,781	[9] 16,500	233	202		6,595
1915	204,300	3,675		12,341			11,486	[9] 16,500	408	386		4,219
1916	309,800	52,678	[10] 39	27,517			10,891	[9] 16,500	1,065	3,039		22,579
1917	289,700	48,971	[10] 19	36,725			7,441	[9] 15,400	1,990	4,382		30,308
1918	343,800	92,322	[10] 9,880	21,994	[10] 19,997		12,001	[9] 15,400	551	6,164		64,702
1919	188,400	5,688	[10] 16,196	8,541	[10] 5,376		8,878	4,409	551	675		40,812
1920	189,400	2,802	[10] 795	11,015	[10] 3,865		8,137	3,048	11	1,232		30,017
1921	147,400	316	[10] 672	2,798			8,850	4,423	11			38,934
1922	154,100	398		767			10,156	934	17	700		25,511
1923	226,200	255	[10] 11,670	3,558			16,345	3,311		717		60,752
1924	321,400	323	[10] 21,915				16,602	13,111	331	[11] 1,364	[11] 3,148	50,918
1925	339,000	121	[10] 33,410				8,906	33,192	13,404	[11] 987	[11] 2,228	41,946
1926	400,000	158	[10] 40,342	[10] 60	[11] 1,653		22,100	33,468	17,618	19	[11] 717	37,388
1927	441,000	225	[10] 19,021		[11] 2,006		19,085	21,268	9,653	423	[11] 797	64,072
1928	498,000	740	[10] 37,752		[11] 22		23,097	32,558	18,384			50,910
1929	700,000	301	[10] 59,303	126	[11] 77		26,691	58,300	47,424		[11] 2,737	55,513
1930	616,000	89	[10] 45,900	[10] 99	[11] 11		25,796	73,546	56,853		[11] 1,730	56,766
1931	423,000	300	[10] 16,752	[10] 101			6,210	73,855	64,357		[11] 224	22,303
1932	330,000	173	551	78			1,714	72,642	43,146	451	[11] 1,102	20,009
1933	451,000	945	[10] 26,625	[10] 2,338			16,297	120,593	28,933	547		17,389
1934	681,800	413	[10] 55,294	[10] 999			33,834	140,434	53,475	140	1,082	24,165
1935	865,000	577	[10] 53,472	1,144	[11] 6		32,826	196,100	58,452	358	1,321	43,822
1936	1,173,000	301	[10] 78,359	923	[11] 4,288		52,191	239,201	59,573	298	560	56,019
1937	1,416,000	2,599	[10] 104,270	4,271	[11] 3,285		58,004	220,000	66,064	3,121	1,809	69,784

1938	1,257,000	909	37,035	627	[11] 1,030	[9] 550	46,808	[9] 220,000	64,452	3,005	6,247	49,447
1939	1,315,000	4,048	65,656	622	[11] 3,918	[9] 3,400	62,932	[9] 220,000	65,617	5,871	[11] 1,232	55,033
1940	1,605,000	2,982	57,703	485	[11] 5,040	[9] 15,400	32,762	[9] 330,000	78,285	7,622	[11] 2,800	62,172
1941	1,831,000	14,258	179,869	3,154	[11] 6,618	[9] 22,000	17,902	[9] 375,000	[9] 77,000	[9] 6,500	[11] 5,309	56,152
1942	2,238,000	112,877	315,779	12,058	[11] 6,598	[9] 42,000	26,786	[9] 440,000	[9] 110,000	[9] 7,600	[11] 3,236	55,534
1943	2,004,000	160,120	390,385	30,007	[11] 8,888	[9] 34,000	17,086	[9] 360,000	[9] 72,000	[9] 7,500	[11] 8,803	37,246
1944	1,538,000	45,629	211,788	27,161	[11] 5,404	----------	20,167	[9] 330,000	[9] 11,000	[9] 7,000	[11] 517	44,302
1945	1,170,000	13,973	190,287	6,243	4,949	----------	2,660	[9] 330,000	[9] 6,600	1,840	[11] 1,179	34,879
1946	1,295,000	4,107	192,188	3,782	[11] 302	----------	9,989	[9] 330,000	[9] 75,000	675	[11] 1,276	[12] 50,167
1947	1,910,000	948	175,498	2,851	----------	----------	2,910	[9] 550,000	[9] 60,000	[9] 2,400	[11] 5,824	38,883
1948	2,350,000	3,619	128,556	2,205	[11] 1,807	[9] 18,200	1,653	[9] 660,000	69,019	[9] 2,600	[11] 7,605	25,262
1949	2,370,000	433	107,330	691	[11] 3	[9] 44,000	4,106	[9] 385,000	120,284	[9] 11,000	[11] 16,397	21,746
1950	2,655,000	404	72,554	319	3,557	[9] 57,000	13,923	[9] 550,000	126,475	[9] 22,500	[11] 20,328	18,737
1951	3,170,000	7,056	87,154	1,254	2,663	[9] 50,000	27,925	[9] 660,000	109,833	[9] 23,700	[11] 13,948	18,706
1952	4,265,000	21,304	68,132	116	2,942	[9] 57,000	35,452	[9] 660,000	118,192	[9] 20,000	[11] 14,867	40,530
1953	4,265,000	58,817	77,205	441	3,942	[9] 52,000	40,520	[9] 660,000	139,950	[9] 21,000	[11] 9,115	72,543
1954	3,700,000	163,365	80,011	146	2,163	110,000	29,508	[9] 690,000	137,216	[9] 21,000	[11] 10,080	50,968
1955	4,020,000	153,253	85,107	320	4,562	135,000	27,902	[9] 750,000	139,119	[9] 21,000	[11] 9,599	100,071
1956	4,570,000	[14] 207,662	59,248	979	4,536	154,000	86,920	[9] 815,000	130,913	[9] 21,000	[11] 5,858	59,009
1957	5,125,000	166,157	127,126	[9] 1,100	8,748	184,000	82,700	[9] 850,000	132,570	[9] 22,000	[11] 5,678	87,968
1958	4,050,000	143,795	[9] 82,801	[9] 1,100	2,899	221,800	[11] 25,550	[9] 880,000	125,188	[9] 22,000	[11] 13,260	67,668

See footnotes at end of table.

TABLE 11.—World production of chromite, by countries, 1900–58, in short tons—Continued

Year	Asia—Continued						Africa				Oceania	
	Iran [6]	Japan [7]	Pakistan	Philippines	Turkey	Other [8]	Egypt	Sierra Leone	Southern Rhodesia	Union of South Africa	Australia	New Caledonia
1900					10,746						3,680	14,326
1901					45,164						2,781	19,455
1902					38,163						500	19,293
1903					33,543						2,185	37,924
1904					21,128						444	52,081
1905					22,305						58	84,804
1906					35,989						17	92,861
1907					31,813				922		33	32,869
1908					12,728				13,358			17,366
1909									25,620			44,103
1910		2,342							44,002			44,092
1911		1,680							52,363			24,113
1912		1,782							69,260		25	30,059
1913		1,467			15,400				63,384		758	50,616
1914		2,332			10,832				48,207		726	78,349
1915		3,295							60,580		848	90,545
1916		9,125							88,871		685	76,811
1917		9,856							72,962		1,259	60,382
1918		6,886			1,102				31,286		674	60,822
1919		6,627			3,858				35,282		280	51,186
1920		4,375			27,558				60,269		1,811	34,480
1921		3,713			11,023				50,188	1,188	69	25,201
1922		4,141			2,756				93,475	96	592	14,596
1923		4,989							96,675		1,335	26,566
1924		5,911			3,748	22			172,724	5,040	865	25,376
1925		6,419			8,274				135,827	15,164	1,078	38,285
1926		7,773			7,352				181,194	13,274	669	36,591
1927		10,783			20,192				218,018	18,694		36,928
1928		10,811			13,061	110			219,428	35,005		56,024
1929		10,100			17,833	55			293,116	70,520	144	57,975
1930		12,509			31,080	1,653			226,671	15,129	188	68,226
1931		10,003			27,985	3,086			89,974	25,722	29	81,736
1932		13,770			60,843				17,298	21,353	109	76,532
1933		21,933			83,091				38,632	37,565	998	55,195
1934		30,007			132,105				79,475	67,635	1,922	60,828
1935		[6] 31,796		1,424	165,867				116,749	99,683	667	60,970
1936		[6] 38,691		13,106	180,647				202,159	193,643	465	52,735
1937		[6] 49,597		77,002	212,203			817	303,816	185,873	514	52,935
1938		[6] 58,219		73,757	235,486	551		557	205,052	194,626	1,049	57,558

1939	------	[6] 63,266	------	147,239	211,251	------	------	11,855	153,314	176,385	130	63,151
1940	------	[6] 62,504	------	224,996	187,198	------	------	19,596	273,070	180,389	551	61,498
1941	------	[6] 60,087	------	256,752	149,599	------	------	15,330	357,079	156,401	392	71,109
1942	480	[6] 74,450	------	[9] 55,000	128,245	3,935	344	11,823	383,954	372,164	402	74,527
1943	1,397	[6] 64,507	------	[9] 66,000	170,320	7,168	1,003	17,974	316,864	179,933	1,105	51,756
1944	13	[6] 78,413	------	[9] 77,000	200,739	2,535	165	10,859	305,398	98,006	860	60,879
1945	------	[6] 31,459	------	------	163,218	------	165	637	205,382	109,229	316	65,949
1946	------	7,803	------	64,959	113,603	------	------	11,355	166,928	233,970	------	27,498
1947	------	2,653	[12] 24,295	215,154	172,625	------	293	18,483	171,025	411,268	------	55,700
1948	------	10,296	20,018	283,133	314,958	------	211	8,693	254,308	455,018	622	82,696
1949	------	29,881	18,953	271,988	497,766	1,102	55	24,362	268,421	445,723	708	98,097
1950	------	36,331	20,300	276,141	465,758	606	40	8,287	321,353	547,106	998	93,477
1951	9,728	45,134	19,848	368,801	676,410	83	------	18,139	330,989	600,767	1,545	97,876
1952	22,046	51,975	19,518	599,121	885,541	------	------	26,312	[13] 861,839	639,370	1,565	118,728
1953	23,657	41,418	26,255	614,086	995,462	------	231	27,277	463,030	798,567	3,070	134,032
1954	23,406	36,138	24,527	442,230	606,707	------	584	21,011	442,509	706,939	5,536	93,645
1955	38,504	29,269	31,808	655,882	715,557	------	926	23,231	449,205	597,372	------	50,790
1956	29,762	43,947	25,487	781,598	918,305	------	281	21,929	448,968	690,855	6,828	53,932
1957	[9] 55,000	51,216	18,114	799,744	1,052,665	------	114	17,602	654,078	733,616	3,415	70,768
1958	[11] 27,558	46,078	26,935	458,903	[9] 524,000	------	[9] 110	[11] 12,556	618,841	696,057	[9] 660	52,249

[1] Data do not add to exact totals shown because of rounding, where estimated figures are included in the detail.
[2] Includes Canada, Guatemala, and Mexico.
[3] Includes Argentina and Brazil.
[4] 1900–17, part of Austria-Hungary; 1918–28, Kingdom of the Serbs, Croats, and Slovenes; and after 1928, Yugoslavia.
[5] Includes Bulgaria, Norway, Portugal, Rumania, Sweden, and United Kingdom.
[6] Year ending Mar. 31 of year following that stated.
[7] Data represent concentrates.
[8] Includes Afghanistan, Indochina, and Lebanon.
[9] Estimate.
[10] U.S. imports.
[11] Exports.
[12] Pakistan included with India through 1946.
[13] Includes 506,158 tons, previously produced and stockpiled but not declared as production until 1952.
[14] Includes 45,710 tons of concentrates produced in 1955–56 from low-grade ore and concentrates stockpiled near Coquille, Oreg. during World War II.

SOURCES: Data compiled from various issues of the Federal Bureau of Mines Minerals Yearbook, the Weltmontanstatistik (Germany), and the Statistical Summary of the Mineral Industry (London).

TECHNOLOGY

Technologic advances in the beneficiation and utilization of subgrade domestic chromite ores led to the construction of a small electric-furnace plant at Nye, Mont. for producing high-carbon, low-chromium ferrochromium. The American Chrome Co. began operating the plant in December 1958 after considerable research, much of which was in cooperation with the Bureau of Mines, had demonstrated the feasibility of producing ferrochromium from the subgrade Mouat concentrate containing approximately 38.5 percent Cr_2O_3 with a Cr/Fe ratio of about 1.6:1. Its research was directed toward improving the Cr/Fe ratio of the Mouat concentrate and toward more efficient mining and beneficiation of the Mouat ores.

Bureau of Mines research on chromium during 1958 included direct electric furnace smelting of chromite ores and concentrates, pyrometallurgical and chemical studies for increasing the Cr/Fe ratio of chromites, preparation of high-purity ductile chromium, and investigation of the properties of high-purity chromium and its alloys.

Samples of ultrapure chromium, containing impurities of only about 10 parts per million, were reported to have been produced by a new iodide process.[14] Several methods of producing chromium metal were patented.[15]

An investigation of the effects of composition on transformation in titanium-chromium alloys resulted in the conclusion that the eutectoid temperature of the titanium-chromium system is above 625° C.[16]

A process for electroplating chromium directly on aluminum was reported to have been developed and used by the chemical, pharmaceutical, food, electronic, aviation, and astronautical industries.[17] As a result of research in plating chromium, several patents were issued during 1958.[18]

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[14] Chemical and Engineering News, New Way to Iodide Chromium: Vol. 36, No. 42, Oct. 20, 1958, p. 32.

[15] Cooper, Hugh S., assignor to Walter M. Weil of Shaker Heights, Ohio, Production of Chromium By Low-Pressure Reduction of Oxides: U.S. Patent 2,850,378, Sept. 2, 1958.

Keller, Wayne H., and Zonis, Irwin S., assignors to National Research Corp. of Massachusetts, Method of Producing Chromium and Niobium: U.S. Patent 2,848,320, Aug. 19, 1958.

Doerner, Henry Alfred (Blanche S. Doerner, sole legatee), Method of Producing Chromium: U.S. Patent 2,837,420, June 3, 1958.

Wainer, Eugene, assignor to Horizons Titanium Corp., Princeton, N.J., Electrolytic Production of Ductile Chromium: U.S. Patent 2,824,053, Feb. 18, 1958.

[16] Aaronson, H. I., Triplett, W. B., and Andes, G. M., Effects of Composition on Transformation in Titanium-Chromium Alloys: Trans. Metallurgical Soc. of AIME, vol. 212, No. 5, October 1958, pp. 624–626.

[17] American Metal Market, Company Develops Process For Plating Chromium to Aluminum: Vol. 65, No. 198, Oct. 11, 1958, p. 5

[18] Safranek, William H., assignor to Rockwell Spring and Axle Co., Coraopolis, Pa., Bright Chromium Alloy Plating: U.S. Patent 2,822,326, Feb. 4, 1958.

Quaely, Martin F., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., Electrodepositing Black Chromium-Vanadium Coatings and Members Therewith: U.S. Patent 2,824,829, Feb. 25, 1958.

Eisenberg, Phillip H., and Raleigh, Douglas O., assignors Sylvania Electric Products, Inc., Corporation, of Massachusetts, Electroless Chromium Plating: U.S. Patent 2,829,059, Apr. 1, 1958:

Brown, Henry, assignor to the Udylite Research Corp., Detroit, Mich., Chromium Electroplating: U.S. Patent 2,846,380, Aug. 5, 1958.

Topelian, Paul J., assignor Tiarco Corp., Newark, N.J., Chromium Plating: U.S. Patent 2,855,348, Oct. 7, 1958.

Hausner, Johann, Karl, Method of Electrodepositing Chromium: U.S. Patent 2,852,447, Sept. 16, 1958.

Results of studies conducted over a span of several years to evaluate chromium 51 for use in radiation chemotherapy were published.[19]

The irradiated metal was found to have a half-life of 28 days, and specimens implanted in rats for 18 months retained their original shiny appearance with no gross evidence of chemical injury to the rat tissues. Except for crystals used in preliminary tests, the ultrapure chromium was supplied by the Bureau of Mines which was the only known source of ductile wire suitable for preparing the tiny cylinders.

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[19] Myers, William G., Radioactive Chromium 51 Gamma Ray Sources, American Journal of Roentgenology, Radium Therapy and Nuclear Medicine, vol. 81, No. 1, January 1959, pp. 99–106.

Clays

By Taber de Polo [1] and Betty Ann Brett [2]

CONTENTS

TOTAL CLAYS sold or used by producers in 1958 decreased 4 percent in tonnage compared with 1957. Small increases were reported only for kaolin and miscellaneous clay. Total imports increased 19 percent over 1957. The tonnage of clays used for refractories and for heavy clay products declined.

The 100 leading firms supply 15 percent of clay production and the next 1,300 supply 85 percent. Clay was consumed by 2,500 widely distributed firms. In 1958 the estimated employment in mines and preparation plants was 12,000.

Trends in the clays industries were toward new plant construction and modernization, installation of more tunnel kilns, and more

TABLE 1.—Salient statistics of clays and clay products in the United States, in thousand short tons and thousand dollars

	1949–53 (average)	1954	1955	1956	1957	1958
Domestic clays sold or used by producers:						
Quantity	[1] 40,408	[1] 42,505	48,105	[2] 50,774	[2] 45,622	43,750
Value	[1] $111,718	[1] $123,284	$139,539	[2] $163,048	[2] $155,805	$143,487
Imports:						
Quantity	142	165	192	176	162	194
Value	$1,923	$2,485	$2,941	$2,969	$2,940	$2,900
Exports:						
Quantity	283	328	406	511	485	450
Value	$6,257	$8,350	$10,891	$12,593	$13,528	$12,129
Value of clay refractories, shipments	$144,134	[3] $129,086	$181,076	$208,608	$207,640	$162,887
Value of principal clay construction products, shipments	----------	$399,600	$491,200	$503,400	$437,000	$452,500

[1] Includes Puerto Rico 1953–54.
[2] Revised figure.
[3] Does not include value of shipments of ground crude fire clay, high-alumina, and silica fire clay.

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

emphasis on research. To meet demands of architects and builders, face brick manufacturers increased the color range of their products.

Considerable interest was aroused in the clay, brick, and building block industries by the commencement of production in January, on a commercial scale, of an all clay lightweight building block to compete with cement block for backup use in masonry walls. Widespread acceptance of this block by builders would result in a substantial increase in clay production.

TABLE 2.—Value of clays produced in the United States, by States

(Thousand dollars)

State	1957	1958	Kinds of clays produced in 1958
Alabama	[1] $1,504	[1] $1,787	Kaolin, fire clay, miscellaneous clay.
Arizona	[2] 177	[2] 179	Fire clay, bentonite, miscellaneous clay.
Arkansas	1,586	1,578	Fire clay, miscellaneous clay.
California	[1] 5,740	5,012	Kaolin, ball clay, fire clay, bentonite, fuller's earth, miscellaneous clay.
Colorado	978	1,111	Fire clay, miscellaneous clay.
Connecticut	408	299	Miscellaneous clay.
Florida	6,067	5,808	Kaolin, fuller's earth, miscellaneous clay.
Georgia	30,120	31,253	Do.
Hawaii	3	(6)	Miscellaneous clay.
Idaho	[3] 17	[2 3] 20	Fire clay, bentonite, miscellaneous clay.
Illinois	5,154	5,910	Fire clay, miscellaneous clay.
Indiana	2,569	2,477	Do.
Iowa	[3] 944	[3] 1,054	Do.
Kansas	1,240	1,145	Do.
Kentucky	3,915	2,957	Ball clay, fire clay, miscellaneous clay.
Louisiana	[2] 642	[2] 755	Bentonite, miscellaneous clay.
Maine	28	26	Miscellaneous clay.
Maryland	[4] 963	[4] 815	Ball clay, fire clay, miscellaneous clay.
Massachusetts	98	111	Miscellaneous clay.
Michigan	1,982	1,813	Do.
Minnesota	[3] 113	150	Fire clay, miscellaneous clay.
Mississippi	3,635	3,338	Ball clay, fire clay, bentonite, fuller's earth, miscellaneous clay.
Missouri	7,648	5,986	Fire clay, miscellaneous clay.
Montana	[2 3] 24	[2 3] 19	Fire clay, bentonite, miscellaneous clay.
Nebraska	135	110	Fire clay, miscellaneous clay.
Nevada	20	(6)	Fire clay, bentonite, miscellaneous.
New Hampshire	51	26	Miscellaneous clay.
New Jersey	[4] 1,872	2,181	Fire clay, miscellaneous clay.
New Mexico	83	[3] 73	Do.
New York	1,270	1,419	Miscellaneous clay.
North Carolina	[1] 1,407	[1] 1,187	Kaolin, miscellaneous clay.
North Dakota	[2] 67	[2] 66	Bentonite, miscellaneous clay.
Ohio	16,073	13,082	Fire clay, miscellaneous clay.
Oklahoma	[2] 642	[2] 579	Fire clay, bentonite, miscellaneous clay.
Oregon	266	293	Miscellaneous clay.
Pennsylvania	22,012	[1] 17,051	Fire clay, kaolin, miscellaneous clay.
South Carolina	5,161	5,156	Kaolin, miscellaneous clay.
South Dakota	[2] 176	[2] 155	Bentonite, miscellaneous clay.
Tennessee	4,228	4,210	Ball clay, fuller's earth, miscellaneous clay.
Texas	[5] 4,933	[5] 5,424	Fire clay, bentonite, fuller's earth, miscellaneous clay.
Utah	[1] 473	[1] 488	Kaolin, fire clay, bentonite, fuller's earth, miscellaneous clay.
Virginia	986	1,143	Miscellaneous clay.
Washington	488	[3] 183	Fire clay, bentonite, miscellaneous clay.
West Virginia	2,691	1,960	Fire clay, miscellaneous clay.
Wisconsin	136	167	Miscellaneous clay.
Wyoming	[3] 11,973	[3] 9,968	Fire clay, bentonite, miscellaneous clay.
Other	[6] 5,107	[6] 4,963	
Total	155,805	143,487	

[1] Value of kaolin included with "Other" to avoid disclosing individual company confidential data.
[2] Value of bentonite included with "Other" to avoid disclosing individual company confidential data.
[3] Value of fire clay included with "Other" to avoid disclosing individual company confidential data.
[4] Value of ball clay included with "Other" to avoid disclosing individual company confidential data.
[5] Value of fuller's earth included with "Other" to avoid disclosing individual company confidential data.
[6] Includes Del., D.C., and Vt. (1957-58); Hawaii and Nev. (1958) and values indicated by footnotes 1 through 5.

REVIEW OF DOMESTIC PRODUCTION, PRICES, AND FOREIGN TRADE BY TYPE OF CLAY

CHINA CLAY OR KAOLIN

There was a small gain in the total tonnage and in the average value of domestic kaolin sold or used. The paper, rubber, refractories, and pottery industries continued to be the principal consumers, together accounting for over 80 percent. The remainder was consumed for a variety of purposes including cement, floor and wall tile, fertilizers, chemicals, insecticides, paint filler or extender, and linoleum.

Georgia continued to be the major producer with over 75 percent of the tonnage.

TABLE 3.—Kaolin sold or used by producers in the United States

	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Year						
1949–53 (average)	1,616,003	$23,388,371	133,151	$726,409	1,749,154	$24,114,780
1954	1,734,394	26,770,397	138,606	1,248,782	1,873,000	28,019,179
1955	1,942,369	29,943,156	224,031	1,939,878	2,166,400	31,883,034
1956	2,003,087	31,829,389	246,833	2,674,327	2,249,920	34,503,716
State						
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
1958						
California	10,516	161,232			10,516	161,232
Florida and North Carolina	31,745	766,702			31,745	766,702
Georgia	1,568,210	28,135,677	128,488	1,212,584	1,696,698	29,348,261
South Carolina	(1)	(1)	(1)	(1)	377,535	4,664,363
Other States [2]	393,055	4,927,702	90,171	1,217,300	105,691	1,480,639
Total	2,003,526	33,991,313	218,659	2,429,884	2,222,185	36,421,197

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, and Alabama, California (1957 only), Pennsylvania (1958 only), and Utah.

TABLE 4.—Georgia kaolin sold or used by producers, by uses

Year	China clay, paper clay, etc.	Refractory uses	Total kaolin		
				Value	
	Short tons (thousand)	Short tons (thousand)	Short tons (thousand)	Total (thousand)	Average per ton
1949–53 (average)	1,091	153	1,244	$17,661	$14.20
1954	1,191	114	1,305	20,526	15.73
1955	1,327	166	1,493	23,376	15.66
1956	1,456	208	1,664	26,605	15.99
1957	1,414	245	1,659	28,210	17.01
1958	1,510	187	1,697	29,348	17.30

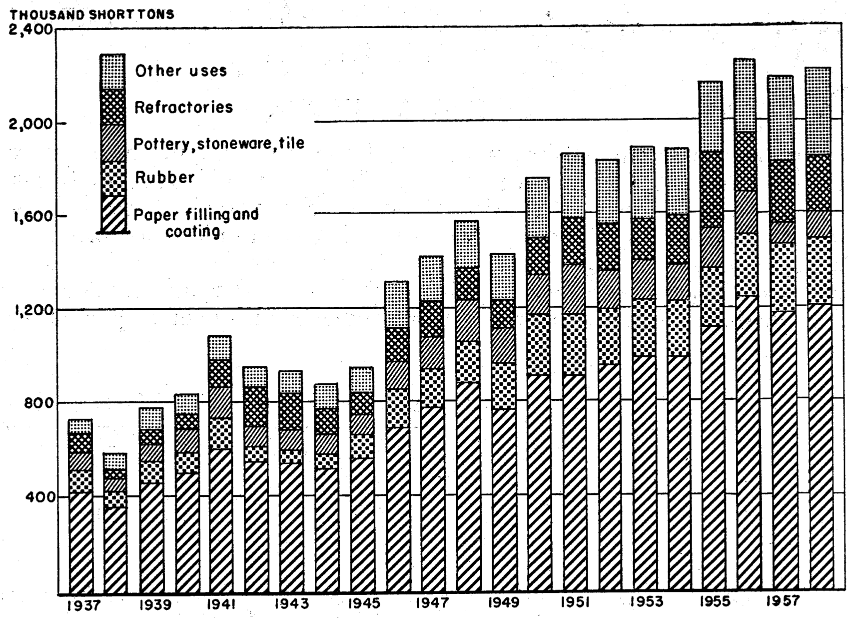

FIGURE 1.—Kaolin sold or used by domestic producers for specified uses, 1937–58.

In December the Oil, Paint and Drug Reporter quoted prices for Georgia kaolin as follows: Dry-ground, air floated, 99 percent through 325-mesh, in bags, carlots, f.o.b. plant, $10 to $12 a short ton; air floated, 99 percent through 300-mesh, in bags, carlots, f.o.b. plant, $13.50 to $14.50 a short ton.

Prices for imported china clay in December were quoted by Oil, Paint and Drug Reporter as follows: White, lump, carlots ex dock (Philadelphia, Pa., and Portland, Maine), $20 to $35 a long ton; powdered ex dock, in bags, $50 a net ton.

Imports of kaolin were 135,000 short tons, virtually the same as for 1957. Over 99 percent of the imports came from the United Kingdom and the remainder from Canada and Mexico.

Exports of kaolin or china clay increased 21 percent compared with 1957; 75 percent went to Canada, 7 percent to Mexico, 4 percent to Venezuela, and 3 percent each to Cuba and Italy. Small tonnages also went to other countries in Central America, South America, Europe, Africa, and Asia.

Culminating 2 years of cooperative research with the Bureau of Mines, J. R. Simplot Company, of Boise, Idaho, announced plans to erect a $2 million clay and silica beneficiation plant adjacent to deposits at Bovill, Idaho. Production was scheduled to begin in the fall of 1959. The plant was designed to treat 200,000 tons of raw material and produce 100,000 tons of processed halloysitic clay annually, for use largely in ceramic and paper industries.

BALL CLAY

Ball clay sold or used by producers decreased slightly in tonnage and value compared with 1957. Tennessee continued to be the major producer, accounting for about 65 percent of the U.S. total tonnage.

The pottery industry consumed approximately 60 percent of the ball clay produced.

Quotations on domestic ball clay in Oil, Paint and Drug Reporter for December 1958 were: Crushed, shed moisture, bulk, carlots, f.o.b. plant (Tennessee), $8 to $11 a short ton; air-floated, in bags, carlots, f.o.b. plant (Tennessee), $17.50 to $21 a ton.

Prices for imported ball clay in December were quoted by Oil, Paint and Drug Reporter as follows: Air-floated, in bags, carlots, Atlantic ports, $42 to $45.75 a short ton; lump, bulk, Atlantic ports, $29.50 to $35.75 a short ton.

Imports of common blue and ball clay decreased 10 percent in tonnage and value compared with 1957. Unmanufactured blue and ball clays represented the major share of the imports; the 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 33,679 short tons—a 20-fold increase over 1957; Canada, with 32,871 short tons in 1958 compared with total imports of 1,608 short tons in 1957, accounted for the increase. Other ball clay imports were: 278 tons from British West Africa, 267 from Mexico, 177 from West Germany, 80 from the United Kingdom, and 6 from Japan.

National Industrial Minerals was building a $250,000 clay processing plant at Assiniboia, Saskatchewan, in the summer of 1958. The plant will refine ball clay for ceramic applications and as a filler in asphaltic products, insecticides, pesticides, and herbicides.

TABLE 5.—Ball clay sold or used by producers in the United States

	Short tons	Value
Year		
1949–53 (average)	304,824	$3,623,032
1954	328,185	4,168,570
1955	411,354	5,386,777
1956	458,806	6,081,318
State		
1957		
California	11,404	80,332
Kentucky	101,953	1,332,543
Tennessee	259,401	3,546,744
Other States [1]	35,528	561,576
Total	408,286	5,521,195

	Short tons	Value
State—Continued		
1958		
California	(2)	(2)
Kentucky	94,217	$1,332,968
Tennessee	252,433	3,541,045
Other States [1]	50,299	628,973
Total	396,949	5,502,986

[1] Includes California (1958 only), Maryland, New Jersey (1957 only), and Mississippi.
[2] Included with "Other States."

FIRE CLAY

Fire clay sold or used by producers in the United States decreased 18 percent compared with 1957. A substantial decline in demand for fire-clay brick was responsible for most of the decrease.

The three States producing the largest quantities—Ohio, Pennsylvania, and Missouri—all reported large decreases, but accounted for 57 percent of the total U.S. fire-clay production. Five of the smaller producing States reported increases over 1957. A 66-percent increase was reported for Illinois.

The principal uses of fire clay were for heavy clay products, including architectural terra cotta, which consumed 51 percent of total output (43 percent in 1957), and for manufacture of refractories, which consumed 44 percent (52 percent in 1957). About 1 percent was consumed in chemicals, 2 percent in floor and wall tile, and 2 percent in a variety of applications. The tonnage for most uses decreased. Increases were reported for clay crucibles, insecticides, other fillers, and artificial abrasives.

The average value per short ton of fire clay sold by producers, as reported to the Bureau of Mines, was $3.24 compared with $3.20 in 1957, $2.86 in 1956, and $3.13 in 1955. The average value of all fire clay, including both sales and captive tonnage, was $4.59 compared with $4.75 in 1957.

The following quotations on firebrick manufactured from fire clay were reported in November by E&MJ Metal and Mineral Markets: Missouri, Kentucky, and Pennsylvania, first quality, $135; second quality, $120; Ohio No. 1, $120; No. 2, $103 per thousand.

Exports of fire clay decreased 8 percent in quantity to 125,923 short tons, but increased 5 percent in value compared with 1957. The average value was $14.93 a short ton compared with $13.11 in 1957. Canada received 57 percent, Mexico 32 percent, and Japan 6 percent of the exports. The remaining 5 percent comprised small tonnages to many destinations in Central and South America, Europe, Asia, and Africa.

TABLE 6.—Fire clay, including stoneware clay, sold or used by producers in the United States [1]

	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Year						
1949–1953 (average)	2,777,888	$8,786,914	7,524,615	$29,203,644	10,302,503	$37,990,558
1954	2,723,506	8,181,056	6,073,759	25,145,829	8,797,265	33,326,885
1955	3,275,044	10,265,553	7,564,785	31,854,002	10,839,829	42,119,555
1956	3,542,541	10,149,016	8,260,552	43,600,870	11,803,093	53,749,886
State						
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

See footnotes at end of table.

TABLE 6.—Fire clay, including stoneware clay, sold or used by producers in the United States [1]—Continued

	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
State						
1958						
Alabama	139, 435	$350, 798	96, 581	$267, 200	236, 016	$617, 998
Arizona	------	------	50	50	50	50
Arkansas	------	------	313, 150	1, 312, 784	313. 150	1, 312, 784
California	150, 624	422, 844	221, 731	693, 950	372, 355	1, 116, 794
Colorado	207, 046	502, 164	60, 118	267, 732	267, 164	769, 896
Illinois	199, 405	1, 075, 626	525, 916	1, 657, 631	725, 321	2, 733, 257
Indiana	(2)	(2)	(2)	(2)	314, 771	517, 544
Kansas	------	------	183, 232	439, 493	183, 232	439, 493
Kentucky	24, 250	81, 222	165, 231	970, 641	189, 481	1, 051, 863
Maryland	(2)	(2)	(2)	(2)	47, 703	200. 291
Missouri	169, 119	509, 660	1, 043, 119	4, 629, 654	1, 212, 238	5, 139, 314
Nebraska	------	------	2, 450	2, 450	2, 450	2, 450
New Jersey	(2)	(2)	(2)	(2)	135, 413	1, 049, 909
Ohio	697, 730	2, 360, 081	1, 595, 729	7, 583, 069	2, 293, 459	9, 943, 150
Oklahoma	------	------	300	3, 000	300	3, 000
Pennsylvania	327, 642	813, 505	1, 216, 633	11, 333, 900	1, 544, 275	12, 147, 405
Texas	(2)	(2)	(2)	(2)	501, 648	1, 135, 043
Utah	4, 563	26, 164	17, 757	48, 184	22, 320	74, 348
West Virginia	(2)	(2)	(2)	(2)	264, 107	1, 732, 634
Other States [3]	356, 931	1, 227, 315	1, 089, 433	3, 841, 123	182, 722	433, 017
Total	2, 276, 745	7, 369, 379	6, 531, 430	33, 050, 861	8, 808, 175	40, 420, 240

[1] Includes stoneware clay as follows: 1949–53 (average)—88,437; 1954—34,705; 1955—62,446; 1956—74,143; 1957—30,089; 1958—26,429 tons.
[2] Included with "Other States."
[3] Includes States indicated by footnote 2 and Idaho, Iowa, Minnesota, Mississippi, Montana, Nevada, New Mexico (1958 only), Washington (1958 only), and Wyoming.

BENTONITE

Bentonite sold and used by producers declined 11 percent compared with 1957, principally because of lower consumption in drilling mud for oil exploration. Decreased drilling activity also accounted for an additional large decrease in bentonite exports—from 74,000 short tons in 1957 to 45,000 tons in 1958.

TABLE 7.—Bentonite sold or used by producers in the United States

	Short tons	Value
Year		
1949–53 (average)	1, 129, 579	$11, 895, 451
1954	1, 278, 393	14, 722, 864
1955	1, 480, 205	17, 219, 015
1956	1, 570, 610	18, 414, 807
State		
1957		
California	[1] 18, 068	[1] 278, 413
Colorado	20	80
Idaho	185	3, 700
Mississippi	220, 313	2, 372, 249
Texas	126, 635	963, 147
Utah	2, 300	29, 800
Washington	165	990
Wyoming	822, 163	11, 724, 855
Other States [2]	261, 018	2, 433, 312
Total	[1] 1, 450, 867	[1] 17, 806, 546
State—Continued		
1958		
California	5, 843	$105, 715
Colorado	------	------
Idaho	(3)	(3)
Mississippi	177, 041	2, 080, 801
Texas	121, 106	889, 014
Utah	6, 325	76, 923
Washington	10	200
Wyoming	702, 237	9, 592, 209
Other States [2]	278, 852	2, 572, 388
Total	1, 291, 414	15, 317, 250

[1] Revised figure.
[2] Includes Arizona, Idaho (1958 only), Louisiana, Montana, Nevada, North Dakota, Oklahoma, and South Dakota.
[3] Included with "Other States."

The price of Wyoming bentonite was given in the Oil, Paint and Drug Reporter for December as follows: 200-mesh, in bags, carlots, f.o.b. mines, $14 a short ton; Imported, Italian white, high gel, in bags, 5-ton lots, ex warehouse, $91 a ton and 1-ton lots, $94 a ton.

The average value a short ton, as reported by the producers to the Bureau of Mines, was $11.86 compared with $12.27 in 1957.

Wyo-Ben Products Co. of Greybull, Wyo., made extensive improvements and additions to its mills and reached a new high in production of 50,000 tons of bentonite. The bentonite reserve was 15 million tons. Construction of a new mechanized plant to supply bentonite for Minnesota's taconite industry was planned by Archer-Daniels-Midland Co., at Colony, Wyo. The company was reported to have 25,000 acres of open-pit bentonite mining property in Wyoming. The Brazil Creek Bentonite Company was incorporated to develop a bentonite deposit about 15 miles west of Glasgow, Mont.

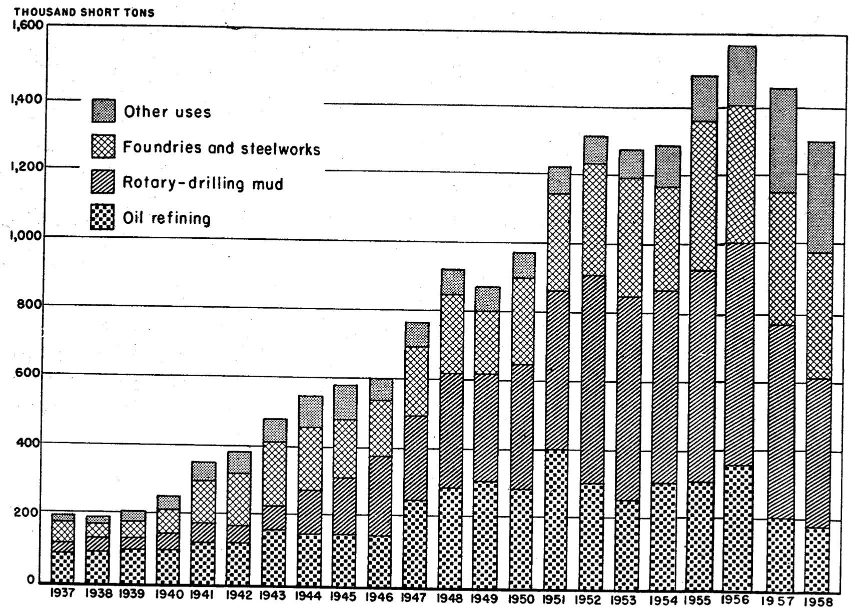

FIGURE 2.—Bentonite sold or used by domestic producers for specified uses, 1937–58.

FULLER'S EARTH

Fuller's earth sold or used by producers decreased 2 percent in tonnage and 6 percent in value compared with 1957. Florida continued to be the leading producing State, accounting for almost 60 percent of the total. The largest single use—over 40 percent—was for absorbents.

The average value a short ton of fuller's earth reported sold or used in the United States was $21.26, compared with $22.01 in 1957.

TABLE 8.—Fuller's earth sold or used by producers in the United States

	Short tons	Value
Year		
1949–53 (average)	411,849	$6,865,276
1954	376,321	6,861,603
1955	369,719	7,620,319
1956	417,715	8,879,324
State		
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
State—Continued		
1958		
California	(2)	(2)
Florida	210,517	$5,143,191
Georgia	83,930	1,425,742
Tennessee	27,485	389,236
Utah	3,086	41,400
Other States [1]	32,865	609,480
Total	357,883	7,609,049

[1] Includes California (1958 only), Mississippi, and Texas.
[2] Included with "Other States."

The following quotations on fuller's earth were published in the Oil, Paint and Drug Reporter for December: Insecticide grade, dried, powdered, in bags, carlots, Georgia or Florida mines, $17.50 a short ton; and Oil-Blacking grade, 100-mesh, in bags, carlots, f.o.b. Georgia and Florida mines, $16.30 to $17 a 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; however, 7,421 short tons was exported according to reports of producers to the Bureau of Mines.

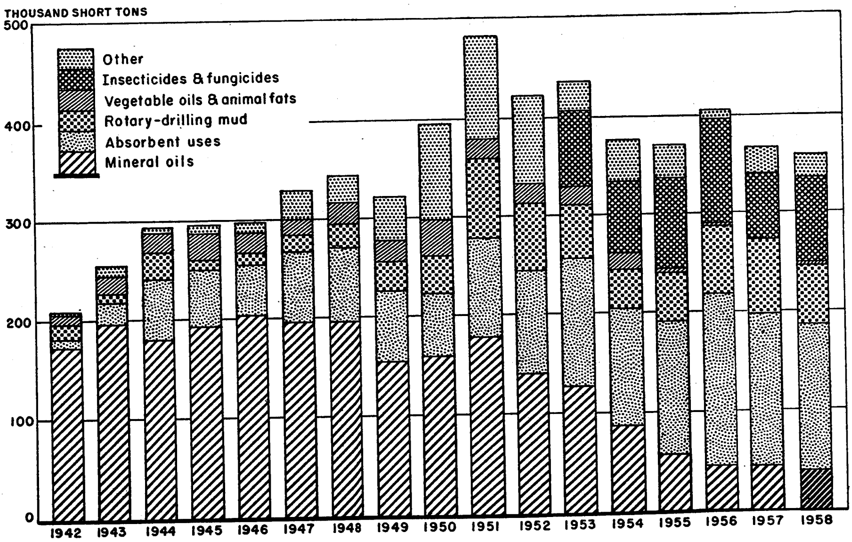

FIGURE 3.—Fuller's earth sold or used by producers for specified uses, 1941–58.

MISCELLANEOUS CLAY

This section presents statistics for the large-tonnage clays and shales—other than those discussed in the preceding pages—used in maufacturing 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 remained virtually the same as in 1957. The quantity of miscellaneous clay used in heavy clay products declined slightly, remained the same for use in cement, but increased in usage 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 1958. Texas was the only State that reported tonnage exceeding 3 million short tons.

The average reported value of miscellaneous clay sold as crude or prepared clay in 1958 was $1.72 a short ton, compared with $1.45 in 1957.

Some special types of clay included under the miscellaneous-clay classification, however, sold at much higher prices. The value of captive tonnage was computed from individual estimates that averaged about $1 a short ton.

The American Cement Corp. announced the purchase of large deposits of limestone and clay in Amador County, Calif.

TABLE 9.—Miscellaneous clay, including shale and slip clay sold or used by producers in the United States

	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Year						
1949–53 (average) [1]	1,190,923	$2,374,968	25,319,421	$24,853,814	26,510,344	$27,228,782
1954 [1]	2,503,316	4,163,872	27,349,057	32,021,221	29,852,373	36,185,093
1955	1,099,230	1,642,354	31,738,954	33,668,556	32,838,184	35,310,910
1956	1,487,222	2,044,557	32,786,954	39,374,481	34,274,176	41,419,038
State						
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	(2)	(2)	(2)	(2)	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	(2)	(2)	(2)	(2)	549,175	599,733
Massachusetts			77,577	97,577	77,577	97,577
Michigan	(2)	(2)	(2)	(2)	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

See footnotes at end of table.

TABLE 9.—Miscellaneous clay, including shale and slip clay sold or used by producers in the United States—Continued

	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
State—Continued						
1957						
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	([2])	([2])	([2])	([2])	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	([2])	([2])	([2])	([2])	239,595	265,556
Pennsylvania	147,156	39,802	1,799,575	5,361,607	1,946,731	5,401,409
South Carolina			583,166	571,113	583,166	571,113
South Dakota	([2])	([2])	([2])	([2])	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	([2])	([2])	([2])	([2])	125,491	295,986
Virginia			893,255	986,302	893,255	986,302
Washington	([2])	([2])	([2])	([2])	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 [3]	107,614	116,826	[4] 4,591,414	[4] 5,329,766	[4] 276,988	[4] 283,171
Total	1,097,620	1,588,484	[4] 29,310,775	[4] 35,923,688	[4] 30,408,395	[4] 37,512,172
1958						
Alabama	50	45	1,311,731	1,169,720	1,311,781	1,169,765
Arizona			119,203	179,003	119,203	179,003
Arkansas			264,678	264,678	264,678	264,678
California	475,763	1,127,817	1,496,766	2,324,739	1,972,529	3,452,556
Colorado	45,435	79,511	135,929	261,284	181,364	340,795
Connecticut	36,540	27,405	162,291	271,725	198,831	299,130
Georgia			1,161,868	478,598	1,161,868	478,598
Idaho			27,000	19,950	27,000	19,950
Illinois	([2])	([2])	([2])	([2])	1,609,535	3,176,787
Indiana	62,772	75,908	992,933	1,883,310	1,055,705	1,959,218
Iowa	([2])	([2])	([2])	([2])	837,219	1,053,557
Kansas			692,209	705,490	692,209	705,490
Kentucky			453,759	571,800	453,759	571,800
Louisiana			755,157	755,157	755,157	755,157
Maine			23,270	25,633	23,270	25,633
Maryland	([2])	([2])	([2])	([2])	556,472	614,399
Massachusetts			84,999	110,999	84,999	110,999
Michigan	([2])	([2])	([2])	([2])	1,663,078	1,813,043
Mississippi			293,108	293,108	293,108	293,108
Missouri			847,751	846,773	847,751	846,773
Montana			23,370	19,430	23,370	19,430
Nebraska			105,462	107,087	105,462	107,087
New Hampshire			26,100	26,100	26,100	26,100
New Jersey			548,893	1,131,270	548,893	1,131,270
New Mexico	([2])	([2])	([2])	([2])	40,196	73,033
New York	1,036	24,750	1,083,811	1,393,675	1,084,847	1,418,425
North Carolina			2,046,561	1,187,119	2,046,561	1,187,119
North Dakota			54,000	65,440	54,000	65,440
Ohio	116,530	102,426	2,809,562	3,036,442	2,926,092	3,138,868
Oklahoma	([2])	([2])	([2])	([2])	575,541	575,541
Oregon	([2])	([2])	([2])	([2])	251,685	293,386
Pennsylvania	125,362	32,301	1,647,963	4,870,945	1,773,325	4,903,246
South Carolina			550,970	492,257	550,970	492,257
South Dakota			155,012	155,012	155,012	155,012
Tennessee			654,814	279,590	654,814	279,590
Texas	([2])	([2])	([2])	([2])	3,096,642	3,400,157
Utah	([2])	([2])	([2])	([2])	125,140	295,363
Virginia			1,152,850	1,143,160	1,152,850	1,143,160
Washington	([2])	([2])	([2])	([2])	195,776	182,884
West Virginia			245,699	227,340	245,699	227,340
Wisconsin			154,177	167,318	154,177	167,318
Wyoming			372,747	375,854	372,747	375,854
Undistributed [3]	116,077	217,022	9,239,305	11,689,276	404,098	428,148
Total	979,565	1,687,185	29,693,948	36,529,282	30,673,513	38,216,467

[1] Includes Puerto Rico 1953–54.
[2] Included with "Undistributed."
[3] Includes States indicated by footnote 1 and Delaware, District of Columbia, Florida, Hawaii (1958), Minnesota (1958), Nevada (1958), and Vermont.
[4] Revised figure.

CONSUMPTION AND USES—ALL CLAYS

Heavy clay products (building brick, structural tile, and sewer pipe) comprised 49 percent of the total clay, the same as in 1957.

The total tonnage of clays consumed decreased 4 percent, but consumption in several branches of the clay industry increased. Some of these increases were as follows: Plastics, 38 percent; plaster and plaster products, 31 percent; chemicals, 30 percent; paint, 21 percent; insecticides, 21 percent; lightweight aggregates, 19 percent; filtering and decolorizing for vegetable oils, 10 percent; and paper coating 7 percent. Some of the decreases in consumption were as follows: Architectural terra cotta, 85 percent; enameling, 59 percent; exports, 34 percent; glass refractories, 31 percent; firebrick and block, 30 percent; total refractories, 29 percent; artificial abrasives, 28 percent; foundries and steelworks, 25 percent; rotary drilling mud, 23 percent; filtering and decolorizing for mineral oils and greases, 18 percent; and other fillers, 12 percent.

TABLE 10.—Clay sold or used by producers in the United States in 1958, 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	93,060	219,351					312,411
Stoneware, including chemical stoneware	1,640	870	16,986			310	19,806
Art pottery, flower pots, and glaze slip	1,275	12,020	9,443			57,164	79,902
Total	95,975	232,241	26,429			57,474	412,119
Floor and wall tile	18,331	93,939	171,259			128,789	412,318
Refractories:							
Firebrick and block	171,487	15,522	2,944,120				3,131,129
Bauxite, high-alumina brick			23,113				23,113
Fire-clay mortar		1,460	120,728			7,134	129,322
Clay crucibles			10,902				10,902
Glass refractories	13,887	21,270	36,270				71,427
Zinc retorts and condensers			58,026				58,026
Foundries and steelworks	5,168		535,375	361,799		7,457	909,799
Saggers, pins, stilts, and wads	5,318	11,205	5,502				22,025
Other refractories	45,570	669	126,355	5		156	172,755
Total	241,430	50,126	3,860,391	361,804		14,747	4,528,498
Heavy clay products: Building brick, paving brick, drain tile, sewer pipe, and kindred products		2,963	4,523,578			17,001,767	21,528,308
Architectural terra cotta	1,130		5,119				6,249
Lightweight aggregates					7,796	4,456,867	4,464,663
Filler:							
Paper filling	500,856						500,856
Paper coating	704,677						704,677
Rubber	282,493					204	282,697
Linoleum and oilcloth	10,221		7,517			1,606	19,344
Paint	43,074		800			186	44,060
Fertilizers	14,445					3,701	18,146
Insecticides and fungicides	36,199		483	30,292	85,276	1,280	153,530
Plaster and plaster products	1,677						1,677
Plastics, organic	14,133	1,500					15,633
Other fillers	40,985	1,724	1,411	167	2,181	106	46,574
Total	1,648,760	3,224	10,211	30,459	87,457	7,083	1,787,194

TABLE 10.—Clay sold or used by producers in the United States in 1958, by kinds and uses, in short tons—Continued

	Kaolin	Ball clay	Fire clay and stoneware clay	Bentonite	Fuller's earth	Miscellaneous clay, including slip clay	Total
Portland and other hydraulic cements	72,252		87,130	18,229		8,928,956	9,106,567
Miscellaneous:							
Enameling		1,314					1,314
Filtering and decolorizing (raw and activated earths):							
Mineral oils and greases				110,165	40,074		150,239
Vegetable or animal oils and fats				69,713	1,658		71,371
Other filtering and clarifying				1,797	109		1,906
Rotary-drilling mud			1,387	425,621	58,464	23,378	508,850
Chemicals	22,510		101,125	41,640	2,003		167,278
Absorbent uses				7,843	148,010		155,853
Artificial abrasives			34			1,015	1,049
Exports	15,844	5,979	12,719	44,590	7,421		86,553
Other uses	105,953	7,163	8,793	179,553	4,891	53,437	359,790
Total	144,307	14,456	124,058	880,922	262,630	77,830	1,504,203
Grand total:							
1958	2,222,185	396,949	8,808,175	1,291,414	357,883	30,673,513	43,750,119
1957	2,183,685	408,286	10,805,099	[1] 1,450,867	366,101	[1] 30,408,395	[1] 45,622,433

[1] Revised figure.

Refractories.—The value of clay refractory shipments decreased 22 percent from the 1957 value. All classifications of clay refractories registered losses.

Trends in the refractories industry indicated that customers were demanding better and more uniform refractories. Because of lower cost, natural materials continued to lead manufactured refractory materials, but it was expected that manufactured materials would eventually replace some natural materials. Castables replaced some prepared shapes. The trend was toward basic refractories in 1958. The cost of super refractories was high, and they were used only in special applications, where cost was not the major consideration.

A railroad freight rate increase on interstate traffic of refractory products was granted effective February 15.

The 1958 edition of the Product Directory of Refractories Industry in the United States, published by The Refractories Institute, listed 2,700 brands of refractories produced by 185 refractories manufacturers. The Institute also published a list of Government specifications on refractories.

The 1957 edition of the Manual of ASTM Standards on Refractory Materials was published.

Close cooperation between coke-oven builders and coke-oven refractories producers resulted in reduction of the number of firebrick shapes required and an increase from 35 to 65 percent in the proportion of machine-made special shapes for a battery of ovens.[3]

The uses of refractories, types used, and past and future growth of the refractories industry were reported.[4]

The Refractories Division of H. K. Porter Co., Inc., increased production facilities by 50 percent at its Canon City, Colo., plant.

[3] Hartman, E. C., Refractories for By-Product Coke Ovens: Blast Furnace and Steel Plant, vol. 47, No. 3, March 1959, pp. 305, 335-338.

[4] Brick and Clay Record, Refractories in Ceramics: Vol. 132, No. 1, January 1958, pp. 59-65, 73.

Kaiser Aluminum and Chemical Corp. announced plans to expand basic refractory brick capacity at its Columbiana, Ohio, plant. When the $750,000 project is completed late in 1959, the firm will have an annual capacity of more than 200,000 tons of basic refractory brick and mixes.

The refractories division of the Norton Co., Worcester, Mass., announced an expansion of its facilities for the production of high alumina, stabilized zirconia, and other high-temperature refractory materials, and the Carborundum Co., Niagara Falls, N.Y., began a $1 million expansion and modernization program at its Refractories Division plant in Keasbey, N.J.

Harbison-Walker Refractories Co. began operating a new multimillion dollar basic refractories plant at Hammond, Ind. A $1.5 million semisilica firebrick plant was built by Valentine Fire Brick Co., at Woodbridge, N.J., to replace a plant destroyed by fire. Walsh Refractories Corp., St. Louis, Mo., purchased additional land and expected to complete a new $1 million plant in 1959 to produce fusion-cast refractories. Mexico Refractories Co. planned construction of a new $2 million plant near Stockton, Calif.

Pacific Clay Products, Los Angeles, Calif., bought Western Refractories Co., of Ione, Amador County, Calif.; Standard Fire Brick Co. of Pueblo, Colo., merged with A. P. Green Fire Brick Co.; and A. P. Green Fire Brick Co. acquired, by an exchange of common stock, the Stevens Fire Brick Co., Macon, Ga.

TABLE 11.—Shipments of refractories in the United States, by kinds

[Bureau of the Census]

Product	Unit of quantity	Shipments 1957 Quantity	Shipments 1957 Value (thousand)	Shipments 1958 Quantity	Shipments 1958 Value (thousand)
Clay refractories:					
Fire-clay brick, standard and special shapes, except superduty.	1,000 9-in. equivalent.	469,941	$71,764	320,034	$56,526
Superduty fire-clay brick and shapes	do	91,221	22,648	60,163	15,375
High-alumina brick and shapes (50 percent Al_2O_3 and over) made substantially of calcined diaspore or bauxite.[1]	do	23,101	9,460	17,395	7,464
Insulating firebrick and shapes	do	57,498	13,583	38,600	9,386
Ladle brick	do	223,094	22,235	167,654	17,024
Hot-top refractories	do	31,762	5,355	25,084	3,975
Sleeves, nozzles, runner brick and tuyères	do	51,848	11,321	34,930	7,448
Glasshouse pots, tank blocks, feeder parts and upper structure shapes used only for glass tanks.[1]	Short ton	17,837	3,962	14,534	3,598
Refractory bonding mortars, air-setting (wet and dry) types.[2]	do	[3] 87,832	[3] 7,872	73,571	6,864
Refractory bonding mortars, except air-setting types.[2]	do	[3] 9,139	[3] 919	6,499	678
Plastic refractories and ramming mixes [1]	do	[3] 125,400	[3] 9,030	104,189	9,030
Castable refractories (hydraulic setting)	do	[3] 101,655	[3] 9,850	91,812	9,077
Insulating castable refractories (hydraulic setting).	do	[3] 19,805	[3] 2,310	19,746	2,380
Ground crude fire clay, high-alumina clay, and silica fireclay.[4]	do	[3] 604,086	[3] 5,838	498,607	4,646
Clay-kiln furniture, radiant-heater elements, potters' supplies, and other miscellaneous refractory items.			5,808		4,808
Other clay refractory materials sold in lump or ground form.[5]	Short ton	[3] 340,413	[3] 5,685	211,856	4,608
Total clay refractories			[3] 207,640		162,887

See footnotes at end of table.

TABLE 11.—Shipments of refractories in the United States, by kinds—Continued

Product	Unit of quantity	Shipments 1957 Quantity	Shipments 1957 Value (thousand)	Shipments 1958 Quantity	Shipments 1958 Value (thousand)
Nonclay refractories:					
Silica brick and shapes	1,000 9-in. equivalent.	304, 210	$62, 002	202, 685	$42, 190
Magnesite and magnesite-chrome (magnesite predominating) brick and shapes (excluding molten cast).	do	[3] 43, 353	[3] 31, 944	39, 673	30, 692
Chrome and chrome-magnesite (chrome ore predominating) brick and shapes (excluding molten cast).	do	[3] 62, 420	[3] 41, 543	42, 582	30, 296
Graphite and other crucibles, retorts, stopper heads, and other shaped refractories.	Short ton	} [3] 12, 291	8, 363	13, 537	8, 119
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.	4, 350	5, 043	4, 047	4, 764
Extra-high alumina brick and shapes made predominantly of fused bauxite, fused or dense-sintered alumina (excluding molten cast).	do	2, 538	4, 227	2, 001	4, 099
Silicon carbide brick and shapes made substantially of silicon carbide.	do	4, 606	9, 196	3, 802	8, 285
Zircon and zirconia brick and shapes made predominantly of these materials.	do	537	1, 738	547	2, 010
Forsterite, pyrophyllite, molten-cast, and other nonclay brick and shapes.			11, 824		11, 793
Nonclay refractory bonding mortars, air-setting (wet and dry) types.	Short ton	[3] 94, 871	[3] 9, 639	97, 800	9, 615
Nonclay refractory bonding mortars, except air-setting types.	do	[3] 23, 201	[3] 1, 906	19, 261	1, 521
Nonclay plastic refractories and ramming mixes (wet and dry) types.	do	[3] 214, 284	[3] 21, 990	188, 337	20, 578
Nonclay refractory castables (hydraulic setting).	do	6, 799	798	5, 947	730
Dead-burned magnesia or magnesite [4]	do	214, 150	10, 914	177, 237	8, 853
Dead-burned dolomite [4]	do	1, 367, 557	22, 424	1, 386, 773	23, 933
Other nonclay refractory materials sold in lump or ground form.[5]	do	[3] 153, 879	[3] 10, 117	147, 200	9, 420
Total nonclay refractories			[3] 253, 668		216, 898
Grand total refractories			[3] 461, 308		379, 785

[1] Excludes data for 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 data for bonding mortars which contain up to 60 percent Al_2O_3, dry basis. Bonding mortars which 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 establishments classified in "manufacturing" industries, and excludes shipments to refractory producers for the manufacture of brick and other refractories.
[5] Includes data for calcined clay, ground brick, and siliceous and other gunning mixes.

Heavy Clay Products.—The Burns Brick Co. in Macon, Ga., began production in January of a lightweight clay block developed to compete with cement blocks for backup in masonry walls. The unit is an 8 x 8 x 16 inch 28 pound clay block which is inexpensive, has low expansion, and is dimensionally stable. Primary reception of this unit resulted in an expansion of the Macon plant announced in July to increase production from 3,000 to 20,000 units per day. The block is made with machinery and methods already well known to the industry. At the Macon plant the production line consists of a rotary kiln operation for expanding clay for aggregate, a block forming operation, a rapid dryer, and the same tunnel kilns used to burn building brick. The principles and techniques used in producing this block are adaptable with changes to a majority of the nation's clay plants. Additional data,[5] customer reaction,[6] and sales and statistics [7] were presented in published articles.

A discussion of the aspects of lightweight aggregate production and operation, including gradation, segregation, batch variation, moisture compensation, cement aggregate ratio, and mixing lightweight concrete, was published.[8]

An article described the operation of a plant producing 1,500 cubic yards per day of lightweight aggregate from clay.[9]

Material Service Corporation, Chicago, Ill., completed one of the largest expanded-shale lightweight aggregate plants in the United States, at Ottawa, Ill. The two kilns installed could produce 1,000 to 1,500 cubic yards of aggregate daily. The plant flow provided for crushing and sizing of the raw shale before expansion, rather than the more common practice in lightweight aggregate plants of supplying kilns with a roughly-sized feed. An article describing the plant included blueprints and product specifications.[10]

Shale-Lite Corp., producer of an expanded-shale lightweight aggregate, began operations at a new plant near Chino, Calif. Construction began on a new $1.5 million lightweight aggregate plant for North Central Lightweight Aggregate Co., at Hamel, Minn. Plant capacity of 75 cubic yards of product a day was planned. Construction also began on a new plant at Russell, Fla., by Southern Lightweight Aggregate Corp., to be known as Florida Solite Corp. It was announced that Clinchfield (Va.) Coal Co. would construct a $1.5 million expanded clay aggregate plant as part of a $20 million expansion program.

Hydraulic Press Brick Co., St. Louis, acquired Midwest Aggregates, Inc., Brooklyn, Ind., increasing its lightweight aggregate production 70 percent.

The manufacturing operations of modern brick plants of Columbia Brick and Tile Co., Columbia, S. C.[11] and Wadsworth Brick and Tile Co., Wadsworth, Ohio,[12] were described.

The National Clay Pipe Manufacturers, Inc., dedicated its new modern research laboratory at Crystal Lake, Ill. Studies planned by the new laboratory and six basic objectives of NCPMI research were discussed in an article.[13] West Virginia Pulp and Paper Co., Charleston, S.C., opened a specialized ceramic laboratory.

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[5] Brick and Clay Record, How the Burns Brick Block is Made: Vol. 133, No. 1, July 1958, pp. 49, 51, 58.

[6] Brick and Clay Record, Readers Respond, See Great Possibilities in Burns Brick Block: Vol. 133, No. 2, August 1958, pp. 42-43.

[7] Brick and Clay Record, vol. 133, No. 4, October 1958, pp. 52-53.

[8] Nensewitz, Karl, Tips on Lightweight Aggregate Handling: Brick and Clay Record, vol. 132, No. 2, pp. 53-55, 69.

[9] Brick and Clay Record, New Aglite Plant Produces 1,500 Cubic Yards Per Day: Vol. 132, No. 1, January 1958, pp. 46-47, 49.

[10] Herod, B. C., Expanded-Shale Plant of Material Service: Pit and Quarry, vol. 50, No. 8, February 1958, pp. 70-72, 74, 75, 78-80, 123-124.

[11] Brick and Clay Record, Cost Cutting Equipment, 499-foot Tunnel Kiln Gives Columbia High Capacity at Low Cost: Vol. 132, No. 3, March 1958, pp. 44-47, 66.

[12] Brick and Clay Record, The Potential Wadsworth Capacity: Vol. 133, No. 4, October 1958, pp. 44-46.

[13] Brick and Clay Record, NCPMI Enters Era of Research: Vol. 132, No. 5, May 1958, pp. 53-60.

Descriptions were given of plants built by Oconee Clay Products Co. at Milledgeville, Ga., designed to produce sewer pipe up to 36 inches in diameter,[14] and Logan Clay Products Co., Logan, Ohio, designed to produce 150 tons of sewer pipe daily.[15]

Production of brick began in new plants by Gladding, McBean & Co., at Corona, Calif., and Southwest Brick Co., at De Leon, Tex.

Construction began on new plants by Washington Brick Co., Muirkirk, Md. (brick), Builders Brick Co., Seattle, Wash. (brick), and Dickota Clay Products Co., Dickinson, S. Dak. (sewer pipe and tile). Plans were announced to build new plants by W. S. Dickey Clay Mfg. Co., at Bessemer, Ala. (clay pipe), and Eastern Brick and Tile Co., Sumter, S.C. (brick and tile).

Articles described new plant additions that enabled Southern Brick Co., Ninety Six, S.C.[16] and Kansas Brick and Tile Company, Hoisington, Kans.[17] to increase production. Modernization and expansion programs were announced by W. G. Bush Co., Nashville, Tenn., Hanley Brick Co., Summerville, Pa., Perrysburg Tile and Brick Co., Perrysburg, Ohio, and Georgia Vitrified Brick and Clay Co., Augusta, Ga.

Great Bend Brick and Tile Co., Inc., sold its manufacturing plants at Great Bend and Kanopolis, Kans., to the Acme Brick Co., Fort Worth, Tex.

The American Vitrified Products Co., Cleveland, Ohio, bought the Tully Concrete Products Co. of St. Louis, Mo.

In its program of diversification and expansion in the construction industry, Illinois Brick Co., Chicago, Ill., acquired all the outstanding shares of Western Brick Co., of Danville, Ill., for $1.5 million. The Danville plant annually manufactured shale face brick, and a lightweight cement product worth $2.5 million.

After completing a $1 million plant expansion, Logan Clay Products Co., Logan, Ohio, announced a merger with Graff-Kittanning Clay Products Co., Worthington, Pa.

A $350,000 fire destroyed a building and brick making machinery of Goshen Brick Co. near Newcomerstown, Ohio, but plans were underway to rebuild.

The need for lang-range planning in clay products plants and suggestions on plant layout and equipment were discussed.[18]

Based on data compiled by the U.S. Department of Commerce, the value of shipments of clay construction products was $452.6 million, 4 percent more than the 1957 value of $437.1 million, and 10 percent less than the 1956 figure of $503.8 million. Shipments of the principal clay product, unglazed brick, were approximately 6,500 million with a value of $209.9 million, compared with 6,300 million brick valued at $205.8 million in 1957, and 7,400 million brick valued at $236.3 million in 1956.

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[14] Brick and Clay Record, How Oconee Mechanizes Large Pipe Production: Vol. 133, No. 3, September 1958, pp. 61-63, 89, 91, 92.

[15] Brick and Clay Record, Automatic, Specialized Operation in Logan's New Double Line Plant: Vol. 133, No. 4, October 1958, pp. 48-51.

[16] Brick and Clay Record, Double Capacity Built In St. Southern: Vol. 132, No. 9, April 1958, pp. 67-68, 98, 100.

[17] Brick and Clay Record, Plant Improvement Program Ups Production by 1.5 Million a Month: Vol. 132, No. 2, February 1958, pp. 44-45.

[18] Hendryx, D. B., Tomorrow's Plant Today: Brick and Clay Record, vol. 133, No. 6, December 1958, pp. 38-39, 50, 52, 63.

TABLE 12.—Shipments of principal structural clay products in the United States[1]

Product and unit quantity	1956		1957		1958	
	Quantity	Value (thousand)	Quantity	Value (thousand)	Quantity	Value (thousand)
Unglazed brick (building) M standard brick	7,381,600	$236,300	6,305,900	$205,800	6,458,800	$209,900
Unglazed structural tile short tons	750,500	9,800	640,700	8,700	542,900	7,700
Vitrified clay sewer pipe and fittings, short tons	2,038,500	90,100	1,629,000	77,500	1,772,300	83,700
Facing tile, ceramic glazed, including glazed brick, M brick equivalent	438,300	32,400	381,600	28,200	399,100	29,100
Facing tile, unglazed and salt glazed, M tile, 8"x5"x12" equivalent	32,300	4,300	19,900	3,400	17,800	3,000
Clay floor and wall tile and accessories, including quarry tile, M square feet	231,300	130,500	207,100	113,400	215,700	119,100

[1] Compiled from information furnished by the Bureau of the Census, U.S. Department of Commerce.

WORLD REVIEW

NORTH AMERICA

Canada.—Papers were published reviewing industrial minerals, including clays, of Alberta,[19] Manitoba,[20] and Saskatchewan.[21]

Bentonite, stoneware, and refractory clays, and brick and tile clay are widely distributed in Alberta. In Saskatchewan stoneware clays are found in the Cypress Hill area, white-burning ball clays and some fire clays in the Wood Mountain-Willowbunch area, fire clay in the Claybank area, and clay suitable for lightweight aggregate and cement near Regina. Some excellent bentonite also occurs in Saskatchewan.

In Manitoba the Winnipeg Light Aggregate Company, Ltd., of Transcona and the Star Light Aggregate Company of St. Boniface established plants for the manufacture of expanded-clay aggregate. In January Lapart Industries began production of non-swelling bentonite from the Morden-Miami area. There were fine brick plants in the area. In 1957 Kaolin and Minerals Exploration, Ltd., was organized to assess the economic potential of a kaolin-silica deposit 15 miles northwest of Arborg.

Reviews of bentonite [22] and clays and clay products [23] in Canada in 1957 were published. The occurrence, use, and export-import information on bentonite, miscellaneous clay and shale, stoneware clay, fire clay, and china and ball clay were reported. Clay products made in Canada from domestic and imported clays during 1957 reached a value of $55,295,000, a small drop from the 1956 figure. Production from domestic clays accounted for 63 percent of this total. The value of imports of clay and clay products in 1957 was $42,739,000, and of exports, $4,062,000.

[19] Govett, G. J., Industrial Minerals of Alberta: Canadian Min. and Met. Bull. (Montreal), vol. 52, No. 564, April 1959, pp. 261-266.
[20] Cowie, Wm. G., Industrial Minerals in Manitoba: Production and Utilization: Canadian Min. and Met. Bull. (Montreal), vol. 52, No. 564, April 1959, pp. 269-275.
[21] Carlson, E. Y., A Review of the Industrial Minerals of Saskatchewan: Canadian Min. and Met. Bull. (Montreal), vol. 52, No. 564, April 1959, pp. 267-268.
[22] Buchanan, R. M., Bentonite in Canada, 1957: Dept. of Mines and Tech. Surveys, Ottawa, Canada, Review 33, May 1958, 6 pp.
[23] Matthews, S., Clays and Clay Products in Canada, 1957: Dept. of Mines and Tech. Surveys, Ottawa, Canada, Review 36, June 1958, 5 pp.

A list of the ceramic plants in Canada was published.[24] The plants were classified and listed under brick and tile, clay sewer pipe, enamel, glass, porcelain and pottery, refractory and abrasive. The operator, address, location, manager, superintendent, raw materials used, and source of raw material were given.

Magcobar Drilling Mud Co. of Calgary, a branch of Magnet Cove Barium Corp. was building a $400,000 plant at Rosalind, Alberta, to mine and beneficiate bentonite. It was expected that the plant would begin to produce in the spring of 1959 at the rate of 25,000 tons a year, a rate capable of meeting the bentonite requirements for the drilling industry in Canada.

Nicaragua.—A plant to manufacture brick, tile, and construction blocks from clay was being built by Ceramics Cheltepe S. A., near Managua.[25]

SOUTH AMERICA

Brazil.—Exports of clays from Brazil were 252 short tons valued at US$6,000.[26]

Colombia.—The production of kaolin was 4,408 short tons.[27]

Ecuador.—The production of kaolin in Ecuador from 1954 to 1958 was as follows: 1954, 71; 1955, 398; 1956, 1,094; 1957, 163; 1958, 35.[28]

Paraguay.—The brick and tile industry was by far the most important mineral industry in Paraguay, and clay resources for these uses are widespread and abundant.[29] Refractory clay resources are relatively scarce. A few of the modern brick plants employ some machine methods.

Peru.—Production of clay for building brick in 1958 totaled 231,000 short tons valued at $471,500.[30] Total clay production was 233,073 short tons in 1958 compared with 237,221 tons in 1957.[31]

EUROPE

Austria.—Clay production in Austria in 1958 was as follows: Clay, 128,488 short tons; clay sand, 47,838 tons; bentonite, 4,199 tons; and kaolin, 330,892 tons.[32]

Cyprus.—The quantity in short tons and value of exports of bentonite from 1954–58 were as follows: 1954, 209, $5,197; 1955, 505, $9,179; 1956, 1,073, $17,547; 1957, 879, $14,076; 1958, 1,001, $17,184.[33]

Denmark.—The production of kaolin in short tons in Denmark, 1954–58 was as follows: 1954, 7,141; 1955, 7,075; 1956, 6,778; 1957, 4,129; 1958, 5,600.[34]

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[24] Dept. of Mines and Tech. Surveys, Ottawa, Ceramic Plants in Canada: Minerals Industry Operators List 6, January 1958, 35 pp.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 2, August 1959, p. 43.
[26] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 1265, Apr. 29, 1959, p. 2.
[27] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 2, August 1959, p. 41.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 2, August 1959, p. 42.
[29] Eckel, E. B., Geology and Mineral Resources of Paraguay, A Reconnaissance: Geol. Survey Prof. Paper 327, 1959, pp. 80-81.
[30] U. S. Embassy, Lima, Peru, State Department Dispatch 896, Apr. 6, 1959, p. 2.
[31] U.S. Embassy, Lima, Peru, State Department Dispatch 943, Apr. 17, 1959, p. 3.
[32] U.S. Embassy, Vienna, Austria, State Department Dispatch 1106, Apr. 9, 1959, p. 1.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, p. 29; Vol. 49, No. 2, August 1959, p. 41.
[34] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 2, August 1959, p. 41.

Germany, West.—The production of crude kaolin totaled 1,657,364 short tons and of marketable kaolin 58,925 tons in 1958, compared with 1,673,409 tons of crude kaolin and 61,582 tons of marketable kaolin in 1957.[35]

Sweden.—According to preliminary reports 170,123 short tons of fire clay and 1,016 short tons of kaolin were produced in Sweden in 1958.[36]

Yugoslavia.—The production of bentonite in Yugoslavia, in short tons, 1955–57 was: 1955, 9,918; 1956, 61; and 1957, 5,368. Fire clay production, in short tons for the same years was: 1955, 131,138; 1956, 105,260; and 1957, 99,470.[37]

In 1957 Yugoslavia imported 9,036 short tons of kaolin and 16,310 short tons of fire clay and exported 3,188 tons of bentonite and 1,884 tons of bleaching clay. All of the exports and most of the imports resulted from trade with the Sino-Soviet bloc.

ASIA

Hong Kong.—The production of kaolin in Hong Kong totaled 8,536 short tons in 1958, compared with 7,796 tons in 1957.[38]

India.—It was reported that large deposits of high-grade fire clay were discovered in Uttar Pradesh.[39] The deposits were in a 7-square-mile area and were estimated to contain about 5 million tons of clay. The deposits are near Village Bansi, Mesra, and Makhrikhoh in the southwestern part of Miazapur district.

Israel.—A flint clay with an alumina content of 40 to 60 percent was being mined in the Makhteesh-Ramon region of the central Negev. Ceramic Materials Co., Ltd., planned to export the clay to European countries.[40]

Japan.—The Japanese Ministry of International Trade and Industry established a schedule of recommended minimum sale prices for various types and sizes of tile.[41] The production of china clay (kaolin) 1954–58, in short tons was: 1954, 13,963; 1955, 13,563; 1956, 15,835; 1957, 17,528; and 1958, 23,327. Fire clay production in short tons for the same years was: 1954, 532,883; 1955, 586,458; 1956, 646,925; 1957, 818,850; and 1958, 570,370.[42]

Korea, Republic of.—Production of kaolin, 1954–58 in short tons, was: 1954, 10,421; 1955, 15,586; 1956, 10,344; 1957, 7,279; and 1958, 23,765.[43]

Pakistan.—Total clay production in 1958 was 12,876 short tons valued at $48,180.[44]

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[35] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 2, August 1959, p. 42.
[36] U.S. Embassy, Stockholm, Sweden, State Department Dispatch 1089, May 20, 1959, pp. 1-2.
[37] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, pp. 28-29.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 1, July 1959, p. 31.
[39] Glass and Ceramic Bulletin (Calcutta), Fire Clay Deposits: Vol. 5, No. 3, July-September 1958, p. 117.
[40] Mining Journal (London), vol. 252, No. 6445, Feb. 27, 1959, p. 238.
[41] U.S. Consulate, Nagoya, Japan, State Department Dispatch 58: Mar. 2, 1958, p. 1.
[42] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 1, July 1959, p. 32.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 2, August 1959, p. 43.
[44] U.S. Embassy, Karachi, Pakistan, State Department Dispatch 985: Apr. 30, 1959, p. 1.

AFRICA

Kenya.—Production of kaolin totaled 1,327 short tons valued at $13,300 in 1958.[45]

Rhodesia and Nyasaland, Federation of.—The production of fire clay, all from Southern Rhodesia, totaled 28,079 short tons in 1957, compared with 19,700 tons in 1956.[46]

Union of South Africa.—Large deposits containing 52 to 60 percent of recoverable kaolin were found in the Bitterfontein area, 300 miles north of Cape Town.[47]

OCEANIA

Australia.—A $112,000 expansion was planned at the Egerton Kaolin mine in the Ballaret district, Victoria.[48]

TECHNOLOGY

A guidebook of some clay deposits in northeastern Maryland and northern Delaware presented field and laboratory data gathered during a study by the Maryland Department of Geology, in cooperation with the Federal Geological Survey and the Federal Bureau of Mines. A geologic description of the Coastal Plain sediments, sample analyses, and an extensive bibliography were included.[49]

The origin of china clay was discussed.[50]

The hydraulic mining methods employed by Goovean and Rostowrack China Clay Co., Ltd., Cornwall, England, were described in detail.[51] The report covered a brief historical sketch of the area and uses of china clay and a detailed description of the geology, mineralogy, hydraulic mining method, and beneficiation. A detailed flow sheet and numerous illustrations were included.

The proceedings of the Fifth National Conference on Clays and Clay Minerals, held in October 1956 and sponsored by the Committee on Clay Minerals of the National Academy of Science—National Research Council and the University of Illinois, were published in 1958. Selected papers from this volume were of special interest to the clay industry.[52]

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[45] U.S. Embassy, Nairobi, Kenya, State Department Dispatch 536: Mar. 31, 1959, p. 1.

[46] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 24.

[47] Mining World and Engineering Record (London), South African Letter: Vol. 174, No. 4516, July 1958, p. 274.

[48] Industrial and Mining Standard (Melbourne), vol. 113, No. 2861, July 17, 1958, p. 26.

[49] National Academy of Sciences, Guidebook for a Field Excursion to Northeastern Maryland and Northern Delaware: 1958, 43 pp.

[50] Cardew, Michael, Genesis of China Clay: Pottery Quart., vol. 4, No. 16, 1957; Ceram. Abs., vol. 42, No. 1, January 1959, p. 28.

[51] Mine and Quarry Engineering (London), Goovean China-Clay Pit, pt. 1: Vol. 24, No. 11, November 1958, pp. 476-485; pt. 2, No. 12, December 1958, pp. 538-543.

[52] Swineford, Ada. Clays and Clay Minerals: Nat. Acad. Sci. and Nat. Res. Council, Washington, D.C., Pub. 566, 1958, 360 pp.

Langston, R. B., and Pask, J. A., Analysis of Consistencies of Kaolin-Water Systems Below the Plastic Range, pp. 4-22.

Sand, L. B., and Ames, L. L., Jr., Altered Siliceous Volcanics as a Source of Refractory Clay, pp. 39-45.

Oakes, D. T., Filtration Theory for Oil-Well Drilling Fluids, pp. 46-60.

van Olphen, H., and Waxman, M. H., Surface Conductance of Sodium Bentonite in Water, pp. 61-80.

Whitehouse, U. G., and McCarter, R. S., Diagenetic Modification of Clay Mineral Types in Artificial Sea Water, pp. 81-119.

Mumpton, F. A., and Roy, Rustum, New Data on Sepiolite and Attapulgite, pp. 136-143.

Kulbicki, Georges, High Temperature Phases in Montmorillonites, pp. 144-158.

Weaver, C. E., A Discussion on the Origin of Clay Minerals in Sedimentary Rocks, pp. 159-173.

Brindley, G. W., and Nakahira, M., A Kinetic Study of the Dehydroxylation of Kaolinite, pp. 266-278.

McAtee, J. L., Jr., Heterogeneity in Montmorillonite, pp. 279-288.

The properties of four domestic ceramic clays, kaolins from Florida and North Carolina and two ball clay samples from Tennessee, were investigated during heating to 1,600° C.[53]

The degree of crystallinity for seven kaolin minerals and the relation between structural characteristics and the physiochemical properties were determined. The samples came from Georgia, New Mexico, and Gifu, Japan.[54]

The relationship between bond energies and thermal energy in kaolinite-water systems was studied.[55]

Laboratory work was conducted on Indian china clays.[56]

An article was published briefly outlining the principles of the hydrocyclone, or liquid-solid cyclone, and the factors affecting performance, with a description of its particular application in the refining of china clay. Centrifugal force is produced by the introduction of the clay slurry into a hollow cylindro-conical vessel under pressure.[57]

The adsorption of a polyethylene glycol ester of oleic acid on montmorillonite in a water system was studied.[58]

The use of montmorillonite clays from Levago Ruba, Malinovka, and Vidabor for purifying transformer oil by the contact method was discussed. Purification may be improved by separating the clay fraction by elutriation followed by preliminary thermal activation at 350° C. for 3 hours.[59]

Tests on precalcining high-carbon clays showed many production advantages, but a higher cost of preparation.[60]

In an attempt to evaluate fire clay mortars a comprehensive investigation was conducted on 32 high-grade brands. These mortars were tested for particle size range, water content, refractoriness-pier, workability, slagging resistance, resistance to deformation under load, bonding strength, chemical composition, mineralogical composition, shrinkage, and resistance to carbon monoxide disintegration. Only three brands had outstanding properties in all tests.[61]

A book was published containing 22 technical papers, most of which were presented at a symposium on ceramic fabrication processes. The articles were presented in six parts: Slip casting, pressure fabrication, plastic forming, drying and firing, special processes (hot pressing, cementitious bonding, nucleation, metal working processes), and ceramic microstructures.[62]

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[53] West, R. R., High-Temperature Reactions in Domestic Ceramic Clays: Bull. Am. Ceram. Soc., vol. 37, No. 6, June 1958, pp. 262-268.

[54] Takahashi, Hiroshi, Structural Variations of Kaolin Minerals: Bull. Chem. Soc. Japan (Tokyo), vol. 31, 1958, pp. 275-283; Chem. Abs., vol. 52, No. 20, October 1958, p. 16990a.

[55] Lawrence, W. G., Theory of Ion Exchange and Development of Charge in Kaolinite-Water Systems: Jour. Am. Ceram. Soc., vol. 41, No. 4, April 1958, pp. 136-140.

[56] Guha, S. K., and Sen, Sudhir, Potentiometric and Conductometric Titration of Minus Two Micron Fraction of Four Indian China Clays: Glass and Ceramic Bulletin (Calcutta), vol. 5, No. 3, July-September 1958, p. 109.

[57] Naylor, T. R., The Hydrocyclone in the Refining of China-Clay: Mine and Quarry Engineering (London), vol. 29, No. 11, November 1958, pp. 510-513.

[58] Brindley, G. W., and Rustom, Mahmoud, Adsorption and Retention of an Organic Material by Montmorillonite in the Presence of Water: Am. Mineral., vol. 43, No. 7-8, July-August 1958, pp. 627-640.

[59] Bel'kevich, P. I., Yanchenko, N. I., Slepovich, F. I., (Regeneration of Waste Oils by Bleaching Clays): Referalivnyy zhurnal, Geologiya (U.S.S.R.), No. 7, 1957, p. 143.

[60] Brick and Clay Record, Allied Engineering Reports Further on Precalcined Clay: Vol. 139, No. 4, April 1959, pp. 10-11.

[61] Eusner, G. R., and Bachman, J. R., Investigation and Testing of 32 High-Grade Mortars for Fireclay Brick: Bull. Am. Ceram. Soc., vol. 37, No. 1, January 1958, pp. 12-21.

[62] Kingery, W. D., Ceramic Fabrication Processes: Technology Press of Mass. Inst. Tech. and John Wiley & Sons, Inc., N.Y., 1958, 235 pp.

An extensive technical manual on ceramics, including basic ceramic raw materials, structural ceramics, stoneware, and other topics was published. Sections dealing with products contain information on all processes necessary to produce a specific product.[63]

The results of studies on the effect of pyrite on efflorescence of structural clay products were published. The retention of part of the sulfur dioxide by the clay material and its subsequent efflorescence tendency were found to depend on the composition of the product, the concentration of sulfurous gases, the temperature of firing, the time of firing, and the duration of exposure to sulfur dioxide in the manufacturing process. The conditions necessary to reduce efflorescence from this source were described.[64]

An attempt was made to isolate the effects of sulfates in clay raw materials on efflorescence from the effects of sulfides and sulfurous fuels. It was found that sulfates react with clays between 1,800° and 1,900° F. with the result that the efflorescence is reduced.[65]

A general description of the equipment used in the application of special coatings to structural clay products was published. Both wet and dry processes were covered.[66]

A report was made on an investigation on the possible economic and production advantages of using fly ash as a partial replacement for some structural-clay raw materials. Physical properties of bodies made from fly ash in combination with shale, fire clay, or bentonite were determined.[67]

A process for attempting to press fire clay beams for glass melting furnaces and characteristics of the beams were given.[68]

By using short reinforcing wires (100-150 mm. long) it was possible to avoid fissures and cracks which occurred in fire-clay plates when longer wires were used.[69]

Advantages were cited for a recently developed process to join clay pipe.[70]

An article described the use of electronic equipment by Davis Fire Brick Co. at its new firebrick plant at Oak Hill, Ohio, to control quality of raw materials and finished product and to regulate the temperature cycles in kilns and dryers.[71]

In the interest of standardization, 28 common and special purpose tests for ceramic tile by the Tile Council of America, Inc., were described. Many tables and references were included in the article.[72]

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[63] Avgustinik, A. I., Ceramics (Moscow 1957): 484 pp.
[64] Brownell, W. E., Efflorescence Resulting From Pyrite in Clay Raw Material: Jour. Am. Ceram. Soc., vol. 41, No. 7, July 1958, pp. 261-266.
[65] Brownell, W. E., Efflorescence Resulting from Sulfates in Clay Raw Materials: Jour. Am. Ceram. Soc., vol. 41, No. 8, Aug. 1, 1958, pp. 310-314.
[66] Verba, R. J., Automatic Application of Special Brick Coatings: Bull. Am. Ceram. Soc., vol. 37, No. 8, August 1958, pp. 364-365.
[67] Bowers, D. J., and Snyder, M. J., Fly Ash as a Raw Material for Structural Clay Products: Bull. Am. Ceram. Soc., vol. 37, No. 5, May 1958, pp. 220-221.
[68] Kvilchenko, I. P., An Attempt of Pressing Fire-Clay Beams for Glass Melting Furnaces on a 750-Ton Friction Press: Ogneupory (Moscow), No. 1, 1958, pp. 35-39.
[69] Gubko, I. T., Kotinskiy, N. F., and Vanzha, N. S., On the Reinforcement of Fire-Clay Plater: Ogneupory (Moscow), No. 1, 1958, pp. 39-40.
[70] Delmonte, J., Epoxy Bonding for Clay Pipe: Brick and Clay Record, vol. 134, No. 2, February 1959, pp. 42-44.
[71] Iron Age, Controls Aid Refractory Output: Vol. 183, No. 12, Mar. 19, 1959, p. 119.
[72] Fitzgerald, J. V., and Kastenbein, E. L., Tests for and Engineering Properties of Ceramic Tile: ASTM Bull., No. 231, July 1958, pp. 74-80.

A report was published on the research at Clemson College in machines and methods for producing clay-bonded, lightweight structural units. Four different forming methods, vibrating block machine, slush casting, and wet and dry pressing, were investigated.[73]

The results of a study by the Engineering Experiment Station of Ohio State University to determine the mechanism of bloating from the chemical and mineralogical standpoint were published. The relationships of firing temperature, particle size, time in the kiln, and the effect of preheat on bloating were discussed.[74]

Patents were issued for the use of kaolin and bentonite in clay catalysts,[75] for the production of white zeolitic fillers or pigments from kaolin,[76] methods for sulfuric acid activation of kaolin,[77] the recovery of aluminum from Georgia kaolin,[78] the use of kaolin in paper coating,[79] and for a mixture of kaolin and ball clay as a refractory composition for coating graphite molds.[80] A method was patented for producing porous material for use in humidifier plates and filters by die pressing ball clay, lime, and water with rice-hull ash and heating to 1,800° to 2,350° F.[81]

Other patents were issued on a liquid composition to bind refractory aggregates and ores without recrystallization,[82] the use of fire clay and anthracite silt in a refractory hot top for ingot molds, [83] the use of fuller's earth for lubricating rolled aluminum before low-temperature annealing,[84] and for a sugar refining adsorbent material possessing improved properties.[85] Fuller's earth or non-swelling bentonite was utilized in the preparation of alkylated aromatics.[86]

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[73] Robinson, G. C., Clay Bonded Block: Brick and Clay Record, vol. 134, No. 2, February 1959, pp. 38-40, 60-61.

[74] Ehlers, E. G., The Mechanism of Lightweight Aggregate Formation: Bull. Am. Ceram. Soc., vol. 37, No. 2, Feb. 15, 1958, pp. 95-99.

[75] Donovan, J. J., and Milliken, T. H., Jr. (assigned to Houdry Process Corp.), Preparation of Active Contact Masses from Kaolin Clays: U.S. Patent 2,848,422, Aug. 19, 1958.

McEvoy, J. E., and Milliken, T. H., Jr. (assigned to Houdry Process Corp.), Removal of Iron From Clay Catalysts: U.S. Patent 2,825,699, Mar. 4, 1958.

Milliken, T. H., Jr., and Weidman, W. L. (assigned to Houdry Process Corp.), Preparation of Porous Kaolin Catalysts: U.S. Patent 2,840,530, June 24, 1958.

Mills, G. A. (assigned to Houdry Process Corp.), Clay Catalysts: U.S. Patent 2,863,839, Dec. 9, 1958.

Mills, G. A., and Talvenheimo, G. (assigned to Houdry Process Corp.), Preparation of Kaolin Catalysts: U.S. Patent 2,848,423, Aug. 19, 1958.

Morrell, J. C., Conversion of Hydrocarbons With the Use of a Kaolin Composite Catalyst: U.S. Patent 2,862,875, Dec. 2, 1958.

[76] Bertorelli, O. L. (assigned to J. M. Huber Corp.), Production of Zeolitic Pigments: U.S. Patent 2,848,346, Aug. 19, 1958.

[77] Minerals and Chemical Corp. of America: British Patent 793,393, Apr. 16, 1958.

[78] Tucker, S., Method for Obtaining Iron-Free Aluminum Compound From Clays: U.S. Patent 2,847,279, Aug. 12, 1958.

[79] McKnight, G. S., Jr., and Brown, R. C. (assigned to Oxford Paper Co.), Coating Compositions: U.S. Patent 2,865,773, Dec. 23, 1958.

Moore & Munger: British Patent 800,493, Aug. 27, 1958.

[80] Stoddard, S. D. (assigned to United States as represented by the Chairman of the Atomic Energy Commission), Refractory Coating for Graphite Molds: U.S. Patent 2,840,480, June 24, 1958.

[81] Jones, J. D., Porous Media: U.S. Patent 2,826,505, Mar. 11, 1958.

[82] Kerla, H., Binding Compositions and Refractory Materials Bound Thereby: U.S. Patent 2,855,318, Oct. 7, 1958.

[83] Whitacre, D. D. (assigned to Whitacre Greer Fireproofing Co.), Hot Top: U.S. Patent 2,846,741, Aug. 12, 1958.

[84] Mills, I. W. (assigned to Sun Oil Co.), Method of Annealing Aluminum: U.S. Patent 2,861,020, Nov. 18, 1958.

[85] Barrett, F. P. (assigned to Baugh & Sons Co.), Granular Adsorbent for Sugar Refining: U.S. Patent 2,831,818, Apr. 22, 1958.

[86] Weaver, L. J. (assigned to Monsanto Chemical Co.), Active Clays as Catalyst Attenuator in the Alkylation of Aromatics: U.S. Patent 2,853,533, Sept. 23, 1958.

Some patents issued during the year covered the uses of bentonite: For an improved drilling mud,[87] mixed with an alkaline soybean meal to pelletize powdered iron,[88] to form stable gels with polar and nonpolar organic liquids,[89] and in subsoil irrigation systems.[90]

In another patent bentonite pellets coated with a water-insoluble material, except for one small entrance, were used for injection into wells. When the pellets absorbed water they expanded and ruptured, permitting the bentonite to seal cracks.[91] A similar patent described a method of recovering circulation in wells by the use of minus 100-mesh expandable dehydrated bentonite coated with a water-repellent substance.[92]

Patents dealing with expanded clay aggregate also were issued.[93]

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[87] Thompson, W. F. (assigned to Sun Oil Co.), Aqueous Drilling Fluid: U.S. Patent 2,828,258, Mar. 25, 1958.

[88] Barker, N. G., and Nordgren, R. (assigned to General Mills, Inc.): Canadian Patent 565,713, Nov. 4, 1958.

[89] Clem, A. G. (assigned to American Colloid Co.), Chemical Compounds and the Production Thereof: U. S. Patent 2,859,234, Nov. 4, 1958.

[90] MarBury, T. M., Soil Irrigation System: U.S. Patent 2,850,843, Sept. 9, 1958.

[91] Armentrout, A. L., Material for Recovering Lost Circulation in Wells: U.S. Patent 2,836,555, May 27, 1958.

[92] Armentrout, A. L., Lost Circulation Recovering Material: U.S. Patent 2,856,354, Oct. 14, 1958.

[93] Blaha, E. (assigned to Selas Corp. of Am.), Apparatus for Converting Clay Particles Into Fused Unicellular Spherical Bodies: U.S. Patent 2,855,191, Oct. 7, 1958.

Blaha, E. (assigned to Selas Corp. of Am.), Pellet Making: U.S. Patent 2,847,702, Aug. 19, 1958.

Neff, J. M., and McLaughlin, J. D. (assigned to Kanium Corp.), Method and Apparatus for Producing Spherulized Clay Particles: U.S. Patent 2,853,285, Sept. 23, 1958.

Sainty, C. L. (assigned to Structural Concrete Components, Ltd.): British Patent 803,823, Nov. 5, 1958.

Cobalt

By Joseph H. Bilbrey, Jr.,[1] and Dorothy T. McDougal[2]

CONSUMPTION of cobalt in the United States decreased 18 percent in 1958, mainly because the two major uses—permanent magnets and high temperature alloys—declined 20 percent.

Domestic mines produced the equivalent of 53 percent of the domestic consumption in 1958. The Calera Mining Co. produced 20 percent more metal than in 1957 at its Garfield, Utah, refinery.

World production of cobalt decreased 8 percent.

TABLE 1.—Salient statistics of cobalt, 1949–53 (average) and 1954–58, in thousand pounds of contained cobalt

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Domestic mine production of ore or concentrate	971	1,996	2,609	3,595	[1] 4,144	4,844
Recoverable cobalt	662	1,439	[1] 1,857	[1] 2,544	[1] 3,303	4,023
Imports	11,832	16,865	18,732	15,577	[1] 17,379	15,954
Stocks Dec. 31 (consumers')	1,174	1,185	1,299	1,244	977	874
Consumption	8,897	7,350	9,740	9,562	9,157	7,542
Price per pound of metal	$1.65–$2.60	$2.60	$2.60	$2.60–$2.35	$2.35–$2.00	$2.00
World: Production (short tons)	9,500	[1] 14,400	[1] 14,700	[1] 15,900	[1] 15,900	14,600

[1] Revised figure.

DOMESTIC PRODUCTION

Mine Production.—Because of the combination of increased mine production and greatly decreased consumption, the United States was able to supply over 50 percent of its cobalt requirements for the first time. Domestic mines produced a record 4.8 million pounds of cobalt in concentrates, equivalent to 4.0 million pounds of recoverable cobalt as compared with 4.1 million pounds (3.3 million pounds recoverable) in 1957. The 1958 production was equivalent to 53 percent of the cobalt consumed in the United States compared with 36 percent in 1957.

The Calera Mining Co. produced 3,061,000 pounds of cobalt in concentrates, 14 percent more than in 1957, and remained the chief producer of cobalt in the United States. It mined and concentrated a copper-cobalt ore at Cobalt, Idaho. The cobalt concentrates were sent to its plant in Garfield, Utah, for reduction to metal.

The Bethlehem Cornwall Corp. produced 6 percent more cobalt in concentrates from its magnetite iron ore at Cornwall, Pa. The cobalt concentrates were shipped to the Pyrites Co., Wilmington, Del., for processing into metal, oxide, and salts.

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

The St. Louis Smelting and Refining Division of National Lead Co. produced 30 percent more cobalt metal than in 1957 from its mining and refining facilities near Fredericktown, Mo.

The Bunker Hill Zinc Plant at Kellogg, Idaho, produced 77 tons of residues, containing 6,579 pounds of cobalt in 1958.

TABLE 2.—Cobalt ore or concentrate produced and shipped in the United States, 1949–53 (average) and 1954–58

	1949–53 (average)	1954	1955	1956	1957	1958
Produced:						
Gross weight_____short tons__	24,085	19,036	28,398	35,985	[1] 38,417	47,345
Cobalt content____thousand pounds__	971	1,996	2,609	3,595	[1] 4,144	4,844
Recoverable cobalt_____do____	662	1,439	[1] 1,857	[1] 2,544	[1] 3,303	4,023
Shipped from mines:						
Gross weight_____short tons__	24,796	19,738	25,101	36,956	39,744	46,294
Cobalt content____thousand pounds__	940	2,219	2,439	3,657	4,123	4,832
Recoverable cobalt_____do____	654	[1] 1,617	[1] 1,735	[1] 2,655	3,281	4,017

[1] Revised figure.

Refinery Production.—Domestic production of cobalt metal declined 17 percent from 1957, principally because the African Metals Corp. plant for refining white alloy at Niagara Falls, N.Y., closed late in 1957. The metal was derived from domestic ores and concentrates; no white alloy, ore, or concentrates were imported during 1958.

Production of cobalt oxide declined 52 percent from 1957, again owing to closing the Niagara Falls facilities. Output of hydrate decreased 33 percent, but production of salts increased 23 percent, and output of driers increased 5 percent.

TABLE 3.—Cobalt materials consumed by refiners or processors in the United States, 1949–53 (average) and 1954–58, in thousand pounds of contained cobalt

Form [1]	1949–53 (average)	1954	1955	1956	1957	1958
Alloy and concentrate	3,010	3,951	4,880	6,399	5,793	4,645
Metal	735	592	884	884	877	999
Hydrate	89	57	79	91	82	57
Carbonate	5	----	----	1	----	----
Purchased scrap	57	173	114	96	93	250
Other		57	63	61	93	56

[1] Total consumption is not shown because the metal, hydrate, and carbonate originated from alloy and concentrate.

TABLE 4.—Cobalt products produced and shipped by refiners and processors in the United States, 1957–58, in thousand pounds

Product	1957				1958			
	Production		Shipments		Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Cobalt content
Metal	4,515	4,377	4,410	4,281	3,702	3,638	4,272	4,196
Oxide	595	425	544	388	292	202	420	296
Hydrate	323	172	310	170	227	116	256	132
Salts:								
Acetate	64	15	75	17	112	26	99	23
Carbonate	214	101	240	114	297	138	295	137
Sulfate	446	100	496	110	479	107	447	101
Other	253	54	259	57	262	62	251	59
Driers	10,582	617	10,768	624	11,252	649	11,263	650
Total	16,992	5,861	17,102	5,761	16,623	4,938	17,303	5,594

CONSUMPTION AND USES

Industry in the United States consumed 18 percent less cobalt than in 1957. Permanent magnet alloys, the leading single use, required 20 percent less cobalt than in 1957. High-temperature, high-strength alloys, ranking second in use, also took 20 percent less. Total metallic uses declined 22 percent.

Consumption of cobalt in nonmetallic uses, exclusive of salts and driers, and consumption of oxide were unchanged from the 1957 rates.

Consumption of cobalt metal and purchased scrap decreased 23 and 2 percent, respectively. Cobalt salts and driers were used at a rate about 2 percent higher than in 1957.

TABLE 5.—Cobalt consumed in the United States, 1949–53 (average) and 1954–58, by uses, in thousand pounds of contained cobalt

Use	1949–53 (average)	1954	1955	1956	1957	1958
Metallic:						
High-speed steel	255	169	209	259	237	88
Other steel	155	112	151	123	109	100
Permanent magnet alloys	2,016	2,124	2,818	2,787	2,927	2,340
Cutting and wear-resisting materials	4,019	183	194	270	264	161
High-temperature high-strength alloys		2,571	3,221	3,019	2,755	2,193
Alloy hard-facing rods and materials	403	432	536	625	501	361
Cemented carbides	305	167	307	253	249	148
Other	227	114	291	365	237	252
Total	7,380	5,872	7,727	7,701	7,279	5,643
Nonmetallic (exclusive of salts and driers):						
Ground-coat frit	448	404	568	525	474	457
Pigments	138	146	236	232	205	251
Other	63	75	115	115	188	161
Total	649	625	919	872	867	869
Salts and driers: Lacquers, varnishes, paints, inks, pigments, enamels, glazes, feed, electroplating, etc. (estimate)	868	853	1,094	989	1,011	1,030
Grand total	8,897	7,350	9,740	9,562	9,157	7,542

TABLE 6.—Cobalt consumed in the United States, 1949–53 (average) and 1954–58, by forms in which used, in thousand pounds of contained cobalt

Form	1949–53 (average)	1954	1955	1956	1957	1958
Metal	6,598	5,120	7,226	7,321	7,028	5,403
Oxide	639	588	906	857	755	754
Purchased scrap	789	789	514	395	363	355
Salts and driers	868	853	1,094	989	1,011	1,030
Total	[1] 8,897	7,350	9,740	9,562	9,157	7,542

[1] Includes a small quantity of ore and alloy.

PRICES

The price of cobalt remained unchanged during 1958; the metal sold at $2 per pound, and black cobalt oxide at $2.15 per pound of contained cobalt.

FOREIGN TRADE [3]

Imports.—The United States imported 16.0 million pounds (cobalt content) of cobalt in 1958, decreasing 8 percent from 1957. Of the total, the Belgian Congo, the chief source, supplied 65 percent and Belgium, 16 percent. All of the metal and oxide imported from Belgium, however, came from white alloy produced in the Belgian Congo. The next two leading sources were the Federation of Rhodesia and Nyasaland, and Canada, supplying 5 percent and 7 percent, respectively.

Exports.—A total of 1,784,867 pounds of cobalt-bearing materials were exported from the United States in 1958. Semifabricated forms furnished 27,267 pounds; the remainder was in the form of ore, concentrate, metal and alloys in crude form, and scrap (5 percent or more cobalt); scrap was the major item. Shipments to West Germany amounted to 68 percent of the total.

Tariff.—The duty on cobalt sulfate has been 2½ cents per pound and on cobalt linoleate 5 cents per pound since June 7, 1951. On September 10, 1955, the duty on salts and compounds not specifically provided for was lowered to 15 percent ad valorem. On June 30, 1958, the duty on cobalt oxide was reduced to 4 cents per pound. Cobalt metal entered duty free.

[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.

TABLE 7.—Cobalt imported for consumption in the United States, 1949–53 (average) and 1954–58, by classes, in thousand pounds

[Bureau of the Census]

Year	White alloy [1]		Ore and concentrate [2]		Metal	
	Gross weight	Cobalt content	Gross weight	Cobalt content	Gross weight	Value (thousand)
1949–53 (average)	4,623	2,122	294	28	[3] 9,372	[3] $19,407
1954	5,465	2,360	27	3	14,228	35,391
1955	5,646	2,464	2	(4)	15,535	38,585
1956	4,708	2,013	77	6	12,974	32,910
1957	1,883	817	140	15	[5, 6] 16,173	[5, 6] 32,431
1958	--------	--------	--------	--------	[3] 15,719	[3] 30,995
	Oxide		**Salts and compounds**		**Total**	
	Gross weight	Value (thousand)	Gross weight	Value (thousand)	Gross weight	Cobalt content (estimated)
1949–53 (average)	[3] 540	[3] $720	59	$39	14,888	11,832
1954	430	723	353	211	20,503	16,865
1955	1,073	1,792	362	249	22,618	18,732
1956	828	1,413	398	247	18,985	15,577
1957	647	853	364	179	[5] 19,207	[5] 17,379
1958	837	1,116	234	145	16,790	15,954

[1] Reported by importer to Bureau of Mines, which adjusted the figures for "Ore and concentrate" for 1949–53 as reported by the Bureau of the Census to exclude "white alloy" from Belgian Congo.
[2] Figures exclude receipts of "white alloy" from Belgian Congo.
[3] Adjusted by Bureau of Mines.
[4] Less than 1,000.
[5] Revised figure.
[6] Includes 4,903 pounds of scrap, valued at $1,698.

TABLE 8.—Cobalt metal, oxide, ore, and white alloy imported into the United States, 1957–58, by countries, in thousands of pounds

[Bureau of the Census]

Country	White alloy, ore and concentrate				Metal		Oxide (gross weight)	
	1957		1958					
	Gross weight	Cobalt content	Gross weight	Cobalt content	1957	1958	1957	1958
North America: Canada	140	15	--------	--------	2,231	1,065	--------	64
Europe:								
Belgium	--------	--------	--------	--------	[1] 1,436	[2] 2,054	647	773
Denmark	--------	--------	--------	--------	5	--------	--------	--------
France	--------	--------	--------	--------	41	25	--------	--------
Germany, West	--------	--------	--------	--------	[1] 856	713	(3)	--------
Norway	--------	--------	--------	--------	762	737	--------	--------
United Kingdom	--------	--------	--------	--------	1,732	13	--------	--------
Total	--------	--------	--------	--------	[1] 4,832	3,542	647	773
Africa:								
Belgian Congo	1,883	817	--------	--------	8,580	[2] 10,295	--------	--------
Rhodesia and Nyasaland, Federation of	--------	--------	--------	--------	530	817	--------	--------
Total	1,883	817	--------	--------	9,110	11,112	--------	--------
Grand total	2,023	832	--------	--------	[1] 16,173	15,719	647	837

[1] Revised figure.
[2] Adjusted by the Bureau of Mines.
[3] Less than 1,000 pounds.

WORLD REVIEW

World production of cobalt declined only slightly in 1958 despite large decreases in output by the Belgian Congo and Canada, usually the two leading producers. These decreases were partly offset by greater production in the United States and the Federation of Rhodesia and Nyasaland. Canada, ranking second in 1957, dropped to fourth place in 1958.

NORTH AMERICA

Canada.—Canadian cobalt was derived chiefly as a byproduct of nickel from the nickel-copper ores of the Sudbury district, Ontario. Other sources were the nickel-copper ores in the Lynn Lake, Manitoba, area and the silver-cobalt ores of the Cobalt-Gowganda area of northern Ontario. A decline of 36 percent in output was caused mainly by decreased production by The International Nickel Company of Canada, Ltd. (Inco).

TABLE 9.—World mine production of cobalt, by countries,[1] 1949–53 (average) and 1954–58, in short tons of contained cobalt [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada [3]	519	1,126	1,659	1,758	1,961	1,261
Mexico (content of ore)	2	(4)				
United States (recoverable cobalt)	327	719	926	1,269	1,651	2,012
Total	848	1,845	2,585	3,027	3,612	3,273
Africa:						
Belgian Congo (recoverable cobalt)	6,697	9,490	9,443	10,019	8,945	7,166
Morocco: Southern zone (content of concentrate)	641	811	834	710	500	1,021
Rhodesia and Nyasaland, Federation of: Northern Rhodesia (content of white alloy, cathode metal, and other products)	718	1,199	741	1,205	1,583	1,774
Total	8,056	11,500	11,018	11,934	11,028	9,961
Oceania:						
Australia (recoverable cobalt)	11	12	12	12	13	13
New Caledonia (content of ore)						143
Total	11	12	12	12	13	156
World total (estimate) [1 2]	9,500	14,400	14,700	15,900	15,900	14,600

[1] Cobalt is also recovered from pyrites produced in Finland and other European countries, and estimates by the author of the chapter are included in the world total.
[2] This table incorporates a number of revisions of data published in previous Cobalt chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included.
[3] 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; Port Saskatchewan, Alberta, and Kristiansand, Norway. The figures exclude the cobalt recovered at Clydach, Wales, from Canadian nickel-copper ores, but an estimate by author of chapter has been included in the world total.
[4] Less than 0.5 ton.

Inco produced electrolytic cobalt from its refinery in Port Colborne, Ontario. It also shipped an impure cobalt oxide to its refinery in Clydach, Wales, for conversion to high-grade oxide, metal, and salts. Output was well below that in 1957 due to reduced production and labor difficulties. Lessened demand for nickel in 1957 and the consequent accumulation of stocks caused Inco to cut nickel production 10 percent in March, a further 10 percent in May and finally, in July, to reduce production to an annual rate equivalent to 65 percent of capacity. Cobalt output declined proportionately. On September 24, members of the International Union of Mine, Mill & Smelter Workers went on strike and did not return until December 22, halting the entire company operation in Ontario. Despite this major loss in production, total deliveries to customers declined only 10 percent, amounting to 2,170,000 pounds in 1958 compared with 2,400,000 pounds in 1957.[4]

Falconbridge Nickel Mines, Ltd., produced slightly more cobalt in 1958 than in 1957. Deliveries in 1958 amounted to 756,000 pounds, a 3-percent decrease from the 1957 figure of 777,000 pounds.[5] The cobalt was recovered from matte made from Sudbury nickel-copper ore. In the Sudbury area, Falconbridge mined some of its ore, purchased some from another mine, and received some from Inco, which mined the Falconbridge properties in the Fecunis area and delivered the ore underground to Falconbridge for hoisting.

Sherritt Gordon Mines, Ltd., produced 274,365 pounds of cobalt in 1958, an increase of 59 percent over the 1957 output of 172,053 pounds, from its nickel-copper ores mined at Lynn Lake, Manitoba.

Deloro Smelting & Refining Co., Ltd., smelted silver-cobalt ores from the Cobalt-Gowganda area on a toll basis for other companies.

Cuba.—The construction of the Freeport Sulphur Co. mining and concentrating facilities at Moa Bay, Cuba, and refining facilities at Port Nickel, La., continued according to schedule. Estimates were that the refinery would start producing cobalt in the third quarter of 1959 and gradually come up to the design capacity of 4.4 million pounds per year.

EUROPE

Finland.—Cupriferous pyrite from the Outokumpu mine in eastern Finland containing about 0.2 cobalt was concentrated, roasted, and the sinter shipped to Duisburg, West Germany, for recovery of copper, iron, zinc, and cobalt.

Germany, West.—The Duisburger Kupferhütte refinery at Duisburg, the major West German cobalt producer, recovered cobalt chiefly from pyrite sinter 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, the only cobalt producer in the Belgian Congo, continued to be the chief world source of cobalt. Output decreased 20 percent in 1958, to 7,166 tons, compared with 8,945 tons in 1957. The Union Minière recovered cobalt from the copper-cobalt ores of mines in the western zone of its mining concession in the Belgian Congo and sent these ores to the Kolwezi concentration plant, where oxide and sulfide concentrates were produced. The concentrates were sent to the Jadotville-Shituru group

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[4] The International Nickel Company of Canada, Ltd., 1958 Annual Report, p. 9.
[5] Falconbridge Nickel Mines, Ltd., 1958 Annual Report, p. 5.

of plants where electrolytic copper and cobalt were produced. Metal from the cobalt electrolysis plant (approximate capacity 7,300 tons a year) was further refined in electric furnaces and granulated by pouring into water. The granules produced by this method contain more than 99.5 percent cobalt. Some high-grade cobalt ore, certain sintered cobalt concentrates, dolomitic concentrates not suitable for leaching, and slag from the electric refining furnaces were sent to the Panda electric smelting plant (capacity, 4,400 tons a year) where the cobalt was recovered in the form of white alloy which contains about 42 percent cobalt. The white alloy was shipped to the cobalt plant in Olen, Belgium (capacity, 3,300 tons a year), for further refining.

Construction of the Luilu plant for the production of electrolytic copper and cobalt continued. This new plant, a few miles from Kolwezi, was scheduled to begin operating in 1960 with an initial production capacity of 1,900 tons of cobalt a year.

Morocco.—Production of cobalt concentrates in Morocco was 10,206 tons in 1958. Cobalt content of the concentrates was 1,021 tons, compared with 500 tons in 1957.

Rhodesia and Nyasaland, Federation of.—Rhokana Corporation, Ltd., produced cobalt from the copper-cobalt ores of the Nkana mine in Northern Rhodesia. Total production was 1,269 tons of cobalt for the fiscal year ending June 30, 1958, compared with 1,330 tons for the previous fiscal year. The average grade of ore milled was 0.188 percent cobalt in 1958 compared with 0.191 percent in 1957.

Chibuluma Mines, Ltd., produced cobalt from a relatively new mine about 7 miles west of Kitwe, Northern Rhodesia. Mining of copper-cobalt ore was begun in late 1955, a mill was completed in May 1956, and a smelting plant was built in Ndola in 1957. The smelting plant was equipped to handle 100 to 150 tons per day of Chibuluma mine concentrates (approximately 4 percent copper and 4 percent cobalt) and produce about 1,000 tons a month of matte, containing 10 to 12 percent each of cobalt and copper. In 1958, all matte was shipped to Belgium for refining, but construction of a refinery to produce cobalt metal on the site was under consideration. The figures for Rhodesia in the world production table have been revised and changed from a fiscal year to a calendar year basis; output from Chibuluma is now included in the 1957 column.

TECHNOLOGY

Cobalt research by the Bureau of Mines in 1958 included basic studies on the physical and mechanical properties of high-purity cobalt, studies devoted to developing new analytical techniques for determining trace impurities in cobalt, development of optimum conditions for the electrolytic separation of cobalt and nickel from electrolytes of various types, and investigations on recovering cobalt from laterite deposits in Missouri, Puerto Rico, the Philippines, and Cuba.

Sherritt Gordon Mines, Ltd., completed installation of a new cobalt leaching circuit at its refinery at Fort Saskatchewan, Alberta, Canada.

Calera Mining Co. produced both electrolytic and hydrogen-reduced cobalt at its refinery at Garfield, Utah. A complete changeover to electrolytic production was planned for early 1959. The electrolytic cobalt produced in 1958 contained about 1.2 percent nickel.

The Centre d'Information du Cobalt, the executive organization of the Cobalt Development Institute, was active in efforts to find new applications for cobalt and increase its known uses. Its research program, conducted in both European and American laboratories, included basic studies on creep behavior, catalysis, magnetic properties, and development of phase diagrams, as well as applied studies on cermets, heat-resisting alloys, electroplating, and many others. The organization disseminates information in the United States through a branch office at Battelle Memorial Institute, Columbus, Ohio. The December 1958, first issue of a quarterly publication entitled "Cobalt" contained technical and nontechnical articles about cobalt and a comprehensive list of abstracts of technical articles on cobalt, its alloys and compounds.

Two new cobalt-bearing alloys for high-temperature jet engine use were developed by General Electric Co. One, J–1610 (also known as René 41), is a precipitation-hardening nickel-base alloy containing 19 percent chromium, 11 percent cobalt, 10 percent molybdenum, 3.1 percent titanium, and 1.5 percent aluminum, intended for use in the 1,600 to 1,800° F. temperature range. The other, J–1650, is a cobalt-base alloy, containing 27 percent nickel, 19 percent chromium, 12 percent tungsten, 3.8 percent titanium, 2 percent tantalum, and 0.02 percent boron, intended for use in the 1,600–1,900° F. range. Both alloys are produced by vacuum melting.

A new alloy, Nimonic 105, developed from Nimonic 100, was added to the Nimonic series of nickel-cobalt-chromium-molybdenum high-temperature alloys. It has a much greater resistance to creep at high operating temperatures and increased resistance to the type of high-temperature corrosion found in gas-turbine engines.[6]

Westinghouse Electric Corp. developed a new nickel-base, precipitation-hardening alloy, Nicrotung, for making cast gas-turbine blades. This alloy is usable in the 1,800° F. range and has the following nominal composition: 12 percent chromium, 10 percent cobalt, 8 percent tungsten, 4 percent aluminum, 4 percent titanium, 0.05 percent each of zirconium and boron.[7]

Patents were issued on the separation of nickel and cobalt; [8] pro-

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[6] Metal Industry, Nimonic 105: Vol. 93, No. 10, Sept. 5, 1958, p. 192.

[7] Metal Progress, Two New 1800° F. Alloys for Cast Turbine Blades: Vol. 74, No. 5, November 1958, p. 83.

[8] Benoit, R. L., Lin, W. C., and Mackiw, V. N. (assigned to Sherritt Gordon Mines, Ltd.), Separation of Nickel From Cobalt: U.S. Patent 2,822,262, Feb. 4, 1958.

Benoit, R. L., and Mackiw, V. N. (assigned to Sherritt Gordon Mines, Ltd.), Separating Nickel From Solutions Containing Nickel and Cobalt: U.S. Patent 2,822,264, Feb. 4, 1958.

Reynaud, F., and Terraz, G. (assigned to Société d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine), Process of Separating Nickel and Cobalt: U.S. Patent 2,842,427, July 8, 1958.

Schaufelberger, F. A. (assigned to Chemical Construction Corp.), Process of Separating Cobalt and Nickel Values: U.S. Patent 2,845,333, July 29, 1958.

Conn, J. B., and Humphrey, W. K. (assigned to Merck & Co., Inc.), Separation of Cobalt From Nickel: U.S. Patent 2,848,322, Aug. 19, 1958.

Lonza Electric and Chemical Works, Ltd., Separating Cobalt and Nickel: British Patent 785,350.

duction of cobalt salts and compounds;[9] recovery of cobalt from low-grade ores, leach solutions and spent catalysts;[10] and alloy compositions.[11]

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[9] Buehler, A. (assigned to Ciba, Ltd.), Complex Cobalt Compounds: U.S. Patent 2,824,864, Feb. 25, 1958.
Yoshida, T., Iwanaga, R., and Mori, H. (assigned to Ajinomoto Co., Inc.), Process for Producing Dicobalt Octacarbonyl: U.S. Patent 2,848,304, Aug. 19, 1958.
Buehler, A., and Zickendraht, C. (assigned to Ciba, Ltd.), Cobaltiferous Azo-Dyestuffs: U.S. Patent 2,855,392, Oct. 7, 1958.
Hasek, R. H. (assigned to Eastman Kodak Co.), Production of Crystalline Cobalt Tetracarbonyl: U.S. Patent 2,865,716, Dec. 23, 1958.
Mond Nickel Co., Ltd., Cobaltous Oxide and Salts: British Patent 799,921.

[10] Mancke, E. B., and Temmel, F. M. (assigned to Bethlehem Steel Co.), Recovery of Copper and Cobalt Values From Sulfate Leach Solutions: U.S. Patent 2,864,692, Dec. 16, 1958.
Dinsmore, R. L., and Spencer, W. V. (assigned to Richfield Oil Corp.), Process of Recovering Cobalt, Cerium, and Manganese Catalysts: U.S. Patent 2,865,708, Dec. 23, 1958.

[11] Clark, C. A. (assigned to The International Nickel Co., Inc.), Nickel-Cobalt Alloy Magnetostrictive Element: U.S. Patent 2,836,492, May 27, 1958.
Hansel, G., Jr. (assigned to General Electric Co.), Cobalt Base Hard Surfacing Alloy: U.S. Patent 2,855,295, Oct. 7, 1958.
Smith, D. L., and Caul, H. J. (assigned to the United States of America), Cobalt-Gallium Dental Alloys: U.S. Patent 2,864,695, Dec. 16, 1958.

Columbium and Tantalum

By William R. Barton [1]

DOMESTIC production capacity far exceeded demand for all columbium (niobium) and tantalum products during 1958. Less than anticipated demand for some columbium-tantalum products resulted in a considerable buildup in consumer ore stocks and concomitant decreases in ore prices.

TABLE 1.—Salient statistics of columbium-tantalum concentrate

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Columbium-tantalum concentrate shipped from mines: [1]						
Pounds	4,639	32,829	12,954	216,606	370,483	428,347
Value	$10,393	$57,262	$22,125	(2)	(2)	(2)
Imports for consumption:						
Columbium-mineral concentrate pounds	2,177,037	6,804,076	9,612,576	5,699,553	3,348,706	2,555,942
Tantalum-mineral concentrate pounds	358,422	981,872	1,907,686	1,312,865	828,265	1,035,588
Industrial consumption: [3]						
Contained metal tons	(2)	180	580	810	[4] 924	593
World: Production of columbium-tantalum concentrates pounds	3,480,000	[4] 9,580,000	[4] 11,540,000	[4] 8,950,000	[4] 6,910,000	5,000,000

[1] 1956–58 data are for columbite-tantalite concentrate plus columbium-tantalum oxide content of euxenite concentrate.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes metal content of all raw materials consumed, including columbium-tantalum bearing tin slags.
[4] Revised figure.

LEGISLATION AND GOVERNMENT PROGRAMS

Public Law 85–701, 85th Congress, was enacted August 21, 1958. The act provided a new program to encourage minerals exploration administered by the Office of Minerals Exploration, successor to the Defense Minerals Exploration Administration. Columbium and tantalum minerals remained eligible for Government assistance loans up to 50 percent of the total allowable costs of exploration.

Purchase of domestic columbium-tantalum ores under Public Law 733, 84th Congress, expired on December 31, 1958. A bill introduced to provide incentive bonuses to producers of columbium-tantalum ores was not enacted.

[1] Commodity specialist.

The Department of Agriculture announced a new list of materials eligible for acquisition through barter transactions on November 14, 1958. The aim of the program was to exchange perishable farm products for strategic minerals produced in foreign countries. Columbite and tantalite are among the minerals eligible for acquisition.

At the request of the Department of Defense, a Materials Advisory Board was formed during 1958 to study columbium and tantalum. Several meetings were held, and by the close of the year a report was in preparation.

DOMESTIC PRODUCTION

Concentrate.—Domestic production of columbium-tantalum concentrate increased to a new high in 1958. The leading producer for the third successive year was Porter Bros. Corp., Bear Valley, Idaho.

Twelve operations (13 in 1957) reported shipments of concentrates from pegmatite deposits in South Dakota and Colorado.

Metals, Compounds, and Alloys.—Capacity to produce columbium and tantalum products, ample in December 1957, continued to increase during 1958. This expansion and demand that was less than anticipated, resulted in domestic industry processing at less than 50-percent capacity. Production of columbium metal totaled about 30 tons in 1958, more than triple 1957. The leading producer was Wah Chang Corp., Albany, Oreg., replacing Kennametal, Inc., Latrobe, Pa., leader in 1957. About 100 tons of tantalum metal was produced, a slight increase over 1957. Fansteel Metallurgical Corp., North Chicago, Ill., and Muskogee, Okla., continued as the leading producer of tantalum. Production of ferrocolumbium and ferrotantalum-columbium totaled 430 tons, a decline of 19 percent from 1957.

E. I. du Pont de Nemours & Co., Inc., announced increased production of columbium and made experimental quantities of columbium and columbium-base alloys available to other manufacturers during 1958. The new columbium-tantalum plant of Fansteel Metallurgical Corp. at Muskogee, Okla., was officially dedicated in March. Kawecki Chemical Co., Boyertown, Pa., completed installation of rolling mill facilities for tantalum. National Research Corp., Cambridge, Mass., began commercial production of high-purity tantalum in July. Stauffer Chemical Co., began constructing a new $300,000 plant at Richmond, Calif., to produce tantalum and columbium pentachlorides. Temescal Metallurgical Corp., Richmond, Calif., became the leading converter of columbium to ingot in 1958. Union Carbide Metals Co. shipped its largest quantity of tantalum ingots (749.5 pounds) in October and displayed the largest ingot ever made (330 pounds) from its columbium during the same month. U.S. Industrial Chemicals Co. built a columbium-tantalum plant with a 3-ton-a-month capacity at Cincinnati, Ohio. A new inert-atmosphere fabrication plant for reactive metals, including columbium and tantalum, was under construction at Universal-Cyclops Steel Corp., Bridgeville, Pa. Fansteel Metallurgical Corp. officially assumed all assets and properties of its wholly-owned subsidiary, Tantalum Defense Corp., in December 1958.

CONSUMPTION AND USES

Domestic industrial consumption of columbium-tantalum-bearing mineral concentrates and slags, measured by contained metal, was 393 tons of columbium and 200 tons of tantalum in 1958. Respective totals in 1957 were 612 and 312 tons.

Use of columbium and columbium-bearing alloys for high temperature applications increased. The latest U.S. rocket plane, the X–15, used as its outer surface Inconel-X, containing 1 percent columbium. Skin temperatures may be as high as 1,000° F. A new Babcock & Wilcox Co. alloy, Croloy 15–15N, designed for use in tubing at 1,200° to 1,500° F., contains about 1 percent Cb plus Ta. Two new Mallory-Sharon Metals Corp. titanium-base alloys for missile and aircraft applications were MST 821 containing 3 percent, and MST 881 containing 1 percent Cb plus Ta. E. I. du Pont de Nemours & Co., Inc., developed a new series of high-temperature columbium-base alloys, one of which contained 80 percent columbium, 10 percent titanium, and 10 percent molybdenum. Battelle Memorial Institute developed a 75-percent-Cb and 25-percent-Ti alloy with good oxidation resistance. Chromium diffusion coating of columbium by Chromalloy Corp. resulted in samples that were exposed at 1,800° F. for 320 hours and subjected to 13 heating and cooling cycles without failure. Great Lakes Steel Corp. marketed a new line (GLX–W) of columbium treated, high strength mild carbon steels, especially suited to heavy mobile equipment such as trucks, because of superior strength, toughness, and weldability.

Kemet Co. announced a new line of solid tantalum capacitors featuring high capacity per unit volume, low dissipation, long shelf life, stability, and ruggedness. Fansteel Metallurgical Corp. announced a new tantalum capacitor line (Blue-Cap) designed to bring the advantages of tantalum capacitors to applications where wider capacity tolerances are permissible. P. R. Mallory & Co., Inc., marketed a mircominiature series of tantalum capacitors known as the M2 line. The Atomic Energy Commission revealed that tantalum had been selected as the container material for the Los Alamos Molten Plutonium Reactor Experiment program (LAMPRE). Metals and Controls Corp. marketed expanded-mesh anodes made from platinum-clad tantalum for rhodium electroplating. Tantalum pentoxide was used as a nonradioactive tracer in glass research.

PRICES

On January 1, 1958, ore containing 65 percent combined pentoxides was quoted in E&MJ Metal and Mineral Markets at $1.15–$1.20 per pound of contained pentoxides for material with a Cb:Ta ratio of 10:1 and $1.00–$1.05 for an 8½:1 ratio. On April 3, 10:1 material was reduced to $1.10–$1.15. On May 15 the quotation became $1.05–$1.10 for 10:1 and $0.95–$1.00 for 8½:1 and prices remained there for the rest of 1958. Prices for foreign tantalite were not reported regularly, but declined from as high as $6.25 per pound of contained Ta_2O_5 in 60-percent material in January, to about $4.50 for similar ore at the close of 1958. Prices for domestic ores continued to be governed by

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Public Law 733, 84th Congress. Small lots that contained an undetermined Cb: Ta ratio and at least 50 percent combined pentoxides were purchased for $3.40 per pound of contained pentoxides.

Columbium metal was quoted by one firm throughout the year, per pound, 99½ percent pure, depending on size of lot, as: Roundels $55–$70, electrode segments $60–$75, rough ingots $65–$80. Tantalum was quoted nominally througout the year, per kilogram, $128 for rod and $100 for sheet. Prices for both forms varied widely, depending upon purity, specified dimensions, and size of order. Shieldalloy Corp., Newfield, N.J., continued to market imported 97-percent-pure columbium powder, f.o.b. Newfield, in large lots, at $16 per pound.

On January 1, 1958, ferrocolumbium was quoted at $4.90 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 Si). By the end of 1958 prices had dropped to the range $3.45–$4.00. The price of ferrotantalum-columbium, per pound of contained Cb plus Ta, dropped during the year from $4.25 to the range $3.05–$3.40.

FOREIGN TRADE [2]

Imports.—Imports of columbium and tantalum mineral concentrate are detailed in tables 2 and 3. Other imports reported in 1958 were: 10 pounds of columbium-tantalum-bearing alloys worth $268 from West Germany; 4,224 pounds of columbium metal valued at $29,277 from West Germany, the United Kingdom and Canada; 239 pounds of tantalum metal worth $14,357 from Austria, the United Kingdom, and West Germany.

Exports.—Exports reported in 1958 were: 54,624 pounds of columbium ores or concentrates valued at $37,335 to West Germany and France; 44 pounds of columbium metal or alloy in crude form worth $842 to Finland; 43 pounds of columbium metal and alloys in semifabricated forms worth $3,820 to the United Kingdom and Belgium-Luxembourg; 6,600 pounds of tantalum ores or concentrates valued at $9,350 to the United Kingdom; 7,757 pounds of tantalum metals, alloys, and scrap in crude form worth $163,326 to West Germany and Brazil; 5,773 pounds of tantalum metal powder valued at $212,048 to West Germany, Belgium-Luxembourg, the United Kingdom, France, Brazil, Austria, Japan, and Switzerland; 5,719 pounds of semifabricated tantalum worth $129,328 to 10 countries.

[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 U.S. Department of Commerce, Bureau of the Census.

TABLE 2.—Columbium-mineral concentrates imported for consumption in the United States, by countries, in pounds

[Bureau of the Census]

Country	1949-53 (average)	1954	1955	1956	1957	1958
South America:						
Argentina		11,023	10,800			2,262
Bolivia	5,011	5,714		3,791		
Brazil	13,067	124,460	233,012	160,462	54,500	101,992
British Guiana	625		7,033			
Total	18,703	141,197	250,845	164,253	54,500	104,254
Europe:						
Germany, West		267,957	849,310		1,653	46,628
Norway	8,073	342,886	562,759	521,003	236,147	310,858
Portugal	14,045	148,732	168,362	31,024	72,953	65,461
Spain	882		2,525			
Sweden	3,342					
United Kingdom [1]				11,200	29,621	
Total	26,342	759,575	1,582,956	563,227	340,374	422,947
Asia:						
Aden				1,350		
Japan	6,367					
Korea, Republic of	400					
Malaya, Federation of	24,446	180,225	515,688	521,741	127,524	709,077
Total	31,213	180,225	515,688	523,091	127,524	709,077
Africa:						
Belgian Congo	342,338	976,832	1,247,901	758,919	905,989	507,725
British West Africa			14,521			
French Equatorial Africa			4,700			
Madagascar		11,060	36,412	10,621	3,075	9,920
Mozambique	19,476	31,183	64,974	43,124	81,422	171,164
Nigeria	1,716,846	4,575,648	5,739,526	3,593,114	1,804,631	543,925
Rhodesia and Nyasaland, Federation of	[2] 4,092	11,788	13,529	6,652		
Uganda [3]	4,903	4,446	24,399	18,780		5,771
Union of South Africa	8,100	76,714	55,539	17,772	31,191	81,159
Total	2,095,755	5,687,671	7,201,501	4,448,982	2,826,308	1,319,664
Oceania: Australia	5,024	35,408	61,586			
Grand total: Pounds	2,177,037	6,804,076	9,612,576	5,699,553	3,348,706	2,555,942
Value	$2,387,389	$14,191,142	$19,912,381	$8,386,659	$3,037,706	$2,345,890

[1] Presumably country of transshipment rather than original source.
[2] Southern Rhodesia.
[3] Classified by the Bureau of the Census as British East Africa.

TABLE 3.—Tantalum-mineral concentrates imported for consumption in the United States, by countries, in pounds

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
South America:						
Argentina			6, 614	4, 409		11, 635
Brazil	34, 563	255, 533	221, 834	140, 039	199, 205	159, 015
French Guiana	2, 197	24, 809	23, 085	14, 532	3, 075	
Total	36, 760	280, 342	251, 533	158, 980	202, 280	170, 650
Europe:						
Belgium-Luxenbourg [1]	21, 312				6, 391	10, 681
Germany, West		62, 865	594, 030			135, 431
Netherlands [1]	5, 900					
Norway			11, 729			
Portugal	37, 950	86, 279	6, 614	7, 054	5, 966	32, 513
Spain	148		11, 276			
Sweden	849	19, 251				992
United Kingdom			28, 533			
Total	66, 159	168, 395	652, 182	7, 054	12, 357	179, 617
Asia:						
Japan [1]	2, 138					
Malaya, Federation of; Singapore, Colony of	1, 145	1, 479	5, 853			6, 000
Total	3, 283	1, 479	5, 853			6, 000
Africa:						
Belgian Congo	240, 781	420, 562	539, 214	953, 092	491, 124	370, 120
Madagascar		6, 173	10, 693	20, 165	6, 835	7, 716
Mozambique		10, 893	57, 184	4, 409	24, 046	149, 777
Nigeria	3, 999	50, 018	303, 692	31, 174	16, 815	34, 537
Rhodesia and Nyasaland, Federation of	[2] 1, 679	4, 944	18, 326	22, 166	38, 975	77, 667
Uganda [3]	410	2, 158	8, 507			2, 034
Union of South Africa	631	4, 480	14, 428	6, 511	6, 910	27, 368
Total	247. 500	499, 228	952, 044	1, 037. 517	584, 705	669, 219
Oceania: Australia	4, 720	32, 428	46, 074	109, 314	28, 923	10, 102
Grand total: Pounds	358, 422	981, 872	1, 907, 686	1, 312, 865	828, 265	1, 035, 588
Value	$460, 053	$1, 972, 320	$4, 820, 453	$1, 180, 118	$948, 638	$1, 838, 338

[1] Presumably country of transshipment rather than original source.
[2] Southern Rhodesia.
[3] Classified by the Bureau of the Census as British East Africa.

TABLE 4.—Average grade of concentrates received by United States consumers and dealers in 1958, by country of origin, in percent of contained pentoxides

Country of origin	Columbite		Tantalite	
	Cb_2O_5	Ta_2O_5	Ta_2O_5	Cb_2O_5
Argentina			34	27
Brazil	46	26	49	23
Germany, West	41	26	34	32
Norway [1]	53	1		
Portugal	48	24	33	33
Malaya, Federation of	59	17		
Belgian Congo	46	25	29	40
Madagascar			52	17
Mozambique			61	17
Nigeria	65	8	48	28
Rhodesia and Nyasaland, Federation of			62	5
Uganda			35	40
Union of South Africa			35	23
Australia			54	17

[1] Pyrochlore concentrate.

WORLD REVIEW

The United States produced or imported 80 percent of the free world supply of columbium-tantalum concentrates in 1958 compared with 66 percent in 1957. Foreign sources contributed 89 percent of the U.S. supply in 1958, compared with 92 percent in 1957. A tabulation of world occurrence of columbium-tantalum ores was published.[3]

NORTH AMERICA

Canada.—A comprehensive summary of Canadian columbium deposits was issued.[4] Thompson-Lundmark Gold Mines, Ltd., conducted surveys near Thompson Lake, Northwest Territories, to ascertain tantalum possibilities. Columbium Mining Products, Ltd., reported satisfactory results on laboratory scale flotation of columbium ore from its property near Oka, Quebec. Beaucage Mines, Ltd., reported good progress on metallurgical testing of pyrochlore ore from North Bay, Ontario. Ferrocolumbium and ferrotantalum-columbium were produced by Atlas Steel, Ltd., and Fahr Alloy Canada, Ltd.

SOUTH AMERICA

Brazil.—A report published in 1957 on the Araxa pyrochlore deposit became available in the United States during 1958.[5] Two samples of tantalite from Amapá territory assayed, 75.0 percent Ta_2O_5, 2.9 percent Cb_2O_5 and 42.0 percent Ta_2O_5, 17.0 percent Cb_2O_5, respectively.

French Guiana.—The consortium Minier Guyanais resumed mining of tantalite at Sursant on the Sinnamarie River.

EUROPE

Austria.—Metallwerk Plansee, Reutte, produced columbium and tantalum metals and carbides, and Treibacher Chemische Werke produced columbium and ferrocolumbium.

Belgium.—Société Générale Metallurgique de Hoboken produced columbium oxide. Tantalum carbide was produced by Société Anonyme Sadaci.

Finland.—Columbium and tantalum carbides were produced by Kovametalli Oy, Helsinki.

France.—Columbium metal and oxide were prepared by Fabriques de Produits Chimiques de Thann et Mulhouse, S.A. Tantalum was fabricated by Compagnie Péchiney. Ferrocolumbium was produced by Société D'Electrometallurgie D'Ugine. Société Kuhlmann produced columbium pentoxide.

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[3] Williamson, R., and Burgin, L., Columbium (Niobium) and Tantalum, Part II: Colorado School of Mines Min. Ind. Bull., vol. 1, No. 6, November 1958, 16 pp.

[4] Rowe, R. B., Niobium (Columbium) Deposits of Canada; Canadian Dept. of Mines and Tech. Surv., Econ. Geology Ser. No. 18, 1958, 108 pp.

[5] Guimaraes, D., Relatorio Sobre A Jazida De Pyrochloro De Barréiro Araxa, Minas Gerais [Report Concerning a Pyrochlore Deposit at Araxa Loampit, Minas Girais]: Div. Fom. Prod. Min., Bull. 103, 1957, 87 pp.

TABLE 5.—World production of columbium and tantalum mineral concentrates by countries,[1] in pounds[2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

<table>
<tr><th rowspan="2">Country</th><th colspan="2">1949–53 (average)</th><th colspan="2">1954</th><th colspan="2">1955</th><th colspan="2">1956</th><th colspan="2">1957</th><th colspan="2">1958</th></tr>
<tr><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th><th>Columbium</th><th>Tantalum</th></tr>
<tr><td>Argentina</td><td colspan="2">592</td><td colspan="2">379</td><td colspan="2">728</td><td colspan="2">3,968</td><td colspan="2">688</td><td>[3] 2,262</td><td>[3] 11,635</td></tr>
<tr><td>Australia</td><td colspan="2">11,879</td><td colspan="2">117,767</td><td colspan="2">27,139</td><td colspan="2">159,655</td><td colspan="2">50,038</td><td colspan="2">[4] 18,000</td></tr>
<tr><td>Belgian Congo (including Ruanda-Urundi)[5]</td><td colspan="2">323,547</td><td colspan="2">967,819</td><td colspan="2">967,819</td><td colspan="2">932,546</td><td colspan="2">524,695</td><td colspan="2">[4] 590,000</td></tr>
<tr><td>Bolivia (exports)</td><td>882</td><td>---</td><td>---</td><td>---</td><td>2,350</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>Brazil (exports)</td><td>28,258</td><td>42,595</td><td>266,757</td><td>107,520</td><td>238,317</td><td>127,205</td><td>177,916</td><td>208,161</td><td>68,206</td><td>204,675</td><td colspan="2">302,030</td></tr>
<tr><td>British Guiana</td><td>[6] 6,600</td><td>---</td><td>4,480</td><td>---</td><td>6,720</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>Canada</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><td>---</td><td>---</td></tr>
<tr><td>French Equatorial Africa</td><td colspan="2">4,736</td><td colspan="2">6,261</td><td colspan="2">2,672</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>French Guiana</td><td colspan="2">[7] 13,228</td><td colspan="2">30,880</td><td colspan="2">20,452</td><td>---</td><td>14,916</td><td>---</td><td>2,976</td><td>---</td><td>---</td></tr>
<tr><td>Germany, West (U.S. imports)</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><td>46,628</td><td>135,431</td></tr>
<tr><td>Madagascar</td><td>[8] 7,569</td><td>---</td><td colspan="2">36,596</td><td colspan="2">38,801</td><td colspan="2">19,400</td><td colspan="2">19,180</td><td>[3] 9,920</td><td>[3] 7,615</td></tr>
<tr><td>Malaya, Federation of</td><td>[9] 59,136</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><td>356,160</td><td>---</td></tr>
<tr><td>Mozambique</td><td colspan="2">[10] 22,058</td><td colspan="2">94,031</td><td colspan="2">82,884</td><td>56,580</td><td>---</td><td colspan="2">288,582</td><td colspan="2">375,997</td></tr>
<tr><td>Nigeria</td><td>2,725,632</td><td>3,136</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><td>1,803,200</td><td>49,930</td></tr>
<tr><td>Norway</td><td>[7] 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><td>609,792</td><td>---</td></tr>
<tr><td>Portugal (U.S. imports)</td><td>[9] 17,556</td><td>[6] 94,876</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>5,966</td><td>65,461</td><td>32,513</td></tr>
<tr><td>Rhodesia and Nyasaland, Federation of</td><td>[6] 3,110</td><td>9,992</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><td>---</td><td>96,260</td></tr>
<tr><td>Sierra Leone</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><td>---</td><td>---</td></tr>
<tr><td>South West Africa</td><td colspan="2">8,788</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><td>4,152</td><td>6,574</td></tr>
<tr><td>Spain (U.S. imports)</td><td>[7] 4,410</td><td>[6] 371</td><td>---</td><td>---</td><td>2,525</td><td>11,276</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>Swaziland (Yttrotantalite)</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>32,920</td><td>---</td><td>---</td></tr>
<tr><td>Sweden (U.S. imports)</td><td>[7] 16,713</td><td>[7] 4,242</td><td>---</td><td>19,251</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>992</td></tr>
<tr><td>Uganda[11]</td><td colspan="2">18,598</td><td colspan="2">23,117</td><td colspan="2">34,003</td><td>10,080</td><td>---</td><td colspan="2">4,032</td><td colspan="2">5,824</td></tr>
<tr><td>Union of South Africa</td><td>---</td><td>11,200</td><td>---</td><td>46,000</td><td>---</td><td>24,000</td><td>---</td><td>2,900</td><td>---</td><td>1,981</td><td colspan="2">37,920</td></tr>
<tr><td>United States (mine shipments)</td><td colspan="2">4,639</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><td colspan="2">428,347</td></tr>
<tr><td>World total (estimate)[2]</td><td colspan="2">3,480,000</td><td colspan="2">9,580,000</td><td colspan="2">11,540,000</td><td colspan="2">8,950,000</td><td colspan="2">6,910,000</td><td colspan="2">5,000,000</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 is strongly predominant. In such instances the production figure has been centered.

[2] This table incorporates a number of revisions of data published in previous Columbium-Tantalum chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.

[3] U.S. imports.

[4] Estimate.

[5] In addition, tin-columbium-tantalum concentrates were produced as follows: 1949–53 (average)—2,672,413 pounds; 1953—3,575,861 pounds; 1954—5,970,057 pounds; 1955—5,456,385 pounds; 1956—6,501,365 pounds; 1957—4,360,699 pounds; 1958—not yet available; columbium-tantalum content averaging about 10 percent.

[6] Average for 1952–53.

[7] Average for 1 year only, as 1953 was first year of commercial production.

[8] Average for 1951–53.

[9] Average for 1950–53.

[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; no further production recorded.

Germany, West.—H. C. Starck, A.G., Goslar, made columbium and tantalum metals, oxides, and carbides. Heraeus Quarzschmelze, G.m.b.H., Hanau, fabricated columbium and tantalum. Geselschaft Fur Elektrometallurgie produced ferrocolumbium and tantalum metal.

Italy.—S.P.A. Leghe e Metalli produced ferrocolumbium.

Norway.—Norsk Bergverk A/S produced both pyrochlore concentrate and ferrocolumbium. Electric Furnace Products Company, Ltd., produced ferrocolumbium.

Spain.—Two reports were published on Spanish columbite-tantalite deposits.[6]

Sweden.—A. B. Ferrolegeringar produced ferrocolumbium.

Switzerland.—Tantalum oxide was produced by Société Des Produits Pharmaceutiques Ciba.

U.S.S.R.—Interest in columbium and tantalum was reflected by many articles in the Soviet literature. A statement was made in a January news broadcast that "the progress of modern aviation is unthinkable without tantalum and columbium." The major Soviet source of columbium ore was believed to be the Kola Peninsula.

United Kingdom.—Murex, Ltd, produced columbium, tantalum, and ferrocolumbium. Ferrocolumbium was also produced by Blackwell's Metallurgical Works, Ltd., Minworth Metals, Ltd., and London & Scandinavian Metallurgical Co., Ltd. Columbium boride was marketed by Borax Consolidated, Ltd. Columbium metal was fabricated by Imperial Chemical Industries, Ltd., and Accles & Pollock, Ltd. High temperature alloys containing columbium were made by Mond Nickel, Ltd., and Hatfields, Ltd.

ASIA

Burma.—A sample of black sand concentrate from the Tavoy area assayed 8.9 percent Cb_2O_5 and 6.0 percent Ta_2O_5 contained in fergusonite and samarskite.

Japan.—Ferrocolumbium was manufactured in electric furnaces by Showa Denko (Showa Electro-Industrial Co.) for use in special steels. Raw material consumed was columbite from Malaya.

Malaya.—A comprehensive report on columbium-tantalum minerals of Malaya became available.[7]

AFRICA

Nigeria.—Decreased demand for columbite caused several companies to reduce columbite mining. The leading Nigerian columbite producer—Amalgamated Tin Mines of Nigeria, Ltd.—reported a modest decrease in production during their most recent fiscal year. The firm's output (in long tons) for the fiscal years ending March 31, 1957, and March 31, 1958, was obtained by the following methods:

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[6] Instituto Geologico Minero de España, Memoria General—1957: 1958, pp. 69–74.
Lopez de Azcona, J. M., and Siguenza, A. C., Investigaciones de Niobio y Tantalo en la Zona de Noya (Coruna) [Investigations of Niobium and Tantalum in the Noya Zone (Coruna)]: Instit. Geol. Miner. Espana, Notas y Comun. No. 50, 1958, pp. 283–315.

[7] Hockin, H. W., Tantalum/Niobium Minerals in Malaya: Malaya Dept. of Mines Bull. 2, 1957, 16 pp.

	1956–57	1957–58
Gravel pumps	203	182
Draglines with washing plants	124	132
Dredge	33	16
Jig plants	5	53
Elevators, hand paddocks, tribute, and contract	52	58
Mill tailings	138	64
	555	505

Rhodesia and Nyasaland, Federation of.—Pyrochlore deposits at Lomba Hill were reported to be promising. Prospecting rights have been granted to Consolidated Goldfields, Ltd.

Tanganyika.—At the Mbeya pyrochlore deposit the 150-ton-per-day pilot concentration plant was placed in operation. Exploration of the deposit continued.

Uganda.—The government approved a program of capital expenditure of £7 million by Sukulu Mines, Ltd., a joint industry-government development venture, of the total £4 million will be spent developing its pyrochlore deposit and £3 million for related railway development.

OCEANIA

Australia.—Australian production of tantalite-columbite was expected to increase in the future because U.S. firms have renewed interest in supplies from Western Australia.

New Zealand.—Tapiolite was reported from southern Westland.[8]

WORLD RESERVES

The total known free world resources of columbium ore were estimated at about 13 million tons of contained Cb_2O_5 at the close of 1958 and were distributed: North America, 1.25 million tons; South America, 10 million tons; Europe, 100,000 tons; Africa, 1 million tons; Asia, 10,000 tons; and Oceania, 1,000 tons. The U.S. resources totaled 250,000 tons. Tantalum free world resources were not well established and were about 100,000 tons at the close of 1958.

TECHNOLOGY

The papers presented during a columbium symposium of the Electrochemical Society held in Washington, D.C., May 15–16, 1957, were published.[9]

Columbium-tantalum technology was discussed at several important meetings in 1958: The spring meeting of the Electrochemical Society, the third reactive metals conference of AIME, the fall meeting of the Metallurgical Society of AIME, and the Second International Conference on the Peacetime Uses of Atomic Energy in Geneva, Switzerland.

Two review articles on columbium-tantalum technology were published.[10] Processing techniques used by Union Carbide Metals Co.[11]

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[8] Hutton, C. O., Notes on Tapiolite, With Special Reference to Tapiolite From Southern Westland, New Zealand: Am. Mineral., vol. 43, No. 1 & 2, January–February, 1958, pp. 112–119.

[9] Gonser, B. W., and Sherwood, E. M., Technology of Columbium (Niobium): John Wiley & Sons, Inc., New York, N.Y., 1958, 120 pp.

[10] Sims, C. T., A Columbium Primer: Jour. Metals, vol. 10, No. 5, May 1958, pp. 340–345. Taylor, D. F., The Extraction of Tantalum and Columbium: Chem. Eng. Prog., vol. 54, No. 4, April 1958, pp. 47–50.

[11] Chilton, C. H., Process Flowsheet—Columbium and Tantalum: Chem. Eng., vol. 65, No. 22, Nov. 3, 1958, pp. 104–107.

and National Research Corp.[12] were described. A general review of geology, metallurgy, and uses was published.[13]

The Porter Bros. Corp. euxenite-columbite-monazite placer mine at Bear Valley, Idaho, and its beneficiation plant at Lowman, Idaho, were described in technical articles.[14]

A sulfuric acid-hydrofluoric acid-hexone solvent extraction system and a colorimetric method for determining columbium in microgram quantities were described.[15] Small quantities of tantalum in columbium were separated by solvent extraction and then, determined photometrically by the pyrogallol method.[16]

Federal Bureau of Mines research on chlorinating euxenite concentrate in the presence of carbon and an alkali chloride additive was described.[17] Personnel at the Ames, Iowa, Laboratory of the Atomic Energy Commission described a liquid extraction system for separating columbium and tantalum.[18]

A technical paper described electron-beam melting and its effect on the composition of columbium and certain alloys.[19]

Tantalum was successfully bonded to copper at Stanford Research Institute. Molten copper was cast directly into an annealed tantalum cone under controlled vacuum-inert gas atmospheres. Brazing alloys also were developed.[20] Methods of applying protective ceramic coatings to tantalum were studied at Armour Research Foundation. The "flame ceramic" process proved most practical.[21] Studies of importance to the Los Alamos Molten Plutonium Reactor Experiment included investigating corrosion and creep behavior of tantalum in flowing sodium.[22] The properties of tantalum and its alloys were discussed by research workers at Battelle Memorial Institute.[23]

The heats of formation of CbO_2, Cb_2N, and Ta_2N were determined by bomb calorimetry by the Federal Bureau of Mines.[24] Heat capacity

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[12] Chemical Week, Low-Pressure Way to High-Purity Tantalum: vol. 83, No. 3, July 19, 1958, pp. 97–102.

[13] Williamson, D. R., and Burgin, Lorraine, Columbium (Niobium) and Tantalum, Part I: Colorado School of Mines Min. Ind. Bull., vol. 1, No. 5, Sept. 1958, 12 pp.

[14] Mining World, Idaho Placer Is Source of 99 Percent of U.S. Columbium-Tantalum Output: Vol. 20, No. 1, January 1958, pp. 38–43, 62.

Dayton, S. H., Radioactive Black Sand Is Yielding Columbite Concentrate at Idaho Mill: Mining World, vol. 20, No. 5, May 1958, pp. 36–41.

[15] Waterbury, G. R., and Bricker, C. E., Separation and Spectrophotometric Determination of Microgram Amounts of Niobium: Anal. Chem., vol. 30, No. 5, May 1958, pp. 1007–1009.

[16] Theodore, M. L., Determination of Tantalum in Niobium: Anal. Chem., vol. 30, No. 4, April 1958, pp. 465–467.

[17] Henderson, A. W., May, S. L., and Higbie, R. B., Chlorination of Euxenite Concentrates: Ind. Eng. Chem., vol. 50, No. 611, April 1958, pp. 611–612.

[18] Koerner, E. L., Jr., Smutz, Morton, and Wilhelm, H. A., Separation of Niobium and Tantalum by Liquid Extraction: Chem. Eng. Prog., vol. 54, No. 9, September 1958, pp. 63–70.

[19] Smith, H. R., Jr., Hunt, C. d'A., and Hanks, C. W., The Development of Large Scale Electron Bombardment Melting and Its Effect on the Composition of Metals and Alloys: Temescal Metallurgical Corp., Richmond, Calif., June 1958, 18 pp.

[20] Bertossa, R. C., and Rau, S., Development of Procedures and Techniques for Preparing Bonded Double Layer Tantalum-Copper Composite Plates: Wright Air Development Center Tech. Rept. 58–396, August 1958, 104 pp.

[21] Arenberg, C. A., Protective Coatings for Tantalum: Wright Air Development Center Tech. Rept. 58–203, July 1958, 14 pp.

[22] Raines, G. E., Weaver, C. V., and Stang, J. H., Corrosion and Creep Behavior of Tantalum in Flowing Sodium. Battelle Memorial Inst. Rept. BMI–1284, Aug. 21, 1958, 24 pp.

[23] Klopp, W. D., and Others, Investigation of the Properties of Tantalum and Its Alloys: Wright Air Development Center Tech. Rept. 58–525, November 1958, 78 pp.

[24] Mah, A. D., Heats of Formation of Niobium Dioxide, Niobium Subnitride, and Tantalum Subnitride: Jour. Am. Chem. Soc., vol. 80, No. 15, Aug. 5, 1958, pp. 3872–3874.

and entropy of CbO_2 at 298.15° K. also were studied.[25] A second annual progress report of the Sylvania Electric Products, Inc., study of self-diffusion of columbium was published.[26]

Studies on columbium-base alloys were published.[27] A new method to prepare cadmium columbate, a material with a high dielectric constant, involved the anodic spark reaction of cadmium in a columbate solution and crystallization of the anode product by heating at 650° C.[28] A new type of silver halide solid electrolyte cell consists of a silver halide bead with a tantalum wire cathode and silver anode.[29]

Several significant U.S. patents bearing on columbium-tantalum process or use technology were issued during 1958.[30]

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[25] King, E. G., Low Temperature Heat Capacities and Entropies at 298.15° K. of Some Oxides of Gallium, Germanium, Molybdenum and Niobium: Jour. Am. Chem. Soc., vol. 80, No. 8, Apr. 20, 1958, pp. 1799–1800.

[26] Resnick, R., Castleman, L. S., and Seigle, L., The Self-Diffusion of Niobium—II: U.S. AEC Rept. SEP–248, June 30, 1958, 12 pp.

[27] Begley, R. T., Development of Niobium-Base Alloys: Wright Air Development Center Technical Report 57–344, Dec. 1958, 180 pp.

Rogers, B. A., Atkins, D. F., Manthos, E. J., and Kirkpatrick, M. E., Uranium-Columbium Alloy Diagram: Trans. Metallurgical Soc., AIME, vol. 212, No. 3, June 1958, pp. 387–393.

Frank, J. W., and Macherey, R. E., Casting Uranium-5w/o Zirconium-1.5w/o Niobium Alloys Into Zirconium and Zircaloy-2 Containers: U.S. AEC Argonne Nat. Laboratory Rept. ANL–5442, July 1958, 49 pp.

[28] McNeill, William, The Preparation of Cadmium Niobate by an Anodic Spark Reaction: Jour. Electrochem. Soc., vol. 105, No. 9, September 1958, pp. 544–547.

[29] Weininger, J. L., Halogen-Activated Solid Electrolyte Cell: Jour. Electrochem. Soc., vol. 105, No. 8, August 1958, pp. 439–441.

[30] Ruhoff, J. R., Martin, G. L., and Gerfen, C. O. (assignors to Mallinckrodt Chemical Works, St. Louis, Mo.), Method of Separating Values of Columbium and/or Tantalum From a Concentrate Also Containing An Element of Group IVB: U.S. Patent 2,819,146, Jan. 7, 1958.

Ruhoff, J. R., Martin, G. L., and Gerfen, C. O. (assignors to Mallinckrodt Chemical Works, St. Louis, Mo.), Method of Separating Values of Columbium and/or Tantalum From a Concentrate Also Containing an Element of Group IVB: U.S. Patent 2,819,945, Jan. 14, 1958.

Raynes, B. C. (assignor to Horizons Titanium Corp., Princeton, N.J.), Method of Producing Refractory Metals: U.S. Patent 2,822,259, Feb. 4, 1958.

Hix, H. B. (assignor to E. I. du Pont de Nemours & Co., Wilmington, Del.), Compositions of Matter: U.S. Patent 2,822,268, Feb. 4, 1958.

Eberle, F. T. (assignor to the Babcock & Wilcox Company, New York, N.Y.), Forgeable High Strength Austenitic Alloy With Columbium-Tantalum Addition: U.S. Patent 2,823,114, Feb. 11, 1958.

Schaefer, H., and Jori, M. (assignors to W. C. Heraeus G.m.b.H., Hanau, Germany), Method for the Separation of Niobium and Tantalum: U.S. Patent 2,829,947, April 8, 1958.

Voiland, E. E. (assignor to the United States of America as represented by the Chairman of the AEC), Separation of Uranium From Zirconium and Niobium by Solvent Extraction: U.S. Patent 2,833,616, May 6, 1958.

Schornstein, A., and Kern, F. (assignors to Ciba, Ltd., Basel, Switzerland), Process for Separating Niobium and Tantalum From Materials Containing These Metals: U.S. Patent 2,842,424, July 8, 1958.

Wilson, A. S. (assignor to the United States of America, as represented by the chairman of the AEC), Precipitation of Zirconium, Niobium, and Ruthenium From Aqueous Solutions: U.S. Patent 2,847,278, Aug. 12, 1958.

Keller, W. H., and Zonis, I. S. (assignors to National Research Corp., Cambridge, Mass.), Method of Producing Chromium and Niobium: U.S. Patent 2,848,320, Aug. 19, 1958.

Glendenin, L. E., and Gest, H. (assignors to the United States of America as represented by the chairman of the AEC), Separation of Radioactive Columbium Tracer: U.S. Patent 2,849,467, Aug. 26, 1958.

Ruhoff, J. R., Martin, G. L., and Gerfen, C. O. (assignors to Mallinckrodt Chemical Works, St. Louis, Mo.), Process for the Separation of Columbium, Tantalum, and Titanium Values: U.S. Patent 2,859,098, Nov. 4, 1958.

Ruhoff, J. R., Martin, G. L., and Gerfen, C. O. (assignors to Mallinckrodt Chemical Works, St. Louis, Mo.), Process for the Separation of Columbium-Tantalum Values: U.S. Patent 2,859,099, Nov. 4, 1958.

von Bichowsky, F., Process for Reducing Niobium Oxides to Metallic State: U.S. Patent 2,861,882, Nov. 25, 1958.

Abkowitz, S., and Moorhead, P. E. (assignors to Mallory-Sharon Titanium Corp., Niles, Ohio), Titanium Base Aluminum-Tantalum-Columbium Alloys: U.S. Patent 2,864,698, Dec. 16, 1958.

Abkowitz, S., and Moorhead, P. E. (assignors to Mallory-Sharon Titanium Corp., Niles, Ohio), Titanium Base Alpha Aluminum-Columbium-Tantalum Alloy: U.S. Patent 2,864,699, Dec. 16, 1958.

Bohnet, W. J., and Bagley, G. D. (assignors to Union Carbide Corp., New York, N.Y.), Drip-Melting of Refractory Metals: U.S. Patent 2,866,700, Dec. 30, 1958.

Copper

By A. D. McMahon [1] and Gertrude N. Greenspoon [2]

ALTHOUGH reduced activity in the copper industry continued through the first 6 months of 1958, the situation changed in the latter half of the year, owing largely to voluntary restrictions in output and increased industrial demand for the metal.

The consumption of refined copper declined each month until May, when it was 25 percent below the monthly average for 1957. Mine production reached the lowest point of the year, influenced in part by workers' summer vacations in July, when output was 33 percent less than the 1957 average. The lowest monthly average price was in March, when it was 19 percent below 1957. Refined stocks were highest in the year at the end of May—43 percent more than on January 1, and unrefined inventories were highest on April 30—12 percent above those on January 1.

Consumption of copper turned upward in June and gained markedly in the second half. In the second quarter consumption was 16 percent under but in the final quarter 13 percent above, 1957 averages. Mine production, on the other hand, continued below the 1957 monthly average until October 1958; for October–December 1958 it was at a rate 3 percent higher than in 1957. Because output gains lagged behind consumption and because imports were lower and exports higher than in 1957, stocks of refined copper at the year end were 56 percent less than on January 1; stocks of unrefined copper were 6 percent less.

For the year as a whole mine output declined 10 percent from 1957 to the lowest rate since 1954; consumption dropped 8 percent and was the smallest since 1949.

Principal primary producers' annual price was 13 percent less than in 1957 and the smallest since 1952.

Imports of unmanufactured copper declined 16 percent in 1958 and were the smallest since 1951, influenced by lower industrial activity in the United States, by the improvement in demand for copper out-

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

side of the United States, by prolonged strikes in Canada, Chile, and Northern Rhodesia, and by resumption of the United States tariff on copper on July 1. Some of these same factors, and further relaxation of export controls as well, influenced the size of exports; exports of refined copper—the chief measurable class—rose 11 percent in 1958 and were the largest since 1929.

After a 7-year suspension the excise tax on copper imports was reimposed July 1. On June 11, 1958, suspension of duties on metal scrap was extended to June 30, 1959. Export controls were relaxed further in 1958. (See Foreign Trade section.)

World production declined 4 percent in 1958 owing to reduced output at United States mines and to decreases in all other most important copper-producing countries, that is, Canada, Chile, Belgian Congo, and Northern Rhodesia. Among the smaller producers, output in Peru also declined, but in Mexico and Australia it rose against the general trend. Most of the larger world producers inaugurated production-curtailment programs early in the year but abandoned the cuts following improvement in overall world consumption. Prolonged labor strikes in Canada, Chile, and Northern Rhodesia played a large part in lowering world output in 1958.

LEGISLATION AND GOVERNMENT PROGRAMS

No contracts for expanding copper production under the Defense Production Act of 1950, as amended, were entered into by the Government in 1958; also, no tax amortizations were granted.

Defense Minerals Exploration Administration (DMEA) entered into a contract March 19, 1958, with Robt. T. Curtiss, covering the Mint claims, Snohomish County, Wash. The total amount was $11,620, and the Government participation was 50 percent. The DMEA expired June 30 and was succeeded by the Office of Minerals Exploration (OME), under the U.S. Department of the Interior. No copper contracts were entered into by OME.

After a 7-year suspension the excise tax on copper imports was reimposed July 1. The effective rate was 1.7 cents a pound as a result of the GATT meetings in Geneva in 1956. The 1.7-cent-rate was to remain in effect when the price of copper was 24 cents a pound or more; if the price dropped below 24 cents, the tariff was to be 2 cents a pound. On June 11, 1958, a bill to continue suspension of duties on metal scrap to June 30, 1959, was signed by President Eisenhower.

Effective November 10, copper items, including ores, concentrates, etc., refined copper, copper scrap, and copper-base scrap, were removed from the U.S. Department of Commerce positive list (requiring export licenses) and placed on the general list for export to all destinations except Hong Kong, Macao, and the Sino-Soviet bloc.

DOMESTIC PRODUCTION

PRIMARY COPPER

Mine Production.—Production of copper by United States mines declined 10 percent to the lowest quantity since 1954. The drop was brought about chiefly by voluntary reductions in rates of operation

TABLE 1.—Salient statistics of the copper industry, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
New (primary) copper produced—						
From domestic ores, as reported by—						
Mines	888, 446	835, 472	998, 570	[1] 1, 104, 156	[1] 1, 086, 859	979, 329
Value .... thousand	$417, 570	$492, 929	$744, 933	$938, 532	$654, 289	$515, 127
Copper ore produced [2]	93, 424, 995	93, 654, 258	112, 549, 665	131, 775, 959	129, 715, 586	114, 824, 468
Average yield of copper, percent	.88	.83	.83	.78	.77	.79
Smelters	894, 163	834, 381	1, 007, 311	1, 117, 580	1, 081, 055	992, 918
Percent of world total	30	25	28	28	27	25
Refineries	884, 549	841, 717	997, 499	1, 080, 207	1, 050, 496	1, 001, 645
From foreign ores, matte, etc., refinery reports	284, 564	370, 202	344, 960	362, 426	403, 680	350, 875
Total new refined, domestic and foreign	1, 169, 113	1, 211, 919	1, 342, 459	1, 442, 633	1, 454, 176	1, 352, 520
Secondary copper recovered from old scrap only	434, 181	407, 066	514, 585	468, 489	[1] 444, 492	411, 367
Imports (unmanufactured)[3]	605, 442	594, 829	594, 100	595, 747	[1] 594, 032	496, 309
Refined	290, 643	215, 086	202, 312	191, 745	162, 309	128, 464
Exports of metallic copper [4]	187, 678	[5] 312, 433	[5] 259, 942	[5] 280, 575	[5] 430, 446	[6] 428, 015
Refined (ingots and bars)	139, 882	215, 951	199. 819	223, 103	346, 025	384, 868
Stocks at end of year (producers)	256, 000	214, 000	235, 000	339, 000	383, 000	305, 000
Refined copper	39, 000	25, 000	34, 000	78, 000	109, 000	48, 000
Blister and materials in solution	217, 000	189, 000	201, 000	261, 000	274, 000	257, 000
Withdrawals (apparent) from total supply on domestic account:						
Total new copper	1, 324, 000	1, 235, 000	1, 336, 000	1, 367, 000	1, 239, 000	1, 157, 000
Total new and old copper (old scrap only)	1, 758, 000	1, 642, 000	1, 851, 000	1, 835, 000	[1] 1, 683, 000	1, 568, 000
Price average ..... cents per pound	23. 5	[7] 29. 5	[7] 37. 3	[7] 42. 5	[7] 30. 1	[7] 26. 3
World:						
Smelter production, new copper	3, 010, 000	[1] 3, 290, 000	[1] 3, 630, 000	[1] 4, 000, 000	[1] 4, 070, 000	3, 930, 000
Mine production	2, 850, 000	3, 110, 000	3, 410, 000	3, 780, 000	3, 900, 000	3, 740, 000

[1] Revised figure.
[2] Includes old tailings smelted or re-treated. Not comparable with mine production figure shown in that latter includes recoverable copper content of ores not classified as "copper."
[3] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering country under bond. Comprises copper in ingots, plates, and bars, ores and concentrates, regulus, blister, and scrap.
[4] Total exports of copper, exclusive of ore, concentrates, composition metal, and unrefined copper. Exclusive also of "Other manufactures of copper," for which quality figures are not recorded before 1953. (See table 40.)
[5] Due to changes in classification 1954–58 data are not strictly comparable to earlier years.
[6] Beginning Jan. 1, 1958, copper rods not separately classified; included in "other copper manufactures."
[7] Exclusive of copper produced abroad and delivered in the United States.

of leading producers owing to lower demand. Cuts were achieved largely by shortening work weeks. In January a 9-percent cut was reported by Phelps Dodge Corp. (Arizona). In March the Miami Copper Co. curtailed underground mining at Miami (Arizona); and the Kennecott Copper Corp. announced cuts in the work week at its four western divisions from 6 days to 5 and, effective May 4, a further shortening to 4 days. Phelps Dodge announced an additional 20-percent cut in May, and the Anaconda Co. closed the Leonard mine that previously had accounted for approximately 10 percent of the Butte (Mont.) output. Following an announced 10-percent additional cut at Inspiration Consolidated Copper Co. mine (Arizona), effective July 1, destruction of a railroad bridge by fire caused a change in the company's plan for a complete shutdown at Inspiration from June 21 to July 7, with vacations scheduled in that period, and postponement of the voluntary curtailment to about October 1. On March 16 San Manuel Copper Corp. (Arizona) eliminated overtime for each of its 2,600 employees by reducing the work week to 5 days. Operations, however, continued on a three-shift, 7-day-week basis.

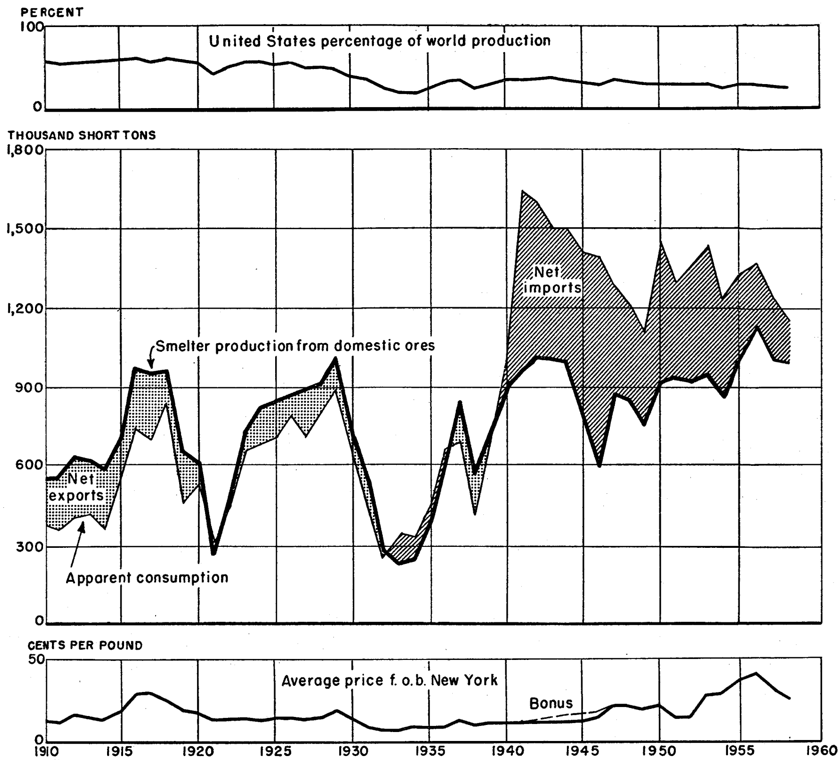

FIGURE 1.—Production, consumption, and price of copper in the United States, 1910–58.

TABLE 2.—Copper produced from domestic ores, as reported by mines, smelters, and refineries, in short tons

Year	Mine	Smelter	Refinery	Year	Mine	Smelter	Refinery
1954	835,472	834,381	841,717	1957	[1] 1,086,859	1,081,055	1,050,496
1955	998,570	1,007,311	997,499	1958	979,329	992,918	1,001,645
1956	[1] 1,104,156	1,117,580	1,080,207				

[1] Revised figure.

In the late months of the year production schedules were stepped up to meet increasing demand. On August 4 Kennecott announced a return to a 5-day-week basis at its four western divisions and to a 6-day-week effective the beginning of September; by October 23 Kennecott's divisions were working 7 days weekly. On October 3 Phelps Dodge stated that its operations would be expanded to a 5½-day week and on October 16 to a 6-day week.

Arizona was again by far the largest copper-producing State, with an expanding share of the total for the United States—50 percent in 1958 and 47 in 1957. Stripping 5 million tons of overburden at the Esperanza mine of Duval Sulphur and Potash Co., Pima County, and construction of a 12,000-ton-per-day mill were continued. The Inspiration Consolidated Copper Co. continued to develop the Christmas mine at Winkelman. Utah with 19 percent, Montana with 9, and Nevada with 7 maintained their 1957 standings. Michigan displaced New Mexico as fifth in importance in 1958, but each supplied 6 percent of the total in that year. Montana and Michigan had virtually unchanged rates of output, but others of the leading six had markedly lower production. The Kennecott Copper Corp., Nevada Mines Div., purchased holdings of Consolidated Coppermines Corp. on February 1, 1958. Before this acquisition Kennecott operated two pits and Consolidated one. Kennecott stated in its annual report to stockholders that operation of the combined properties (pits) by Kennecott greatly improved operating procedures.

Classification of production by mining methods showed that approximately 71 percent of the recoverable copper and 76 percent of the copper ore came from open pits, compared with 72 and 77 percent, respectively in 1957. The decline in relative importance of open-pit copper mining, which began in 1955 as a result of initial operations at the San Manuel mine in Arizona and White Pine mine in Michigan, was thus continued. 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 7 produced 52 percent of the United States total, the first 10 produced 76 percent, and the entire 25 furnished 97 percent.

TABLE 3.—Copper ore and recoverable copper produced by open-pit and underground methods, percent of total

Year	Open pit		Underground		Year	Open pit		Underground	
	Ore	Copper	Ore	Copper		Ore	Copper	Ore	Copper
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
1949	78	70	22	30	1958	76	71	24	29

TABLE 4.—Mine production of recoverable copper in the United States in 1958, by months [1]

Month	Short tons	Month	Short tons
January	88,659	August	66,163
February	82,272	September	82,053
March	87,323	October	91,097
April	84,457	November	94,366
May	78,688	December	95,315
June	68,264		
July	60,672	Total	979,329

[1] Monthly figures adjusted to final annual mine-production total.

TABLE 5.—Mine production of recoverable copper in the United States, with production of maximum year, and cumulative production from earliest record to end of 1958, by States, in short tons

State	Maximum production [1]		Production by years						Total production from earliest record to end of 1958
	Year	Quantity	1949–53 (average)	1954	1955	1956	1957	1958	
Western States and Alaska:									
Alaska	1916	59,927	2	4	1	(2)	(2)	5	685,915
Arizona	1957	515,854	393,485	377,927	454,105	505,908	515,854	485,839	16,226,489
California	1909	28,644	680	362	613	859	945	749	635,638
Colorado	1938	14,171	3,061	4,523	4,323	4,228	5,115	4,193	292,844
Idaho	1958	9,846	2,411	4,828	5,618	6,656	7,912	9,846	157,965
Montana	1916	176,464	61,612	59,349	81,542	96,426	91,512	90,683	7,422,077
Nevada	1942	83,663	53,297	70,217	78,925	[3] 80,824	77,750	66,137	2,517,854
New Mexico	1942	80,100	68,767	60,558	66,417	74,345	67,472	55,540	2,153,258
Oregon	1916	1,791	12	5	4	7	23	10	12,468
South Dakota	1918	32							106
Texas	1928	224	9		1				1,384
Utah	1943	323,989	259,870	211,835	232,949	250,604	237,857	189,184	7,815,761
Washington	1940	9,612	4,504	3,636	3,958	2,926	1,700	52	121,621
Wyoming	1900	2,102		1		3	4	(2)	16,335
Total			847,710	793,245	928,456	[3] 1,022,786	1,006,144	902,238	38,059,715
West Central States: Missouri	1949	3,670	2,805	1,925	1,722	1,890	[3] 1,604	1,429	[4] 46,402
States east of the Mississippi:									
Alabama	1907	42							(5)
Georgia	1917	465							(5)
Maine	1918	383							(5)
Maryland	1917	146							(5)
Massachusetts	1906	5							(5)
Michigan	1916	136,846	23,178	23,593	50,066	61,526	58,400	58,005	5,238,930
New Hampshire	1908	[6] 94							(5)
North Carolina	1930	6,695		(7)	(7)	4,102	7,516	8,073	(5)
Pennsylvania	1942	6,410	3,985	3,270	4,110				(5)
South Carolina	(5)	(5)							(5)
Tennessee	1930	10,584	7,171	9,087	9,911	10,449	9,790	9,109	(5)
Vermont	1954	4,352	3,597	4,352	4,305	3,403	3,405	475	(5)
Virginia	1944	291							(5)

Wisconsin	1914	5							(5)
Total			37,931	40,302	68,392	79,480	79,111	75,662	[8] 6,000,138
Grand total	1956	1,104,156	888,446	835,472	998,570	[3] 1,104,156	[3] 1,086,859	979,329	[9] 44,106,255

[1] For Missouri and States east of the Mississippi, maximum since 1905.
[2] Less than 1 ton.
[3] Revised figure.
[4] Small quantity for Wisconsin included with Missouri.
[5] Data not available.
[6] The 1908 volume of Mineral Resources credits this figure to Massachusetts and New Hampshire; the 1909 volume credits it to New Hampshire alone.
[7] Less than 0.5 ton.
[8] For States other than Michigan, figures represent largely smelter output. Excludes small quantity, not separable, for Wisconsin shown with Missouri.
[9] Largely smelter production for States east of the Mississippi except Michigan.

TABLE 6.—Mine production of copper in the principal districts [1] of the United States, in terms of recoverable copper, in short tons

District or region	State	1949–53 (average)	1954	1955	1956	1957	1958
West Mountain (Bingham)	Utah	258, 910	210, 643	232, 016	249, 417	236, 486	187, 972
Copper Mountain (Morenci)	Arizona	137, 843	114, 362	124, 630	127, 350	106, 977	96, 588
Summit Valley (Butte)	Montana	61, 149	59, 240	81, 428	96, 292	91, 392	90, 557
Globe-Miami	Arizona	86, 932	63, 222	86, 575	86, 947	79, 606	75, 333
Old Hat	do	152	2	(2)	39, 078	(3)	74, 705
Warren (Bisbee)	do	21, 448	41, 884	58, 145	72, 080	73, 392	63, 718
Lake Superior	Michigan	23, 178	23, 593	50, 066	61, 526	58, 400	58, 005
Central (including Santa Rita)	New Mexico	[4] 66, 475	58, 178	64, 084	71, 216	65, 377	55, 074
Ajo	Arizona	62, 876	60, 794	70, 222	66, 432	62, 458	54, 930
Mineral Creek (Ray)	do	40, 493	40, 462	49, 174	53, 518	56, 888	(3)
Robinson (Ely)	Nevada	52, 705	43, 972	44, 417	50, 130	(3)	(3)
Yerington	do	186	26, 040	33, 918	31, 216	27, 034	(3)
Pima (Sierritas, Papago, Twin Buttes)	Arizona	681	4, 132	(3)	4, 840	20, 156	21, 081
Silver Bell	do	37	(3)	(3)	19, 975	(3)	(3)
Pioneer (Superior)	do	20, 945	26, 521	23, 948	23, 891	21, 776	(3)
Eureka (Bagdad)	do	9, 393	8, 838	11, 040	6, 752	11, 081	12, 017
Ducktown	Tennessee	7, 172	9, 087	9, 911	10, 449	9, 790	9, 109
Blackbird	Idaho	[5] 442	(3)	2, 673	3, 328	(3)	(3)
Lebanon County	Pennsylvania	3, 985	3, 270	4, 110	(3)	(3)	(3)
Coeur d'Alene	Idaho	1, 781	2, 566	2, 637	2, 669	3, 473	3, 884
Ashe County	North Carolina	------	(3)	(3)	(3)	2, 886	3, 630
San Juan Mountains	Colorado	2, 560	2, 076	1, 843	2, 835	3, 520	2, 561
Redcliff (Battle Mountain)	do	288	2, 355	2, 246	(3)	1, 193	(3)
Southeastern Missouri	Missouri	2, 805	1, 925	1, 722	1, 890	[6] 1, 604	1, 429
Verde (Jerome)	Arizona	9, 080	(3)	(3)	(3)	(3)	(3)
Orange County	Vermont	3, 597	4, 352	4, 305	3, 403	3, 405	475
Lordsburg	New Mexico	1, 796	2, 210	(3)	2, 120	1, 716	(3)
Cochise	Arizona	1, 245	1, 947	1, 948	1, 669	1, 104	16
Chelan Lake	Washington	[7] 4, 394	[8] 3, 534	[8] 3, 733	2, 630	1, 571	------

[1] Districts producing 1,000 short tons or more in any year of the period 1954–58.
[2] Less than 0.5 ton.
[3] Figures withheld to avoid disclosing individual company operations.
[4] Includes average for Burro Mountain for 1949 to avoid disclosing individual company operations.
[5] Includes Spring Mountain and Texas for 1952 to avoid disclosing individual company operations.
[6] Revised figure.
[7] Includes average for Peshastin Creek and Wenatchee for 1949–50 to avoid disclosing individual company operations.
[8] Includes Ferry and King to avoid disclosing individual company operations.

TABLE 7.—Twenty-five leading copper-producing mines in the United States in 1958, 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	San Manuel	Old Hat	Arizona	San Manuel Copper Corp	Copper ore.
5	Copper Queen-Lavender Pit	Warren (Bisbee)	do	Phelps Dodge Corp	Do.
6	New Cornelia	Ajo	do	do	Copper, gold-silver ores.
7	Chino	Central	New Mexico	Kennecott Copper Corp	Copper ore.
8	Ray Pit	Mineral Creek (Ray)	Arizona	do	Do.
9	Inspiration	Globe-Miami	do	Inspiration Consolidated Copper Co	Do.
10	White Pine	Lake Superior	Michigan	White Pine Copper Co	Do.
11	Yerington	Yerington	Nevada	The Anaconda Co	Do.
12	Silver Bell	Silver Bell	Arizona	American Smelting & Refining Co	Do.
13	Magma	Pioneer (Superior)	do	Magma Copper Co	Do.
14	Liberty Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Do.
15	Copper Cities	Globe-Miami	Arizona	Copper Cities Mining Co	Do.
16	Pima	Pima	do	Pima Mining Co	Do.
17	Calumet & Hecla, Inc	Lake Superior	Michigan	Calumet & Hecla, Inc	Copper ore and tailings.
18	Veteran Pit	Robinson (Ely)	Nevada	Kennecott Copper and Consolidated Coppermines Corp.	Copper ore.
19	Miami	Globe-Miami	Arizona	Miami Copper Co	Do.
20	Bagdad	Eureka (Bagdad)	do	Bagdad Copper Corp	Do.
21	Burra-Boyd	Polk County	Tennessee	Tennessee Copper Co	Copper-zinc ore.
22	Blackbird	Blackbird	Idaho	Calera Mining Co	Copper ore.
23	Cornwall	Lebanon County	Pennsylvania	Bethlehem Steel Co	Magnetite-pyrite-chalcopyrite ore.
24	Ore Knob	Ashe County	North Carolina	Appalachian Sulfides, Inc	Copper ore.
25	Mineral Hill-Daisy	Pima	Arizona	Banner Mining Co	Do.

TABLE 8.—Copper ore sold or treated in the United States in 1958, with copper, gold, and silver content in terms of recoverable metal [1]

State	Ore sold or treated (short tons)	Recoverable metal content				Value of gold and silver per ton of ore
		Copper		Gold (fine ounces)	Silver (fine ounces)	
		Pounds	Percent			
Alaska	7	10,000	71.43		101	$13.00
Arizona	56,255,809	913,973,800	.81	114,262	3,543,044	.13
California	4,295	171,100	1.99	330	5,085	3.76
Colorado	37,611	2,746,000	3.65	3,194	803,748	22.31
Idaho	300,277	11,865,300	1.98	9,800	24,600	1.22
Michigan [2]	7,293,956	116,010,000	.80			
Montana	10,096,767	173,516,906	.86	14,251	2,167,491	.24
Nevada	9,573,143	132,223,700	.69	39,008	399,729	.18
New Mexico	5,725,600	80,958,400	.71	1,717	29,152	.02
North Carolina	153,809	7,260,000	2.36	876	15,157	.29
Oregon	850	19,500	1.15	115	76	4.82
Tennessee [3]	1,265,900	18,218,000	.72	124	44,592	.04
Utah	24,091,415	361,501,300	.75	280,320	2,143,790	.49
Vermont	23,475	950,000	2.02		5,101	.20
Washington	1,548	40,000	1.29	54	391	1.45
Wyoming	6	800	6.67		13	2.00
Total	114,824,468	1,819,464,806	.79	464,051	9,182,070	.21

[1] Excludes copper recovered from precipitates as follows: Arizona, 53,129,500 pounds; Idaho, 2,000 pounds; Montana, 5,781,205 pounds; New Mexico, 28,410,500 pounds; Utah, 11,974,700 pounds. Also excludes some copper recovered from precipitates in California; figures withheld to avoid disclosing individual company operations.
[2] Includes tailings.
[3] Copper-zinc ore.

TABLE 9.—Copper ore concentrated in the United States in 1958, with content in terms of recoverable copper

State	Ore concentrated (short tons)	Recoverable copper content	
		Pounds	Percent
Arizona	55,805,752	863,779,700	0.77
California	4,092	133,200	1.63
Idaho	297,665	11,598,000	1.95
Michigan [1]	7,293,956	116,010,000	.80
Montana	10,094,932	173,455,906	.86
Nevada	[2] 9,474,466	[2] 126,019,400	.67
New Mexico	[3] 5,523,909	[4] 80,102,400	.73
North Carolina	153,809	7,260,000	2.36
Oregon	850	19,500	1.15
Tennessee [5]	1,265,900	18,218,000	.72
Utah	24,087,400	361,329,400	.75
Vermont	23,475	950,000	2.02
Washington	1,548	40,000	1.29
Total	114,027,754	1,758,915,506	.77

[1] Includes tailings.
[2] Includes ore treated by straight leaching, and copper precipitates recovered therefrom; Bureau of Mines not at liberty to publish.
[3] In addition 165,000 tons was treated by straight leaching.
[4] In addition 150,900 pounds of copper was recovered by straight leaching.
[5] Copper-zinc ore.

TABLE 10.—Copper ore shipped to smelters in the United States in 1958, 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
Alaska	7	10,000	71.43	Nevada	98,677	6,204,300	3.14
Arizona	450,057	50,194,100	5.58	New Mexico	36,691	705,100	.96
California	203	37,900	9.33	Utah	4,015	171,900	2.14
Colorado	37,611	2,746,000	3.65	Wyoming	6	800	6.67
Idaho	2,612	267,300	5.12				
Montana	1,835	61,000	1.66	Total	631,714	60,398,400	4.78

TABLE 11.—Copper ores[1] produced in the United States, 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
1949-53 (average)	768,815	3.44	89,029,712	0.86	93,424,995	0.88	0.0059	0.088	0.29
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
1958	631,714	4.78	114,027,754	.77	114,824,468	.79	.0040	.080	.21

1 Includes old tailings, smelted or re-treated, etc., for 1949–52.
2 Includes some ore classed as copper-zinc ore.
3 Includes copper ore leached.

Smelter Production.—The recovery of copper from ores of domestic origin by smelters in the United States declined 8 percent. Less copper came also from foreign ores smelted and from secondary sources; the total produced at primary smelters was 10 percent less than in 1957.

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.

TABLE 12.—Copper produced by primary smelters in the United States, in short tons

Year	Domestic	Foreign	Secondary	Total
1949-53 (average)	894,163	101,245	58,644	1,054,052
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
1958	992,918	76,134	61,848	1,130,900

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.

The Kennecott Copper Corp. completed and put into operation a new copper smelter at Hayden, Ariz., to treat copper concentrate produced by the company Ray Mines Division, formerly processed by the Hayden smelter of American Smelting and Refining Co. A.S. & R.'s Hayden plant was being used for the output of new Arizona mines. On April 30, A.S. & R. agreed to sell the Garfield (Utah) smelter to Kennecott, which took possession and began operating the plant on January 2, 1959.

Refinery Production.—The refinery output of primary copper in the United States came from 14 plants; 8 of them employed the electrolytic method only, 3 used the furnace process on Lake Superior copper, and 2 used both electrolytic and furnace methods. One western smelter fire-refined part of its blister but shipped the remainder to electrolytic refineries. The leaching plant of the Inspiration Consolidated Copper Co. at Inspiration, Ariz., produced electrolytic copper direct from leaching solutions; a substantial part of 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 1,714,000 tons of refined copper a year and produced at 83 percent of capacity.

Five large electrolytic refineries were on the Atlantic seaboard; three lake refineries on the Great Lakes; and four electrolytic refineries west of the Great Lakes (one each at Great Falls (Mont.), Tacoma (Wash.), El Paso (Tex.), and Garfield (Utah)). The El Paso plant of the Phelps Dodge Refining Corp. and the Carteret plant of the

TABLE 13.—Primary and secondary copper produced by primary refineries in the United States, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
Primary:						
From domestic ores, etc.:[1]						
Electrolytic	781, 934	777, 507	883, 674	948, 732	945, 394	892, 758
Lake	23, 565	22, 510	35, 387	57, 053	58, 814	59, 111
Casting	79, 050	41, 700	78, 438	74, 422	46, 288	49, 776
Total	884, 549	841, 717	997, 499	1, 080, 207	1, 050, 496	1, 001, 645
From foreign ores, etc.:[1]						
Electrolytic	283, 132	353, 667	320, 822	351, 768	372, 791	340, 470
Casting and best select	1, 432	16, 535	24, 138	10, 658	30, 889	10, 405
Total refinery production of new copper	1, 169, 113	1, 211, 919	1, 342, 459	1, 442, 633	1, 454, 176	1, 352, 520
Secondary:						
Electrolytic[2]	155, 578	156, 764	196, 386	220, 340	203, 073	199, 508
Casting	14, 246	23, 179	10, 169	13, 477	8, 521	7, 828
Total secondary	169, 824	179, 943	206, 555	233, 817	211, 594	207, 336
Grand total	1, 338, 937	1, 391, 862	1, 549, 014	1, 676, 450	1, 665, 770	1, 559, 856

[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 processing.
[2] Includes copper reported from foreign scrap.

American Metal Climax, Inc., produced fire-refined copper, in addition to the electrolytic grade. Of the above plants, the lake refinery of the Quincy Mining Co. was closed in February.

Kennecott Copper Corp. was constructing a new electrolytic copper refinery on the Patapsco River south of Baltimore, Anne Arundel County, Md. The new plant was to cost about $30 million and to have an eventual capacity of 16,500 tons of electrolytic copper monthly. Operations were scheduled to begin in August 1959.

The Cerro de Pasco Corp. purchased the Lewin-Mathes electrolytic refinery at Monsanto, Ill., in mid-1957; since then that plant has treated significant quantities of Peruvian blister.

TABLE 14.—Copper cast in forms at primary refineries in the United States

Form	1957		1958	
	Thousand short tons	Percent	Thousand short tons	Percent
Wirebars	1,028	62	950	61
Cathodes	170	10	176	11
Billets	165	10	161	10
Ingots and ingot bars	152	9	147	10
Cakes	136	8	107	7
Other forms	15	1	19	1
Total	1,666	100	1,560	100

Copper Sulfate.—Production of copper sulfate declined 31 percent, and shipments fell 34 percent. Of the total shipments, producers' reports indicated that 20,800 tons (15,700 in 1957) was for agricultural uses, 18,100 (20,800) for industrial uses, and 7,600 (33,800) for other purposes, chiefly for export. The main reason for the drop in shipments of copper sulfate was the substantial reduction in the use of copper sulfate in Central America, because of substitution of oil as a fungicide spray for trees and foliage in banana plantations. Experiments with banana sprays were described.[3]

TABLE 15.—Production, shipments, and stocks of copper sulfate, in short tons

Year	Production		Shipments (gross weight)	Stocks at end of year[1] (gross weight)
	Gross weight	Copper content		
1949–53 (average)	88,145	22,034	88,924	5,489
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
1958	48,596	12,149	46,580	5,168

[1] Some small quantities are purchased and used by producing companies, so that the figures given do not balance exactly.

[3] The Lamp, The Sigatoka Slayer: Vol. 41. No. 1, Spring 1959, pp. 6–9.

SECONDARY COPPER AND BRASS[4]

Recovery of copper in unalloyed and alloyed form from all classes of noferrous scrap metal in the United States totaled 797,000 short tons, 5 percent less than in 1957 and the lowest since 1949. Of the 44,000-ton drop, 28,000 tons was chargeable to foundries. As usual, secondary copper recovered from copper scrap constituted about 99 percent of the total copper from all types of scrap.

Secondary copper smelters increased their production of refined copper 53 percent, or to 39,000 tons; but, except for a slight increase in copper powder, the output of all other secondary copper products declined.

The three principal groups of copper scrap users—secondary smelters, primary copper producers, and brass mills—consumed 351,000, 326,000, and 324,000 tons, respectively, of copper scrap, from which they recovered 298,000, 210,000, and 319,000 tons, respectively, of nonferrous secondary metals. All these quantities are less than the corresponding quantities for 1957. In 6 months of 1958 the secondary

TABLE 16.—Secondary copper produced in the United States, in short tons

	1949–53 (average)	1954	1955	1956	1957 [1]	1958
Copper recovered as unalloyed copper	222, 803	212, 241	246, 928	273, 060	248, 015	255, 121
Copper recovered in alloys [2]	674, 062	627, 666	742, 076	657, 604	593, 872	542, 267
Total secondary copper	896, 865	839, 907	989, 004	930, 664	841, 887	797, 388
From new scrap	462, 684	432, 841	474, 419	462, 175	397, 395	386, 021
From old scrap	434, 181	407, 066	514, 585	468, 489	444, 492	411, 367
Percentage equivalent of domestic mine output	101	101	99	84	77	81

[1] Revised figures.
[2] Includes copper in chemicals, as follows: 1949–53 (average), 18,419; 1954, 18,055; 1955, 15,898; 1956, 14,739; 1957, 14,240; 1958, 9,491.

TABLE 17.—Copper recovered from scrap processed in the United States, by kind of scrap and form of recovery, in short tons

Kind of scrap	1957 [1]	1958	Form of recovery	1957 [1]	1958
New scrap:			As unalloyed copper:		
Copper-base	391, 033	381, 173	At primary plants	211, 594	207, 336
Aluminum-base	6, 089	4, 693	At other plants	36, 421	47, 785
Nickel-base	232	125			
Zinc-base	41	30	Total	248, 015	255, 121
Total	397, 395	386, 021	In brass and bronze	561, 890	517, 680
Old scrap:			In alloy iron and steel	2, 508	2, 272
Copper-base	440, 805	408, 149	In aluminum alloys	14, 800	12, 445
Aluminum-base	2, 800	2, 538	In other alloys	434	379
Nickel-base	689	509	In chemical compounds	14, 240	9, 491
Tin-base	30	27	Total	593, 872	542, 267
Zinc-base	168	144			
Total	444, 492	411, 367	Grand total	841, 887	797, 388
Grand total	841, 887	797, 388			

[1] Revised figures.

[4] Prepared by Archie J. McDermid, commodity specialist.

TABLE 18.—Copper recovered as refined copper, in alloys and in other forms, from copper-base scrap processed in the United States, in short tons

	From new scrap		From old scrap		Total	
	1957	1958	1957	1958	1957	1958
By secondary smelters	52,592	50,480	202,662	202,222	255,254	252,702
By primary copper producers	98,910	94,431	119,251	115,415	218,161	209,846
By brass mills	222,782	220,968	26,814	25,008	249,596	245,976
By foundries and manufacturers	15,516	14,258	87,059	60,452	102,575	74,710
By chemical plants	1,233	1,036	5,019	5,052	6,252	6,088
Total	391,033	381,173	440,805	408,149	831,838	789,322

TABLE 19.—Production of secondary copper and copper-alloy products in the United States, in short tons

Item produced from scrap	Gross weight produced 1957	Gross weight produced 1958
Unalloyed copper products:		
Refined copper by primary producers	211,594	207,336
Refined copper by secondary smelters	25,312	38,672
Copper powder [1]	7,348	7,768
Copper castings	3,761	1,345
Total	248,015	255,121

Item produced from scrap	Nominal composition (percent) Cu	Sn	Pb	Zn	Ni	1957	1958
Brass and bronze ingots:							
Tin bronze	88	10		2		15,728	13,874
Leaded tin bronze	88	6	1.5	4.5		18,253	16,050
Leaded red bronze	85	5	5	5		91,790	83,935
Leaded semired brass	81	3	7	9		57,096	63,195
High-leaded tin bronze	80	10	10			19,268	13,295
Do	84	6	8	2		16,876	13,279
Do	75	5	20			4,098	3,237
Leaded yellow brass	66	1	3	30		16,817	14,804
Nickel silver	58	2	7	18	14	3,634	3,020
Do	65	4	3	5	22		
Low brass	80			20		2,481	2,434
Conductor bronze	94	2	2	2		696	535
Manganese bronze	60 Cu 40 Zn, ±Mn, Al, etc					15,777	12,478
Aluminum bronze	90 Cu 10 Al, ±Mn, Zn, Fe, etc					5,907	4,881
Silicon bronze	92 Cu +Si, ±Zn, Fe, Al, Mn					4,243	4,357
Copper-base hardeners and special alloys						11,583	11,948
Total						284,247	261,322
Brass-mill products						329,956	319,125
Brass and bronze castings						102,447	74,593
Brass powder						[2] 1,225	971
Copper in chemical products						14,240	9,491
Grand total						[2] 980,130	920,623

[1] Includes black copper shipments.
[2] Revised figure.

smelters had the highest consumption of the three groups; in 3 months the primary producers were highest; and in 3 months the brass mills were highest. The trend in total scrap consumption was downward in the first half of 1958 and upward in the second half—a somewhat similar pattern to that followed in 1957—but monthly consumption was lower at the beginning of 1958 than at the beginning of 1957.

Brass mills recovered 98 percent of the scrap consumed in brass-mill products; secondary smelters recovered 85 percent of the scrap consumed, chiefly in brass ingot; and primary producers recovered 64 percent of the scrap consumed as refined copper. A few secondary smelters also produced refined copper. The differences in percentages of copper recovered are due to variations in grades of scrap consumed by the different groups. The primary producers consume considerable scrap that is low in copper and high in iron, because iron is a necessary ingredient in matte, an intermediate product in primary copper smelter operations. Many secondary copper smelters are remelters only of metallic scrap, but some of the larger plants also use low-grade scrap and residues. Brass mills use only high-grade metallic scrap in a remelting operation, and their production of copper and brass sheet and strip requires higher grade metal than can be used in the casting alloys made by the secondary smelters.

TABLE 20.—Composition of secondary copper-alloy production, gross weight in short tons

Year	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Total
BRASS AND BRONZE INGOT PRODUCTION [1]							
1957	224,703	12,828	17,425	28,737	493	61	284,247
1958	205,536	12,265	16,643	26,395	418	65	261,322
SECONDARY METAL CONTENT OF BRASS-MILL PRODUCTS							
1957	249,597	94	3,167	75,597	1,406	95	329,956
1958	245,968	180	2,620	69,124	1,205	28	319,125
SECONDARY METAL CONTENT OF BRASS AND BRONZE CASTINGS							
1957	80,074	4,675	12,227	5,338	34	99	102,447
1958	57,552	3,047	8,191	5,694	30	79	74,593

[1] About 95 percent from scrap and 5 percent from other than scrap.

TABLE 21.—Stocks and consumption of new and old copper scrap in the United States in 1958, 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	2,853	35,219	-	4,212	31,204	35,416	-	2,656
No. 2 wire, mixed heavy, and light copper	3,508	55,721	-	3,204	52,975	56,179	-	3,050
Composition or red brass	4,253	82,389	-	29,720	51,224	80,944	-	5,698
Railroad-car boxes	88	749	-	-	663	663	-	174
Yellow brass	5,525	59,595	-	8,214	50,067	58,281	-	6,839
Cartridge cases and brass	259	1,289	-	4	1,210	1,214	-	334
Auto radiators (unsweated)	3,020	43,076	-	-	40,721	40,721	-	5,375
Bronze	1,924	25,380	-	7,675	17,182	24,857	-	2,447
Nickel silver	594	2,937	-	454	2,501	2,955	-	576
Low brass	262	2,795	-	1,978	579	2,557	-	500
Aluminum bronze	236	346	-	53	428	481	-	101
Low-grade scrap and residues	7,274	45,781	-	22,299	24,864	47,163	-	5,892
Total	29,796	355,277	-	77,813	273,618	351,431	-	33,642
Primary producers:								
No. 1 wire and heavy copper	665	47,739	-	22,390	24,728	47,118	-	1,286
No. 2 wire, mixed heavy, and light copper	2,989	106,122	-	54,287	50,299	104,586	-	4,525
Refinery brass	1,412	29,698	-	6,100	20,933	27,033	-	4,077
Low-grade scrap and residues	31,254	141,027	-	47,856	99,001	146,857	-	25,424
Total	36,320	324,586	-	130,633	194,961	325,594	-	35,312
Brass mills: [1]								
No. 1 wire and heavy copper	4,633	72,752	-	57,690	15,062	72,752	-	6,638
No. 2 wire, mixed heavy, and light copper	1,798	27,236	-	25,207	2,029	27,236	-	2,750
Yellow brass	22,037	155,478	-	154,304	1,174	155,478	-	16,202
Cartridge cases and brass	1,635	35,855	-	25,431	10,424	35,855	-	2,226
Bronze	1,028	1,892	-	1,835	57	1,892	-	1,016
Nickel silver	2,119	6,267	-	6,220	47	6,267	-	2,411
Low brass	2,760	18,938	-	18,875	63	18,938	-	2,298
Aluminum bronze	248	234	-	234	-	234	-	121
Mixed alloy scrap	3,739	5,628	-	5,628	-	5,628	-	9,863
Total [1]	39,997	324,280	-	295,424	28,856	324,280	-	43,525
Foundries, chemical plants and other manufacturers:								
No. 1 wire and heavy copper	2,588	16,611	480	4,718	12,642	17,360	311	2,008
No. 2 wire, mixed heavy, and light copper	1,625	10,790	961	4,021	6,569	10,590	1,090	1,696
Composition or red brass	2,057	6,135	10,932	2,615	4,119	6,734	10,657	1,733
Railroad-car boxes	3,950	44,611	1,890	-	44,232	44,232	1,907	4,312
Yellow brass	2,569	12,918	6,634	5,666	7,562	13,228	6,760	2,133
Auto radiators (unsweated)	134	6,133	-	-	5,961	5,961	-	306
Bronze	1,709	2,118	1,566	710	1,420	2,130	1,938	1,325
Nickel silver	57	95	150	3	89	92	153	57
Low brass	174	1,385	1,249	21	1,396	1,417	1,184	207
Aluminum bronze	288	671	325	239	405	644	324	316
Low-grade scrap and residues	1,678	4,651	1,297	813	4,973	5,786	1,261	579
Total	16,829	106,118	25,484	[2] 18,806	[2] 89,368	[2] 108,174	25,585	14,672

See footnotes at end of table.

TABLE 21.—Stocks and consumption of new and old copper scrap in the United States in 1958, gross weight in short tons—Continued

Class of consumer and type of scrap	Stocks, beginning of year	Receipts: Purchased scrap	Receipts: Machine shop scrap	Consumption: Purchased scrap: New	Consumption: Purchased scrap: Old	Consumption: Purchased scrap: Total	Consumption: Machine shop scrap	Stocks, end of year
Grand total:[3]								
No. 1 wire and heavy copper	10,739	172,321	480	89,010	83,636	172,646	311	12,588
No. 2 wire, mixed heavy, and light copper	9,920	199,869	961	86,719	111,872	198,591	1,090	12,021
Composition or red brass	6,310	88,524	10,932	32,335	55,343	87,678	10,657	7,431
Railroad-car boxes	4,038	45,360	1,890		44,895	44,895	1,907	4,486
Yellow brass	30,131	227,991	6,634	168,184	58,803	226,987	6,760	25,174
Cartridge cases and brass	1,894	37,144		25,435	11,634	37,069		2,560
Auto radiators (unsweated)	3,154	49,209			46,682	46,682		5,681
Bronze	4,661	29,390	1,566	10,220	18,659	28,879	1,938	4,788
Nickel silver	2,770	9,299	150	6,677	2,637	9,314	153	3,044
Low brass	3,196	23,118	1,249	20,874	2,038	22,912	1,184	3,005
Aluminum bronze	772	1,251	325	526	833	1,359	324	538
Low-grade scrap and residues[4]	41,618	221,157	1,297	77,068	149,771	226,839	1,261	35,972
Mixed alloy scrap	3,739	5,628		5,628		5,628		9,863
Total[3]	122,942	1,110,261	25,484	522,676	586,803	1,109,479	25,585	127,151

[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, 1,029 tons of new and 4,137 old; copper-base alloy scrap, 329 tons of new and 4,959 old.
[3] Includes machine-shop scrap receipts and consumption for foundries, chemical plants, and other manufacturers.
[4] Includes refinery brass.

TABLE 22.—Consumption of copper and brass materials in the United States, by principal consuming groups, in short tons

Item consumed	Primary producers	Brass mills	Wire mills	Foundries, chemical plants, and miscellaneous users	Secondary smelters	Total
1957						
Copper scrap	348,184	335,148		141,930	353,464	1,178,726
Refined copper[1]		533,954	773,632	36,662	7,876	1,352,124
Brass ingot		6,757	734	[2] 278,318		285,809
Slab zinc		101,212		4,240	6,938	112,390
Miscellaneous		181		201	[3] 7,103	7,485
1958						
Copper scrap	325,594	324,280		108,174	351,431	1,109,479
Refined copper[1]		479,510	740,270	23,715	7,182	1,250,677
Brass ingot		4,906	160	[2] 254,039		259,105
Slab zinc		91,562		3,122	6,691	101,375
Miscellaneous		82		200	8,177	8,459

[1] Detailed information on consumption of refined copper will be found in table 25.
[2] Shipments to foundries by smelters plus decrease in stocks at foundries.
[3] Revised figure.

TABLE 23.—Dealers' monthly average buying prices for copper scrap and consumers' alloy-ingot prices at New York in 1958, in cents per pound

[Metal statistics, 1959]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
No. 1 Heavy Copper Scrap	15.80	15.20	15.06	15.75	15.98	17.95	18.08	17.90	17.58	20.37	21.41	19.84	17.58
No. 1 Composition Scrap	15.27	14.70	14.42	14.75	14.75	16.08	15.95	15.93	15.75	17.45	17.43	16.80	15.77
No. 1 Composition Ingot	26.41	25.64	24.92	25.25	25.25	26.63	27.00	27.00	27.00	28.64	28.82	28.00	26.71

CONSUMPTION

Apparent withdrawals of primary copper on domestic account, which includes deliveries to the national strategic stockpile, when there are any, decreased 7 percent and were the smallest on record since 1949.

TABLE 24.—New refined copper withdrawn from total year's supply on domestic account, in short tons

	1949-53 (average)	1954	1955	1956	1957	1958
Production from domestic and foreign ores, etc	1,169,113	1,211,919	1,342,459	1,442,633	1,454,176	1,352,520
Imports [1]	290,643	215,086	202,312	191,745	162,309	128,464
Stock at beginning of year [1]	43,000	49,000	25,000	34,000	78,000	109,000
Total available supply	1,502,756	1,476,005	1,569,771	1,668,378	1,694,485	1,589,984
Copper exported [1]	139,882	215,951	199,819	223,103	346,025	384,868
Stock at end of year [1]	39,000	25,000	34,000	78,000	109,000	48,000
Total	178,882	240,951	233,819	301,103	455,025	432,868
Apparent withdrawals on domestic account [2]	1,324,000	1,235,000	1,336,000	1,367,000	1,239,000	1,157,000

[1] May include some copper refined from scrap.
[2] Includes copper delivered by industry to the national strategic stockpile.

Actual consumption of refined copper likewise was the smallest since 1949. These data are based on reports from consumers of quantities entering processing, with no adjustment for stock changes of material in process. Unlike table 24, in which all but new copper is eliminated so far as possible, table 25 does not distinguish between new and old copper but covers all copper in refined form.

Distribution of actual consumption by principal consuming groups followed the usual pattern with wire mills consuming 59 percent and brass mills 38 percent of the total. There has been a gradual increase in the percentage taken by wire mills and a drop for brass mills. In 1957 the percentages were 57 and 40, respectively, and in 1953, 50 and 46, respectively. Consumption in the first 6 months of the year was 15 percent below the average monthly rate in 1957 but rose markedly in the second half and averaged 20 percent above the first 6 months. In the final quarter consumption averaged 32 percent more than in January to March.

TABLE 25.—Refined copper consumed, by classes of consumers, in short tons

Class of consumer	Cathodes	Wire bars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1957							
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	4,118	758	15,161		194	147	20,378
Miscellaneous [1]	1,905	205	3,208	205	495	8,786	14,804
Total	102,694	810,177	112,368	158,761	156,981	11,143	1,352,124
1958							
Wire mills	4,394	723,450	11,464			962	740,270
Brass mills	91,192	47,354	74,098	116,659	150,160	47	479,510
Chemical plants			407			490	897
Secondary smelters	4,080		2,485	219		398	7,182
Foundries	3,285	413	9,731	15	201	238	13,883
Miscellaneous [1]	779	40	1,012	111	501	6,492	8,935
Total	103,730	771,257	99,197	117,004	150,862	8,627	1,250,677

[1] Includes iron and steel plants, primary smelters producing alloys other than copper, consumers of copper powder and copper shot, and miscellaneous manufacturers.

STOCKS

Producers' stocks of refined and unrefined copper declined 20 percent. At the beginning of the year they were the highest since the end of 1945. Conforming with extension of the low industrial activity producers' inventories continued to accumulate until the end of April, when they were another 70,000 tons higher. As business improved, copper stocks began to drop, and from April 30 to the year end declined every month; they were 78,000 tons less at the end than at the beginning of the year. Refined stocks declined 56 percent and at the year end were the smallest since 1955, whereas the larger tonnage unrefined class decreased 6 percent and was likewise the smallest since 1955.

Figures compiled by the Copper Institute show that domestic stocks of refined copper fell to less than one-half in 1958, or from 181,024 tons to 80,722. 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 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 and metal in transit from smelters to refineries. 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 446,400 tons at the end of 1958 (a 4-percent increase over those on hand January 1). Working stocks (see table 27) were 326,400 tons (6 percent less than on January 1). After unfilled sales of metal were taken into account, copper classed as "available for sale" was 32,500 tons, or 65 percent more than at the beginning of the year.

TABLE 26.—Stocks of copper at primary smelting and refining plants in the United States at end of year, in short tons

Year	Refined copper [1]	Blister and materials in process of refining [2]	Year	Refined copper [1]	Blister and materials in process of refining [2]
1949–53 (average)	39,000	217,000	1956	78,000	261,000
1954	25,000	189,000	1957	109,000	274,000
1955	34,000	201,000	1958	48,000	257,000

[1] May include some copper refined from scrap.
[2] Includes copper in transit from smelters in the United States to refineries therein.

TABLE 27.—Stocks of copper in fabricators' hands at end of year, 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)
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
1958	446,358	90,401	326,438	177,869	32,452

[1] Includes in-process metal and primary fabricated shapes. Also includes small quantities of refined copper held at refineries for fabricators' account.
[2] Columns (1) plus (2) minus (3) and minus (4) equals column (5).

PRICES

Reports from copper-selling agencies indicate that 1,227,000 tons of domestic refined copper was delivered to purchasers at an average price of 26.3 cents a pound. The average price of foreign copper delivered in the United States was 25.0 cents a pound.

At the beginning of the year the principal primary producers were quoting 27 cents a pound for electrolytic copper, delivered. On January 13 and 14 the price was reduced to 25 cents, where it remained until June. A principal producer raised the price to 26.5 cents on June 16, and a range of 25–26.5 cents continued until all increased on July 17. Two producers raised quotations to 27.5 cents, effective October 13, and the third moved up on October 14. Effective October 24 principal producers were quoting 29 cents, and this price was maintained beyond the year end.

There were more changes in custom smelters' price, the movements responding to changes in economic conditions more closely. The price

TABLE 28.—Average weighted prices of copper deliveries,[1] consumers' plants, in cents per pound

Year	Domestic copper	Foreign copper	Year	Domestic copper	Foreign copper
1954	29.5	29.4	1957	30.1	29.6
1955	37.3	37.5	1958	26.3	25.0
1956	42.5	43.2			

[1] Covers copper produced in the United States and delivered here and abroad and copper produced abroad and delivered in the United States; excludes copper both produced and delivered abroad, whether or not handled by United States selling agencies.

was 25.5 cents at the beginning of the year, fell to 23 cents (the lowest of the year) in February, rose to 26.5 to 27 cents in mid-June, and fluctuated between 25.5 and 27 cents a pound until mid-October, when it rose to 27.5 and later in the month to 30 cents. It declined to 29 cents in late November and was unchanged at the year end.

London Price.—Quotations on the London Metal Exchange were the lowest of the year on February 13, when cash copper was quoted at £160 5s. (equivalent to about 20.03 cents a pound). The price rose virtually without interruption to £260 (about 32.5 cents) on November 6 and then continued unchanged to the year-end. The average for the year £197 13s. 3d. (24.7 cents), was the lowest since 1950, when Government controls were in effect.

TABLE 29.—Average monthly quoted prices of electrolytic copper for domestic and export shipments, f.o.b. refineries, in the United States and for spot copper at London, in cents per pound.

Month	1957				1958			
	Domestic f.o.b. refinery [1]	Domestic f.o.b. refinery [2]	Export f.o.b. refinery [2]	London spot [3] [4]	Domestic f.o.b. refinery [1]	Domestic f.o.b. refinery [2]	Export f.o.b. refinery [2]	London spot [3] [4]
January	35.82	35.526	33.337	33.19	25.46	25.114	21.253	21.52
February	33.05	32.576	30.553	30.67	24.82	24.397	20.079	20.48
March	31.82	31.452	29.555	29.87	24.82	24.018	20.738	21.38
April	31.82	31.517	29.775	30.12	24.82	24.253	21.631	22.08
May	31.82	31.288	29.448	29.64	24.82	24.298	21.944	22.47
June	30.72	30.334	28.410	28.29	25.18	24.689	23.670	24.42
July	29.07	28.690	26.727	27.08	25.95	25.674	24.397	25.01
August	28.46	28.098	25.694	25.92	26.32	26.088	25.179	25.77
September	26.82	26.435	23.926	24.11	26.32	26.081	25.489	26.19
October	26.82	26.335	22.931	23.31	27.40	27.310	28.573	29.61
November	26.82	26.339	23.109	23.51	28.82	28.665	29.476	30.43
December	26.82	26.320	22.418	22.73	28.82	28.583	26.041	27.66
Average	29.99	29.576	27.157	27.36	26.13	25.764	24.123	24.79

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.
[3] Metal Bulletin (London)
[4] Based on average monthly rates of exchange by Federal Reserve Board.

FOREIGN TRADE [5]

Most of the copper imported into the United States entered the country in unmanufactured form and required treatment by milling, smelting, or refining. Most copper exported was in refined form, in

[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.

the first stages of fabrication, or in manufactured items, such as electric motors, automobiles, and equipment of various types.

Imports.—Imports of unmanufactured copper declined 16 percent in 1957 and were the smallest since 1951. All classes of imports, except old and scrap for remanufacture, fell with cruder types—ores and concentrates—dropping most, or 56 and 21 percent, respectively. The unrefined and refined classes decreased 11 and 21 percent, respectively. The total imports from most of the major sources of supply dropped markedly, as follows: Chile 15, Canada 38, Rhodesia and Nyasaland, Federation of, 22, and Peru 27. Some large sources, however, sent more copper to the United States (Mexico 5, Union of South Africa 46, Belgian Congo 52, and the Philippines 12 percent).

Of the principal suppliers of ores, concentrates, and regulus or coarse copper—Chile, the Philippines, Cuba and the Union of South Africa—only the Philippines shipped more copper to the United States than in 1957. Of the unrefined class of imports, Chile supplied 68 percent of the total but shipped 12 percent less than in 1957, and other principal suppliers were Mexico with 15 percent of the total and 7 percent more, Rhodesia and Nyasaland, Federation of, 6 percent and 3 percent less, and the Union of South Africa 5 percent and 138 percent more. Canada, Rhodesia, and Belgian Congo, accounted for 49, 14 and 12 percent, respectively, of the refined imports. Tonnages from the first two declined 28 and 36 percent, respectively, but from Belgian Congo they rose 52 percent.

Resumption of the U.S. tariff on copper July 1 probably affected the movement of copper from some sources to the United States.

Exports.—Of measurable copper exports, refined copper was by far the most important class. Shipments of refined copper rose 11 percent and were the largest since 1929. The most important purchasers took more copper, as follows: United Kingdom was the destination of 30 percent of the total exported and took 29 percent more than in 1957; France 24 and 67 percent, respectively; and West Germany 17 and 30 percent, respectively. On the other hand, Italy, the destination of 8 percent, took 9 percent less than in 1957. Of other classes of unmanufactured copper, insulated copper wire, n.e.s., had the largest tonnage, which, however, was only 11,400 tons compared with 16,600 in 1957. Trade patterns were influenced in part by strikes in Northern Rhodesia, Canada, and Chile, which sent buyers to other than normal suppliers.

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TABLE 30.—Copper (unmanufactured) imported into the United States, 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
1949–53 (average) [2]	4,330	103,058	3,857	190,865	290,643	12,689	605,442
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	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] 3,202	[3] 120,224
Cuba	1,004	15,846				585	17,435
Mexico	165	[3] 3,622	[3] 3,354	37,574	2,924	107	[3] 47,746
Other North America			3			540	543
Total	2,002	[3] 47,105	[3] 4,427	37,574	90,406	[3] 4,434	[3] 185,948
South America:							
Bolivia	1,513	2,937	13				4,463
Chile	1,609	15,678	79	208,460	10,190		236,016
Peru	[3] 3,646	8,027	1,253	14,486	14,224		[3] 41,636
Other South America	24	105	191			666	986
Total	[3] 6,792	26,747	1,536	222,946	24,414	666	[3] 283,101
Europe:							
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				(4)	447	682	[3] 1,129
Total		8,937		(4)	8,093	692	[3] 17,722
Asia:							
Philippines	7	13,053	7				13,067
Turkey				3,496			3,496
Other Asia	21				(5)	1	22
Total	28	13,053	7	3,496	(5)	1	16,585
Africa:							
Belgian Congo					10,221		10,221
Rhodesia and Nyasaland, Federation of		75	2	[3] 17,298	28,055		[3] 45,430
Union of South Africa	9,243	3,838		5,744	1,120		19,945
Total	9,243	3,913	2	[3] 23,042	39,396		[3] 75,596
Oceania	773		224	14,078		5	15,080
Grand total	[3] 18,838	[3] 99,755	[3] 6,196	[3] 301,136	162,309	[3] 5,798	[3] 594,032
1958							
North America:							
Canada	326	6,301	1,248		62,849	4,089	74,813
Cuba	335	13,657				472	14,464
Mexico	162	2,796	2,712	40,030	4,235	88	50,023
Other North America			3			450	453
Total	823	22,754	3,963	40,030	67,084	5,099	139,753
South America:							
Bolivia	581	2,814					3,395
Chile	207	16,174		183,051	713		200,145
Peru	2,017	6,835	1,095	9,132	11,349		30,428
Other South America	50	370	113	5	1	424	963
Total	2,855	26,193	1,208	192,188	12,063	424	234,931

See footnotes at end of table.

TABLE 30.—Copper (unmanufactured) imported into the United States, 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
Europe:							
Germany, West					4,158	15	4,173
Malta, Gozo, and Cyprus		6,384			527		6,911
Sweden					1,063		1,063
United Kingdom					6,958	227	7,185
Other Europe					448	1,208	1,656
Total		6,384			13,154	1,450	20,988
Asia:							
Philippines	4	14,515	3			61	14,583
Turkey				1,094			1,094
Other Asia	14					26	40
Total	18	14,515	3	1,094		87	15,717
Africa:							
Belgian Congo					15,515		15,515
Rhodesia and Nyasaland, Federation of		336	4	16,777	18,052		35,169
Union of South Africa	3,900	9,018		13,655	2,596		29,169
Total	3,900	9,354	4	30,432	36,163		79,853
Oceania: Australia	629			4,438			5,067
Grand total	8,225	79,200	5,178	268,182	128,464	7,060	496,309

[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] Revised figure.
[4] Revised to none.
[5] Less than 1 ton.

TABLE 31.—Copper (unmanufactured) imported into the United States by countries, in short tons, in terms of copper content [1]

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada (including Newfoundland and Labrador)	81,820	89,911	107,034	120,489	[2] 120,224	74,813
Cuba	19,836	18,282	21,122	16,345	17,435	14,464
Mexico	58,429	51,229	49,642	52,835	[2] 47,746	50,023
Other North America	572	406	693	671	543	453
Total	160,657	159,828	178,491	190,340	[2] 185,948	139,753
South America:						
Bolivia	4,282	3,913	3,301	4,500	4,463	3,395
Chile	297,867	266,933	226,772	236,623	236,016	200,145
Peru	19,742	22,450	31,119	42,841	[2] 41,636	30,428
Other South America	536	7	20	772	986	963
Total	322,427	293,303	261,212	284,736	[2] 283,101	234,931
Europe:						
Belgium-Luxembourg	1,402	718	383	800	447	56
France	1,902	1,587	2,128	991	660	1,188
Germany [3]	2,509	81	3,582	2,744	[2] 2,552	4,173
Malta, Gozo, and Cyprus	5,619		4,388	6,945	8,937	6,911
Netherlands	170		2,291	11	22	392
Norway	1,713	5,664	149	5,969		20
Sweden	455		1,024	254	2,689	1,063
United Kingdom	1,020	25	11,650	3,356	2,415	7,185
Yugoslavia	10,911	3,886	2,149	138		
Other Europe	116	17			(4)	
Total	25,817	11,978	27,744	21,208	[2] 17,722	20,988
Asia:						
Japan	11,540	1	75	799	1	26
Philippines	11,806	19,425	13,321	10,911	13,067	14,583
Turkey	4,702	2,664	547	5,586	3,496	1,094
Other Asia	313	32	170	12	21	14
Total	28,361	22,122	14,113	17,308	16,585	15,717
Africa:						
Belgian Congo	1,180	15,539	14,160	12,764	10,221	15,515
Northern Rhodesia	54,284	[5] 61,905	73,464	27,562	45,430	35,169
Southern Rhodesia	717					
Union of South Africa	8,478	13,482	13,089	21,291	19,945	29,169
Other Africa	14			1,085		
Total	64,673	90,926	100,713	62,702	[2] 75,596	79,853
Oceania:						
Australia	3,424	16,672	11,827	19,453	15,075	5,067
Other Oceania	83				5	
Total	3,507	16,672	11,827	19,453	15,080	5,067
Grand total	605,442	594,829	594,100	595,747	[2] 594,032	496,309

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] Revised figure.
[3] Beginning Jan. 1, 1952, classified as West Germany.
[4] Revised to none.
[5] Beginning July 1, 1954, classified as Federation of Rhodesia and Nyasaland.

TABLE 32.—Old brass and clippings from brass or Dutch metal[1] imported for consumption in the United States

[Bureau of the Census]

Year	Short tons		Value	Year	Short tons		Value
	Gross weight	Copper content			Gross weight	Copper content	
1949-53 (average)	17,509	12,740	$4,618,703	1956	6,519	4,310	[2] $3,002,940
1954	5,272	3,657	1,567,574	1957	7,911	4,643	[2] 2,393,405
1955	11,758	8,295	5,170,383	1958	6,763	4,201	1,851,560

[1] For remanufacture.
[2] Data known to be not comparable with other years.

TABLE 33.—Copper imported for consumption in the United States, 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
1949-53 (average) [2]	4,007	$1,816,099	94,110	$43,637,718	3,092	$1,782,006
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	[4] 20,951	[4] 12,216,626	[4] 62,361	[4] 34,258,232	[4] 5,361	[4] 3,212,609
1958	5,926	2,357,336	84,871	37,968,199	4,925	2,172,363

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	
1949-53 (average) [2]	171,134	$89,260,121	292,529	$155,310,624	12,150	$4,688,439	$296,495,007
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	[4] 301,136	179,440,276	162,309	97,024,574	[4] 5,843	[3, 4] 3,048,969	[3, 4] 329,201,286
1958	138,633	66,320,458	124,629	61,139,201	5,849	2,676,350	172,633,907

[1] Excludes 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] Data known to be not comparable with other years.
[4] Revised figure.

TABLE 34.—Copper exported from the United States, in short tons

[Bureau of the Census]

	Ore, concentrates, matte, and other unrefined copper (copper content)	Refined in cathodes, billets, ingots, wire bars, and other crude forms	Rods [1]	Old and scrap	Pipes and tubes	Plates and sheets	Wire and cable, bare [2]	Wire and cable, insulated	Other copper manufactures [2]
1949–53 (average)	439	139,882	5,106	13,788	2,341	632	7,870	18,059	(3)
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	15,656	346,025	1,659	48,989	1,354	265	11,119	21,035	238
1958									
North America:									
Canada	21	2,650	-	394	799	47	153	3,188	142
Cuba	-	803	-	-	110	18	85	1,043	1,354
Mexico	9,850	707	-	-	36	8	151	641	24
Other North America	27	9	-	-	130	13	170	1,297	11
Total	9,898	4,169	-	394	1,075	80	559	6,169	1,531
South America:									
Argentina	21	13,007	-	-	29	-	31	46	1
Brazil	-	8,874	-	-	17	-	3	125	3
Other South America	-	342	-	-	184	10	906	2,816	697
Total	21	22,223	-	-	230	10	940	2,987	701
Europe:									
Belgium-Luxembourg	-	2,156	-	127	2	-	-	27	-
France	-	91,155	-	3,025	-	1	-	116	(4)
Germany, West	941	65,831	-	12,906	9	3	6	25	19
Italy	615	30,547	-	2,079	2	(4)	7	25	-
Netherlands	-	14,250	-	813	-	24	-	86	-
Norway	-	4,174	-	-	(4)	1	11	2	-
Spain	-	66	-	424	(4)	-	1,078	227	1
Sweden	-	7,163	-	-	-	-	7	35	1
Switzerland	-	11,395	-	-	7	(4)	-	5	-
United Kingdom	-	115,462	-	35	-	1	1	93	-
Other Europe	-	4,760	-	702	9	5	524	121	3
Total	1,556	346,959	-	20,111	29	35	1,634	762	24
Asia:									
India	-	957	-	1,244	15	-	18	104	-
Japan	(4)	8,750	-	58	19	-	1	187	18
Other Asia	-	1,138	-	19	194	26	1,098	3,810	25
Total	(4)	10,845	-	1,321	228	26	1,117	4,101	43
Africa	-	-	-	35	46	5	725	376	2
Oceania	-	672	-	-	-	4	55	87	1
Grand total	11,475	384,868	(1)	21,861	1,608	166	5,030	14,482	2,302

[1] Beginning Jan. 1, 1958, not separately classified; included in "Other copper manufactures."
[2] Owing to changes in classifications, 1952–58 data not strictly comparable with earlier years.
[3] Weight not recorded before 1953; 1953—294 tons.
[4] Less than 1 ton.

TABLE 35.—Copper exported from the United States

[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
1949-53 (average)	439	$252,301	187,678	$110,429,054	(2)	$1,140,727	188,117	$111,822,082
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
1958	11,475	5,864,534	[3] 428,015	[3] 229,534,839	[3] 2,302	[3] 1,567,100	441,792	236,966,473

[1] Owing to changes in classifications 1952-58 data not strictly comparable with earlier years.
[2] Weight not recorded before 1953; 1953—294 tons ($352,124).
[3] Beginning Jan. 1, 1958 copper rods not separately classified; included in "Other copper manufactures."

TABLE 36.—Copper-base alloys (including brass and bronze) exported from the United States, by classes

[Bureau of the Census]

Class	1957		1958	
	Short tons	Value	Short tons	Value
Ingots	373	$655,938	276	$505,235
Scrap and other forms	69,996	32,968,165	28,502	10,456,481
Bars, rods, and shapes	585	863,812	565	772,424
Plates, sheets, and strips	789	1,423,807	555	951,029
Pipes and tubes	1,461	2,367,487	1,198	1,594,892
Pipe fittings	1,301	3,362,056	1,528	3.454,384
Plumbers' brass goods	[1] 2,801	[1] 7,681,084	2,670	6,997,664
Welding rods and wire	777	1,659,934	709	1,382,330
Castings and forgings	435	699,405	245	442,462
Powder	209	221,805	283	273,065
Hardware	(2)	3,863,742	(3)	(3)
Semifabricated forms, not elsewhere classified	27	62,968	34	76,400
Other copper-base-alloy manufactures	(2)	488,866	(3)	(3)
Total	(2)	[1] 56,319,069	(2)	[4] 26,906,366

[1] Revised figure.
[2] Weight not recorded.
[3] Beginning Jan. 1, 1958 not separately classified.
[4] Not strictly comparable to earlier years.

TABLE 37.—Unfabricated copper-base alloy[1] ingots, bars, rods, shapes, plates, sheets, and strips exported from the United States

[Bureau of the Census]

Year	Short tons	Value	Year	Short tons	Value
1949-53 [2] (average)	4,082	$3,344,039	1956 [2]	2,233	$3,844,261
1954 [2]	3,492	2,924,161	1957 [2]	1,747	2,943,557
1955 [2]	2,175	3,200,780	1958 [2]	1,396	2,228,688

[1] Includes brass and bronze.
[2] Owing to changes in classifications, data 1953-58 not strictly comparable with earlier years

TABLE 38.—Copper sulfate (blue vitriol) exported from the United States

[Bureau of the Census]

Year	Short tons	Value	Year	Short tons	Value
1949-53 (average)	36,215	$6,391,725	1956	30,177	$8,036,233
1954	29,762	5,780,801	1957	33,644	6,534,037
1955	37,382	8,381,815	1958	7,248	1,175,944

TABLE 39.—Brass and copper scrap imported into and exported from the United States, in short tons

[Bureau of the Census]

	1949-53 (average)	1954	1955	1956	1957	1958
Imports for consumption:						
Brass scrap (gross weight)	17,509	5,272	11,758	6,519	7,911	6,763
Copper scrap (copper content)	12,150	4,752	12,577	5,410	[1] 5,843	5,849
Exports:						
Brass scrap [2]	13,563	93,972	45,260	50,485	69,996	28,502
Copper scrap	13,788	75,749	31,137	25,681	48,989	21,861

[1] Revised figure.
[2] Beginning Jan. 1, 1952, classified as copper-base-alloy scrap (new and old).

TABLE 40.—Copper scrap imported into and exported from the United States, 1958, by countries, in short tons

[Bureau of the Census]

Country	Exports		Imports	
	Unalloyed copper scrap	Copper-alloy scrap	Unalloyed copper scrap (copper content)[1]	Copper-alloy scrap (gross weight)
North America:				
Canada	394	364	3,757	3,414
Cuba		2	353	40
Other North America		7	502	517
Total	394	373	4,612	3,971
South America:				
Venezuela			420	
Other South America		38	4	106
Total		38	424	106
Europe:				
France	3,024	1,784	464	1,452
Germany, West	12,906	7,075	15	5
Italy	2,079	2,732		
United Kingdom	35	58	227	
Other Europe	2,067	2,556	20	
Total	20,111	14,205	726	1,457
Asia:				
India	1,244	650		
Japan	58	12,973	26	35
Philippines			61	1,194
Other Asia	19	258		
Total	1,321	13,881	87	1,229
Africa	35	5		
Grand total	21,861	28,502	5,849	6,763

[1] Changes in Minerals Yearbook 1957, p. 450, should read as follows in short tons: Canada, 3,202; total North America, 4,479; grand total 5,843.

Tariff.—After a 7-year suspension the excise tax on copper was reimposed July 1. The effective rate was 1.7 cents a pound as a result of the GATT meetings in Geneva in 1956. The 1.7-cent rate was to remain in effect when the price of copper was 24 cents a pound or more; if the price dropped below 24 cents, the tariff was to be 2 cents a pound. On June 11, 1958, a bill to continue suspension of duties on metal scrap to June 30, 1959, was signed by President Eisenhower.

WORLD REVIEW

World demand for copper declined in 1958, largely because of the sharp decrease in the United States caused by the industrial recession that characterized late 1957 and early 1958. Many leading world producers voluntarily reduced production rates; and labor strikes, particularly in Canada and Northern Rhodesia, caused additional curtailment in output. As a consequence, world production dropped 4 percent to 3,740,000 tons in 1958, with all leading copper-producing countries, except possibly the U.S.S.R., sharing the decrease. Production dropped 10 percent in the United States, 8 in Northern Rhodesia, 5 in Chile, 3 in Canada, and 2 in Belgian Congo.

TABLE 41.—World mine production of copper, by countries, in short tons [1] [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	261,785	302,732	325,994	354,860	359,109	346,816
Cuba	20,194	17,500	20,800	18,200	18,000	14,343
Mexico	67,220	60,413	60,269	60,478	66,800	71,609
United States	888,446	835,472	998,570	1,104,156	1,086,859	979,329
Total	1,237,645	1,216,117	1,405,633	1,537,694	1,530,768	1,412,097
South America:						
Bolivia (exports)	5,245	4,034	3,855	4,896	4,320	3,168
Brazil				730	880	1,400
Chile	415,928	400,861	477,873	539,844	535,306	509,541
Peru	34,421	42,356	47,844	50,966	63,023	54,852
Total	455,594	447,251	529,572	596,436	603,529	568,961
Europe:						
Austria	2,289	3,381	2,841	2,579	2,574	2,695
Bulgaria [3]	2,200	6,600	6,900	5,800	7,700	8,800
Finland	20,666	23,150	23,700	23,150	28,700	31,820
France	634	88	580	450	440	770
Germany:						
East [3]	13,000	22,800	23,100	23,100	24,250	24,250
West	1,833	2,600	1,335	1,076	1,203	1,156
Ireland						[3] 5,300
Italy	142	357	365	373	310	660
Norway	15,688	14,980	15,419	16,488	16,787	16,535
Poland	[4] 2,900	5,300	6,100	8,000	8,300	[3] 8,800
Portugal	625	475	600	1,066	619	[3] 1,200
Spain [5]	8,365	7,951	6,726	7,525	11,077	8,230
Sweden	16,807	14,565	17,275	18,436	19,924	21,369
U.S.S.R. [3] [6] [7]	280,000	352,000	385,000	430,000	470,000	470,000
Yugoslavia [7]	37,585	33,394	31,151	32,390	37,186	37,117
Total [3] [6]	403,000	488,000	521,000	570,000	629,000	639,000

See footnotes at end of table.

TABLE 41.—World mine production of copper, by countries, in short tons [1] [2]—Con.

Country	1949–53 (average)	1954	1955	1956	1957	1958
Asia:						
Burma [3]	45	110	165	165	143	143
China [3] [7]	5,700	8,800	11,000	13,000	16,500	[8] 16,500
Cyprus (exports)	26,143	30,059	26,179	39,497	43,676	36,614
India	7,101	8,300	8,500	8,800	9,000	9,150
Japan	50,156	73,056	80,466	86,497	90,066	89,053
Korea, Republic of	432	550	1,760	970	710	590
Philippines	12,359	15,817	19,247	29,722	44,513	51,842
Taiwan	939	550	1,100	1,593	1,840	1,700
Turkey [7]	18,277	27,042	26,234	27,297	29,896	24,835
Total [3] [6]	121,200	164,300	174,700	207,500	236,300	230,400
Africa:						
Algeria	86	236	74	209	476	435
Angola	1,218	3,691	2,011	3,154	3,735	3,273
Belgian Congo [7]	204,848	243,424	259,161	275,538	267,028	262,054
French West Africa	-----------	90	152	105	-----------	-----------
Morocco: Southern Zone	520	884	823	852	694	1,216
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	347,912	438,708	395,308	445,466	480,313	441,073
Southern Rhodesia	128	298	1,179	1,931	3,226	8,429
South-West Africa	13,024	15,668	23,588	28,980	29,910	30,975
Tanganyika [9]	204	478	650	1,276	1,178	1,770
Union of South Africa	37,352	46,638	49,239	51,252	50,959	54,615
Total	605,292	750,115	732,185	808,763	837,519	803,840
Oceania: Australia	22,748	45,760	50,956	59,406	63,508	82,269
World total (estimate)	2,850,000	3,110,000	3,410,000	3,780,000	3,900,000	3,740,000

[1] In addition to the countries listed, Albania, Czechoslovakia, Hungary, and Iran also produce copper, but production data are not available. No estimates are included in the total.
[2] 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.
[3] Estimate.
[4] Average for 1950–53.
[5] According to Yearbook of American Bureau of Metal Statistics. These data do not include content of iron pyrites, the copper content of which may or may not be recovered.
[6] Output from U.S.S.R. in Asia included with U.S.S.R. in Europe.
[7] Smelter production.
[8] Data represents estimate of 1957 production; however, 1958 production was probably much greater.
[9] Copper content of exports and local sales.

NORTH AMERICA

Canada.—The uptrend in mine output of copper, in progress since 1954, and the establishment of new annual production peaks that began in 1955 were interrupted in 1958. The downturn resulted chiefly from a prolonged yearend labor strike at International Nickel Co. of Canada properties in Ontario, largest copper producer in Canada. Output of refined copper was 330,000 tons compared with 324,000 in 1957. Consumption of refined copper was 123,000 and 118,000 tons, respectively, in the 2 years. There was considerable exploration, notably in the Mattagami Lake area in Northern Quebec, and the Highland Valley area in British Columbia.

The Export Control List, issued as P.C. 1958–1158, on August 15, 1958, relaxed controls over the export of metals and minerals. All forms of copper thus were permitted to be exported without a license.

At the International Nickel Co. of Canada, Ltd., in *Ontario* operations were at less than capacity levels for the first time in almost a decade. The sharp decline in nickel consumption during the year led to three successive curtailments in production, which also reduced

TABLE 42.—World smelter production of copper, 1949–53 (average) and 1954–58, by countries, in short tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	228, 608	253, 365	288, 997	328, 458	323, 540	329, 785
Mexico	57, 437	48, 527	49, 730	52, 089	62, 061	67, 109
United States [2]	995, 407	945, 899	1, 106, 526	1, 231, 352	1, 178, 145	1, 069, 052
Total	1, 281, 452	1, 247, 791	1, 445, 253	1, 611, 899	1, 563, 746	1, 465, 946
South America:						
Chile	391, 722	372, 818	447, 292	506, 256	496, 736	482, 143
Peru	24, 826	29, 178	34, 862	35, 005	46, 137	42, 282
Total	416, 548	401, 996	482, 154	541, 261	542, 873	524, 425
Europe:						
Austria	6, 917	10, 357	11, 363	11, 799	10, 450	10, 525
Bulgaria [3]	[4] 1, 400	3, 000	4, 000	5, 000	5, 600	6, 600
Finland	19, 347	23, 551	24, 583	24, 767	28, 469	33, 873
Germany:						
East [3]	21, 200	28, 000	30, 000	33, 000	33, 000	33, 000
West [5]	209, 893	258, 271	286, 306	279, 463	279, 231	295, 609
Italy	122	140	1, 024	373	310	[3] 660
Norway	10, 827	14, 210	15, 142	17, 013	17, 357	19, 261
Poland	[5] 13, 200	9, 000	17, 300	22, 400	22, 000	19, 180
Spain	5, 880	6, 374	6, 477	6, 940	6, 600	5, 556
Sweden	16, 968	18, 422	19, 159	18, 673	21, 472	22, 268
U.S.S.R. [3 6]	280, 000	352, 000	385, 000	430, 000	470, 000	470, 000
Yugoslavia	37, 585	33, 394	31, 151	32, 390	37, 186	37, 117
Total [3 6 7]	623, 300	757, 000	832, 000	882, 000	932, 000	954, 000
Asia.						
China [3]	5, 700	8, 800	11, 000	13, 000	16, 500	[8] 16, 500
India	6, 963	8, 020	8, 155	8, 543	8, 790	8, 782
Japan	51, 246	75, 914	89, 353	101, 946	120, 013	113, 957
Korea, Republic of	172	288	362	1, 000	874	885
Taiwan	583	1, 012	1, 295	1, 659	1, 883	1, 833
Turkey	18, 277	27, 042	26, 234	27, 297	29, 896	24, 835
Total [3 6]	82, 900	121, 100	136, 400	153, 400	178, 000	166, 800
Africa:						
Angola	1, 225	1, 909	861	1, 425	1, 791	1, 533
Belgian Congo	204, 848	243, 424	259, 161	275, 538	267, 028	262, 054
Rhodesia and Nyasaland, Fed. of: Northern Rhodesia	340, 249	424, 045	384, 357	429, 503	466, 157	419, 943
Uganda	-----	-----	-----	168	8, 361	12, 130
Union of South Africa	36, 416	45, 152	47, 480	48, 681	48, 229	53, 406
Total	582, 738	714, 530	691, 859	755, 315	791, 566	749, 066
Oceania: Australia	21, 203	42, 613	41, 932	54, 914	56, 985	72, 360
World total (estimate)	3, 010, 000	3, 290, 000	3, 630, 000	4, 000, 000	4, 070, 000	3, 930, 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: 1949–53 (average) 894,163; 1954, 834,381; 1955, 1,007,311; 1956, 1,117,580; 1957, 1,081,055; and 1958, 992,918.
3 Estimate.
4 Average for 1950–53.
5 Includes scrap.
6 Output from U.S.S.R. in Asia included with U.S.S.R. in Europe.
7 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.
8 Data represents estimate of 1957 production; however, 1958 production was probably much greater.

TABLE 43.—Copper produced (mine output) in Canada, by Provinces, in short tons [1]

Province	1949–53 (average)	1954	1955	1956	1957	1958 (preliminary)
British Columbia	23,002	25,088	22,127	21,682	15,411	6,759
Manitoba	14,480	12,274	19,380	17,973	18,551	13,007
New Brunswick			35	6	5,738	355
Newfoundland	3,102	3,481	3,052	3,108	4,535	18,628
Northwest Territories	1				165	453
Nova Scotia	234	991	1,027	404		
Ontario	122,997	140,776	146,407	156,271	171,703	140,736
Quebec	66,669	83,930	101,021	122,300	112,409	131,854
Saskatchewan	31,300	36,192	32,945	33,116	30,597	37,673
Total	261,785	302,732	325,994	354,860	359,109	349,465

[1] Dominion Bureau of Statistics, Department of Trade and Commerce, Government of Canada, Preliminary Report on Mineral Production, 1958.

copper production. A labor strike from September 24 to December 22 cut output further. The ore mined by the company in the Sudbury district totaled 9.5 million tons, of which 8.9 million tons was from underground operations and 0.6 million tons was open pit, compared with 16.0, 14.9, and 1.1 million tons, respectively, in 1957. The company delivered 105,300 tons of copper during 1958, of which 75 percent went to Canada and United Kingdom. Reimposition of the United States duty in July was said to have virtually ended deliveries to United States markets.

Falconbridge Nickel Mines, Ltd., the other important copper-producing company in *Ontario*, was also more important as a producer of nickel than copper. Deliveries of 15,400 tons of copper in 1958 exceeded the previous record of 13,200 tons in 1956. Ore deliveries from company mines established a new peak at 2 million tons. The Falconbridge and Longvack mines increased production, and preproduction work at Fecunis yielded a larger tonnage, whereas output slackened at the Hardy mine and none came from the Mount Nickel mine, which was closed in the latter part of 1957. Ore purchased from Norduna added materially to the quantity of ore delivered to treatment plants. The Fecunis mine opening was delayed, but it was expected to be in operation by mid-1959. The new smelter was blown in on January 16, 1958.

In its first full year of production Geco Mines, Ltd., Manitouwadge area, milled 1,286,000 tons of ore averaging 2.48 percent copper, 2.31 percent zinc, and some gold and silver. Copper content of concentrates was 30,500 tons. The copper concentrate was shipped to the Noranda smelter and the zinc concentrate went to a United States plant for treatment.

At the Horne mine of Noranda Mines, Ltd., in *Quebec* 1,335,000 tons of ore was mined. The smelter treated 627,000 tons of Horne ore and concentrate and 749,000 tons of material for others and produced 28,300 tons of copper from Horne and 107,100 tons for others. The copper was recovered at the electrolytic copper refinery of the Noranda subsidiary, Canadian Copper Refiners, Ltd., Montreal East.

The increased capacity of the Montreal East refinery of Canadian Copper Refiners, Ltd., subsidiary of Noranda, was available for larger receipts of crude materials from the Noranda and Gaspé smelters.

Copper production rose to 239,000 tons compared with 175,000 tons in 1957.

Ore production at the mine of the Gaspé Copper Mines, Ltd., subsidiary of Noranda, was 2,302,000 tons, and 2,212,000 tons, averaging 1.64 percent copper, was milled. A total of 247,000 tons of concentrate and fluxing ore, including 44,000 tons of customs concentrate, was smelted. Anode production was 43,500 tons, including 8,200 tons of custom copper. The average grade of ore treated was expected to decline to about 1.29 percent copper, about the average grade of the 64 million tons of ore reserves.

At the Quemont Mining Corp., Ltd., mine, which adjoins the Horne mine, 859,000 tons of ore, averaging 1.31 percent copper and more zinc, was milled. The copper concentrate produced, containing 10,200 tons of copper, was smelted at the Noranda smelter.

The mill of the Waite Amulet Mines, Ltd., subsidiary of Noranda, treated 288,000 tons of ore and produced concentrate containing 9,400 tons of copper.

The Normetal Mining Corp., Ltd., milled 355,000 tons of ore averaging 3.2 percent copper and a higher percentage of zinc in 1958. The concentrate produced contained 10,800 tons of copper. Copper concentrate was shipped as usual to Noranda for smelting.

East Sullivan Mines milled 896,000 tons of ore, averaging 1 percent copper, with gold, silver and zinc values in 1958, compared with 905,000 tons, averaging 1.18 percent copper and other values, in 1957.

Opemiska Copper Mines milled 353,000 tons of ore averaging 3.95 percent copper, with gold and silver values, in 1958. Copper production was 13,000 tons compared with 8,600 tons in the 10 months operated in 1957. Mine and mill expansion, still underway at the yearend, had increased capacity to a little over 1,000 tons of ore a day, and the daily rate was expected to be 2,000 tons by November 1959.

In the fiscal year ended June 30, 592,000 tons of ore, averaging 2.07 percent copper, with gold and silver values, was milled by Campbell Chibougamau Mines, Ltd., resulting in an output of concentrates containing 11,500 tons of copper, compared with 618,000 tons of ore and 13,900 tons of copper in 1956–57.

Saskatchewan and *Manitoba* together produced 15 percent of Canada's total in 1958, largely from the Hudson Bay and Sherritt Gordon properties.

The Hudson Bay Mining and Smelting Co., Ltd., mined and hoisted 1,518,000 tons of ore, averaging 2.77 percent copper and 4.2 percent zinc, from the Flin Flon mine and a total of 120,000 tons containing a much higher percentage of copper from the Schist Lake, North Star, and Birch Lake mines. The mill treated 1,670,000 tons from the mines, and 5,000 tons of Birch Lake and Flin Flon ore was delivered for direct smelting. A total of 335,000 tons of copper concentrate, averaging 13.86 percent copper, was produced. The smelter treated 448,000 tons of Hudson Bay concentrates, residues, and direct smelting ores. Refined-copper production amounted to 45,500 tons, compared with 44,300 tons in 1957.

Sherritt Gordon Mines, Ltd., mined and milled 892,000 tons of ore at its property at Lynn Lake chiefly for its nickel content but recovered 4,900 tons of copper in concentrates. Mill expansion underway was expected to be completed by mid-1959.

Production at the Britannia mine, of the Howe Sound Co., *British Columbia*, was halted March 1 owing to adverse conditions in the copper market; but, following a reversal in market conditions, was expected to be resumed in March 1959.

In *New Brunswick* Heath Steele Mines, Ltd., subsidiary of American Metal Climax, Inc., suspended its breaking-in operations in the spring of 1958 at its lead-zinc-copper mine near Newcastle because of low metal prices. The mine and mill were placed on a standby basis, awaiting improved economic conditions.

Only 1 ton of refined copper was imported in 1958, compared with 4,200 in 1957.

Exports of copper in ore, matte, and regulus, etc., totaled 30,300 (46,500 in 1957) tons; Norway was the destination of 14,900 (13,800), the United States 10,700 (30,500), Japan 2,200 (none), and the remainder went (in smaller quantities) to the United Kingdom, Belgium, and West Germany. Exports of ingots, bars, and billets in 1958, as compared with 1957, were as follows, by countries of destination, in short tons:

Destination:	*1957*	*1958*
United Kingdom	84, 672	90, 927
United States	86, 300	63, 865
France	12, 502	20, 806
Germany, West	1, 315	14, 051
India	3, 968	11, 652
Netherlands	341	9, 089
Italy	1, 092	6, 137
Switzerland	1, 567	2, 380
Brazil	1, 541	1, 994
Belgium	------	1, 008
Other	5, 496	2, 729
Total	198, 794	224, 638

In addition, 14,400 (11,800) tons of rods, strips, sheet, and tubing was shipped, of which 4,000 (4,400) went to Switzerland, 4,000 (2,300) to the United States, and 3,300 (2,400) to United Kingdom. Copper scrap slag skimmings totaling 11,100 (12,300) tons also were exported in 1958.

SOUTH AMERICA

Chile.—Reduced production at the Chuquicamata and Andes mines was counterbalanced in part only by an increase at the El Teniente mine; output at small- and medium-size mines was little changed. The overall result was a 5-percent decline in copper output. Chile continued to rank second among world copper-producing countries.

There was a 32-percent rise in the cost of living, compared with 17 percent in 1957, according to the annual report to stockholders of the Kennecott Copper Corp. Increases to the company in costs of labor, goods, and services, it stated, were substantially offset by increases in the rate of exchange allowed the company for its peso requirements; in 1958 the rate was 793 pesos and in 1957 616 pesos to the U.S. dollar. In December 1958 the currency was devalued further to 989 pesos to the dollar.

TABLE 44.—Principal types of copper exported from Chile, January–August 1958, in short tons

Destination	Refined		Standard (blister)	Total
	Electrolytic	Fire-refined		
Germany, West	16,924	4,453	25,244	46,621
Italy	7,269	2,834	3,483	13,586
Netherlands	25,809	----------	----------	25,809
Spain	----------	----------	6,970	6,970
Sweden	5,868	----------	----------	5,868
Switzerland	----------	2,127	----------	2,127
United Kingdom	14,167	32,238	7,497	53,902
United States	61	----------	115,526	115,587
Other	6	112	----------	118
Total	70,104	41,764	158,720	270,588

At the El Teniente mine of the Braden Copper Co., subsidiary of the Kennecott Copper Corp., 11.3 million tons of ore was treated and 191,600 tons of copper produced, compared with 10.9 million and 172,700 tons, respectively, in 1957. The fact that copper demand in Europe, where Braden copper is sold, continued strong made it possible for Braden to operate at capacity within available hydroelectric power limits and, with other favorable factors, permitted establishment of alltime records for ore and copper production. Replacement with modern equipment of old flotation machines was completed in early 1958 and permitted improved metallurgy and lower unit costs. At the smelter a modern 75-ton-per-day sulfuric acid plant was installed and placed in operation.

At the Chuquicamata mine of Chile Exploration Co., subsidiary of The Anaconda Co., 234,600 tons of copper was produced, compared with 263,400 tons in 1957. Operations were adversely affected by voluntary curtailments in the first quarter owing to lower copper demand, and by a 50-day labor strike in April and May. Capacity operations characterized the remainder of the year. Conversion of a portion of the electrolytic tankhouse for refining blister was completed. Further conversion of sections was continuing and when finished was to increase electrolytic refining capacity from 4,000 tons a month to 7,000. Additional grinding capacity at the mill is mentioned in the chapter section on Technology.

The Andes Copper Mining Co., another subsidiary of Anaconda, produced 36,000 tons of copper compared with 43,300 in 1957. Development at the El Salvador mine was directed toward production of ore for the start of concentrator operations in April 1959 and full production by mid-year. The mill under construction was designed to handle up to 25,000 tons a day. The concentrate in slurry form was to be piped 17 miles to Llanta, thence shipped by rail to the smelter at Potrerillos.

The Africana mine of the Santiago Mining Co., another Anaconda subsidiary, produced 14,300 tons of concentrate, averaging 28.73 percent copper, which was shipped to the United States for smelting and refining.

At the Rio Blanco property, Aconcagua and Santiago Provinces, on which the Cerro de Pasco Corp. held options, exploration and development, including core drilling and underground work, as well as investigation of engineering and economic factors, was continued. In all, 112 million tons of ore averaging 1.6 percent copper was indicated thus far, of which 81 million was considered proved ore. Tentative plans call for mining the deposit at a rate of about 11,000 tons a day, using the block caving method of mining. Options to purchase the property were extended to October 1, 1960, and in the latter part of 1958 Cerro de Pasco purchased a 16.8-percent interest in Rio Blanco Copper Corp., Ltd., whose wholly-owned Chilean subsidiary owned the Rio Blanco mining claims.

The Paipote smelter, operated by the Government's Empresa Nacional de Fundiciones, produced 22,700 tons of blister copper compared with 17,600 tons in 1957. In addition, output from Chile's small- and medium-size copper mines was 28,600 tons of copper in ores, concentrates, and cement copper compared with 33,000 in 1957.

In addition to the exports shown in table 44, 17,000 tons of ore and concentrate was shipped in the first 8 months, of which 7,600 tons went to the United States, 7,300 to West Germany, 1,700 to Japan, 200 to Belgium, and the remaining 200 to Sweden and the Netherlands.

Peru.—Largely as a result of the world oversupply of copper in early 1958, production was curtailed, and the total for the year was 13 percent less than in 1957—the first decrease in 6 years. The Cerro de Pasco Corp. reported that the foreign exchange value of the Peruvian sol declined sharply following withdrawal of support of the exchange market by the Banco Central de Reserva on January 21. The exchange rate had been relatively stable since March 1954 at about 19 to the dollar, fell to 24.60 to the dollar by the yearend, and was continuing downward. Cerro de Pasco's production of copper was 41,400 tons in 1958 compared with 45,300 in 1957, of which 32,700 was from corporation and 33,800 from leased ores. The bulk of Cerro's production of blister was being refined at the Oroya refinery. Since purchase of the Lewin-Mathes electrolytic refinery at Monsanto, Ill., in mid-1957, the excess blister has gone to the United States for refining.

Stripping at the Toquepala mine of Southern Peru Copper Corp. proceeded normally, according to the annual report to stockholders of American Smelting and Refining Co. and the construction program of the general contractor progressed at a faster rate than anticipated. The new date for completion of the entire project was early 1960. The 114-mile industrial railroad from the smelter to Ilo and thence to Toquepala was completed in November 1958 and put into operation. Excellent progress was reported on construction of the concentrator, and construction at the smelter, the powerplant and on the transmission line from the powerplant to Toquepala was reported ahead of original expectations.

EUROPE

Ireland.—The new 4,000-ton mill of St. Patrick's Copper Mines, Ltd., a subsidiary of Mogul Mining Corp. (Toronto, Canada) at Avoca, was to have been completed by midyear.[6] Ore averaged

[6] Coughlin, William, Ireland Prepares for a Reconnaissance in Mining: Eng. and Min. Jour., vol. 159, No. 5, May 1958, pp. 82–84.

slightly more than 1 percent copper, with pockets running 7–8 percent. Production was expected to yield 160 tons per day of concentrates containing 25 percent copper, and 500 tons of pyrite concentrate. Development was being undertaken by the Emerald Isle Mining Co., a subsidiary of Can-Erin Mining Corp. of Toronto, Canada, at Allihies, and other copper and other deposits were being investigated. Exploration had disclosed reserves at Avoca amounting to 20 million tons.[7]

United Kingdom.—Consumption of primary and secondary copper in the United Kingdom (the world's second largest copper-consuming country) rose to 598,800 tons from 568,400 tons in 1957. Approximately 150,000 tons of copper in scrap was consumed in each year. Of the 1958 total, 578,400 tons of refined copper and 86,900 tons in scrap were consumed for semimanufactured products, and 20,300 tons of refined copper and 62,500 tons in scrap were for castings, copper sulfate, and miscellaneous products. Inventories of blister and refined copper, exclusive of Government stocks, fell from 102,500 tons at the end of 1957 to 66,200 at the end of 1958.

On November 3 the British Board of Trade announced that it would offer 10,000 tons of Government stockpile copper for "delivery and pricing" from mid-November to the end of January 1959; on November 25 it indicated that 7,500 tons more would be offered before the middle of January and on December 31 that the remaining Government stocks—30,000 tons—would be disposed of in February to November 1959.

Production of copper sulfate dropped from 49,200 tons in 1957 to 31,400 in 1958.

According to the British Bureau of Nonferrous Metal Statistics, imports of copper into the United Kingdom in 1957 and 1958 were as follows:

TABLE 45.—Copper imported into the United Kingdom, in short tons

Country	1957			1958		
	Blister	Electrolytic	Fire-refined	Blister	Electrolytic	Fire-refined
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	124,617	118,098		90,583	120,400	
United States		82,630	10,639		105,944	6,858
Chile	3,298	45,211	40,632	16,072	24,211	49,842
Canada		85,794			89,200	
Belgian Congo		3,360			3,920	
Peru		2,669			2,875	
Norway		1,228			1,858	
Belgium		675			1,339	
Union of South Africa		225	532			840
Japan					140	
Turkey	999					
Sweden		529				
Germany, West		84				
Other countries	635	34	1	729	579	
Total	129,549	340,537	51,804	107,384	350,466	57,540

[7] Mining Journal, Copper and Pyrites at Avoca: Vol. 251, No. 6431, Nov. 21, 1958. pp. 560–561.

Exports and reexports of refined copper were 65,800 tons (53,200 in 1957), of which 18,300 (9,500) went to West Germany, 9,000 (4,800) to the United States, 6,200 (4,300) to Argentina, 4,100 (none) to the U.S.S.R., 3,400 (2,400) to the Netherlands, 3,200 (1,500) to India, 3,100 (none) to China, 2,500 (none) to Hungary, and the remainder in quantities of less than 2,000 tons each to other countries. France took 14,800 tons in 1957 but only 1,700 in 1958. No blister copper was reexported in 1958 compared with 551 tons in 1957.

Yugoslavia.—Copper output remained at the 1957 level despite an increase of 16 percent in ore production, indicating a drop in ore grade. According to a recent report,[8] reconstruction of the copper smelter at the Bor mine, in connection with the opening of the Majdanpek mines, was well under way. The normal-gage railway to Bor was nearly finished, and the sulfuric acid plant and the buildings for the reverberatory furnace and converter at Bor were half finished. All sections were expected to be in operation in 1961. The Majdanpek mines north of Bor were prepared for a 6,000-ton-per-day ore output, and foundations for the flotation mill were being laid.

ASIA

India.—Reserves of copper ore are not large according to a recent report.[9] The only economic deposits are in the Singbhum copper belt in Bikar. India's ore reserve is calculated at not more than 4 million tons, averaging about 2–2.5 percent copper. Only one company—the Indian Copper Corp.—was mining copper, and production was about 8,000 tons of fire-refined metal annually, or only about one-fifth of India's total copper consumption. Fire-refined copper needs appeared to be holding steady, while those for electrolytic copper were increasing. The Indian Copper Corp. proposed extensive program of prospecting and development was aimed at increasing present output and making India less dependent on copper imports. The company was granted a license by the Government for producing electrolytic copper and proposed an 8,400-ton plant for completion by 1961.

Philippines.—Production advanced for the fifth successive year and established a new alltime peak; it was 3.7 times as large as in 1953. New and expanded production at the properties of the Lepanto and Atlas companies chiefly caused the rapid gains.

Copper production of 14,400 tons by the Lepanto Consolidated Mining Co. slightly exceeded the output in 1957 and ranked second only to the alltime peak rate in 1954. Ore mined averaged 3.26 percent copper and that milled 3.33 percent.

A total of 3.5 million tons of ore, averaging 0.69 percent copper, was mined by open-pit methods and milled at the Toledo mine of Atlas Consolidated Mining and Development Corp. Concentrates produced contained 20,800 tons of copper. Mining was curtailed in the early months of the year by an extended drought, but the company was taking steps to reduce water problems in the future.

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[8] Mining World Catalogue, Survey and Directory Number, 1959: Vol. 21, No. 5, Apr. 25, 1959, p. 143.

[9] Bracken, Katherine W. (American consul), Copper Industry and Trade in India: State Dept. Dispatch 400, Calcutta, India, Apr. 10, 1958, 23 pp.

AFRICA

Belgian Congo.—Copper production dropped for the second successive year, following a 7-year rise. A total of 262,100 tons was produced, or 2 percent less than in 1957 and 5 below the alltime record rate in 1956. The Union Minière du Haut-Katanga was, as heretofore, the only producer.

A total of 7.6 million tons of ore was produced, largely (5.9 million tons) by open-pit methods, in the Western Group of mines, consisting of the Kamoto (2.0), Musonoi (1.8), Ruwe (1.8), and Kolwezi (0.3). At the Prince Leopold mine, in the Southern Group, 1.2 million tons was producd by underground methods. A new method of mining with metal supports was said to be working well. This method had eliminated a great part of the wooden timber, thus reducing the fire hazard. Some uranium-radium ore from the Shinkolobwe mine and small quantities of ore from other properties made up the remainder of the total tonnage produced.

The Kolwezi mill treated 4.1 million tons of ore and produced 680,000 tons of concentrates, averaging 27.1 percent copper, with cobalt values. The first three sections of the mill treated siliceous oxidized ore, principally from Kamoto and Ruwe mines. The fourth and fifth were fed with mixed oxide-sulfide ore from Musonoi pit and from stocks. The mixed ore was treated by sulfidizing and flotation. The Kipushi mill treated 1.1 million tons, the Ruwe washing plant treated 1.8 million tons, and the remainder was treated at the Shinkolobwe and Ruashi plants.

Copper production came from the following plants:

	Short tons
Lubumbashi (blast furnaces and converters)	106,243
Shituru works (lixiviation, electrolysis, and refining)[1]	143,820
Electric smelters of Panda:	
Crude copper exported	8,792
Recoverable copper contained in white cobalt alloy	629
Recoverable copper contained in zinc concentrates sold, as well as in copper muds	205
	259,689

[1] This figure includes 4,427 tons of recoverable copper in cathodes exported.

The first stage of the fully mechanized electrolytic plant at Luilu was to be completed and the plant commissioned in 1960. It was to have a capacity of 55,000 tons of copper and 1,900 tons of cobalt. Completion of the second stage was to be postponed until 1962.

Rhodesia and Nyasaland, Federation of.—*Northern Rhodesia* ranked behind the United States, Chile, and probably the U.S.S.R. in copper production in 1958. Output fell 8 percent below the record rate in 1957.

Nchanga Consolidated Copper Mines, Ltd., Rhokana Corp., Ltd., and Bancroft Mines, Ltd., decided to reduce their combined output by 10 percent for 1 year, beginning April 1, 1958, conforming to the programs of other large world producers. The proposed cut was to be made by abandoning temporarily newly begun production at the substantially higher cost Bancroft mine and by adjusting outputs at Rhokana and Nchanga mines. Rhokana and Nchanga undertook to make payments sufficient to finance cost of development work and pumping operations at Bancroft and to cover the payment of interest on loans. This overall plan permitted production at Nchanga and Rhokana to be expanded.

Northern Rhodesia's output was cut sharply by labor strikes that halted operations from September 15 to November 5. A general wage increase was granted all African miners in the Rhodesian Copperbelt, effective December 1. The increase amounted to 7 cents (US) per shift worked.

In the fiscal year ended June 30 an increased quantity of power was imported from Le Marinel hydroelectric station in the Belgian Congo. The fact that unit costs were lower was beneficial to copper producers. It was anticipated that the Copperbelt would be receiving power from the new Kariba hydroelectric project on the Zambezi River by 1960, thus making the area independent of Belgian Congo power.

A total of 5,708,000 tons of ore, averaging 1.87 percent copper, was mined and milled by Roan Antelope Copper Mines, Ltd., in the fiscal year ended June 30, 1958, and concentrate produced contained 89,600 tons of recoverable copper. A voluntary cut to 90 percent in the production rate was aimed at helping to correct the then world situation of oversupply. The average copper content of ore mined dropped to 1.87 percent from 1.95 percent in fiscal 1956–57. A total of 89,500 tons of molten blister copper was produced, of which 85,500 tons was of fire-refinable grade and 4,000 tons went to the Ndola plant for electrolytic refining. The Roan Antelope smelter produced, in addition to company copper, 18,900 tons for Chibuluma and 1,300 tons for Nchanga, so that the total smelter output was 109,700 tons—the highest in history.

Mufulira Copper Mines, Ltd., produced 104,100 tons of copper in the fiscal year ended June 30, 1958, compared with 110,500 tons in the preceding fiscal year. Work was progressing on the £16 million project at Mufulira West, which was to increase operations of this company by 50 percent in about 5 years.

The Chibuluma Mines, Ltd., output of 30,400 tons of blister copper in the fiscal year ended June 30, 1958, compared with 16,200 tons in the preceding year, was made possible by smelting abnormally high concentrate stocks accumulated before June 30, 1957, owing to temporary smelter capacity shortage.

During June part of the first stage of the new Ndola electrolytic refinery of Ndola Copper Refineries, Ltd., was brought into operation, and by July the entire "stage 1" of the refinery was commissioned. Production of refined copper wirebars began in September and the proposed annual rate of 61,600 tons was expected to be achieved shortly. The capacity was to be doubled by addition of another unit, already under construction.

A total of 4,480,000 tons of ore was hoisted and 4,472,000 tons, averaging 2.53 percent copper, milled by the Rhokana Corp., Ltd., in the fiscal year ended June 30, 1958. Concentrate production was 372,000 tons, averaging 27.79 percent copper and 1.428 percent cobalt. Copper production totaled 96,600 tons, of which 32,700 tons was blister and 63,900 tons electrolytic copper. The smelter produced 206,200 tons of blister and anode copper, of which 29,200 was blister and 70,600 anode for Rhokana, 25,900 blister and 59,800 anode for Nchanga, 18,000 blister for Bancroft, 2,000 blister for Kansanshi and the remainder for others.

Copper production was at a new record-high level at mines of Nchanga Consolidated Copper Mines, Ltd., in the fiscal year ended March 31, 1958. A total of 3,564,000 tons of ore, averaging 4.87 percent copper, was mined, 3,544,000 tons was milled and 149,000 tons of copper in concentrates produced. A total of 135,700 tons of copper was produced, 23,900 tons of blister and 111,800 tons of electrolytic. Expanded production was due mainly to operations that began in April 1957, at the Nchanga open pit. In April 1958 mining began at the Chingola open pit. Underground operations at the Nchanga West ore body continued at about the previous rate.

TABLE 46.—Copper exported from Federation of Rhodesia and Nyasaland in 1958, in short tons

Destination	Ore and concentrates	Blister	Electrolytic			Copper slimes
			Bar and ingot	Cathodes	Wire-bars	
Argentina			330		9,413	
Belgium	1	101	353	1,896	3,875	209
Brazil			16		8,370	
France		1,779	4,360	1,399	18,789	
Germany, West	5,601	35,788		4,791	5,629	
India		2,265	2,711		20,053	
Italy		448			11,789	
Japan	1,333					
Netherlands	8	5,905	1,010	3,001	7,484	
Spain	2,250	560				
Sweden	2,262		280		17,232	
Union of South Africa	5,480	204	716	19	11,622	
United Kingdom		99,560	2,801	12,017	118,278	
United States	732	15,584		2,042	15,884	100
Other countries		336			963	
Total	17,667	162,530	12,577	25,165	249,381	309

Rhodesia Copper Refineries, Ltd., produced 180,600 tons of refined copper in the fiscal year ended June 30, or 163,700 tons of refined shapes and 16,900 tons of cathodes. High blister sales commitments of Northern Rhodesian copper-producing companies led to an anode copper shortage and to the less than capacity refinery operations.

In *Southern Rhodesia* output rose from 3,200 tons in 1957 to 8,400 in 1958. The increase was due chiefly to expansion in production at the Mangula mine, a subsidiary of Messina (Transvaal) Development Co., Ltd. In the fiscal year ended September 30 this property produced 10,700 tons of concentrates, averaging 51.96 percent copper. A second mill, which was to permit doubling of production, was expected to be in operation by March 1959.

South-West Africa.—The uptrend in copper production, in progress since 1954, continued in 1958, and a new record was established for the fifth successive year. The Tsumeb Corp., Ltd., milled 666,000 tons of ore, averaging 5.66 percent copper, in the fiscal year ended June 30, compared with 638,000 tons, averaging 5.03 percent copper, in fiscal 1957. About 29,000 tons of copper was sold, compared with 28,000 tons. The Tsumeb mine also produces large quantities of lead and zinc. Preparations were underway for developing ore indicated below the 30th level.

Uganda.—At the Kilembe mine of Kilembe Mines, Ltd., only copper producer in Uganda and subsidiary of Frobisher, Ltd., 12,100 tons of blister was produced, or 44 percent more than in 1957, the first full year of operation. The new 500-ton concentrator for treating higher grade oxide ore was completed during the year and placed in operation in mid-December. Weakness in the cobalt market led to continued stockpiling of cobaltiferous pyrite concentrate and to plans for expanding copper operations.

Union of South Africa.—Contrary to the movement in most important copper-producing areas, production in the Union rose to a new peak in 1958, despite curtailment in operations during much of the year owing to lessened demand.

In the fiscal year ended June 30, O'okiep Copper Co., Ltd., produced 34,900 tons of blister copper, compared with 31,300 tons in fiscal 1957. Ore milled totaled 1,591,000 tons, averaging 2.25 percent copper. The sulfide ore reserve on June 30 was 27.4 million tons, averaging 2.23 percent copper, or 2 million more than in 1957. The added tonnage was principally in the Carolusberg area, where the reserve was increased from 9.2 million tons containing 1.61 percent copper to 12.8 million averaging 1.71 percent. Plans were being made to bring the Carolusberg ore body into production in 1962 to replace production from older mines nearing exhaustion.

The Messina (Transvaal) Development Co., Ltd., the other leading producer, was said [10] to have introduced further economies during the year, to offset metal market conditions, and to have incorporated electronic control equipment in its Transvaal mill.

OCEANIA

Australia.—The continued uptrend in copper production, virtually uninterrupted since the late forties, resulted in a new high record rate in 1958—30 percent more than in 1957, 38 more than in 1956, and 61 percent above the previous peak in 1912. Expansion at the Mount Isa mine was chiefly responsible for the trend.

Mount Isa Mines, Ltd., Queensland, subsidiary of American Smelting and Refining Co., milled 1,854,000 tons of ore in the fiscal year ended June 30, 1958, from which were recovered 34,900 tons of blister copper, 57,100 tons of lead bullion (containing 4,256,000 ounces of silver), and 40,500 tons of zinc concentrate (containing 21,300 tons of zinc). Improvements in ore-dressing procedures were reported to have produced higher economic recoveries and lower overall costs. The new electrolytic refinery at Townsville was scheduled to begin operation in mid-1959. Equipment to roll copper rod at the refinery was purchased, and rod production was expected to begin by the end of 1959.

Production of cathode copper by the Mount Lyell Mining & Railway Co., Ltd., Tasmania, exceeded 11,000 tons. Production at the Mount Morgan mine of Mount Morgan, Ltd., Queensland, was 7,600

[10] Mining World Catalogue, Survey and Directory Number, 1959: Vol. 21, No. 5, Apr. 25, 1959, p. 131.

tons. The reserve was estimated at 14.1 million tons, averaging 1.08 percent copper. Peko Mines, N.L., milled 109,000 tons of ore, containing 7,500 tons of copper, at its mine on Tennant Creek, Northern Territory, in the year ended June 24.

WORLD RESERVES

Copper occurrences have been found in almost every country, but most of the world's known copper reserves are in but a relatively few regions; the major unmined copper resources are concentrated in (1) Chile and Peru, (2) western United States, (3) Northern Rhodesia and Belgian Congo, (4) the U.S.S.R., and (5) Canada.

These main sources of copper compose 93 percent of the measured and indicated world reserves, which are estimated, in terms of metal content, at 170 million tons of copper. Chile leads, with 46 million tons, followed in order by the United States (32.5 million), Northern Rhodesia (24.5 million), Belgian Congo (20 million), Soviet Bloc (16 million), Peru (12.5 million) and Canada (7 million). Substantial ore bodies make up the smaller reserves of Yugoslavia (1.2 million), Union of South Africa and South-West Africa (1.1 million), Philippines (1 million), Australia (1 million), Mexico (750,000), Turkey (500,000), and Cyprus (200,000). Significant mines in Cuba, Bolivia, Finland, Norway, Spain, Sweden, India, and Japan will account for an estimated additional 6 million tons of copper ore. The above estimates are based on the assumption that the cost-price ratio will be such as to permit the mining of ore having approximately the same grade as that now being produced.

TECHNOLOGY

The Bureau of Mines[11] published information on results of investigations at copper deposits.

The Geological Survey[12] published information on deposits in Arizona, Nevada, and New Mexico.

Exploratory studies in the Northern Rhodesian Copper-belt[13] showed that metal leached from weathering ore deposits accumulates in seasonal headwater swamps, or dambos, where metal-bearing groundwaters debouch at the surface. Systematic sampling of

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[11] Thurmond, R. E., and Storms, W. R., Discovery and Development of the Pima Copper Deposit, Pima Mining Co., Pima County, Ariz.: Bureau of Mines Inf. Circ. 7822, 1958, 19 pp.
Hardwick, W. R., Open-Pit Mining Methods and Practices at the Chino Mines Division, Kennecott Copper Corp., Grant County, N. Mex.: Bureau of Mines Inf. Circ. 7837, 1958, 64 pp.
Smith, M. Clair, Methods and Operations at the Yerington Copper Mine and Plant of the Anaconda Co., Weed Heights, Nev.: Bureau of Mines Inf. Circ. 7848, 1958, 37 pp.
McWilliams, John R., Mining Methods and Costs at the Holden Mine, Chelan Division, Howe Sound Co., Chelan County, Wash.: Bureau of Mines Inf. Circ. 7870, 1958, 44 pp.

[12] Tschanz, C. M., Laub, D. C., and Fuller, G. W., Copper and Uranium Deposits of the Coyote District, Mora County, N. Mex.: Geol. Survey Bull. 1030–L, 1958, pp. 343–398.
Anderson, C. A., and Creasey, S. C., Geology and Ore deposits of the Jerome Area, Yavapai County, Ariz.: Geol. Survey Prof. Paper 308, 1958, 185 pp.
Trites, A. F., Jr., and Thurston, R. H., Geology of Majuba Hill, Pershing County, Nev.: Geol. Survey Bull. 1046–I, 1958, pp. 183–203.

[13] Webb, John S., and Tooms, J. S., with analytical assistance by Gilbert, M. A., Geochemical Drainage Reconnaissance for Copper in Northern Rhodesia: Bull. Inst. Min. and Met., vol. 68, No. 626, January 1959, pp. 125–144.

dambos and stream sediment promises to assist primary mineral reconnaissance in Northern Rhodesia and elsewhere.

The widespread occurrence of copper showings over a large area of northern Nova Scotia led to recent studies that showed the mineralization to be of supergene origin.[14] The deposits investigated proved uneconomic but are similar to those of the Colorado Plateau region of southwestern United States. Some 26 shallow drill holes, totaling 3,089 feet, were drilled to investigate the deposits.

The Toquepala porphyry-copper deposit is in southern Peru, 55 airline miles north of the small city of Tacna and the same distance inland from the port of Ilo. The geology of the deposit was described.[15] Quellaveco and Cuajone, geologically similar deposits lie 12 and 19 miles north of Toquepala. The large Chuquicamata deposit (Chile) is 400 miles south. From 1938 until 1942 Cerro de Pasco Copper Co. partly explored the deposit by adits and diamond drill holes. The Northern Peru Mining Co., a wholly-owned subsidiary of American Smelting and Refining Co., undertook regional engineering studies in 1945 and drill exploration in 1949. The deposit contains 400 million tons averaging a little over 1 percent copper. It is currently undergoing large-scale development by Southern Peru Copper Corp., which is owned by American Smelting and Refining Co., Phelps Dodge Corp., Cerro de Pasco Copper Corp. and Newmont Mining Co.

Use of a reportedly improved pilot hole-surveying method at the Calloway mine (Copperhill, Tenn.), of the Tennessee Copper Co., gave favorable results.[16]

Conversion to the use of ammonium nitrate for use in blasting at the Utah Copper pit of Kennecott Copper Corp. was discussed.[17]

Haulage costs at the Bagdad mine were reported during the year.[18] Conditions imposed by the adverse terrain and isolated locale of the mine account in part for interest in mining methods and equipment employed there.

A semiautomatic hoist was installed at the 2966 station of the Copper Queen, (Ariz.) mine, Phelps Dodge Corp., because, it was said,[19] neither the bulk of supplies handled nor the number of men engaged in developing the 3,100-foot level justified the constant attention of two cagers and two hoist operators.

The El Salvador mine, of Andes Copper Mining Co., about 18 miles north of Potrerillos, Chile, was expected to be in production at 30,000 tons of ore per day in the first half of 1959. Mining was to be by block caving, and the ore was to be dropped from upper levels to the Inca adit, through which it was to be transported out of the mine to the primary crushing plant, one-half mile from the portal.[20] The 14-

[14] Brummer, J. J., Supergene Copper-Uranium Deposits in Northern Nova Scotia: Econ. Geol. vol. 53, No. 3, May 1958, pp. 309–324.

[15] Richard, Kenyon, and Courtright, James H., Geology of Toquepala, Peru: Min. Eng., vol. 10, No. 2, February 1958, pp. 262–266.

[16] Lee-Aston, R., At Calloway Mine an Innovation in Hole Surveying Held Error to 1 Ft. per 354.5 Ft. of Hole Drilled: Min. Eng., Vol. 10, No. 3, March 1958, pp. 346–351.

[17] Snow, L. E., "Here's How We Do It".: Min. Cong. Jour., vol. 44, No. 7, July 1958, pp. 62–64.

[18] Hutti, John B., Bagdad Reports Haulage Costs: Eng. and Min. Jour., vol. 159, No. 10, October 1958, pp. 112–116.

[19] Himebaugh, A. E., Semi-Automatic Hoist at Copper Queen Proves Safe and Economical: Min. Eng., vol. 10, No. 5, May 1958, pp. 566–567.

[20] Robbins, H. E., Dudley, T. H., and Lucero, E. A., El Salvador Reports on Inca Adit Progress: Min. Eng., vol. 10, No. 3, March 1958, pp. 333–336.

by 17-foot tunnel was to pass through more than 3½ miles of faulted ground. On October 25, 1957, the tunnel extended 1.79 miles. There was a 308.8-million-ton proved reserve, averaging 1.49 percent copper.

Research at the White Pine mine in Michigan resulted in development of a safe and economical mining method for extracting both ore-bearing shale beds, making possible simultaneous removal of the full column of ore. Copper values in the White Pine ore body occur in two rather flatly dipping shale beds (the lower or Parting shale and the Upper shale). Between the two beds are almost barren layers of sandstone and shale. The problem attacked by the company mining and geological departments and mining consultants was whether it was more economical to mine the lower Parting shale bed alone or to mine both beds and to discard as much as possible of the barren material between them. The first step was to prove that the roof over the upper ore bed could be supported over adequate widths without excessive expense; this has been successfully accomplished. The second step was to work out a mining method to selectively remove the upper and lower beds while discarding as much as possible of the barren intervening material. Several months of experimental mining was required to develop an economical method. The most serious problems in full-column mining have now been solved.

Since early in 1954 the Bureau of Mines has conducted a research project at the White Pine mine, involving stratigraphy studies and experimentation with systems of rock bolting to develop designs of support in the new roof horizon over the upper shale. The results obtained from these studies, carried on in three experimental rooms, indicated the roof span and the system of bolting that could be employed to form a stable roof. Investigations are being continued to apply the information gained from the experimental room studies to the current production stopes.

An extensive lateral belt system to convey ore from the mining faces to underground crushing stations was completed in 1958.

The Pima Mining Co. solved the problem of mining a relatively narrow, steeply dipping ore body by using a rockover skip system in conjunction with trucks for removing ore and waste from its open-pit workings southwest of Tucson, Ariz.[21]

The importance of maintenance facilities to efficient operation of Anaconda's Berkeley pit, Mont., was indicated by the care and planning given in designing them.[22] Ore production was scheduled at 17,500 tons per day from reserves totaling over 100 million tons.

Favorable results in using cyclone classification in the No. 3 ball-mill grinding circuit made possible immediate plans for increasing the capacity of the concentrator at the Chuquicamata mine of the Chile Exploration Co., Chile.[23] Using cyclones in place of spiral classifiers was expected to permit changing the 10 rod mills and 10 ball mills to 10 rod mills and 15 ball mills without increasing plant area. Grind-

[21] Engineering and Mining Journal, Skip Hoisting Solves Deep Pit Problem: Vol. 159, No. 3, March 1958, pp. 98–99.

[22] Engineering and Mining Journal, Berkeley Pit Maintenance Area is Planned for Efficiency: Vol. 159, No. 3, March 1958, pp. 110–113.

[23] Sanders, D. S., Cyclone Classification at Chuquicamata: Min. Cong. Jour., vol. 44, No. 3, March 1958, pp. 55–58, 72.

ing capacity was expected to be increased from about 38,000 tons a day to 45,000.

In the mill of Chibuluma Mines, Ltd., Northern Rhodesia, which came into production in 1956, copper is floated first with Aerofloat 208 and methyl isobutyl carbinol while cobalt is depressed with lime and sodium cyanide.[24] Cobalt minerals then are floated after activation with copper sulfate, acidation of the pulp with sulfuric acid, frothing with pine oil, and use of sodium isopropyl xanthate as a collector.

The new leach-precipitation-flotation facility at the Ray mine, Arizona, of Kennecott Copper Corp. produced its own sponge iron and sulfuric acid from pyrite waste material in Ray ore, and permitted an increase of approximately 10 percent in the quantity of copper recovered from the mined ore.[25]

Solution of the problem of handling fine, slimy copper pulp made possible savings in fuel as well as greater furnace throughput at the White Pine mine of White Pine Copper Co.[26]

FluoSolids treatment of Yanahara pyrrhotite gave Japan's Dowa Mining Co. a profit on copper, sulfuric acid, and iron ore and reduced pyrite-mining costs.[27]

Two papers [28] described experimental data gathered during the startup of the 14-foot-diameter FluoSolids reactor at the Jadotville plant of Union Minière du Haut Katanga, Belgian Congo, and improvements brought to the operating conditions.

A pressure-leaching and reduction process was used by Sherritt Gordon Mines, Ltd., Fort Saskatchewan, Canada, in producing refined nickel from nickel-copper concentrate.[29] The need to separate the copper before the nickel in solution could be precipitated as refined metal led to development of a process of separating the copper and nickel from leach solutions.

Laboratory experiment showed [30] that copper and sulfur could be obtained with high current efficiency by electrodecomposition of cuprous electrodes in a barium chloride electrolyte. A possible method was outlined for large-scale production.

Flash smelting takes place when the concentrate, with or without additional fuel, is suspended in gases containing oxygen, whereby the heat of oxidation reactions brings the suspended particles to a smelting temperature. First flash smelting on a commercial scale was said to have been done at Harjavalta, Finland,[31] where it has been in opera-

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[24] Harper, J. E., How Chibuluma Floats Copper-Cobalt: Min. World, vol. 20, No. 11, October 1958, pp. 38–42.

[25] Engineering and Mining Journal, Kennecott Dedicates the Hayden Smelter: Vol. 160, No. 1, January 1959, p. 102.

[26] Engineering and Mining Journal, How White Pine Filters Fine, Slimy Pulp: Vol. 159, No. 12, December 1958, pp. 104–105.

[27] Kurushima, Hidesaburo, and Foley, R. M., Fluosolids Roasting of Dowa's Yanahara Sulfides: Min. Eng., vol. 10, No. 10, October 1958, pp. 1057–1061.

[28] Theys, L. F., and Lee, L. V., Sulfate Roasting Copper-Cobalt Sulfide Concentrates: Jour. Metals, vol. 10, No. 2, February 1958, pp. 134–136.

Theys, L. F., Progress Report on Roasting Copper-Cobalt Concentrates: Jour. Metals, vol. 10, No. 7, July 1958, p. 476.

[29] Mackiw, V. N., Benoit, R. L., Loree, R. J., and Yoshida, N., Simultaneous Distillation of Ammonia and Separation of Copper From Nickel-bearing Solutions: Chem. Eng. Prog., vol. 54, No. 3, March 1958, pp. 79–85.

[30] Hoar, T. P., and Ward, R. G., The Production of Copper and Sulphur by the Electro-Decomposition of Cuprous Sulphide: Inst. Min. and Met., vol. 67, pt. 8, 1957–58, No. 618, May 1958, pp. 393–410.

[31] Bryk, Petri, Ryselin, John, Honkasalo, Jorma, and Malmstrom, Rolf, Flash Smelting Copper Concentrates: Jour. Metals, vol. 10, No. 6, June 1958, pp. 395–400.

tion since 1949. The Furukawa Mining Co. modernized its smelter at Ashio, Japan, and in March 1956 began its operation on the same general principles as at Harjavalta.

A paper summarized data on converter plant practice at 40 copper-converter plants in 18 countries and included a partial analysis and comments on the effect of converter slag composition and temperature on the formation and elimination of magnetite and the life of basic and neutral refractories.[32]

Installation of suspended basic roofs on two furnaces greatly increased the roof life, as well as the availability of the furnaces.[33]

American Smelting and Refining Co. massive, newly installed copper electric arc furnace at Perth Amboy, N.J.—world's largest—is 18 feet in diameter, has a bath capacity of 90 tons of molten metal, and can produce continuously 30 tons of tough pitch copper per hour.[34] Electric melting of cathodes obviates the poling step required when copper is melted in a coal- or gas-fired reverberatory furnace. A.S.& R. installed a continuous wire bar wheel and a semicontinuous cake casting unit.[35] The new plant considered in its entirety—arc furnace, melting, and continuous casting—was said to be the first major advance in copper-refining practice in 50 years.[36]

An article [37] pointed out similarities between the copper and steel metallurgical industries. The well-established use of oxygen in steelmaking suggested the possibility of similar advances in copper refining.

Copper and nickel powders, it was said, could be rolled into strip on a commercial basis.[38]

Studies of the results of an investigation into the pressing and sintering properties of atomized copper powder indicate that this type affords an entirely satisfactory substitute for typical electrolytic copper powders, sometimes being preferable at a lower manufacturing cost.[39]

An article [40] appraised the results of an extensive series of experiments on the tensile properties of copper of exceptionally high purity.

The second annual Materials Selector listed properties of copper and a wide variety of its alloys, as well as of other metals and alloys

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[32] Lathe, F. E., and Hodnett, L., Data on Copper Converter Practice in Various Countries: Trans. Metal. Soc. AIME, vol. 212, No. 5, October 1958, pp. 603–617.

[33] Bridgstock, Guy, Suspended Basic Roofs for Copper Furnaces, 1. At Canadian Copper Refiners, Ltd., and Towers, John and Brown, Robt. N., 2. At United States Metals Refining Co.: Jour. Metals, vol. 10, No. 6, June 1958, pp. 412–413.

[34] Mining Engineering, Largest Copper Melting Arc Furnace Goes on Steam: Vol. 10, No. 3, March 1958, p. 318.

Engineering and Mining Journal, ASARCO's Semi-Continuous Casting of Copper Cakes: Vol. 159, No. 4, April 1958, p. 109.

[35] Steel, Copper Melting Arc Furnace Starts Up: Vol. 142, No. 6, Feb. 10, 1958, pp. 100–101.

[36] Starratt, F. Weston, Tough-Pitch Copper Continuously Cast: Jour. Metals, vol. 10, No. 6, June 1958, pp. 404–406.

[37] Kurzinski, E. F., New Techniques for Copper Refining: Jour. Metals, vol. 10, No. 8, August 1958, pp. 533–537.

[38] Metal Progress, Rolling Metal Powder Into Strip: Vol. 74, No. 5, November 1958, pp. 142–144. Digest of Perfected and Practical Methods of Processing Powder into Commercial Strip, by Richard A. Smucker. Paper presented at AISE convention, Cleveland, Ohio, September 1958.

[39] Bell, G. R., Webb, F. B., and Woolfall, R., Pressing and Sintering Characteristics of Certain Copper and Tin Powder Mixes: Metallurgia, vol. 58, No. 349, November 1958, pp. 233–241.

[40] Voce, E., The Strain Hardening Behavior of High Purity Copper: Metallurgia, vol. 57, No. 341, March 1958, pp. 111–116.

and other materials.[41] Another report described the properties, fabrication and uses of an important group of copper alloys.[42]

A recent article[43] discussed continuing progress made in the metallurgy of copper and its alloys.

Difficult problems in corrosion have been solved by combining copper alloys with ferrous or other alloys as duplex tube or clad components, according to a recent article,[44] which stated that selection of wise combinations of duplex or clad metals should prove economical from the standpoint of long, trouble-free service life.

A new method of plating copper on aluminum and its alloys eliminates the need for special pretreatment, zincate dips, and others.[45]

A series of articles described problems in connection with welding copper and its alloys and solutions thereto.[46]

Continuous heavy copper plating of steel wire calls for heavy use of corrosion-resistant tanks, mixing devices, piping, pumps, and other items.[47]

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[41] Materials Selector, published by Materials in Design Eng., vol. 48, No. 5, Mid-October 1958, 478 pp.

[42] Everhart, J. L., Cupro-Nickels Offer Corrosion Resistance and Hot Strength: Materials in Design Eng., vol. 47, No. 5, May 1958, pp. 114–120.

[43] Voce, E., Copper and Its Alloys, a Survey of Technical Progress During 1958: Metallurgia, vol. 59, No. 352, February 1959, pp. 88–92.

[44] Hall, R. V. L., Copper Alloys for Corrosion Resistance: Chem. Eng. Prog., vol. 54, No. 6, June 1958, pp. 51–55.

[45] Atkinson, J. T. N., Acid Copper Plating on Aluminum: Electrochem. Soc. Jour., vol. 105, No. 1, January 1958, pp. 24–27.

[46] Spencer, Lester F., How To Weld Copper and Its Alloys: Steel, vol. 142, No. 4, Jan. 27, 1958, pp. 86–89. No. 8, Feb. 24, 1958, pp. 90, 93, 96, and 98. No. 11, Mar. 17, 1958, pp. 110–112, 114 and 116. No. 19, May 12, 1958, pp. 106–108. No. 21, May 26, 1958, pp. 122–123.

[47] Chemical and Engineering News, Alloys Have Field Day: Vol. 36, No. 3, Jan. 20, 1958, p. 50.

Diatomite

By L. M. Otis [1] and James M. Foley [2]

PRODUCTION of diatomite declined in 1958 for the first time since 1952.

DOMESTIC PRODUCTION

California retained the position it has maintained since 1910 as the leading diatomite-producing State. Nevada was second in quantity of diatomite produced followed in order by Oregon and Washington.

The number of plants in production during 1958 dropped from 13 to 11. These were operated by nine companies.

Great Lakes Carbon Corp. conducted diatomite exploration and stripping near Fort Rock, Lake County, Oreg. Large-scale samples were trucked to its plant at Lower Bridge, Deschutes County, to determine quality and milling characteristics. The company reported a 12-percent increase over 1957 in production at its Lower Bridge plant in 1958.

The second diatomite plant of the Eagle-Picher Co., formally placed in operation at Lovelock, Nev., on October 10, 1958, was described in an article.[3] The plant was designed and built by Kaiser Engineers at a cost of $2.5 million and has an annual capacity of 36,000 tons of processed diatomite for use as filtering material. Diatomite will be obtained from a newly developed deposit, 15 air miles northwest of Lovelock. The other Eagle-Picher plant at Clark, Nev., continued to produce diatomite for polish, insulation, anticaking agents for fertilizers, fillers, industrial absorbents, lightweight aggregates, and other uses.

TABLE 1.—Diatomite sold or used in the United States by producers, 3-year totals

	1939–41	1942–44	1945–47	1948–50	1951–53	1954–56
Domestic production (sales)..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

[1] Commodity specialist.
[2] Supervisory statistical assistant.
[3] California Mining Journal, Eagle-Picher's Lovelock Diatomaceous Earth Plant in Operation: Vol. 28, No. 4, December 1958, p. 22.

A new diatomite operation was begun in southwest Kern County, Calif., near Maricopa. A processing mill was reported in operation in 1958.[4]

CONSUMPTION AND USES

The uses of diatomite changed little from 1957. Most all pressure filters continued to employ diatomite with no large-scale competitive product in view. The filler market included principally paper, paints, varnish, brick, tile, ceramic, oilcloth, linoleum, plastics, soap, detergents, welding-rod coatings, belt dressing, crayons, and phonograph records.

Diatomite was used as insulation against temperature change for ovens, kilns, safes, refrigerators, driers, evaporators, cold-storage houses, pipes, flues, furnaces, retorts, stacks, stills, stoves, tanks, and many other items. Acoustical plaster and cast panels for sound-deadening walls and ceilings also consumed diatomite.

The miscellaneous uses included abrasives, absorbents, carriers for catalysts, herbicides and fungicides, glazes, enamels, flatting agents for paints, and manufacturing sodium and calcium silicates.

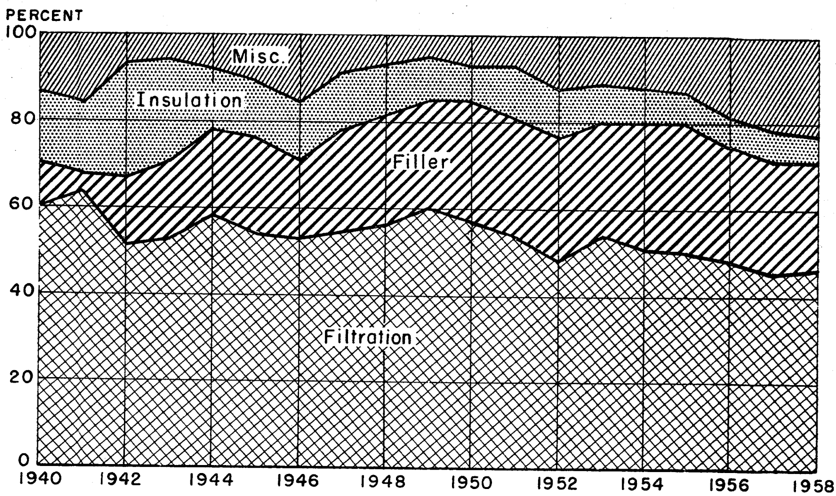

FIGURE 1.—Proportion of diatomite sales in the United States for each principal class of use, 1940–58.

PRICES

Prices were generally higher in 1958 and varied according to purity; particle-size range; color; whether uncalcined, calcined, or calcined with fluxes; whether delivered in bulk or bagged; and type of bag used.

The average increase in value of diatomite sold or used in 1958 over 1957 was 6.5 percent, based on corrected valuations for 1957 received by the Bureau of Mines since the 1957 Yearbook chapter was issued.

[4] California Mining Journal, Kern County Westside District Developing New Industry With Diatomaceous Deposits: Vol. 27, No. 12, August 1958, p. 16.

TABLE 2.—Average annual value of diatomite per ton, by uses

Use	1957[1]	1958	Use	1957[1]	1958
Filtration	$53.69	$56.91	Fillers	$41.87	$45.23
Insulation	43.38	41.43	Miscellaneous	24.25	26.18
Abrasives	136.79	137.00	Weighted average	43.36	46.18

[1] Corrected figures.

FOREIGN TRADE

Refined diatomite, principally of filtering quality, was exported to many countries.

WORLD REVIEW

Canada.—Canadian imports of diatomite in 1957 increased 20 percent over 1956 to a new high of 24,288 short tons. Percentage distribution of consumption was estimated as follows: Fertilizer dusting, 45; filtration, 40; fillers, 13; insulation, 1; and miscellaneous, 1. An increase was anticipated in consumption for filter cake in uranium-ore processing. Virtually all Canadian imports came from the United States.

A small but increased tonnage of diatomite was produced 6 miles north of Quesnel, Central British Columbia. The material was shipped as mined to Vancouver, where it was dried, ground, and screened. It was sold locally as filler, as concrete admixture, and for insulating brick. The price at Toronto and Montreal, bagged, in carlots, ranged from $56 to $160 a ton.[5]

Guatemala.—A diatomite occurrence is reported at Fiscal, 11 miles from Guatemala City, along the Atlantic Highway. The diatomite was used to increase the silica content of cement. It was said to be of fresh-water origin and probably of Tertiary age and was estimated to cover 2 to 2.5 square miles and to average about 30 feet in thickness.[6]

Mexico.—Imports of diatomite into Mexico were as follows:

Year	*Short tons*	*Value*
1955	3,315	US$293,900
1956	4,340	287,500
1957	3,225	221,800

Virtually all imports came from the United States; a few tons came from West Germany.

Scotland.—Diatomite was mined at Loch Cruithan in Skye for use as a car polish. Part-time labor, normally employed in agriculture, was used.[7]

Union of South Africa.—There were two producers of diatomite, the Charles Kieselguhr mine, Transvaal, and the Vereeniging Brick & Tile Co., Ltd., Vereeniging. Local sales in 1956 were 731 short tons, valued

[5] Ross, J. S., Diatomite in Canada, 1957: Dept. Mines and Tech. Surveys, Ottawa, Canada, Rev. 37, 1958, 4 pp.

[6] U.S. Embassy, Guatemala City, Guatemala, State Dept. Dispatch 261: Nov. 18, 1958, 3 pp.

[7] Chemical Trade Journal and Chemical Engineer (London), vol. 143, No. 3734, Dec. 26, 1958, p. 1516.

TABLE 3.—World production of diatomite, by countries,[1] in short tons[2]

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

Country[1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	66	4	16	2	120	6
Costa Rica	366	595	3,000	6,737	[3] 1,800	[3] 1,800
Guatemala	[3] 10,600	[3] 12,900	[3] 16,500	[3] 16,000	20,600	21,190
United States	278,000	[4] 368,426	[4] 368,426	[4] 368,426	[4] 368,426	[4] 368,426
South America:						
Argentina	2,394	2,868	6,988	2,682	4,084	[3] 3,900
Chile	773	31	550			
Peru		2	1	34	39	
Europe:						
Austria	3,909	3,532	4,445	5,490	3,823	4,086
Denmark:						
Diatomite	[5] 22,238	30,337	39,103	31,331	[5] 22,238	[5] 22,238
Moler[6]	[3] 54,000	42,990	39,442	40,080	41,074	[3] 40,800
Finland	1,488	1,367	2,059	2,535	1,874	2,315
France[7]	60,194	68,092	70,025	69,546	86,240	[3] 86,000
Germany, West[7]	45,044	53,666	62,575	72,890	76,561	[3] 112,700
Italy	10,455	11,160	10,635	9,651	29,707	[3] 29,800
Portugal[7]	1,225	2,011	2,499	1,985	1,613	[3] 1,650
Spain[7]	8,051	10,002	15,927	13,048	12,615	[3] 13,000
Sweden	1,853	1,013	1,625	1,243	1,317	[3] 1,300
United Kingdom:						
Great Britain	11,875	10,778	24,656	19,361	18,706	[3] 18,700
Northern Ireland	8,719	4,675	7,293	6,577	6,842	[3] 6,600
Yugoslavia	[8] 3,075	4,439	4,490	[3] 4,400	[3] 4,400	[3] 4,400
Asia: Korea, Republic of	99	1,377	3,393	3,912	1,472	518
Africa:						
Algeria	20,690	38,581	30,384	26,360	10,360	29,762
Egypt	1,328	173	545	320	678	[3] 660
Kenya	4,321	3,649	3,304	5,418	4,737	3,777
Union of South Africa	632	1,047	850	635	606	359
Oceania:						
Australia	6,679	6,091	5,647	6,484	5,968	[3] 4,400
New Zealand	143	188	623	152	3,537	[3] 3,500
World total (estimate)[1 2]	600,000	725,000	765,000	760,000	770,000	825,000

[1] Diatomaceous earth is 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 exactly to totals shown because of rounding where estimated figures are included in the detai .
[3] Estimate.
[4] Average annual production 1954–56.
[5] Average annual production 1947–55.
[6] A clay-contaminated diatomite used principally for lightweight building brick.
[7] Includes tripoli.
[8] Average 1952–53 only.

at US$13.70 per ton.[8] Of 606 short tons of diatomite produced in 1957, 123 tons was sold locally at an average price of US$13.35 per ton.[9]

TECHNOLOGY

An article described the manufacturer of insulating brick from a mixture of ground, rather impure, diatomite and sawdust at Colchester, England. The mixture was extruded through dies, cut to brick size, and placed in drying ovens for 5 to 14 days. After drying, the green bricks were fired with producer gas at 900°C. maximum.[10]

A breakable target made of ground limestone, coal-tar pitch, a paraffinic oil, and a low-density bulking agent such as diatomite was patented for trapshooting.[11]

[8] Bureau of Mines, Mineral Trade Notes: Vol. 45, No. 6, December 1957, p. 28.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, p. 29.
[10] Iron & Coal Trades Review, Production of Insulating Material: Vol. 177, No. 4725, Dec. 12, 1958, pp. 1418–1420.
[11] Allison, A. G., and Slyh, J. A. (assigned to Remington Arms Co., Inc., Bridgeport, Conn.), Target Composition: U.S. Patent 2,831,778, Apr. 22, 1958.

A patent was issued covering the manufacture of a lightweight, porous, sound-absorbing tile composed of diatomite, water, sawdust or other carbonaceous material, and a dispersion of a glazing frit in a suitable vehicle, formed into blocks and heated to 1,800° to 2,200° F.[12]

Diatomite is used as a filler in a patented method of stabilizing the set of gypsum plaster. A mixture of alum and lime is reacted in water, dried, and added to calcined gypsum, together with a filler of raw gypsum, diatomite, silica flour, or expanded perlite.[13]

The use of diatomite as an absorbent in preparing a hormone substance was patented.[14]

A heat-resisting sealing and caulking compound was patented; it comprised asbestos fiber, diatomite, tall oil, petroleum-oil residue, balata resin, a drier, and a cationic compound.[15]

A patent was issued for an oil-well cement made by mixing portland cement, diatomite, bentonite, and chemical reagents to increase the thickening time and reduce water loss of the cement.[16]

The use of prepared diatomite as a high-specific-surface-area carbon carrier for making bubble glass was patented.[17]

A patent was issued for purifying air by conducting the fumes or vapors through diatomite impregnated with ferric acetate.[18]

A method of bleaching diatomite was patented. The diatomite is added to phosphoric acid and the mixture roasted at 550° to 850° C.[19]

A patent was issued for a dentrifice consisting of minus-325-mesh, plus-2-micron diatomite mixed with a little dry, powdered, castile soap.[20]

An adsorption process for separating fission products was patented. In this process, plutonium from solutions of neutron-irradiated uranium is adsorbed onto diatomite.[21]

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[12] Heine, H. W., Acoustical Tile and Method of Manufacturing It: U.S. Patent 2,825,420, Mar. 4, 1958.

[13] Schneiter, H. J., and Oshida, O. A. (assigned to National Gypsum Co., Buffalo, N.Y.), Gypsum Plaster Set Stabilization: U.S. Patent 2,820,714, Jan. 21, 1958.

[14] Bunding, I. M. (assigned to Armour & Co., Chicago, Ill.), Preparation of Adrenocorticotrophin by Adsorption on Diatomaceous Earth: U.S. Patent 2,843,524, July 15, 1958.

[15] Turner, E. M. (assigned to Mohawk Industries, Ind., Sparta, N.J.), Sealing Composition: U.S. Patent 2,847,315, Aug. 12, 1958.

[16] Shell, F. J. (assigned to Phillips Petroleum Co.), Cement Composition: U.S. Patent 2,852,402, Sept. 16, 1958.

[17] D'Eustachio, D. (assigned to Pittsburgh Corning Corp.), Method of Producing Cellulated Articles: U.S. Patent 2,860,997, Nov. 18, 1958.

[18] Bollinger, K. (assigned to Colasit A. G., Wimmis, Switzerland), Method for Purifying Air Contaminated by Acid or Nitrous Impurities: U.S. Patent 2,856,259, Oct. 14, 1958.

[19] Pesce, L., Italian Patent 529,036, June 18, 1955.

[20] Menzies, A., Dentifrice Comprising Diatomaceous Silica: U.S. Patent 2,820,000, Jan. 14, 1958.

[21] Seaborg, G. T., and Willard, J. E. (assigned to United States of America as represented by the Chairman of the Atomic Energy Commission, Separation of Plutonium from Uranium and Fission Products: U.S. Patent 2,819,144, Jan. 7, 1958.

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Feldspar, Nepheline Syenite, and Aplite

By Taber de Polo [1] and Gertrude E. Tucker [2]

FELDSPAR

DOMESTIC production of crude feldspar and flotation concentrate declined in 1958 because of decreased demand from the glass and pottery industries during the first half of the year. Excess feldspar production capacity and continued competition from substitutes resulted in an additional small drop in the price of glass-grade feldspar from $10 to $9.80 per short ton, f.o.b. producers' plants in the North Carolina area.

The North Carolina feldspar industry was helped toward the end of the year by a reduction of freight rates to northern feldspar consuming areas.

TABLE 1.—Salient feldspar statistics

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Crude feldspar:						
Domestic sales: [1] [2]						
Long tons	459,667	526,590	550,861	560,074	498,057	469,738
Thousands	$3,466	$4,517	$4,528	$5,829	$4,935	$4,278
Average per long ton	$7.54	$8.58	$8.22	$10.41	$9.91	$9.11
Imports:						
Long tons	11,360	79	105	258	72	73
Thousands	$90	$3	$9	$9	$7	$5
Average per long ton	$7.96	$42.49	$89.01	$36.09	$92.03	$63.82
Ground feldspar:						
Sales by merchant mills: [1] [3]						
Short tons	500,769	568,480	596,158	608,661	503,170	469,602
Thousands	$6,853	$7,684	$8,584	$8,957	$7,062	$6,540
Average per short ton	$13.69	$13.45	$14.40	$14.72	$14.04	$13.93
Apparent domestic consumption: long tons [1]	471,027	526,669	550,966	560,332	498,129	469,811
World: Production:						
Long tons	800,000	930,000	1,050,000	1,095,000	1,050,000	1,025,000

[1] Revised figures, 1952–57.
[2] See table 2 for distribution of feldspar by derivation.
[3] See table 5 for distribution of feldspar by derivation.

DOMESTIC PRODUCTION

Crude Feldspar.—North Carolina continued as the leading producer; California ranked second. The quantity of feldspar produced by flotation in Georgia, and North Carolina, continued to increase and in

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

1958 constituted over 80 percent of the feldspar production from the area and nearly 60 percent of the entire U.S. output.

Crude feldspar figures include hand-cobbed feldspar, flotation concentrate, and the feldspar content of feldspar-silica mixtures.

TABLE 2.—Crude feldspar sold or used by producers in the United States [1]

Year	Derivation of feldspar							
	Hand-sorted		Flotation concentrate		Feldspathic sands		Total	
	Long tons	Value (thousands)	Long tons	Value (thousands)	Long tons	Value (thousands)	Long tons	Value (thousands)
1949-53 (average)	(2)	(2)	410,235	$3,189	49,432	$277	459,667	$3,466
1954	(2)	(2)	411,018	3,491	115,572	1,026	526,590	4,517
1955	(2)	(2)	465,378	3,801	85,483	727	550,861	4,528
1956	234,993	$1,729	250,307	3,441	74,774	659	560,074	5,829
1957	227,826	1,958	208,984	2,449	61,247	528	498,057	4,935
1958	198,460	1,346	218,178	2,450	53,100	482	469,738	4,278

[1] Revised figures, 1952-57.
[2] Included with flotation concentrate.

TABLE 3.—Crude feldspar sold or used by producers in the United States, by States

State	1957		1958	
	Long tons	Value (thousands)	Long tons	Value (thousands)
Colorado	43,818	$307	34,648	$237
Connecticut New Hampshire	53,776	566	59,628	297
Maine	14,330	92	13,034	83
North Carolina	233,439	2,728	(1)	(1)
South Dakota	41,316	267	23,229	145
Other States [2]	[3] 111,378	[3] 975	[4] 339,199	[4] 3,516
Total	[3] 498,057	[3] 4,935	469,738	4,278

[1] Included with "Other States" to avoid disclosing individual company confidential data.
[2] Includes Arizona, California, Georgia, North Carolina (1958), Texas, Virginia, and Wyoming.
[3] Revised figure.
[4] Partly estimated.

International Minerals & Chemical Corp. built a feldspar plant at Custer, S. Dak., to replace the one destroyed by fire in July.

Bell Minerals Co. mechanized its mines at Perham and Conant, Maine, and increased storage capacity for crude ore.

An article described the history and operation of the feldspar plant at Monticello, Ga., of the Appalachian Minerals Co., a division of the Feldspar Corp. It was the only plant in the United States producing a high-potash feldspar by flotation.[3]

Feldspar mines and associated buildings in Spruce Pine, N.C., owned by the Whitehall Co., Inc., were offered for sale. No shipments of feldspar from these properties had been recorded since about 1948.

Ground Feldspar.—Thirteen States reported production of ground

[3] Trauffer, W. E., No Waste in Georgia Feldspar Plant: Pit and Quarry, vol. 51, No. 4, October 1958, pp. 116–119.

feldspar from 24 mills. 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 over 60 percent of the entire tonnage of ground feldspar. Ground feldspar figures include flotation concentrate and the feldspar content of feldspar-silica mixtures. Statistics have been broken down to show the origin of the feldspar (hand-cobbed, flotation concentrate, and feldspathic sands).

TABLE 4.—Ground feldspar sold by merchant mills [1] in the United States

Year	Active mills	Domestic feldspar [2]		Canadian feldspar		Total [2]	
		Short tons	Value (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1949–53 (average)	24	487,632	$6,540	13,137	$313	500,769	$6,853
1954	25	566,746	7,638	1,734	46	568,480	7,684
1955	24	596,158	8,584			596,158	8,584
1956	25	608,661	8,957			608,661	8,957
1957	23	503,170	7,062			503,170	7,062
1958	24	469,602	6,540	(3)	(3)	469,602	6,540

[1] Exclude potters and others who grind for consumption in their own plants.
[2] Revised figures, 1952–57. Number of active mills revised, 1952–55.
[3] Included with domestic feldspar.

CONSUMPTION AND USES

Crude Feldspar.—Virtually all 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, in short tons, by derivation and uses [1]

Year	Hand-sorted					Flotation concentrate				
	Glass	Pottery	Enamel	Other	Total	Glass	Pottery	Enamel	Other	Total
1949–53 (average)	(2)	(2)	(2)	(2)	(2)	226,148	189,419	23,272	6,566	445,405
1954	(2)	(2)	(2)	(2)	(2)	236,301	167,824	18,088	16,826	439,039
1955	(2)	(2)	(2)	(2)	(2)	204,757	224,162	25,919	45,579	500,417
1956	65,357	136,144	24,732	23,356	249,589	183,267	62,451		29,607	275,325
1957	54,283	109,910	26,052	16,742	206,987	166,933	58,131		6,170	231,234
1958	48,376	93,805	21,734	13,519	177,434	171,002	53,205		8,489	232,696

Year	Feldspathic sands					Grand total				
	Glass	Pottery	Enamel	Other	Total	Glass	Pottery	Enamel	Other [4]	Total
1949–53 (average) [3]	55,364				55,364	281,512	189,419	23,272	6,566	500,769
1954	124,536	4,905			129,441	360,837	172,729	18,088	16,826	568,480
1955	88,583	1,004		6,154	95,741	293,340	225,166	25,919	51,733	596,158
1956	74,900			8,847	83,747	323,524	198,595	24,732	61,810	608,661
1957	58,643			6,306	64,949	279,859	168,041	26,052	29,218	503,170
1958	49,003	4,767		5,702	59,472	268,381	151,777	21,734	27,710	469,602

[1] Revised figures, 1952–57.
[2] Included with flotation concentrate.
[3] Includes data for 1952–53 only, for feldspathic sands.
[4] Includes other ceramic uses, soaps, and abrasives.

Ground Feldspar.—Most feldspar consumers bought material already ground, sized, and ready for use in their manufactured products. In 1958 the glass, pottery, and enamel industries consumed 94 percent of the ground feldspar sold by merchant mills.

TABLE 6.—Ground feldspar shipped, by States of destination, from merchant mills in the United States, in short tons

Destination	1954	1955	1956	1957	1958
California	150,422	128,366	[1] 120,941	[1] 75,012	77,407
Illinois	60,391	37,305	73,067	[1] 56,853	48,385
Indiana	13,864	(2)	(2)	(2)	16,353
Maryland	16,324	15,016	18,835	15,930	14,000
Massachusetts	4,764	5,539	5,647	[1] 4,746	3,738
New Jersey	32,465	38,125	41,144	[1] 29,358	24,306
New York	28,923	22,242	23,169	[1] 21,849	20,883
Ohio	58,198	102,273	79,757	[1] 61,834	56,367
Pennsylvania	79,688	62,072	69,506	[1] 64,302	60,322
Tennessee	12,618	(2)	(2)	(2)	(2)
West Virginia	46,636	36,677	(2)	[1] 44,893	(2)
Wisconsin	6,534	10,674	10,813	9,822	8,664
Other destinations [3]	[1] 57,653	[1] 137,869	165,782	[1] 118,571	139,127
Total	[1] 568,480	[1] 596,158	[1] 608,661	[1] 503,170	469,607

[1] Revised figure.
[2] Included with "Other destinations."
[3] Includes Alabama (1954), Arkansas, Colorado, Connecticut (1954, 1956, and 1958), Florida (1954), Georgia (1954), Kansas (1954 and 1958), Kentucky, Louisiana, Maine (1957–58), Michigan, Minnesota, Mississippi, Missouri, New Hampshire (1954 and 1956), New Mexico (1955), North Carolina (1954), North Dakota (1956), Oklahoma, Rhode Island, Texas, Washington (1954–57), shipments that cannot be separated by States, and shipments to States indicated by footnote 2. Also includes exports to Canada, England (1954–58), Mexico, Panama (1954 and 1957–58), Peru (1954), Philippines (1954), Puerto Rico, Venezuela (1954–57), West Germany (1957–58), and small quantities to unspecified countries.

TABLE 7.—Crude feldspar sold or used by producers in the United States, imports, and apparent domestic consumption

Year	Production [1]		Imports		Apparent domestic consumption [1]	
	Long tons	Value (thousands)	Long tons	Value (thousands)	Long tons	Value (thousands)
1949–53 (average)	459,667	$3,466	11,360	$90	471,027	$3,556
1954	526,590	4,517	79	3	526,669	4,520
1955	550,861	4,528	105	9	550,966	4,537
1956	560,074	5,829	258	9	560,332	5,838
1957	498,057	4,935	72	7	498,129	4,942
1958	469,738	4,278	73	5	469,811	4,283

[1] Revised figures, 1952–57.

PRICES

The average value of crude feldspar was $9.11 per long ton compared with $9.91 in 1957.

The average selling price of ground feldspar was $13.93 per short ton, a decrease of 1 percent from 1957.

The following producing States had the highest selling price per short ton: Illinois, $23.26; Tennessee, $21.46; New Jersey, $20.86; Arizona, $20.76; New Hampshire, $20.71; and Virginia, $20.59.

The highest average value by uses was reported for enamel at $20.79 per short ton.

Quotations on ground feldspar in E&MJ Metal and Mineral Markets throughout 1958 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). Some producers sold ground glass-grade feldspar for as low as $9.80 per short ton.

FOREIGN TRADE [4]

According to reports from grinders, ground-feldspar exports decreased 29 percent. Countries of destination were Canada, England, Mexico, Panama, Puerto Rico, West Germany, and small quantities to unspecified countries.

Cornwall Stone—Imports for consumption of ground cornwall stone (from England) decreased from 70 long tons in 1957 to 40 in 1958.

TABLE 8.—Feldspar imported (all from Canada) for consumption in the United States

[Bureau of the Census]

Year	Crude		Ground		Year	Crude		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1949–53 (average)	11,360	$90,429	20	$553	1956	258	$9,311	1,374	$33,589
1954	79	3,357	898	22,449	1957	72	6,626	3,969	66,548
1955	105	9,346	1,254	31,737	1958	73	4,659	6,584	100,564

WORLD REVIEW

The estimated free world production of feldspar in 1958 and the distribution of production by countries remained virtually the same as in 1957.

[4] 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 9.—World production of feldspar, by countries,[1] in long tons[2]

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

Country[1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada (sales)	27,636	14,371	16,207	16,208	18,259	15,848
United States (sold or used)	459,667	526,590	550,861	560,074	498,057	469,738
Total	487,303	540,961	567,068	576,282	516,316	485,586
South America:						
Argentina	9,542	4,633	4,501	7,999	4,271	[3] 4,900
Brazil	[3] 12,000	(4)	(4)	(4)	(4)	(4)
Chile	961	1,319	854	826	[3] 800	[3] 800
Peru	85	----	----	----	----	----
Uruguay	765	696	381	----	168	267
Total[3]	23,400	19,000	19,000	22,000	18,000	19,000
Europe:						
Austria	2,658	2,137	2,510	2,677	2,612	2,613
Finland	8,935	12,062	12,529	8,799	9,055	13,188
France	55,411	61,021	71,847	75,966	65,224	[3] 68,900
Germany, West	83,031	124,586	163,599	164,166	188,269	187,504
Italy	21,074	28,449	52,097	50,479	57,012	55,198
Norway	25,649	27,764	39,434	52,437	[3] 50,000	[3] 50,000
Portugal	486	----	592	912	1,161	[3] 1,200
Spain (quarry)[5]	749	----	1,611	2,104	4,392	5,933
Sweden	39,736	48,494	50,639	52,500	52,968	43,709
Yugoslavia	----	----	----	----	----	[3] 13,800
Total[1, 3]	245,000	310,000	400,000	415,000	440,000	450,000
Asia:						
Hong Kong	----	----	120	60	1,156	1,653
India	2,381	6,476	5,230	3,263	7,872	[3] 5,900
Japan[6]	21,094	33,627	30,587	48,665	43,417	[3] 44,000
Philippines	----	----	----	----	49	74
Viet Nam, South	----	1,663	1,880	[3] 2,000	[3] 2,000	[3] 2,000
Total	23,475	41,766	37,817	53,988	54,494	[3] 54,000
Africa:						
Eritrea	40	6	12	12	394	413
Kenya	4	----	----	----	120	26
Madagascar	5	----	----	203	----	----
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	[7] 919	----	----	----	----	447
Union of South Africa	5,106	3,525	6,421	9,730	11,381	7,708
Total	6,074	3,531	6,433	9,945	11,895	8,594
Oceania: Australia[8]	11,822	16,384	20,833	18,629	9,607	7,243
World total (estimate)[1, 2]	800,000	930,000	1,050,000	1,095,000	1,050,000	1,025,000

[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 exactly 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 figures: 1949–53 (average) 7,937 tons; 1954, 8,160 tons; 1955, 5,041 tons; 1956, 3,524 tons; 1957, 4,472 tons; 1958, 4,249 tons.
[6] In addition, the following quantities of aplite and other feldspathic rock were produced: 1949–53 (average), 59,123 tons; 1954, 74,817 tons; 1955, 66,291 tons; 1956, 63,723 tons; 1957, 82,670 tons; 1958, 75,988 tons.
[7] Average for 1950–53.
[8] Includes some china stone.

TECHNOLOGY

The geology of two feldspar-containing areas in the Southwest and one in New England was described.[5]

[5] Kuellmer, F. J., Alkali Feldspar in a Tertiary Porphyry Near Hillsboro, N. Mex.: Jour. Geol., vol. 66, No. 3, March 1958, pp. 151–162.
Humphrey, F. L., and Wyatt, M., Sheelite in Feldspathized Granodiorite at the Victory Mine, Gabbs, Nev.: Econ. Geol., vol. 53, No. 1, January 1958, pp. 38–64.
Stugard, Frederick, Jr., Pegmatites of the Middletown Area, Connecticut: Geol. Survey Bull. 1942–Q, 1958, pp. 613–683.

Articles on the genesis, mineralogy, and geology of feldspars were published.[6]

Work was conducted on thin section identification of feldspar.[7]

The identification of potassium feldspar in thin sections and immersion liquids was discussed. Its slightly reddish hue observable under the polarizing microscope was used as a distinguishing feature.[8]

Structural studies were made on plagioclase[9] and orthoclase[10] feldspars.

It was shown that measurements of principal refractive indices could give a reliable estimate of the composition of a plagioclase feldspar regardless of its structural state.[11]

It was concluded from available optical and X-ray data that there were an infinite number of stable forms of both sodium and potassium feldspar between the highest and lowest temperature forms.[12]

X-ray diffractometer measurements were made on 111 analyzed plagioclase feldspars.[13]

Academic research on feldspar continued in the U.S.S.R.[14]

A method was developed to measure thermal expansion and contraction of feldspar microscopically to augment information gained by chemical analysis.[15]

The results of experiments on surface exchange reactions of feldspar were published.[16]

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[6] Kreiling, A., Origin of Feldspars and Feldspar Deposits: Euro-Ceram. (Dusseldorf), vol. 8, No. 4, 1958, pp. 100–101.
Marmo, Valdi, Orthocline and Microcline Granites: Am. Jour. Sci., vol. 256, 1958, pp. 360–364.
Perrault, Guy, Atomic Structure of the Feldspars: Ingenieur (Montreal), vol. 43, No. 172, 1957, pp. 24–27; Chem. Abs., vol. 52, No. 14, July 25, 1958, p. 11666f.
Pirani, Rossana [Chemical and Optical Studies of Some Feldspars of Orthogenetic Pegmatites From the Middle Val Venosta]: Rendiconti soc. Mineral. ital., vol. 13, 1957, pp. 329–340; Chem. Abs., vol. 52, No. 14, July 25, 1958, p. 11666g.
Science Newsletter, New Compounds Formed Sixty Miles Deep in Earth: Vol. 74, No. 19, Nov. 8, 1958, p. 297.
Vetter, Hans, Feldspars and Feldspathic Rocks: Euro-Ceram. (Dusseldorf), vol. 8, No. 2, 1958, pp. 25–30.

[7] Gradwell, R., Simple Fusion Method for Determination of Plagioclase Feldspar From Thin Section: Am. Mineralogist, vol. 43, No. 3–4, March–April 1958, pp. 368–370.

[8] Savolahti, Antti [Identification of Potassium Feldspar]: Geologic (Helsinki), vol. 10, 1958, p. 23; Chem. Abs., vol. 52, No. 20, Sept. 25, 1958, p. 15355f.

[9] Marfunin, A. S. [The Petrographic Significance of Structural Transformations in Feldspars]: Sov. Geologiya (U.S.S.R.), vol. 51, 1956, pp. 249–264.
Smith, J. V., "The Effect of Temperature, Structural State and Composition on the Albite, Pericline and Acline–A Twins of Plagioclase Feldspars": Am. Mineralogist, vol. 43, No. 5–6, May–June 1958, pp. 546–551.

[10] Saxena, E. R., and Datar, D. S., Extraction of Potassium From Feldspar, VIII Structure of Feldspar: Jour. Indian Chem. Soc., vol. 18, 1955, pp. 203–208; Chem. Abs., vol. 52, No. 18, Sept. 25, 1958, p. 15355f.

[11] Smith, J. R., The Optical Properties of Heated Plagioclases: Am. Mineralogist, vol. 43, No. 11–12, November–December 1958, pp. 1179–1194.

[12] Smith, J. V., and Mackenzie, W. S., The Alkali Feldspars: IV. The Cooling History of High-Temperature Sodium-Rich Feldspars: Am. Mineralogist, vol. 43, No. 9–10, September–October 1958, pp. 872–889.

[13] Smith, J. V., and Gay, P., Powder Patterns and Lattice Parameters of Plagioclase Feldspars II: Mineralogical Mag. (Cambridge), vol. 31, 1958, pp. 744–762.

[14] Marfunin, A. S., A New Diagram of Optical Orientation of Acid and Medium Plagioclase: Dokz An U.S.S.R. (Moscow), vol. 118, No. 6, February 1958, pp. 1183–1186; Monthly Index of Russian Access, vol. 11, No. 5, August 1958, p. 1447.
Nazarenko, M. F., and Razumova, V. L., Kinetics of a Quartz Solution in a Feldspar Fusion: Trudy Institut Stroitel' STVA L'—Stroimaterialov an Kazakh (Trans.), No. 1, 1958, pp. 91–95; Monthly Index of Russian Access., vol. 11, No. 6, September 1958, p. 1798.

[15] Zwetsch, A. [A Study of French Feldspar]: Bull. Soc. franc. Ceram., 1957, No. 36, pp. 3–19; Ceram. Abs., vol. 42, No. 2, February 1959, p. 62.

[16] Nash, V. E., and Marshall, C. E., Surface Reaction of Silicate Minerals; I Reactions of Feldspar Surfaces With Acidic Solutions: Missouri Univ. Agr. Experimental Station Res. Bull. 613, 1956, 36 pp.; II Reactions of Feldspar Surfaces With Salt Solutions: Missouri Univ. Agr. Experimental Station Res. Bull. 614, 36 pp.

The use of various other feldspar rocks to augment diminishing resources of feldspar-containing pegmatites in many countries was discussed.[17]

An article described the electrostatic processing of feldspar and included detailed flowsheets and diagrams.[18]

The preparation and application of ceramic bodies and glazes using feldspar were discussed.[19]

NEPHELINE SYENITE

Domestic Consumption.—Domestic consumption in the glass and ceramic industries of nepheline syenite imported from Canada maintained the same high volume as in 1957. 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.[20]—Prices of processed nepheline syenite per short ton were quoted as follows, f.o.b. works, bags, carlots: Glass grade (30-mesh) $15; Pottery grade (200- to 325-mesh) $21.50 to $28; Byproduct grade (100-mesh) $10 (add $3 per short ton to bulk quotations for bags and bagging).

TABLE 10.—Nepheline syenite imported for consumption in the United States

[Bureau of the Census]

Year	Crude		Ground		Year	Crude		Ground	
	Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
1949–53 (average)	10,073	$40,961	59,277	$835,919	1956			140,306	[1]$2,136,092
1954			95,782	[1]1,436,325	1957			166,989	[1]2,505,248
1955			111,863	1,856,062	1958	160	$2,696	164,814	2,253,062

[1] Data known to be not comparable with other years.

Foreign Trade.—Imports of nepheline syenite mostly for use in the glass industry (all from Canada), decreased 1 percent in volume and 10 percent in value from 1957.

World Review.—From available data Canada appears to be the major producer of nepheline syenite for the ceramic industries.

Deposits occur also in Norway, India, and Korea. The nepheline syenite of India has been considered for use in glass manufacturing, but there has been no production. U.S.S.R. is the only other country producing a ceramic raw material containing abundant nepheline. Part of this product was used as a source of alumina.

[17] Magidovich, V. I. [From Foreign Experiences in the Utilization of Feldspar Rocks in the Glass and Ceramics Industry]: Razvedka i Okhrana Nedr (U.S.S.R.), 1958, No. 6, pp. 57–59.

[18] Northcott, E., and LeBaron, I. M., Application of Electrostatics to Feldspar Beneficiation. Min. Eng., vol. 10, No. 10, October 1958, pp. 1087–1093.

[19] Sturmer, C. M., Feldspar in Ceramic Bodies and Glazes: Euro-Ceram. (Dusseldorf), vol. 8, No. 2, 1958, pp. 40–41.

[20] Reeves, J. E., Nepheline Syenite: Canada Dept. of Mines and Tech. Surveys, Ottawa, No. 44, April 1959, p. 5.

TABLE 11.—Canadian nepheline syenite,[1] production and trade

	1957		1958	
	Short tons	Value	Short tons	Value
Production (shipments)	200,016	$2,754,060	201,306	$2,613,446
Exports, crude and processed material:				
United States	156,379	2,096,587	152,862	1,977,523
United Kingdom	2,553	42,622	4,084	64,274
Puerto Rico	949	15,405	1,650	30,105
Other countries	4,461	81,229	1,485	26,519
Total	164,342	2,235,843	160,081	2,098,421

[1] Reeves, J. E., Nepheline Syenite: Canada Dept. of Mines and Tech. Surveys, Ottawa, No. 44, April 1959, p. 2.

Technology.—Nepheline deposits in Finland [21] and Norway [22] were described in the literature.

A bulletin abstracting many articles on the use of nepheline syenite was published.[23]

The geology and processing of nepheline syenite by the American Nepheline Corp., Nephton, Ontario, were described. Its production capacity was 600 tons a day of ground nepheline syenite for the pottery and glass trade. Flowsheets were included.[24]

Large deposits of calcite-nepheline ore containing 96-percent nepheline were reported in the U.S.S.R.[25]

Nepheline syenite can be used at low cost with excellent results in tools for producing high-temperature plastic parts made of ceramic material. Thirty-eight percent nepheline syenite and 9 percent feldspar were used.[26]

APLITE

Production of aplite for making amber glass and window glass decreased appreciably. The only aplite producers were: Riverton Lime & Stone Co. Division, Chadbourn Gotham, Inc., in Amherst County and Consolidated Feldspar Department, International Minerals & Chemical Corp. in Nelson County both near Piney River, Va.

The geology and mineralogy of an aplite deposit in Montana were discussed.[27]

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[21] Sahama, Th. G., A Complex Form of Nepheline From Iivaara, Finland: Am. Mineralogist, vol. 43, No. 1–2, January–February 1958, pp. 165–166.

[22] Tilley, C. E., Nepheline Associations: Verhandel. Ned. Geol.-Maynbouwk Genoot., Geol. Series 16, 1956, pp. 403–413; Ceram. Abs., vol. 52, No. 22, Nov. 25, 1958, p. 6076e.

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[24] Trauffer, W. E., Nepheline Syenite: Pit and Quarry, vol. 50, No. 7, July 1958, pp. 76–78, 80–81, 84–87.

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Ferroalloys

By H. Austin Tucker[1] and Hilda V. Heidrich[2]

COMPARED with 1957, output, shipments, and value of ferroalloy products in 1958 decreased about 30 percent, and steel-ingot and casting production declined about 24 percent.

In this chapter each ferroalloy is described only as an alloying vehicle; other commodity aspects are reported in the separate chapters in this volume.

DOMESTIC PRODUCTION AND SHIPMENTS

In 1958, 1.7 million short tons of ferroalloys was produced in 38 electric furnace, 10 blast-furnace, and 6 alumino-thermic plants. This industry was conducted in 18 States; Pennsylvania was the leading producer with 412,000 short tons, followed by Ohio with 378,000. Production was also reported from Alabama, Florida, Idaho, Illinois, Iowa, Kentucky, Montana, New Jersey, New York, Oregon, South Carolina, Tennessee, Texas, Virginia, Washington, and West Virginia. The Bureau of Mines has collected data on 30 ferroalloys, the most important of which are listed in table 1.

Manganese Alloys.—Ferromanganese production was exceeded only by that for iron, aluminum, and copper. Ten producers operated 5 blast furnace plants and 12 electric furnace plants in 11 States. Pittsburgh Coke & Chemical Company began commercial production in its blast-furnace plant at Neville Island, Pa. Tennessee Products and Chemical Corporation did not operate its blast-furnace plant.

The four companies operating five blast-furnace plants produced 41.4 percent less ferromanganese than in 1957. The average value was $239 a ton, slightly higher than the $237 average value for 1957. Stocks on hand at the end of 1958 were 110,594 tons, 19 percent more than at the beginning of the year.

The 6 companies operating 12 electric furnace plants produced 10 percent less ferromanganese than in 1957. Shipments from electric plants were 5 percent less than production. The average value was $240 a ton, the same as in 1957. Stocks on hand at the end of the year totaled 57,973 tons—29 percent more than at the beginning of the year.

Ferromanganese imported for consumption in the United States dropped precipitously in both tonnage and value, as shown in table 4, amounting to about 81 percent less than in 1957.

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TABLE 1.—Ferroalloys produced and shipped from furnaces in the United States

	1957				1958			
	Production		Shipments		Production		Shipments	
	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value (thousand)	Gross weight (short tons)	Alloy element contained (average percent)	Gross weight (short tons)	Value (thousand)
Ferromanganese:								
Blast furnace	735,493	77.03	665,011	$157,813	430,790	77.34	413,272	$98,898
Electric furnace	228,321	77.53	217,055	52,191	205,946	78.47	194,827	46,749
Total ferromanganese	963,814	77.14	882,066	210,004	636,736	77.70	608,099	145,647
Silicomanganese	114,566	66.07	107,946	27,853	80,977	65.73	82,013	20,638
Ferrosilicon	417,025	55.24	395,454	70,789	286,396	55.78	319,791	54,879
Silvery iron	351,826	12.20	360,649	31,656	228,114	11.47	224,521	18,257
Ferrochromium	[1] 410,327	67.11	402,115	175,628	[1] 263,598	66.19	260,469	115,179
Other chromium alloys	[2] 84,260	40.71	76,492	23,453	[2] 40,808	41.86	46,652	14,980
Total ferrochromium	494,587	62.61	478,607	199,081	304,406	62.94	307,121	130,159
Ferrotitanium	6,676	21.55	6,831	3,410	4,440	26.58	4,612	3,294
Ferrophosphorus	77,167	24.26	69,127	2,502	98,628	23.68	75,124	3,253
Ferrocolumbium and ferrotantalum-columbium	[3] 530	58.11	434	2,357	430	58.37	467	1,974
Ferronickel	20,564	44.08	19,708	49,836	23,793	44.50	24,785	45,943
Other	[4] 68,780	26.17	62,590		[4] 47,673	26.35	48,964	
Total	2,515,535	57.63	2,383,412	597,488	1,711,593	56.87	1,695,497	424,044

[1] Includes low- and high-carbon ferrochromium and chromium briquets.
[2] Includes ferrochrome-silicon, exothermic chromium additives, and other chromium alloys.
[3] Includes chrom-columbium.
[4] Includes alsifer, ferroboron, ferromolydbenum, ferrotungsten, ferrovanadium, simanal, spiegeleisen zirconium-ferrosilicon, ferrosilicon-zirconium, and other miscellaneous ferroalloys.

Silicomanganese, the high-silicon, low-carbon alloy, comprised 11 percent of the manganese alloys produced. It was made by 7 companies in 14 electric furnace plants in 9 States. Production, shipments, and total value of silicomanganese declined 29, 24, and 26 percent, respectively, from comparable totals in 1957. Stocks on hand at the end of 1958 were 25,000 tons, the same as at the beginning of the year.

Ferrosilicon.—Ferrosilicon was produced by 11 companies in 22 electric furnace plants in 11 States. The production, shipments, and total value declined 31, 19, and 23 percent, respectively, from 1957. The cost per ton decreased to $171.61 in 1958 from $178 in 1957. The price of contained silicon ranged from 8.8 to 49.4 cents a pound, depending on grade, but most of the commodity was sold within the range of 12 to 18 cents a pound. At yearend 54,000 tons remained unsold.

In February, Ohio Ferro-Alloys Corp. began operating its new electric furnace plant at Powhatan Point, Ohio, producing silicon metal and ferrosilicon.

Silvery Iron.—High-silicon silvery pig iron was produced by five companies in three blast furnace plants and three electric furnace plants in four States. About two-thirds of the total was made in blast furnaces and had an average silicon content of 8.7 percent.

The silicon content of that made in electric furnaces averaged 15.9 percent. The cost a ton for blast furnace silvery iron was about $75 and for electric furnace, $91. However, the cost of contained silicon per pound in the blast furnace product was 43 cents and in the electric furnace product, 29 cents. Production was down 35 percent, consumption 38 percent, and total value 42 percent. At the end of 1958, 66,200 tons of silvery iron remained on hand at the producers' plants, compared with 62,600 tons at the beginning of the year.

Chromium Alloys.—Ferrochromium alloys and metal were produced from 766,000 tons of chromite ore and concentrate in 19 plants operated by 11 companies in 10 States. American Chrome Co. became a producer with a small electric furnace plant at Nye, Mont.

The average unit value of the ferrochromium product increased about 2 percent from $416 a ton in 1957 to $424, but the cost a pound of contained chromium remained the same. At yearend 61,941 tons of ferrochromium remained unsold, compared with 73,000 tons in 1957.

Molybdenum Products.—Climax Molybdenum Company and Molybdenum Corporation of America plants, together with the plant of the Electro Metallurgical Company at Alloy, W, Va., continued to produce molybdenum products.

The average grade of ferromolybdenum was 62.3 percent valued at $2,070 a ton, equal to $1.66 a pound of contained metal, which was down 4 cents from the peak price of $1.70 established in 1957. The average cost of miscellaneous molybdenum products was $874 a ton, with the actual prices ranging from $470 to $3,500 a ton.

Ferrophosphorus.—Ferrophosphorus was produced as a byproduct by seven companies in nine electric furnace plants in five States. At midyear, Shea Chemical Corporation merged with Hooker Electrochemical Co. Hooker produced ferrophosphorus at the Shea plant in Columbia, Tenn., but not at its Niagara Falls plant as in preceding years.

The cost of a ton of ferrophosphorus increased for the third year, reaching $43.31 a ton, $7 more than in 1957. Stock on hand at the end of the year totaled 130,349 tons, compared with 97,186 tons in 1957.

Titanium Alloys.—Titanium alloys were produced by five companies in four electric furnaces, and two alumino-thermic plants in three States. Shieldalloy Corporation in Newfield, N.J. was a new producer.

Again approximately half of the total tonnage produced was ferrotitanium, in which the titanium content varied from 17 to 70 percent. The cost a ton of ferrotitanium varied from $241 to $3,500, depending on grade, with an average of $1,237. The average unit value of all titanium alloys for the year was $714, an increase of 43 percent. The average cost a pound of contained titanium in ferrotitanium was $1.70 in 1958, an increase of 8 percent over the $1.56 obtained in 1957. The average cost a pound of contained titanium in all products was $1.34 in 1958, an increase of 17 percent over 1957. Producers' stocks on hand at the end of 1958 were 1,020 tons for all titanium alloys, compared with 1,130 tons in 1957.

Ferrovanadium.—Ferrovanadium continued to be produced by two companies in two electric furnace plants in two States. The average vanadium content of the ferrovanadium was 54 percent, the average value of contained vanadium was $3.17 a pound, down 4 cents from 1957, and production, shipments, and total value uniformly declined about 30 percent. Stock on hand at the end of 1958 increased 26 percent over that of 1957.

Ferrozirconium.—One company continued to produce ferrozirconium but in only one plant. The average grade of the alloy remained at 13 percent, and the value of the contained zirconium increased 4 cents to 76 cents a pound. Production decreased 90 percent, shipments 69 percent, and value 67 percent, from comparable quantities in 1957. Stock remaining in the producers' bins at yearend decreased 51 percent from 1957. Shipments were over three times larger than production.

Ferroboron.—Ferroboron was produced by three companies in two electric furnace plants and one alumino-thermic plant in three States. The AISI reports that 219,250 tons of alloy-steel ingots with boron was produced compared with 257,969 tons in 1957.

Salient details of the ferroboron produced and sold in 1958 are that the boron content averaged 16.3 percent, that the cost increased 20 percent to $7.42 a pound of contained metal, that production was up 29 percent, and that shipments and value declined 39 percent from the comparable quantities in 1957. Stock on hand at the end of the year was 44 percent less than in 1957.

Ferrotungsten.—Ferrotungsten continued to be produced by three companies in two electric furnace plants and one alumino-thermic plant in two States. The average tungsten content was 80 percent and was sold at a cost of $2.30 a pound of contained metal, a decline of 14 percent from $2.67 a pound in 1957. Production decreased 56.4 percent, shipments remained the same, and total value declined 16 percent. The companies' stocks remaining at their plants at yearend were down 40 percent.

Columbium and Tantalum.—Ferrocolumbium was produced by five companies in three electric furnace plants and two alumino-thermic plants in four States. The average columbium content was 58 percent at an average selling price of $3.70 a pound of contained metal, a decrease of 24 percent from the average selling price of $4.89 obtained in 1957. Production increased 23 percent in 1958, shipments 52 percent, and total value 17 percent. Stocks on hand at yearend increased 55 percent.

Ferrotantalum-columbium was produced by two of the companies making ferrocolumbium in the same plants. This duplex ferroalloy averaged a total of 60 percent tantalum plus columbium content and sold for $3.43 a pound of these contained alloy metals, a decrease of 97 cents, or 22 percent, from 1957. Shipments exceeded production by 56 percent. Stocks on hand were down 36 percent from 1957.

Nickel.—One company (Hanna Nickel Smelting Co., Riddle, Oreg.) continued to make all the ferronickel produced.

CONSUMPTION AND USES

Most ferroalloys produced were consumed by the steel industry. Small quantities of certain alloys were used by the aluminum and other nonferrous metallurgical enterprises and by the chemical industry. The alloy-steel-ingot production reported to the AISI was

TABLE 2.—Consumption of silvery pig iron, ferrosilicon, silicon metal, silicon briquets, and miscellaneous silicon alloys in the United States, in 1958, by end uses, in short tons

Alloy	Silicon content (percent)	Steel ingots and castings [1]	Steel castings [1]	Iron foundries and miscellaneous	Total	Stocks, Dec. 31
Silvery pig iron	5-13	8,435	9,227	92,730	110,392	20,535
Do	14-20	76,417	5,025	55,114	136,556	35,459
Ferrosilicon	[2] 21-55	97,504	8,711	44,124	150,339	26,322
Do	56-70	19,172	61	249	19,482	2,252
Do	71-80	30,508	450	5,392	36,350	5,345
Do	81-89	1,910	182	1,328	3,420	786
Do	90-95	3,690	13	1,901	5,604	1,213
Silicon metal and refined silicon		1		12,899	12,900	1,775
Silicon briquets		241	1,056	25,330	26,627	5,268
Miscellaneous silicon alloys [3]		11,160	2,028	6,851	20,039	2,717
Total		249,038	26,753	245,918	521,709	101,672

[1] Data for castings made by companies that also produce steel ingots are included with "steel ingots and castings" and excluded from "steel castings."
[2] Nearly all this material is in the range of 40 to 55 percent silicon.
[3] Includes calcium-silicon, calcium-manganese-silicon, silicon-manganese-zirconium, alsifer, ferrocarbo, and miscellaneous other silicon alloys.

6.7 million tons, which includes: 4.3 million ingot tons of heat-treatable engineering steel; 813,000 tons of high-silicon electrical sheets; 609,000 tons of low-alloy, high-strength non-heat-treated engineering and constructional alloy; 534,000 tons of nominal 18–8 nickel-chrome stainless steels (AISI 300 series); and 335,000 tons of essentially nickel-free chromium stainless steels (AISI 400 and 500 series). Additionally, ferroalloys were used in 1 million tons of steel made into castings at foundries independent of the steel producers. Shipments of alloy tool and die steels were 62,000 tons, made from an unknown quantity of ingot.

Several of the ferroalloy producers supplied consumers with their products in preweighed small containers, providing means for accurate alloy additions and permitting savings on alloy costs. The containers also provide added savings by preventing losses in transit and by eliminating weighing and some handling.

Manganese Alloys.—A total of 818,000 tons of manganese metal and manganese alloys was consumed by the iron and steel industry, according to reports made to the Bureau of Mines. Distribution was as follows: 76 percent high-carbon ferromanganese, 6.4 medium- and low-carbon ferromanganese, 10.6 percent silicomanganese, 4.5 percent spiegeleisen, 1.1 percent manganese metal, and 1.3 percent manganese briquets. This distribution is essentially that of 1957, but the total tonnage is 18 percent less.

A total of 1.5 million tons of manganese ore was consumed in the United States. Most of this total was converted to ferromanganese, which was used in producing 85.2 million tons of steel ingots and castings made at steel mills and 1 million tons of steel castings made at independent foundries. Of the 674,000 tons of ferromanganese consumed, 622,000 tons (92.3 percent) was the high-carbon variety, and the remainder was medium and low carbon. Additionally, 87,000 tons of silicomanganese, 37,000 tons of spiegeleisen, and 4,000 tons of manganese briquets were consumed by the iron and steel industry.

Silicon Alloys.—The consumption of silicon alloys declined 25 percent from that of 1957, paralleling the general decline of steel production. Steel castings sustained the greatest decrease, 34 percent. In respect to commodities, 90–95 percent ferrosilicon suffered the greatest loss of consumption, being down 35 percent from 1957. The silicon commodities that showed the least declines of consumption as an alloy were silicon metal and refined silicon. Silicon was used in the aluminum production industry, which maintained a higher rate of activity in 1958 than did steel.

Ferrosilicon was used principally as a deoxidizer for most grades of partly and completely deoxidized steel and also as an alloy in electrical sheets and in other silicon alloy steels. Silicon and other alloy additions are often made more economically in combinations such as silico-manganese. Two new combinations were introduced by one company in 1958, a high-silicon, high-carbon ferrochrome and a low-carbon ferromanganese-silicon. The latter was used as a slag-reducing agent and as a source of low-carbon manganese, especially in making the AISI 200 series stainless steel. The high-silicon, high-carbon ferrochrome was used in making the AISI 52100 and 4300 grades of engineering alloy steels.

Chromium Alloys.—Consumption of chromium alloys of all grades by the steel industry in 1958 was reported to the AISI to be 225,000 tons with 127,300 tons of contained metal. A comparable Bureau of Mines survey showed that 201,500 tons of alloy with 117,000 tons of contained chromium were used in 1958, a decline of 42 and 39 percent respectively from 1957. Of this quantity, 66 percent was consumed in the production of stainless steels and 28 percent in other alloy steels.

Chromium, as a ferroalloy, had two chief uses, to retard corrosion and oxidation in stainless and high-temperature steels, and to increase the hardenability, strength, and wear resistance of engineering-alloy steels. The chromium alloy most commonly used in 1958 was low-carbon ferrochromium, with 86,400 tons consumed, representing 43 percent of the total alloy and 50 percent of all the contained chromium. High-carbon ferrochromium was the second most commonly used chromium alloy, with 53,700 tons consumed. Other ferrochromium alloys used included low-carbon ferrochromium silicon, chromium briquets, and exothermic ferrochrome-silicon.

Nickel.—Exclusive of scrap, 41,400 tons of nickel was consumed for use as a ferroalloying element in steel, 14 percent less than 1957. Another 7,400 tons was used in high-temperature and electrical-resistance alloys, 24 percent less than 1957. Of the 41,400 tons of nickel used as a ferroalloying element, 23,000 tons went into stainless steels, 14,500 tons into engineering-alloy steels, and 3,900 into cast iron, representing declines from 1957 of 15, 9, and 30 percent, respectively.

Molybdenum.—The steel industry consumed 7,400 tons of contained molybdenum in producing high-speed and other alloy steels, compared with 10,000 tons in 1957. Engineering alloys, including stainless, accounted for 6,900 tons of these wrought products. The next largest uses of molybdenum in descending order were: Steel castings, 930 tons; gray and malleable castings, 870 tons; and high-temperature alloys, 600 tons, representing declines of 15, 24, and 13 percent, respectively, from 1957. Of the 12,000 tons of all molybdenum products consumed, 8,100 tons was in the form of molybdic oxide, 2,450 tons in ferromolybdenum and molybdenum silicide, and most of the remainder in molybdenum metal.

Tungsten Products.—A total of 2,757 tons of contained tungsten was consumed by U.S. industries. Since tungsten contributes hot-hardness and wear-resistance qualities to steel, nearly 35 percent of the contained tungsten used, 962 tons, was consumed for use in high-speed and other tool steels, and in high-temperature applications. A somewhat larger consumption was in carbides, 1,081 tons, for use in tools and dies, and for other wear-resistant purposes. Manufacturers of steel ingots and ferrotungsten consumed 26 percent of the total, 700 tons of contained tungsten, compared with 1,055 tons in 1957, a decrease of 34 percent.

The steel manufacturers reported to the Bureau of Mines that 550 tons of contained tungsten was consumed in the alloying of high-speed-tool steel, 150 tons in other tool steel, and 160 tons in all other kinds of steel, a total of 860 tons representing 31 percent of total tungsten consumption. Steel manufacturers consumed 40 percent less tungsten than in 1957.

Columbium and Tantalum Alloys.—Despite the decline in ferroalloy consumption more ferrocolumbium was used. In 1958, 132 tons of contained metal was used compared with 126 tons in 1957. The consumption of ferrotantalum-columbium, however, decreased 23 percent to 95.6 tons of contained metals. The greatest gain in the consumption of columbium was in nonferrous, high-temperature alloys, which used from 14.9 tons in 1957 to 24.3 tons in 1958—an increase of 63.1 percent. Most of both ferroalloys was consumed in the production of stainless steel (AISI 347 and 348), in which 101 tons or 76 percent of ferrocolumbium and 56 tons or 59 percent of ferrotantalum-columbium were used. More of the combined ferroalloy was used in other alloy steels than was ferrocolumbium, 5.5 tons of the latter and 17 tons of the former. Of the contained alloy metal in the ferrotantalum-columbium alloys, 15 percent of most of the products was tantalum and 45 percent columbium.

Titanium Alloys.—The Bureau of Mines figures show that 4,612 tons of ferrotitanium with 1,225 tons of contained titanium, was shipped, a decline of 32 and 17 percent respectively from comparable figures for 1957. An estimated 123 tons of titanium (10 percent) was consumed in producing 30,715 tons of AISI 321, according to the AISI.

Ferrovanadium.—The quantity of vanadium metal consumed was 1,260 tons. Of this, 1,060 tons was used for the production of iron and steel alloys and 78 tons for nonferrous alloys. High-speed-steel production consumed 194 tons, down 200 tons or 51 percent from 1957, and other alloy-steel production consumed 845 tons, down 178 tons or 17 percent from 1957.

Ferrovanadium was the most commonly used vanadium compound with 1,022 tons (81.6 percent) of vanadium metal consumed in this alloy in 1958, a 25.6-percent decline from 1957.

Ferrozirconium.—As reported to the AISI, consumption of ferrozirconium by the iron and steel industry was 1,837 tons compared with

4,303 tons in 1957, and 7,648 tons in 1956, decreases of 57 and 76 percent, respectively. The proportion of contained zirconium has increased from an average of 15 percent in 1956 to 21 percent in 1957 and 28 percent in 1958. The calculated consumption of zirconium is 1,000 tons for 1956, 900 tons for 1957 and 505 tons for 1958.

Ferroboron.—Ferroboron was used to increase hardenability and to increase the thermal-neutron absorption cross section of steels. The latter quality is useful for control and shielding applications in nuclear reactors. The AISI reported that 30 tons of ferroboron containing 6.2 tons of boron was consumed as compared with 16 tons containing 3.3 tons of boron in 1957. This large increase in consumption, reversing the downward trend which began in 1953, may be attributable to its relatively new use in nuclear reactor installations.

FOREIGN TRADE [3]

The consumption of imported ferroalloys and ferroalloy metals declined more severely than consumption of ferroalloys produced domestically. Imports for consumption declined 60 percent in 1958, from 423,700 tons (revised) in 1957 to 166,900 tons in 1958. The value of these consumed imports decreased 57 percent, from $88 million (revised) in 1957 to $37.9 million in 1958. Imports for consumption of ferromanganese were down 81 percent in tonnage and value, and of ferrosilicon, 37 percent in tonnage and 46 percent in value.

One aspect of the decline, which accounted for the greater decrease in consumption of imports than domestic products, was the nearly complete cessation of the U.S. Government stockpiling program.

[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.—Ferroalloys and ferroalloy metals imported for consumption in the United States, by varieties

[Bureau of the Census]

Variety of alloy	1957			1958		
	Gross weight (short tons)	Content (short tons)	Value	Gross weight (short tons)	Content (short tons)	Value
Calcium silicide	249	(1)	$97,077	65	(1)	$25,111
Chromium metal	1,354	(1)	[2] 2,747,923	2,353	(1)	4,767,655
Chromium nickel and chromium vanadium	(3)	(1)	1,692			
Ferroboron				2	(1)	3,920
Ferrocerium and other cerium alloys	4	(1)	[2] 26,393	6	(1)	46,429
Ferrochrome and ferrochromium:						
Containing 3 percent or more carbon	31,316	19,543	8,155,493	12,274	7,068	2,907,111
Containing less than 3 percent carbon	16,353	11,367	6,304,912	12,505	8,897	4,911,090
Ferrochromium-tungsten, chromium tungsten, chromium-cobalt-tungsten, tungsten nickel, and other compounds of tungsten, n.s.p.f. (tungsten content)	(1)	33	[2] 112,099	(1)	(4)	983
Ferromanganese:						
Containing not over 1 percent carbon	767	676	[5] 405,056	76	64	28,164
Containing over 1 and less than 4 percent carbon	15,237	12,268	3,970,527	8,878	7,180	2,121,722
Containing not less than 4 percent carbon	[5] 322,075	244,877	[5] 55,860,098	54,978	42,277	8,895,906
Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum (molybdenum content)	(1)	748	2,047,540	(1)	56	138,347
Ferrosilicon	19,904	3,813	1,678,814	11,613	2,398	905,392
Ferrotitanium	128	(1)	99,982	101	(1)	72,709
Ferrotungsten	252	207	674,364	97	79	153,841
Manganese silicon (manganese content)	(1)	5,109	1,140,679	(1)	8,908	1,656,054
Silicon-aluminum and aluminum-silicon	40	(1)	[2] 21,252	27	(1)	13,757
Silicon metal (silicon content)	(5 6)	(5 7)	[2 5] 2,075	7	6	2,948
Tungsten in combinations, in lump, grains, or powder (tungsten content)	(1)	41	[2] 238,663	(1)	51	230,323
Tungstic acid and other alloys of tungsten, n.s.p.f. (tungsten content)	(1)	6	34,005	(1)	(8)	1,299

[1] Not recorded.
[2] Data known to be not comparable with 1958.
[3] 400 pounds.
[4] 83 pounds.
[5] Revised figure.
[6] 60 pounds.
[7] 50 pounds.
[8] 220 pounds.

TABLE 4.—Ferromanganese and ferrosilicon imported for consumption in the United States, by countries

[Bureau of the Census]

Country	Ferromanganese (manganese content) (excluding silicomanganese)				Ferrosilicon (silicon content)			
	1957		1958		1957		1958	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	94, 873	$22, 544, 924	153	$46, 281	3, 776	$1, 635, 261	2, 291	$840, 484
Mexico	1, 628	366, 793	624	147, 688				
Total	96, 501	22, 911, 717	777	193, 969	3, 776	1, 635, 261	2, 291	840, 484
South America: Chile	1, 022	230, 183	1, 513	276, 500				
Europe:								
Belgium-Luxembourg	3, 571	[1] 956, 290	3, 182	519, 715				
France	[1] 67, 722	[1] 15, 529, 446	12, 394	3, 135, 993			3	1, 567
Germany, West	[1] 32, 900	[1] 7, 478, 187			37	43, 553	43	46, 050
Italy							54	15, 555
Norway	9, 465	[1] 2, 529, 040	43	9, 850				
Yugoslavia	3, 465	866, 307	3, 525	738, 044				
Total	117, 123	[1] 27, 359, 270	19, 144	4, 403, 602	37	43, 553	100	63, 172
Asia:								
India			483	114, 796				
Japan	42, 734	9, 638, 636	27, 604	6, 056, 925				
Total	42, 734	9, 638, 636	28, 087	6, 171, 721				
Africa:								
Belgian Congo	441	95, 875						
Union of South Africa							7	1, 736
Total	441	95, 875					7	1, 736
Grand total	257, 821	[1] 60, 235, 681	49, 521	11, 045, 792	3, 813	1, 678, 814	2, 398	905, 392

[1] Revised figure.

TABLE 5.—Ferroalloys and ferroalloy metals exported from the United States, by varieties

[Bureau of the Census]

Variety of alloy	1955		1956		1957		1958	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Ferrochrome	4, 693	$2, 266, 579	5, 538	$2, 891, 379	4, 535	$2, 419, 102	1, 920	$1, 012, 260
Ferromanganese	1, 789	642, 806	2, 248	682, 257	7, 395	1, 866, 456	1, 406	463, 896
Ferromolybdenum	175	353, 073	472	1, 052, 281	192	447, 098	113	244, 755
Ferrophosphorous	53, 055	1, 345, 514	75, 411	2, 339, 328	50, 318	1, 901, 036	44, 503	1, 468, 445
Ferrosilicon	1, 689	308, 033	2, 115	483, 021	2, 649	502, 401	2, 177	391, 621
Ferrotitanium and ferrocarbon-titanium	245	65, 091	364	148, 459	367	130, 046	323	138, 431
Ferrotungsten	2	9, 698	1	4. 203	2	10, 092	1	3, 508
Ferrovanadium	220	991, 955	139	650. 955	134	519, 955	76	294, 933
Other ferroalloys	457	251, 887	316	158, 805	262	129, 468	[1] 189	[1] 109, 146
Spiegeleisen					29	2, 735	834	79, 243
Total	62, 325	6, 234, 636	86, 604	8, 410, 688	65, 883	7, 928, 389	[1] 51, 542	[1] 4, 206, 238

[1] Owing to changes in classifications by Bureau of the Census data not strictly comparable with other years.

Fluorspar and Cryolite

By Robert B. McDougal [1] and James M. Foley [2]

FLUORSPAR

DOMESTIC consumption of fluorspar declined sharply in 1958. Quoted prices remained virtually unchanged throughout the year. Government purchases were a factor in maintaining domestic production, but the purchase program established by Public Law 733 in mid-1956 terminated at the end of 1958. Several mines and mills were closed, and adjustments were made in the operational status of other facilities. Imports for consumption also declined from the record high achieved in 1957.

TABLE 1.—Salient statistics of crude and finished fluorspar, in short tons

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Production:						
Crude fluorspar:						
Mine production	732,673	616,900	656,500	922,100	861,500	818,100
Crude material milled or washed	656,348	622,600	667,500	775,700	790,600	814,800
Cleaned or concentrated fluorspar recovered	305,860	247,700	268,400	306,500	322,600	310,600
Finished fluorspar production (shipment from mines and mills)	306,902	245,628	279,540	329,719	328,872	319,513
Value, thousands	$12,870	$12,333	$12,590	$14,257	$15,777	$15,071
Imports for consumption	230,720	293,320	363,420	485,552	631,367	392,164
Value, thousands	$6,039	$8,962	$8,540	$11,225	$16,031	$9,777
Exports	798	643	874	197	754	3,374
Value, thousands	$47	$50	$65	$31	$81	$191
Consumption	475,070	480,374	570,261	621,354	644,688	494,227
Stocks on hand at end of year:						
Domestic mines:						
Crude [1]	100,151	184,143	139,077	189,021	[2] 214,934	207,210
Finished	25,744	26,370	23,439	[2] 19,161	[2] 17,317	18,677
Consumers' plants	188,827	143,813	140,577	189,679	227,990	185,291
Importers	13,647	26,100	54,021	53,900	70,600	92,477
World:						
Production	1,090,000	1,350,000	1,545,000	1,860,000	1,920,000	1,760,000

[1] This crude (run-of-mine) fluorspar in most cases is subjected to some type of processing before it can be marketed.
[2] Revised figure.

LEGISLATION AND GOVERNMENT PROGRAMS

Government programs affecting fluorspar were related primarily to stockpiling, mineral exploration, or mobilization plans. Revisions of stockpile objectives were made by the Office of Civil and Defense Mobilization (OCDM) on the basis of a 3-year mobilization period instead of 5.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

Office of Minerals Exploration.—Exploration programs continued to be encouraged by financial assistance from the Defense Minerals Exploration Administration (DMEA) and its successor, the Office of Minerals Exploration (OME). There were four exploration contracts in force at the end of 1958, compared with two at the end of 1957. Since the inception of the program in 1951 through December 31, 1958, 20 contracts for fluorspar have been executed. Of these, 1 was canceled and 15 were terminated by the end of 1958. Total value of the 15 contracts terminated was $462,261, of which the Government advanced $236,147. No certificates of discovery or development were issued during the year on contracts involving fluorspar.

Defense Materials Service.—Under provisions of Public Law 733—the "Domestic Tungsten, Asbestos, Fluorspar, and Columbium-Tantalum Production and Purchase Act of 1956"—domestic acid fluorspar was acquired by the Defense Materials Service (DMS) of the General Services Administration (GSA). When this purchase program terminated on December 31, 1958, the domestic producers had shipped 156,603 short tons valued at $8,477,202 during its 2½ years of existence.

Congress passed legislation to extend for 1 year the purchases of acid fluorspar under Public Law 733; however, this legislation was vetoed by President Eisenhower. In his veto message the President pointed out that whereas the Public Law 733 program had succeeded in its objective of maintaining a high level of domestic production, it had failed in its goal of assisting the domestic producing industry to adjust to normal commercial markets. The veto message stated further that acid fluorspar was included in the Minerals Stabilization Plan then before Congress, and that the program for this material included in the Minerals Stabilization Plan was preferable to an extension of the Public Law 733 program. The Minerals Stabilization Plan was not enacted by the Congress.

Purchases of domestic metallurgical fluorspar by the GSA were terminated at midyear as no purchases were authorized by ODM for fiscal year 1959. Deliveries under contracts entered into prior to June 30, 1958, will continue at a reduced rate until July 1959.

Commodity Credit Corporation.—The Federal Government also acquired fluorspar through barter authorized under the Agricultural Trade Development Act of 1954.

TABLE 2.—DMEA fluorspar contracts in force during 1958, by States, counties, and mines

State and operator	Property	County	Contract		
			Date	Total value [1]	Status Dec. 31, 1958
Idaho:					
Idaton, Inc	Smothers	Idaho	April 1957	$10,000	In force.
Illinois:					
New Jersey Zinc Co	Project II	Pope	June 1958	39,192	Do.
Kentucky:					
Reynolds Metals Co	Grimes (Eli Brown)	Livingston	June 1958	48,880	Do.
Do	Watson, Hicks, Tyner Tracts.	Crittenden	June 1958	59,710	Do.

[1] Government participation, 50 percent. Total actual expenditures by the Government on terminated and certified contracts often were less than the obligated funds.

DOMESTIC PRODUCTION

Fluorspar was produced in Arizona, California, Colorado, Illinois, Kentucky, Montana, Nevada, and Utah. Fluorspar output shipped from mines totaled 319,500 short tons valued at $15,071,400 and comprised by grade as follows: Acid, 191,800 tons at $10,434,900; ceramic, 22,800 tons at $998,700; and metallurgical, 104,900 tons at $3,637,800. Illinois continued to be the leading producing State, supplying about 48 percent of the total production.

Output of crude ore from domestic mines totaled 818,100 short tons, a decline of about 5 percent from 1957. Mines producing over 20,000 tons accounted for about 87 percent of the mine-run ore. In 1958, 17 mills, including those operated by consumers, processed 814,800 tons of crude ore to recover 310,600 tons of finished fluorspar of which 210,900 tons was flotation concentrate. The balance comprised gravel-sized fluorspar, material from several reworked dumps, and a small quantity of hand-sorted acid fluorspar. The output of finished fluorspar in 1957 from 16 mills, which totaled 322,600 tons, was recovered from 790,600 tons of crude ore and included 217,600 tons of flotation concentrate. During 1958, 12,100 tons of crude fluorspar was marketed as mined, dump, and tailings material, and a small amount of handpicked acid fluorspar compared with the similar production of 104,300 tons in 1957.

TABLE 3.—Domestic mine production of crude fluorspar according to size of operation

Production	1957		1958	
	Short tons	Percent	Short tons	Percent
Under 1,000 [1]	2,800	0.3	6,800	0.8
1,000–10,000	68,600	8.0	55,300	6.8
10,000–20,000	41,000	4.8	43,600	5.3
Over 20,000	749,100	86.9	712,400	87.1
Total	861,500	100.0	818,100	100.0

[1] Includes prospects and reworked dumps and tailings of previous mining and milling operations.

Consumer-operated mines produced 142,100 tons of crude ore, and their mills, processing 145,500 tons, recovered 59,600 tons of finished fluorspar.

Production in Illinois declined about 11 percent from 1957, and of the 152,100 short tons of finished fluorspar shipped, 136,000 tons comprised flotation concentrate. Shipments in 1957 totaled 169,900 tons of finished fluorspar and included 152,700 tons of flotation concentrate or about 52 percent of the U.S. supply.

Fluorspar mining was resumed at properties of the Rosiclare Lead and Fluorspar Mining Co.[3] The company had ceased operations in March 1954 due to the prices of fluorspar and had leased some of its mining properties in the northern region of Hardin County to three independent operators. Exploration was planned in 1958.

[3] Skillings Mining Review, Fluorspar Mining Resumed–Rosiclare, Illinois: Vol. 46, No. 41, Jan. 11, 1958, p. 12.

TABLE 4.—Shipments of finished fluorspar

State	1957			1958		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Illinois	169,939	$8,827,171	$51.94	152,087	$7,930,613	$52.15
Kentucky	20,626	979,357	47.48	[1] 25,861	1,201,408	46.46
Utah	11,087	387,042	34.91	16,109	563,726	34.99
Other:						
Montana	64,339			53,654		
Arizona						
California				59,464	5,035,655	44.52
Colorado	62,881	5,583,318	43.89			
Nevada				12,338	339,987	27.56
Tennessee				----------	----------	----------
Total	328,872	15,776,888	47.97	319,513	15,071,389	47.17

[1] Shipments of marketable fluorspar was reported at 25,284 short tons valued at $1,181,000. Since production in the chapter is reported as shipments from mines and mills, the 25,861 tons valued at $1,201,408 is used.

Two new blanket deposits on the Goose Creek fault in Hardin County were discovered by the Hoeb Fluorspar Mining Co.[4] The deposits, one at the 160-foot level containing fluorspar, lead, and zinc, and the other at the 260-foot level containing primarily "coontail" fluorspar, occur under the Bethel sandstone and vary in width from 25 to 30 feet.

Three major producers in the Illinois-Kentucky district made slight reductions in the work week or employment.[5] The Minerva Oil Co. reduced its force from 200 to 170 and continued to operate a 5-day-week schedule. Ozark-Mahoning reduced its work week from 6 to 5 days. The Aluminum Co. of America, Rosiclare works, reduced its work week from 5 to 4 days and its force by 55 persons. In November the Rosiclare mill of Alcoa resumed a 5-day work week, after operating on a 4-day schedule since June.[6]

Fluorspar production in Montana declined about 16 percent from 1957.

Colorado production, nearly all acid fluorspar, increased.

Finished fluorspar output in Kentucky reached the highest level of production since 1954 and was about 23 percent above the 1957 output.

Production of all metallurgical fluorspar in Utah rose about 43 percent above 1957 to its highest level in 5 years.

Fluorspar output in Nevada increased over that for 1957. The Wah Chang Mining Corp. recovered acid fluorspar as a byproduct of processing scheelite at its flotation mill near Tempiute until about midyear when the mill closed.

The reactivation of the Burro Chief Mines, Inc. and the construction of a flotation mill near Deming, N. Mex., by H. E. McCray were reported.[7] The sink-float concentrating mill with a capacity of 150 to 200 tons per day was to treat ore from a wide area of southwestern

[4] Engineering and Mining Journal, vol. 159, No. 4, April 1958, p. 172.
[5] Engineering and Mining Journal, vol. 159, No. 5, May 1958, p. 144.
[6] Engineering and Mining Journal, vol. 159, No. 11, November 1958, p. 163.
[7] Western Mining & Industrial News, To Build Fluorspar Mill in New Mexico: Vol. 26, No. 9, September 1958, p. 11.

TABLE 5.—Fluorspar shipped from mines in the United States, by grades and industries

Grade and industry	1957				1958			
	Quantity		Value		Quantity		Value	
	Short tons	Percent of total	Total	Average	Short tons	Percent of total	Total	Average
Ground and flotation concentrates:								
Hydrofluoric acid [1]	186, 946	83. 0	$10,502,364	$56. 18	189, 816	88. 4	$10,333,620	$54. 44
Glass	18, 693	8. 3	831, 454	44. 48	14, 818	7. 0	642, 107	43. 33
Ceramic and enamel	4, 181	1. 8	197, 975	47. 35	[2] 3, 724	[2] 1. 7	[2] 174, 982	[2] 46. 99
Nonferrous	2, 119	. 9	100, 135	47. 26	2, 240	1. 0	106, 999	47. 77
Ferrous	[3] 11, 198	5. 0	425. 088	37. 96	2, 363	1. 1	103, 025	43. 60
Miscellaneous [4]	2, 124	1. 0	97, 741	46. 02	1, 676	. 8	74, 814	44. 64
Total	225, 261	100. 0	12, 154, 757	53. 96	214, 637	100. 0	11, 435. 547	53. 28
Fluxing gravel and foundry lump:								
Ceramic and enamel					(5)	(5)	(5)	(5)
Nonferrous	548	0. 5	17, 940	32. 74	74	0. 1	3, 177	42. 93
Ferrous [1]	100, 191	96. 7	3, 478, 081	34. 71	101, 240	96. 5	3, 545, 649	35. 02
Miscellaneous [4]	2, 872	2. 8	126. 110	43. 91	3, 562	3. 4	87, 016	24. 43
Total	103, 611	100 0	3, 622, 131	34. 96	104, 876	100. 0	3, 635, 842	34. 67
All grades:								
Hydrofluoric acid [1]	186 946	56. 8	10, 502, 364	56. 18	189, 816	59. 4	10, 333, 620	54. 44
Glass	18, 693	5. 7	831, 454	44. 48	14, 818	4. 6	642, 107	43. 33
Ceramic and enamel	4, 181	1. 3	197, 975	47. 35	3, 724	1. 2	174, 982	46. 99
Nonferrous	2, 667	. 8	118, 075	44. 27	2, 314	. 7	110, 176	47. 61
Ferrous [1]	[3] 111, 389	33. 9	3, 903, 169	35. 04	103, 603	32. 4	3, 648, 674	35. 22
Miscellaneous [4]	4, 996	1. 5	223. 851	44. 81	5, 238	1. 7	161, 830	30. 89
Total	328, 872	100. 0	15. 776, 888	47. 97	319, 513	100. 0	15, 071, 389	47. 17

[1] Includes shipments to GSA.
[2] Includes gravel and lump fluorspar to avoid disclosing individual company confidential data.
[3] Includes pelletized flotation concentrates.
[4] Includes exports.
[5] Included with ceramic and enamel under ground and flotation concentrates; see footnote 2.

New Mexico and possibly adjoining Arizona. The output, metallurgical-grade (60 percent CaF_2), will go to GSA.

A small quantity of acid fluorspar was produced in California. Fluorspar was reported produced in several areas in Arizona.

CONSUMPTION AND USES

Consumption of fluorspar was about 23 percent lower than in 1957. Fluorspar was reported consumed in 36 States in 1958; however, according to reports of shipments from producers, dealers and brokers, and importers reporting to the Bureau of Mines, shipments were made to industries in several additional States.

Acid fluorspar consumed to produce hydrofluoric acid was approximately 21 percent below that consumed in 1957, due in part to the decline in aluminum production; however, an increase in chemicals derived from hydrogen fluoride was noted.

The production of hydrofluoric acid and its uses were described in an article.[8]

[8] Stuewe, A. H., Hydrogen Fluoride; Where It Goes, How It's Made, Why It's Growing; Chem. Eng. News, vol. 36, No. 51, Dec. 22, 1958, pp. 34-38, 57.

Bell Aircraft Corp. was reported to have harnessed liquid fluorine for use as an oxidizer in rocket fuels.[9] Propellent combinations such as kerosene and liquid oxygen provide a specific impulse at sea level of about 245 pounds of thrust per second for each pound of propellent consumed. Depending upon the fuel used, this thrust could be raised to 300 or 345 pounds using liquid fluorine as the oxidizer rather than liquid oxygen.

Early in 1958 the General Chemical Division of Allied Chemical & Dye Corp. began construction of a new hydrofluoric acid plant at Nitro, W. Va., to supply the industrial expansion in the Charleston area that includes Union Carbide Chemical's new fluorocarbon plant under construction in 1957 at nearby Institute, and General Chemical's liquid fluorine plant at Metropolis, Ill.[10] Pennsalt Chemicals Corp. anticipated completion in July of an expansion program at its Calvert City, Ky., hydrofluoric acid facilities, increasing the plant's capacity by about 50 percent.[11]

The fluoridation of city water supplies was received with mixed emotions throughout the country.[12] It was estimated that more than 34 million people in a total of nearly 1,650 cities and towns were drinking fluoridated water at the end of 1958. Baltimore, Philadelphia, St. Louis, and Washington, D.C. were among the big cities having fluoride-treated water systems; however, New York City resisted any attempt at fluoridation. Sodium silicofluoride was the most important, though not the least expensive, fluoride chemical used for this purpose. A method recently developed by the U.S. Public Health Service and in use in two communities utilizes ceramic fluorspar. Fluorspar costs were about one-third those of sodium silicofluoride, the next lowest cost compound used.

The application of fluorinated oils, greases, and waxes as lubricants in contact with corrosive, hazardous chemicals was described in an article.[13] These oils are resistant to compressed oxygen, mixed inorganic acids, caustic solutions, halofluoride gases, oleum, red fuming nitric acid, and 90 percent hydrogen peroxide. One of the largest uses for the lubricants is in compressors handling these hazardous chemicals. Silicone oils, usually considered for difficult lubrication problems, are not as resistant to oxidizing agents as fluoropolymers; however, silicone oils have a big advantage over fluorolubricants in that they remain fluid at low temperatures.

STOCKS

According to reports of producers, fluorspar in stock at mines, mills, and shipping points at the end of 1958 totaled 225,900 short tons, of which 18,700 tons was finished fluorspar and 207,200 tons represented crude fluorspar. This crude (run-of-mine) fluorspar in most cases must be processed before it can be marketed.

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[9] Oil, Paint and Drug Reporter, Fluorine Successfully Tamed as Rocket Propellent Oxidizer, Seen Ultimate Breakthrough: Vol. 174, No. 9, Sept. 1, 1958, pp. 5, 35.
[10] Chemical and Engineering News, vol. 36, No. 8, Feb. 24, 1958, p. 23.
Chemical Engineering, vol. 65, No. 7, Apr. 7, 1958, p. 202.
[11] Chemical Engineering Progress, vol. 54, No. 5, May 1958, p. 176.
[12] Chemical Week, Fluoride Makers Toast Water Treatment: Vol. 83, No. 11, Sept. 13, 1958, p. 110.
[13] Chemical Engineering, Lubricate Under Corrosive Conditions: Vol. 65, No. 3, Feb. 10, 1958, pp. 154, 156, 158.

Consumers' stocks at the end of 1958 totaled 185,291 tons, about 19 percent lower than at the end of 1957. Fluorspar stocks at steel plants decreased approximately 28 percent and at the December rate of consumption were equivalent to a 9-month supply.

TABLE 6.—Fluorspar (domestic and foreign) consumed and in stock in the United States by grades and industries, in short tons

Grade and industry	1957		[1] 1958	
	Consumption	Stocks at consumers' plants on Dec. 31	Consumption	Stocks at consumers' plants on Dec. 31
Acid grade:				
Hydrofluoric acid	328,672	43,234	258,935	47,163
Glass	3,221	361	3,916	481
Enamel	118	27	125	40
Welding rod coatings	819	60	810	61
Nonferrous	131	29	25	40
Special flux				
Ferroalloys	[2] 1,763	[2] 1,330	2,137	1,224
Primary aluminum				
Total	[2] 334,724	[2] 45,041	265,948	49,009
Ceramic grade:				
Glass	27,899	3,746	25,123	3,653
Enamel	4,314	697	4,776	944
Welding rod coatings	1,154	149	200	34
Nonferrous	118	26	5,339	911
Special flux	7,983	1,363	1,134	193
Ferroalloys				
Total	41,468	5,981	36,572	5,735
Metallurgical grade:				
Glass	1,017	127	824	171
Enamel	800	96	88	----
Welding rod coatings	343	44	164	164
Nonferrous	5,123	1,653	1,773	1,778
Special flux				
Ferroalloys	[2] 2,723	[2] 762	1,467	971
Primary magnesium				
Iron foundry	15,382	9,618	12,883	8,826
Basic open-hearth steel	212,304		150,328	
Electric-furnace steel	30,376	164,668	24,033	118,637
Bessemer steel	428		147	
Total	[2] 268,496	[2] 176,968	191,707	130,547
All grades:				
Hydrofluoric acid	328,672	43,234	258,935	47,163
Glass	32,137	4,234	29,863	4,305
Enamel	5,232	820	4,989	984
Welding road coatings	2,316	253	1,174	259
Nonferrous	5,372	1,708	7,137	2,729
Special flux	7,959	1,356	257	157
Ferroalloys	1,981	610	1,691	869
Primary aluminum	2,529	1,489	2,790	1,362
Primary magnesium				
Iron foundry	15,382	9,618	12,883	8,826
Basic open-hearth steel	212,304		150,328	
Electric-furnace steel	30,376	164,668	24,033	118,637
Bessemer steel	428		147	
Total	644,688	227,990	494,227	185,291

[1] Glass, enamel, and other (including welding rod coatings, nonferrous, special flux, and ferroalloys), partly estimated from sample canvass of consumers who accounted for more than 95 percent of total usage in 1957.

[2] Revised figure.

TABLE 7.—Production of steel, and consumption and stocks of fluorspar (domestic and foreign) at basic open-hearth and electric-furnace steel plants

	1949-53 (average)	1954	1955	1956	1957	1958
Production of basic open-hearth steel ingots and castings at plants consuming fluorspar.........thousand short tons..	85,628	79,099	99,927	95,175	100,297	75,215
Consumption of fluorspar in basic open-hearth steel production thousand short tons..	226	174	217	228	212	150
Consumption of fluorspar per short ton of basic open-hearth steel made..pounds..	5.3	4.4	4.3	4.8	4.2	4.0
Stocks of fluorspar at basic open-hearth steel plants at end of year thousand short tons..	144	95	102	143	158	111
Production of electric-furnace steel ingots and castings at plants consuming fluorspar..........thousand short tons..	6,232	5,380	7,511	8,814	9,551	6,462
Consumption of fluorspar in electric-furnace steel production thousand short tons..	30	21	33	36	30	24
Consumption of fluorspar per short ton of electric-furnace steel made......pounds..	9.6	7.9	8.9	8.2	6.4	7.4
Stocks of fluorspar at electric-furnace steel plants at end of year thousand short tons..	5	8	5	12	6	8

TABLE 8.—Fluorspar (domestic and foreign) consumed in the United States, by States, in short tons

State	1957	1958 [1]	State	1957	1958 [1]
Alabama, Georgia, North Carolina, and South Carolina	12,268	[2] 10,155	Maryland	5,494	5,330
Arkansas, Kansas, Louisiana, and Oklahoma	88,622	29,096	Massachusetts	443	324
California	35,985	12,621	Michigan	20,453	14,594
Colorado and Utah	22,944	17,607	Missouri	4,340	3,738
Connecticut	585	747	New York	20,204	13,832
Delaware and New Jersey	79,275	120,944	Ohio	72,151	58,360
Florida, Rhode Island, and Virginia	1,059	698	Oregon and Washington	1,686	670
Illinois	97,454	62,974	Pennsylvania	82,882	55,164
Indiana	33,451	25,307	Tennessee	1,058	499
Iowa, Minnesota, Nebraska, South Dakota, and Wisconsin	4,948	[3] 3,828	Texas	21,221	15,848
Kentucky	30,111	29,197	West Virginia	8,054	5,924
			Undistributed		6,770
			Total	644,688	494,227

[1] Consumption partly estimated from sample canvass of consumers who accounted for more than 95 percent of total usage in 1957.
[2] Alabama, Georgia, and South Carolina.
[3] Iowa, Minnesota, and Wisconsin.

TABLE 9.—Stocks of fluorspar at mines or shipping points in the United States by States, at end of year, in short tons

State	1956		1957		1958	
	Crude [1]	Finished	Crude [1]	Finished	Crude [1]	Finished
Arizona			[2] 73,121 (Arizona, California, Colorado, Nevada)	[2] 1,089 (Arizona, California, Colorado, Nevada)	26,384 (Arizona, California, Colorado, Nevada)	410 (Arizona, California, Colorado, Nevada)
California	1,300					
Colorado, Nevada	[2] 84,045	1,017				
Illinois	[2] 99,093	[2] 11,772	[2] 133,081	7,359	147,657	7,377
Kentucky	1,126	6,372	5,914	5,905	11,334	4,125
Montana	[2] 2,657	(3)	2,813	2,964	21,830	6,765
Utah	800		5		5	
Total	[2] 189,021	[2] 19,161	[2] 214,934	[2] 17,317	207,210	18,677

[1] This crude (run-of-mine) fluorspar in most cases is subjected to some type of processing before it can be marketed.
[2] Revised figure.
[3] Revised to none.

PRICES

According to E&MJ Metal and Mineral Markets the prices of different grades of domestic and foreign fluorspar during 1958 were as follows: Domestic acid concentrates, per short ton bulk carload lots f.o.b. Illinois-Kentucky and Colorado, $50, some sales at $55 from January to the end of November when only the $50 value was indicated. In bags, the price was $4 to $5 extra. During the year, European acid fluorspar, c.i.f. U.S. ports, duty paid, was quoted at $50 to $52 with spot lots $1 more.

Ceramic fluorspar containing 93 to 94 percent CaF_2, variable amounts of calcite and silica, and 0.14 percent Fe_2O_3 was quoted at $43 to $46 throughout the year. This grade containing 95 percent CaF_2 was quoted at $45 to $48 per short ton, in bulk, f.o.b. Illinois-Kentucky throughout the year. Quoted prices for ceramic fluorspar in 100-pound bags was $4 to $5 per ton higher than those for bulk shipments.

Metallurgical fluorspar with an effective CaF_2 content of 72½ percent, per short ton, f.o.b. shipping point, Illinois-Kentucky was quoted at $37 to $41, the higher price for spot lots, throughout the year. Metallurgical containing 70 percent and 60 percent plus CaF_2 was quoted at $36 to $40 and $33 to $36.50, respectively, per short ton, f.o.b. shipping point, Illinois-Kentucky throughout 1958. Pelletized flotation concentrate containing 65 percent effective CaF_2 was quoted at $33 per short ton, f.o.b. shipping point, Illinois-Kentucky during the year.

European metallurgical fluorspar containing 72½ percent effective CaF_2, c.i.f. U.S. ports, duty paid, was quoted at $33 per ton contract and $35 per ton spot lots throughout 1958, following a rise to those prices late in 1957. Metallurgical fluorspar from Mexico, containing 72½ percent effective CaF_2, all rail, duty paid, f.o.b. border, was quoted at $25 per short ton from November 1957. For this grade f.o.b. border, barge, Brownsville, Tex., the price after November 1957 was quoted at $27 per ton.

FOREIGN TRADE [14]

In October the Domestic Fluorspar Producers Association applied to the U.S. Tariff Commission under Section 7 of the Trade Agreements Extension Act of 1951, as amended, for an investigation regarding acid fluorspar. The Commission found that the application was premature and that an application would be appropriate only after the Government had terminated its purchase programs and had an opportunity to observe the developments for a reasonable period of time.

The OCDM was requested by several domestic fluorspar producers to make an investigation of fluorspar imports to determine whether or not they were threatening to impair the national security in accordance with Section 8 of the Trade Agreements Extension Act of 1958. Upon receipt of a report with recommendations from OCDM

[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.

TABLE 10.—Fluorspar imported for consumption in the United States, by countries and customs districts

[Bureau of the Census]

	1957						1958					
	Containing more than 97 percent calcium fluoride		Containing not more than 97 percent calcium fluoride		Total		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	Short tons	Value	Short tons	Value	Short tons	Value
North America:												
Canada:												
El Paso							37	$919			37	$919
Ohio							5, 627	126, 235			5, 627	126, 235
Philadelphia	19, 099	$865. 943	955	$43, 888	20, 054	$909, 831	2, 471	94, 743			2, 471	94, 743
Washington							22	645			22	645
Total	19, 099	865, 943	955	43, 888	20, 054	909, 831	8, 157	222, 542			8, 157	222, 542
Mexico:												
Arizona			58	857	58	857						
Buffalo			10, 583	158, 753	10. 583	158, 753						
Dakota							59	610			59	610
El Paso	18, 621	477, 221	30, 034	579, 358	48, 655	1, 056, 579	17, 205	443, 564	13. 951	$290, 508	31, 156	734, 072
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	109, 945	3, 699, 374	85. 252	1, 142, 296	195, 197	4, 841, 670
Massachusetts									8	153	8	153
Michigan			6, 352	113, 463	6, 352	113, 463			2, 110	34, 457	2, 110	34, 457
Mobile									4, 879	69, 564	4, 879	69, 564
Ohio									2, 644	39, 648	2, 644	39, 648
Philadelphia			28, 193	567, 210	28, 193	567, 210	1, 545	56, 953	7, 385	208, 347	8, 930	265, 300
St. Louis	[1] 24, 236	[1] 922, 686			[1] 24, 236	[1] 922, 686						
San Diego			29	582	29	582						
Total	[1] 182, 889	[1] 5, 832. 100	208, 159	3, 196, 126	[1] 391, 048	[1] 9, 028, 226	128, 754	4, 200, 501	116, 229	1, 784, 973	244, 983	5, 985, 474
Total North America	[1] 201, 988	[1] 6, 698, 043	209, 114	3, 240, 014	[1] 411, 102	[1] 9, 938, 057	136, 911	4, 423, 043	116, 229	1, 784, 973	253, 140	6, 208, 016

Europe:												
Germany, West:												
New Orleans	6,653	271,870			6,653	271,870	10,146	310,959			10,146	310,959
Philadelphia	6,974	249,136			6,974	249,136	9,192	368,468			9,192	368,468
Total	13,627	521,006			13,627	521,006	19,338	679,427			19,338	679,427
Italy:												
Maryland	[1] 22,173	[1] 717,710			[1] 22,173	[1] 717,710						
Michigan			485	18,648	485	18,648	3,854	131,748			3,854	131,748
Ohio	15,120	403,260			15,120	403,260	6,129	156,681			6,129	156,681
Philadelphia	[1] 101,472	[1] 2,882,872	1,032	18,250	[1] 102,504	[1] 2,901,122	44,030	1,058,310			44,030	1,058,310
San Francisco							5,118	132,600			5,118	132,600
Total	[1] 138,765	[1] 4,003,842	1,517	36,898	[1] 140,282	[1] 4,040,740	59,131	1,479,339			59,131	1,479,339
Spain:												
Maryland			1,861	24,930	1,861	24,930			3,042	40,368	3,042	40,368
New Orleans							5,159	121,650			5,159	121,650
Ohio	9,115	229,497			9,115	229,497	10,246	260,208			10,246	260,208
Philadelphia	44,514	1,034,150	6,617	88,828	51,131	1,122,978	32,965	801,061	5,102	68,325	38,067	869,386
Total	53,629	1,263,647	8,478	113.758	62,107	1,377,405	48,370	1,182,919	8,144	108,693	56,514	1,291,612
Switzerland: Philadelphia							3,959	116,357			3,959	116,357
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	130,798	3,458,042	8,144	108,693	138,942	3,566,735
Africa: Union of South Africa: Michigan	1,133	21,726			1,133	21,726	82	2,206			82	2,206
Grand total	[1] 412,246	[1,2] 12,639,995	219,121	[2] 3,391,090	[1] 631,367	[1,2] 16,031,085	267,791	7,883,291	124,373	1,893,666	392,164	9,776,957

[1] The following material that entered bonded warehouses during 1955 and 1956 was withdrawn from bonded warehouses for the U.S. 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).

[2] Data known to be not comparable with 1958.

the President is authorized by the Act to take such action as he thinks necessary to eliminate the threat, if one exists.

Imports.—Fluorspar imported for consumption totaled 392,200 short tons valued at $9.8 million or about 62 percent of the 1957 imports. Domestic production was exceeded by imports for the seventh consecutive year. Mexico was again the principal foreign source, supplying 245,000 tons or about 62 percent of total imports. Italy supplied 59,100 tons, about 15 percent, and Spain 56,500 tons, about 14 percent of the total. The U.S. Government imported 80,700 short tons compared with 78,000 tons in 1957.

Exports.—Exports totaled 3,374 short tons valued at $191,386, compared with 754 tons valued at $80,703 in 1957. Canada received 3,289 tons of fluorspar and the remainder was shipped to Belgium-Luxembourg, Colombia, Cuba, France, West Germany, the Netherlands, the Union of South Africa, and Venezuela.

TABLE 11.—Imported fluorspar delivered to consumers in the United States, by uses [1]

Use	1957 [2]			1958		
	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 [3]	169,134	$7,657,123	$45.27	205,593	$8,774,021	$42.68
Glass, ceramic, and enamel	16,338	853,979	52.27	23,439	1,155,676	49.31
Ferrous [3]	188,353	5,211,629	27.67	115,961	3,274,766	28.24
Nonferrous	2,610	101,118	38.74	3,008	108,402	36.04
Other	12,066	321,093	26.61	3,679	137,872	37.48
Total	388,501	14,144,942	36.41	351,680	13,450,737	38.25

[1] Estimated in part.
[2] Revised figures.
[3] Includes shipments to GSA.

TABLE 12.—Fluorspar exported from the United States

[Bureau of the Census]

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1949–53 (average)	798	$47,355	$59.34	1956	197	$31,275	$158.76
1954	643	50,492	78.53	1957	754	80,703	107.00
1955	874	64,981	74.35	1958	3,374	191,386	56.72

WORLD REVIEW

NORTH AMERICA

Canada.—Fluorspar production in Canada dropped from 140,071 short tons valued at US$3,462,103 in 1956 to 66,245 tons valued at US$1,784,950 in 1957.[15] This decline in production was due in part to the completion and termination of a contract between St. Lawrence Corp. of Newfoundland and the U.S. Government in mid-1957 and in

[15] Dominion Bureau of Statistics (Ottawa), Preliminary Report on Mineral Production; 1957, pp. 8-9; 1958, pp. 8-9.

part to marketing difficulties that resulted in the suspension of mining operations.[16] Newfoundland Fluorspar Ltd., a subsidiary of the Aluminum Co. of Canada, closed down its mine at St. Lawrence in August 1957 for a plant changeover and expansion program. Following the installation of new surface and underground equipment, which was expected to increase the capacity and efficiency at the mining and milling operation, the company resumed operations in late February 1958.[17]

TABLE 13.—World production of fluorspar, by countries,[1] in short tons [2]

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

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	74,731	118,969	128,114	140,071	66,245	[3] 62,000
Mexico (exports)	115,859	146,198	200,220	360,117	389,807	[4] 244,982
United States (shipments)	306,909	245,628	279,540	329,719	328,872	319,513
Total	497,499	510,795	607,874	829,907	784,924	[3] 626,495
South America:						
Argentina	5,643	14,308	16,031	12,983	8,544	[3] 8,800
Bolivia (exports)	101	213	569	300	----------	----------
Brazil	[3] 390	[5] 487	----------	----------	----------	----------
Total	6,134	15,008	16,600	13,283	8,544	[3] 8,800
Europe:						
France	61,030	81,788	94,863	93,412	103,066	[3] 99,000
Germany:						
East [3]	73,000	90,000	90,000	90,000	68,000	72,000
West	128,937	190,916	170,816	160,937	148,812	129,966
Italy	49,483	85,041	110,694	136,675	158,915	154,297
Norway	886	488	317	198	331	----------
Spain	58,010	81,032	73,653	81,281	97,439	[3] 113,500
Sweden (sales)	4,006	4,140	1,459	976	2,966	3,188
United Kingdom	80,465	92,607	96,235	102,536	104,467	86,695
Total [1 3]	460,000	630,000	645,000	670,000	690,000	665,000
Asia:						
China [3]	(6)	(6)	100,000	145,000	165,000	[7] 165,000
Japan	3,940	6,771	5,738	8,911	8,542	5,826
Korea, Republic of	6,137	9,360	11,105	3,431	5,644	1,786
Turkey	187	----------	23	----------	----------	88
U.S.S.R.[3 8]	86,000	110,000	110,000	165,000	165,000	180,000
Total [1 3]	110,000	170,000	240,000	335,000	400,000	410,000
Africa:						
Morocco: Southern zone	1,907	1,188	44	137	----------	----------
Rhodesia and Nyasaland, Federation of:						
Southern Rhodesia	250	120	480	942	97	6
South-West Africa	2,289	3,063	675	----------	24	4
Tunisia	1,071	----------	----------	----------	----------	----------
Union of South Africa	10,784	21,996	32,839	35,065	35,106	48,251
Total	16,301	26,367	34,038	36,144	35,227	48,261
Oceania: Australia	459	21	316	834	784	31
World total (estimate)[1 2]	1,090,000	1,350,000	1,545,000	1,860,000	1,920,000	1,760,000

[1] In addition to countries listed, fluorspar is produced in Belgium 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 and Cryolite chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] U.S. imports.
[5] Exports.
[6] Data not available; estimate by senior author of chapter included in total.
[7] Data represents 1957 production; however, 1958 production was probably much greater.
[8] 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.

[16] Canada Department of Mines and Technical Surveys, Fluorspar in Canada, 1957: Ottawa, 7 pp.
[17] Northern Miner (Toronto), vol. 43, No. 49, Feb. 27, 1958, p. 10.

Huntingdon Fluorspar Mines Ltd., at Madoc in eastern Ontario, was the only other fluorspar producer in Canada. Operations were resumed by the company in May 1957 on the 80-foot level of the old Kilpatrick property. More than 2,000 tons was produced in 1957 despite a serious underground water problem. Because the mines in the area were small operations and had limited capital and equipment, it was not possible to develop sufficient ore reserves for the planning of long-term regular production.

Exports of 23,630 tons valued at Can$590,750 in 1957 were greatly reduced from the 78,380 tons valued at Can$1,941,500 in 1956, due to the contract fulfillment and subsequent termination by the U.S. Government. Imports in 1957 totaling 14,547 tons—Mexico, 11,514 tons; the United States, 1,578 tons; the Union of South Africa, 1,091 tons; and the United Kingdom, 364 tons—dropped from 28,148 tons in 1956. Consumption of fluorspar in 1956 totaled 96,226 tons, of which 76,452 tons was used to produce heavy chemicals (68,592 tons in 1955), 18,979 tons used at steel plants (18,610 tons in 1955), 669 tons used at glass plants (592 tons in 1955), an estimated 100 tons in enameling and glazing (97 tons in 1955), and 26 tons in white metal alloys (36 tons in 1955).

The Tariff Board took no action regarding a proposed tariff on fluorspar imports following the hearings held May 6–7, 1958, in Ottawa.[18]

Two companies, St. Lawrence Corp. of Newfoundland, Ltd., and Huntingdon Fluorspar Mines, Ltd., had proposed a $10-per-ton tariff on imports currently entering duty free. They maintained that it was becoming more difficult to compete with imports and that without such a duty they could not operate profitably. The Tariff Board later reported that it would not recommend a tariff on fluorspar.

Mexico.—Production of acid fluorspar was doubled at the Rosita mine of the American Smelting and Refining Co.[19] Capacity was increased to 40,000 tons per year. The increase in production reportedly was shipped largely to hydrofluoric acid producers in the United States. Geologists of Dow Chemical Co. reported they had found the world's largest fluorspar deposits. There are two deposits a few miles apart, known as Quatras Palmas (Four Palms) and Pico Anterio.[20] The recently drilled deposits are within 40 miles of the U.S. boundary near Big Bend National Park, Tex. The fluorspar outcrops and can be mined in open pits by diesel shovel. It was reported that La Domincia, S.A. De C.V., a subsidiary of Dow Chemical Co., will construct a 100-ton-per-day acid fluorspar mill 1.5 miles downstream from Las Vegas De Stillwell in Mexico on the Rio Grande 25 miles from the mine.[21] Concentrate will be trucked to the railroad at Marathon, Tex.

The mining companies of La Valenciana, S.A. and Las Cuevas were reported to be contemplating exporting fluorspar through Manzanillo, Colina to Japanese steel mills and foundries.[22] An initial

[18] Tariff Board (Ottawa), Report Relative to the Investigation ordered by the Minister of Finance respecting Fluorspar: Reference No. 126, 1958, 60 pp.
[19] Chemical and Engineering News, vol. 38, No. 8, Feb. 24, 1958, p. 23.
[20] Hardin County Independent, Elizabethtown, Illinois, World's Largest Deposits of Spar Found in Mexico: Vol. 90, No. 14, Mar. 12, 1959, p. 1.
[21] Rock Products, vol. 61, No. 12, December 1958, p. 44.
[22] U.S. Consulate, Guadalajara, Jalisco, Mexico, State Department Dispatch 21: Oct. 23, 1958, 1 p.

shipment of 500 tons was made to Kobe. The Manzanillo port activities will be developed further with the export of fluorspar.

The hydrofluoric acid plant of Flour-mex, S.A., which opened in the fall of 1957 at Santa Clara, experienced difficulties in the production of hydrofluoric acid. In 1958 Stauffer Chemical Co. acquired 50 percent interest in the plant, in return for cash and technical aid in producing both anhydrous and aqueous hydrofluoric acid.[23] The plant was reported to be sufficient in size to serve Mexico's entire needs into the foreseeable future. Raw materials are local fluorspar and sulfuric acid from another Stauffer affiliate.

SOUTH AMERICA

Argentina.—Fluorspar production in Argentina in 1957 totaled 8,544 short tons valued at 5,848,000 pesos (US$325,000).

Brazil.—During the first half of 1958, Brazil imported from Czechoslovakia 1,698 pounds of hydrofluoric acid at a value of US$385.[24]

EUROPE

Germany, West.—The poor fluorspar market conditions that existed in 1957 deteriorated even further during 1958 with no prospects of improvement.[25] Only three independent producers remain in West Germany, the rest having affiliated with large chemical companies that were able to provide the necessary financial aid.

Foreign competition, from East Germany—where prices were said to be manipulated—and from Spain and Italy, was the industry's main problem. Imports that had been liberalized were curtailed in the case of East Germany for 1959.

Italy.—Fluorspar production in Italy in 1958 totaled 154,297 short tons valued at from $25.60 to $28.81 per unit (85 to 96 percent CaF_2).

Sweden.—In 1957, 29 tons of fluorspar was exported and 9,716 tons imported, compared with 1 ton and 9,814 tons in 1956, and 15 tons and 7,671 tons in 1955, respectively.[26]

United Kingdom.—Production of fluorspar during 1958, reported by the Board of Trade, was as follows: Acid, 26,168 short tons; metallurgical, 55,269 tons; and ungraded or crude, 5,258 tons; total, 86,695 tons.[27]

Four areas—Andover, Anglesey, Kilmarnock, and Watford—were selected for a Ministry of Health experiment designed to test the efficacy of adding fluorides to the drinking water as a preventive of dental decay.[28]

The Andover Corp. stopped the experimental addition of fluorides to the town's water supply in the face of a campaign organized by a

[23] Chemical and Engineering News, vol. 36, No. 44, Nov. 3, 1958, p. 68; Stauffer Picks Three Ways to Diversify: Vol. 37, No. 3, Jan. 19, 1959, pp. 30-33.
[24] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 692: Dec. 17, 1958, p. 1.
[25] U.S. Consulate General, Duesseldorf, Germany, State Department Dispatch 218: Mar. 25, 1959, p. 20.
[26] U.S. Embassy, Stockholm, Sweden, State Department Dispatch 210: Aug. 20, 1958, p. 2.
[27] U.S. Embassy, London, England, State Department Dispatch 2824: May 27, 1959, p. 11.
[28] Chemistry and Industry (London): No. 32, Aug. 9, 1958, p. 1010; No. 35, Aug. 30, 1958, p. 1150.

group of ratepayers. The project's opponents, a group known as the Anti-Fluorides Committee and in control of the local council in 1958, reversed the council's decision of 1956 approving the experiment.

The East Worcestershire Waterworks Co. rejected a request by two Worcestershire towns, Bromsgrove and Redditch, to add fluorine to their water supply because it was not certain whether it had legal power to comply. Action was deferred until the results of the Ministry of Health's experiments in the three remaining test areas have been announced.

ASIA

China.—China has long been a fairly important world producer of fluorspar, although accurate production figures are not available. Fluorspar production is centered primarily in the Chekiang Province. During 1956, China exported 100,000 short tons of fluorspar to the Soviet Union and 36,300 tons to Japan, the second largest importer of Chinese fluorspar. Imports by these two countries were of the same order in 1957.

India.—The Mineral Mining Co. (Private) Ltd. made application to the Indian Government for prospecting licenses to cover recently discovered fluorspar deposits.[29] Imports from the United Kingdom and China were made to meet the local industrial requirements.

Japan.—Imports totaling 6,851 short tons valued at 60 million yen (US$167,000) from Communist China during March, April, and May, 1958, were reported.[30]

Japan produces about one-eighth to one-seventh of the fluorite annually required by her industries.[31]

Fluorspar imports increased in recent years at a more rapid rate than domestic output in order to meet the growing needs of the iron and steel industry, calcium cyanamide producers, and aluminum refiners. Lately, Communist China has become the largest foreign source, supplying 19,740 short tons out of 32,372 tons imported in the first half of 1957.

The quality of the domestic production improved after World War II. Whereas before the war only metallurgical fluorspar had been produced, afterward ceramic and acid fluorspar was also produced; however, metallurgical accounts for nearly 60 percent of the domestic demand.

Korea, Republic of.—Location of principal fluorspar mines in the Republic of Korea were reported as follows:[32] Busang Mine, Chung Chong Pukdo; Daekak Mine, Kyonggi Do; and Uil Mine, Chungchong Pukdo. Exports of fluorspar in 1958 totaled 13,000 short tons valued at $254,000.[33]

U.S.S.R.—Flourite was among the minerals found in deposits in Yakutia, Eastern Siberia.[34]

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[29] Mining World, vol. 20, No. 3, March 1958, p. 90.
[30] U. S. Embassy, Tokyo, Japan, State Department Dispatch 1552: June 24, 1958, p. 3, 116: July 25, 1958, p. 4; 644: Dec. 10, 1958, p. 3.
[31] U. S. Embassy, Tokyo, Japan, State Department Dispatch 1570: June 26, 1958, p. 8.
[32] U. S. Embassy, Seoul, Korea, State Department Dispatch 70: Aug. 9, 1958, p. 4.
[33] Monthly Statistical Review, Bank of Korea, April, 1959, p. 96.
[34] Northern Miner (Toronto), vol. 64, No. 24, Sept. 4, 1958, p. 6.

AFRICA

Union of South Africa.—Seven major fluorspar producers were reported in 1958:[35] Aladdins Fluorspar Mine, Johannesburg; Fluorspar Export (Pty.), Ltd., Johannesburg; Frank Martin & Co. (Pty.), Ltd., Germiston (direct exporter); Fritzmoor Exploration (Pty.), Ltd., Johannesburg; Natal Fluorspar (Pty.), Ltd., Johannesburg; Rhenosterfontein Fluorspar Mines (Pty.), Ltd., Zeerust, Transvaal; Vergenoeg Mining Co., (P. F. Theron), Pienaars River, Transvaal.

TABLE 14.—Fluorspar exports from the Union of South Africa

[Department of Mines, Pretoria]

Country of destination	1957		1958	
	Short tons	F.o.b. value	Short tons	F.o.b. value
Australia	112	$4,234	152	$5,606
Belgian Congo	18	882	224	8,733
Brazil	135	2,643		
Canada			341	9,156
Finland	710	14,960	345	6,765
France	117	2,212		
Germany			587	11,511
Ghana	2	148	3	154
Japan	5,351	94,441	16,536	308,532
Kenya	2,164	37,677	2,326	40,211
Netherlands	1,713	29,126	2,746	40,731
Norway	128	3,338	111	2,598
Philippines	51	988	32	635
Portugal			10	196
Rhodesia	270	3,016	543	7,549
Sweden	9,393	170,475	7,293	137,130
Uganda	353	6,908	2,468	48,376
United Kingdom			228	7,535
United States	2,225	42,795		
Total	22,742	413,843	33,945	635,418

TECHNOLOGY

Industrial interest in fluorine continued to run high though consumption of fluorspar was well below the previous year.

Laboratory and pilot-plant tests on the defluorination and recovery of evolved fluorine from phosphate rock were discussed.[36]

The Tennessee Valley Authority (TVA) planned research at its fertilizer-munitions development center at Muscle Shoals, Ala., for recovery of byproduct fluorine compounds suitable for industrial consumption.[37]

Currently fluorine evolved from phosphate rock is neutralized to prevent atmospheric pollution and discharged as waste.

The Allied Chemical & Dye Corp. liquid fluorine plant under construction in 1957 at Metropolis, Ill., began operations in 1958.[38]

[35] Minerals, Department of Mines, Quarterly Information Circular: (Pretoria, Union of South Africa), October to December, 1958, p. 40.
[36] Hall, Milton B., and Banning, Lloyd H., Removing and Recovering Fluorine from Western Phosphate Rock and Utilizing the Defluorinated Rock: Bureau of Mines Rept. of Investigations 5381, 1958, 49 pp.
[37] Oil, Paint and Drug Reporter, TVA Has Plans–New Fertilizers, Better Processes: Vol. 174, No. 15, Oct. 6, 1958, pp. 5, 54.
[38] Chemical and Engineering News, Fluorine at Metropolis: Vol. 36, No. 44, Nov. 3, 1958, p. 28.

Fluorine generated at the plant, uranium oxide from various AEC facilities, and hydrofluoric acid from General Chemical's various producing plants will be used to make uranium hexafluoride scheduled for output early in 1959.

In the United States uranium tetrafluoride is made by reacting uranium oxide with anhydrous hydrogen fluoride, a corrosive and hazardous chemical. The Spanish Board of Nuclear Energy developed a safe and simple process to make uranium tetrafluoride without using hydrogen fluoride.[39] Ammonium diuranate is reacted with vaporized ammonium fluoride at 500° C. for 4 to 5 hours. Under a licensing arrangement with the Spanish agency, a German firm delivered a uranium plant incorporating this fluorination step to Argentina and had another on order for India.

A new method was developed to utilize a fluorocarbon gas rather than carbon dioxide as a foaming agent to produce a new type of rigid urethane foam thermal insulation.[40] Urethane resins are made by reacting an isocyanate with a polyester or polyether. Avoiding water which is normally added, the ingredients are dissolved in a liquid fluorocarbon initially a few degrees below its boiling point. The temperature is raised and the fluorocarbon gasifies and foams the mixture. Many advantages are claimed for the new insulating material; the higher molecular weight of the gas trapped in the bubbles apparently accounts for lower foam conductivity; it flows readily into corners of the mold and has a more uniform foam structure; the foam is less permeable to moisture; and the amount of expensive isocyanate used is reduced. Major manufacturers of home refrigerators were either in production or seriously considering production of models utilizing this new-type insulation. To the consumer this means a less bulky refrigerator in outer dimensions or, conversely, more usable space inside.

Other developments in the field of fluorocarbons were noted throughout 1958. Research by electrical manufacturers on another fluorocarbon gas, octafluorocyclobutane, revealed its superiority to sulfur hexafluoride as a dielectric or insulating gas in high voltage electrical equipment.[41] A strong affinity for electrons, high molecular weight, and chemical stability even at elevated temperatures account for its outstanding dielectric properties.

A new fluorinated hydrocarbon producer, fourth in the field, was anticipating plant operation by year's end.[42] Union Carbide Chemicals, marketing its fluorinated hydrocarbon under the name of Ucon, joined Du Pont's Freon, General Chemical's Genetron, and Pennsalt's Isotron as an aerosol propellant and refrigeration agent.

Emission of fluorine into the atmosphere has been one of the most important problems in air pollution where there are industries using fluorides. A portable version of an earlier bulky laboratory fluoride analyzer using the color-producing reaction of soluble fluorides with a zirconium-Erichrome Cyanine R reagent was developed by two

[39] Chemical Engineering, New Process Avoids Hazards of HF: Vol. 65, No. 22, Nov. 3, 1958, p. 52.
[40] Chemical Engineering, vol. 65, No. 24, Dec. 1, 1958, pp. 51, 54.
[41] Chemical Engineering, vol. 65, No. 10, May 19, 1958, p. 76.
[42] Chemical and Engineering News, More Fluorocarbon Gas: Vol. 36, No. 48, Dec. 1, 1958, p. 26.

scientists at Washington State Institute of Technology.[43] The instrument contains automatic cycling equipment, air reagent reaction tube, photocell, photometer, recorder, and other items required for reagent volume control and sample rate flow.

A new nuclear fuels plant was placed in operation at Erwin, Tenn., early in 1958, when it became possible for the first time to purchase U_3O_8 concentrate directly from ore-processing mills rather than through the Atomic Energy Commission (AEC).[44] The plant produced a wide range of nuclear materials from three basic raw materials—uranium concentrate, thorium concentrate, and enriched uranium hexafluoride. Although processes and techniques were based on procedures originally developed by the AEC, some original equipment design was done to streamline the basic flow sheet.

CRYOLITE

Natural cryolite, from the only known commercial-size deposit, at Ivigtut, Greenland, was mined by a Danish concern under a concession from the Government of Denmark. A portion of the mine production was shipped to the United States, where the Pennsalt Chemicals Corp. processed the ore at its Natrona, Pa., mill. Synthetic cryolite was produced in the United States by the Aluminum Co. of America at East St. Louis, Ill., Reynolds Metals Co., at Bauxite, Ark., and the Kaiser Aluminum & Chemical Corp., at Chalmette, La. These three firms also reclaimed cryolite from scrapped pot linings of aluminum reduction cells.

The Oil, Paint and Drug Reporter throughout the year quoted prices on cryolite 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. Slightly higher prices on natural cryolite were quoted quarterly in the Chemical and Engineering News during 1958.

A synthetic cryolite plant was erected at Garfield, Utah, by United Heckathorn Co.[45] The necessary byproduct fluorides were to be removed from the phosphoric acid circuit of the adjacent plant of Western Phosphates, Inc., and mixed with other chemicals to produce about 3,000 tons of cryolite annually.

Cryolite imports for 1949 through 1958 shown in table 15 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. The 2,380 tons shown as imported from Canada in 1957 was believed to be a transshipment of crude ore from Greenland.

Exports of natural and synthetic cryolite in 1958 totaled 164 short tons valued at $46,001, of which 105 tons at $26,440 was shipped to Canada, with the balance going to India, Mexico, Portugal, and the Union of South Africa.

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[43] Chemical and Engineering News, More Pollutant Detectors: Vol. 36, No. 38, Sept. 22, 1958, p. 81.

[44] Chemical Engineering, Short Cut to Uranium Fuels: Vol. 65, No. 21, Oct. 24, 1958, pp. 138-141.

[45] Mining World, vol. 20, No. 4, April 1958, p. 63.

TABLE 15.—Cryolite imported for consumption in the United States, in short tons

[Bureau of the Census]

	Short tons	Value		Short tons	Value
1949-53 (average)	28,864	$2,226,701	**1958**		
1954	21,141	2,215,887			
1955	21,980	3,189,761	North America: Greenland [1]	14,754	$611,550
1956	23,122	2,901,355			
1957			Europe:		
			Denmark	329	19,721
North America:			France	662	135,600
Canada	2,380	100,938	Germany, West	4,240	826,257
Greenland [1]	14,398	610,615	Italy	3,711	647,899
			Netherlands	489	91,172
Total	16,778	711,553	U.S.S.R	1	260
Europe:			Total	9,432	1,720,909
Denmark	408	29,537			
France	1,102	206,944	Grand total	24,186	2,332,459
Germany, West	10,407	[2] 2,196,202			
Italy	4,017	857,245			
Total	15,934	[2] 3,289,928			
Grand total	32,712	[2] 4,001,481			

[1] Crude natural cryolite.
[2] Revised figure

Gem Stones

By John W. Hartwell[1] and Betty Ann Brett[2]

HE ESTIMATED VALUE of gem material produced in the United States in 1958 exceeded $1 million for the first time. Material collected was nearly 1 million pounds.

The Federal Trade Commission suggested that the descriptive terms—cultured, man-made, and created-by-man—should not be used as designations for laboratory-produced emeralds, sapphires, or other gem stones. It was suggested that they be called synthetic, imitation, simulated, or some word of like meaning to distinguish them from natural stones.

DOMESTIC PRODUCTION

Forty-one States reported production compared with 32 in 1957. Oregon was the leading producing State with an estimated $200,000, the same as in 1957. Ten States—Oregon, California, Texas, Nevada, Arizona, Washington, Wyoming, Utah, Colorado, and Montana—produced 87 percent of the total value. Increased production was reported for 19 States; decreased production, for 3 States.

Gem materials were found in about 200 new localities mostly in Eastern States. The principal varieties of gem material produced in decreasing order, by weight, were petrified wood, agate, rose quartz, quartz crystal, obsidian, and jade. In decreasing order, by value, the principal varieties were turquois, agate, petrified wood, jade, and quartz crystal.

Agate.—Agate produced was valued at $50,000, a 60-percent drop from 1957. Only 39 tons of this material was collected, compared with 200 tons in 1957. The principal States, in decreasing order of production, were Oregon, New Mexico, California, Wyoming, and Texas. The value of production in Oregon was about the same as in 1957; that in New Mexico was about half the 1957 value.

Diamond.—Production of diamond in Arkansas was reported at 475 carats, valued at over $5,000. Hundreds of individuals paid fees for the privilege of searching for the gems on privately owned diamond deposits in Pike County.

Three diamonds, smoky in color, were recovered from a mud pipe in Pershing County, Nev., and a claim was filed on the deposit. Diamond also was discovered 155 feet underground by the Jersey Quarry Co. in an unidentified locality in Illinois. The diamonds from Illinois were reported to be too small for gems.

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

Jade.—Jade production was valued at $60,000, a 20-percent increase compared with 1957. Alaska was the principal producing State, followed by Wyoming, California, and Colorado.

Jade was found in its place of formation in Fremont County, Nev. All jade previously recovered in this area was from alluvial deposits.

In California, good-quality jade was recovered from a deposit under 36 feet of water off the coast at San Simeon by skin divers. Jade also was produced in Arizona and Nevada.

A new lapidary shop was built at the Shungnak Jade Project School, Shungnak, Alaska, and a portable diamond drill was obtained to core jade boulders as an aid in the search for gem-grade material. A shortage of gem-quality jade prompted intensified prospecting.

Petrified Wood.—Over 110 tons of petrified wood was produced, about equal to the 1957 quantity. Estimated value of production was about $50,000, principally from Arizona, Utah, Wyoming, Oregon, and California. Navajo County, Ariz., was the main producing area, with a value estimated at $12,000.

Turquois.—Arizona was the leading producing State, with 80,000 pounds, but because the turquois was low grade its value was only $16,000. Nevada produced only 1,500 pounds but led in value of production with $30,000. Colorado production was 350 pounds, valued at $16,000. New Mexico production was about 5,000 pounds, valued at $5,000.

Miscellaneous Gem Material.—Rose quartz production in South Dakota was 35 tons, valued at $5,000. A small output also was reported from Maine.

A vein of noncrystalline smoky quartz, ranging from light brown to deep black, was discovered in Jasper County, Ga. Excellent gems were cut from unflawed pieces.[3]

Precious opal produced in Nevada was valued at less than $2,000, compared with $52,000 in 1957.

Obsidian (26,000 pounds) valued at $7,000 was about 2½ times the quantity estimated for 1957. Obsidian was used principally in tumbling machines for making baroque gems.

Quartz crystal (52,000 pounds), valued at $23,000, came principally from Garland and Montgomery Counties, Ark. Other producing States were California, Utah, and Pennsylvania.

Feldspar gem-stone production totaled 9,000 pounds, valued at $5,000. The principal producing States were South Dakota, Virginia, Pennsylvania, and Colorado.

About 1,800 pounds of beryl specimens, valued at $1,500 was produced in Mohave County, Ariz.

Copper mineral specimens totaling 6,800 pounds valued at $11,000 were produced in Arizona. Of this total, 1,300 pounds was chrysocolla, valued at about $3,800.

The quantity and value of some other gem stones produced were: Fluorite, 5,000 pounds, $1,400; onyx, 15,000 pounds, $5,000; rhodonite, 10,000 pounds, $3,000; and tourmaline, 2,000 pounds, $8,000.

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[3] Gleason, F. E., Smoky Quartz in Georgia: Georgia Mineral Newsletter, vol. 11, No. 4, Winter 1958, pp. 132–133.

TABLE 1.—Estimated production of gem stones in the United States, in thousand dollars

	1957	1958
Alaska	(1)	(1)
Arizona	$75	$86
Arkansas	(1)	23
California	100	150
Colorado	35	38
Connecticut	(2)	3
Idaho	5	5
Illinois	2	1.3
Maine	(2)	5
Maryland	(2)	1.5
Montana	35	35
Nebraska	2	2
Nevada	100	100
New Hampshire	(2)	5
New Jersey	(2)	4
New Mexico	30	28
New York	5	8
North Carolina	(2)	1.3
Oregon	200	200
Pennsylvania	(2)	2
South Dakota	15	16
Texas	100	100
Utah	12	40
Vermont		1
Virginia		3
Washington	75	75
Wyoming	55	52
Other States [2]	36	21
Total	882	1,006

[1] Included with "Other States."
[2] Less than $1,000 value with "Other States" include: Florida (1957), Georgia (1957–58), Iowa (1957–58), Kansas (1958), Kentucky (1958), Massachusetts (1958), Michigan (1957–58), Minnesota (1957–58), Missouri (1957–58), North Dakota (1957–58), Ohio (1958), Oklahoma (1958), South Carolina (1958), Tennessee (1958), and West Virginia (1958).

CONSUMPTION

Sales of lapidary equipment and supplies, gem materials (excluding diamond), and mineral specimens slightly exceeded 1957 sales, with an estimated $5.5 million. Synthetic and imitation gem-stone sales from domestic and foreign suppliers were estimated at $11 million. Purchases of natural gem materials, exclusive of diamond, were reported to be about $15 million.

The apparent consumption (domestic production plus imports minus exports) of gem stones was over $151 million compared with $142 million in 1957.

PRICES

Retail prices for some natural gem stones, cut and polished in foreign countries, in 1957–58 were as follows:

Variety, size or color:	*Range of prices per carat, dollars*
Alexandrite (1–2 carats)	5–15
Alexandrite (5–20 carats)	Up to 200
Alexandrite (cats-eye, 5–6 carats)	Up to 100
Chrysoberyl (1 carat)	20–25
Garnet (demantoid, 1–2 carats)	Up to 100
Peridot (up to 6 carats)	1–2
Peridot (100 and over)	8–18
Ruby (2 carats and over)	2,500 up
Ruby (½ carat and under)	2–5
Ruby (star, all sizes)	Up to 1,500
Sapphire (golden)	10–25
Spinel (ruby)	Up to 100
Spinel (purple, pink, blue)	Up to 10
Tourmaline (purple, pink, ruby)	Up to 15
Tourmaline (green)	5–10
Zircon (pale blue)	1–2
Zircon (deep blue)	8–10
Zircon (white)	4–7

SOURCE: Jewelers' Circular-Keystone, vol. 128, No. 7, April 1958, pp. 104, 110, 112, 114–117; No. 8, May 1958, pp. 68, 70, 76; No. 9, June 1958, pp. 58, 60, 62.

Wholesale prices paid per carat for rough and uncut alexandrite ranged from $300 to $500 for Ceylon stones and up to $500 for the Siberian variety. Sapphires of the alexandrite variety, from Ceylon, cost about $50 per carat wholesale.

FOREIGN TRADE [4]

Imports of gem stones decreased nearly 2 percent in value from 1957. Gem diamonds supplied 85 percent of total imports, the same as in 1957. Precious stone imports from the Federation of Rhodesia and Nyasaland were reported for the first time and were valued at $141,000.

Decreases in the value of cut but not set imported gem stones were reported for synthetic gems (51 percent), emeralds (31 percent), and rubies and sapphires (10 percent). Increases were noted in natural pearls (24 percent), rough or uncut precious stones (excluding diamond) (22 percent), and cultured pearls (9 percent).

WORLD REVIEW

World diamond production increased 2.7 million carats over 1957. Of the world total, 18 percent was of gem quality. Sales of gem diamond in 1958 were 5.2 million carats valued at about $140 million compared with 5.5 million carats valued at $148 million in 1957.

TABLE 2.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States

[Bureau of the Census]

Item	1957		1958	
	Carats	Value (thousand)	Carats	Value (thousand)
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 997,162	[1 2] $77,170	1,129,297	$72,430
Cut but unset, suitable for jewelry, dutiable	609,775	65,418	718,422	68,065
Emeralds: Cut but not set, dutiable	37,245	[2] 1,595	38,848	1,100
Pearls and parts, not strung or set, dutiable:				
Natural		480		597
Cultured or cultivated		[2] 9,509		10,347
Other precious and semiprecious stones:				
Rough or uncut, duty-free		[2] 630		717
Cut but not set, dutiable		[2] 3,164		2,904
Imitation, except opaque, dutiable:				
Not cut or faceted		[2] 60		65
Cut or faceted:				
Synthetic		[2] 464		228
Other		[1 2] 10,125		9,311
Imitation, opaque, including imitation pearls, dutiable		[2] 23		17
Marcasites, dutiable: Real and imitation		[2] 26		26
Total		[1 2] 168,664		165,807

[1] Revised figure.
[2] Data known to be not comparable with 1958.

[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.

Countries reporting increases in production were: Tanganyika, 28 percent; Belgian Congo, 7 percent; and Ghana, 7 percent. All other countries reported lower production than in 1957.

TABLE 3.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957				1958			
	Rough or uncut		Cut but unset		Rough or uncut		Cut but unset	
	Carats	Value (thousand)	Carats	Value (thousand)	Carats	Value (thousand)	Carats	Value (thousand)
North America: Canada	5,850	$568	419	$52	8,085	$885	1,318	$103
South America:								
Argentina	147	3	9	(1)	290	7	10	12
Brazil	3,426	135	778	76	5,631	295	287	17
British Guiana	4,782	136	236	24	6,739	210	40	6
Surinam	2,726	88	-	-	27	1	-	-
Venezuela	61,890	2,058	4	(1)	39,405	1,114	40	4
Total	72,971	2,420	1,027	100	52,092	1,627	377	39
Europe:								
Austria	-	-	-	-	-	-	62	9
Belgium-Luxembourg	130,646	13,308	345,899	37,483	192,980	12,831	455,267	40,740
France	21,052	846	6,228	987	11,267	424	7,386	898
Germany, West	588	18	29,873	2,020	784	19	35,323	2,442
Hungary	-	-	105	4	-	-	-	-
Italy	-	-	147	22	-	-	119	60
Netherlands	4,248	319	22,686	2,914	8,252	983	24,046	2,927
Switzerland	917	27	134	108	-	-	279	100
United Kingdom	[2] 646,890	[2] 55,507	3,275	552	646,077	50,448	6,543	1,447
Total	[2] 804,341	[2] 70,025	408,347	44,090	859,360	64,705	529,025	48,623
Asia:								
Ceylon	-	-	-	-	-	-	142	21
Hong Kong	-	-	3	(1)	-	-	207	15
India	23	2	385	259	-	-	57	4
Iran	-	-	147	13	-	-	-	-
Israel	3,462	129	151,488	13,686	7,088	146	150,438	12,769
Japan	249	4	1,297	116	-	-	308	22
Lebanon	-	-	-	-	1,250	60	-	-
Malaya, Federation of } Singapore, Colony of }	300	44	-	-	-	-	-	-
Singapore, Colony of			-	-	290	42	-	-
Thailand	-	-	152	1	-	-	-	-
Total	4,034	179	153,472	14,075	8,628	248	151,152	12,831
Africa:								
Belgian Congo	4,150	14	-	-	5,025	30	-	-
British East Africa	-	-	1	(1)	479	15	-	-
French Equatorial Africa	23,690	634	-	-	6,521	224	-	-
French West Africa	2,469	52	-	-	3,686	92	-	-
Ghana	-	-	-	-	72,951	553	-	-
Liberia	45,496	1,608	-	-	22,989	805	4	(1)
Southern British Africa	-	-	42	3	-	-	-	-
Union of South Africa	[2] 34,161	[2] 1,670	46,284	7,063	88,815	3,191	36,546	6,469
Western Portuguese Africa	-	-	-	-	666	55	-	-
Total	[2] 109,966	[2] 3,978	46,327	7,066	201,132	4,965	36,550	6,469
Oceania: Australia	-	-	183	35	-	-	-	-
Grand total	[2] 997,162	[2] [3] 77,170	609,775	65,418	1,129,297	72,430	718,422	68,065

[1] Less than $1,000.
[2] Revised figure.
[3] Data known to be not comparable with 1958.

NORTH AMERICA

Canada.—Upstream gravels near Princeton district, British Columbia, yielded seven or eight minute diamonds. The area was staked, and further prospecting and sampling were anticipated.[5]

An article on industrial minerals in Canada contained a section on the occurrence of gem stones and mineral crystals. Some information was given on the size of the Canadian gem-stone industry.[6]

SOUTH AMERICA

Brazil.—In 1957 the National Department of Mineral Production authorized rough-diamond exports of over 7,800 carats valued at nearly $250,000 and over 55,600 carats of cut semiprecious gems valued at about $5,500.[7]

British Guiana.—Exports of diamond in 1958 were 31,000 carats valued at $1,394,000 or over $42 per carat, compared with 29,000 carats in 1957. The 1958 production of diamond reversed a decreasing trend apparent since 1955.[8]

A new diamond-cutting plant was established, costing $20,000.[9]

Paraguay.—No gem stones were produced, but probable locations were discussed in a report.[10]

Venezuela.—Nearly 14,500 carats of gem-quality diamonds were produced compared with about 24,800 carats in 1957.[11]

EUROPE

Belgium.—The demand for gem diamond lessened throughout the world, especially in the United States, Belgium's principal buyer.

Imports of cuttable gem diamonds decreased 20 percent by weight compared with 1957, and imports of polished gems were 37 percent less. Exports were 7 percent less.

Purchasers in the United States bought 79 percent by weight of all uncut gem diamonds sold and 50 percent of the polished gems.[12]

Portugal.—The Government established a diamond-cutting corporation, Sociedade Portuguesa de Lapidocão de Diamantes in Lisbon. This company will process stones produced in Angola, formerly exported to the United Kingdom, and will purchase additional stones from London diamond interests.[13]

United Kingdom.—Gem-diamond sales of the Central Selling Organization in London were $138.4 million, 6.4 percent below 1957 sales.[14]

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[5] Canadian Mining Journal, Royal Canadian Venturers: Vol. 79, No. 9, September 1958, p. 154.

[6] Western Miner and Oil Review (Vancouver, B.C.), The Search for Industrial Minerals in Canada: Vol. 31, No. 6, June 1958, pp. 36–37.

[7] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 332: Sept. 23, 1958, p. 2.

[8] U.S. Consulate, Georgetown, British Guiana, State Department Dispatch 150: Mar. 13, 1959, p. 30.

[9] Mining Journal (London): Vol. 251, No. 6426, Oct. 17, 1958, p. 421.

[10] Eckel, E. B., Geology and Mineral Resources of Paraguay, A Reconnaissance: Geol. Survey Prof. Paper 327, 1959, p. 83.

[11] U.S. Embassy, Caracas, Venezuela, State Department Dispatch 856: May 14, 1958, p. 1; Dispatch 962: Apr. 29, 1959, Encl. 1, p. 2.

[12] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, pp. 30–32.

[13] U.S. Embassy, Lisbon, Portugal, State Department Dispatch 337: Jan. 2, 1958, p. 1.

[14] Jewelers' Circular-Keystone, vol. 129, No. 5, February 1959, p. 142.

ASIA

Afghanistan.—Lapis lazuli production totaled over 1.5 short tons. The value of the uncut material was $41 to $45 per pound, and the cut and polished gems were valued at $59 to $136 per pound.[15]

India.—The production of emeralds in 1957 totaled 338,000 carats, compared with 474,000 carats in 1956. Diamond production was 790 carats in 1957 and 1,535 in 1958.[16]

Israel.—Diamond exports from Israel were US$32.7 million in 1957, and US$32 million in 1958. It was estimated they would reach US$35 million during the 1959–60 period.[17]

Japan.—Pearl standards were raised to reduce the number of inferior grade pearls exported. Members of the Pan-Japan Pearl Cultivators Cooperation warned all pearl producers to avoid buying or selling cultured pearls produced by using a nucleus of synthetic material. The difficulty of drilling such pearls without breaking caused a damaging effect upon the cultured pearl export trade.[18]

The United States was the biggest market for cultured pearls, taking about 70 percent of exports. The remainder was exported to Europe. Exports of over 54,000 pounds of cultured pearls to the United States was expected in 1958.[19]

Thailand.—Only a small quanity of gem stones originate in Thailand. Imports in 1956 were over 13 million carats, of which 12 million was synthetic stones. Most of the imported gems were cut, polished, and sold locally. Gem-stone exports were over 1 million carats, principally synthetic gems, zircons, and sapphires.[20]

U.S.S.R.—A 7-year plan was drafted for the development of the Yakutia diamond industry in the U.S.S.R. It was expected that the home demand for gem diamonds would be met under this plan.[21] During exploitation of the Yakutia diamond deposits, gem-quality chrysolites were found.[22]

AFRICA

Basutoland.—Diamond was discovered in a kimberlite pipe in the Makhotlong area. Only small gem and industrial diamonds were recovered.[23]

French Guinea.—A short history was written on the occurrence and production of diamond in French Guinea. Most gem diamonds found were of poor quality. Production was 250,000 carats.[24]

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[15] U.S. Embassy, Kabul, Afghanistan, State Department Dispatch 466: May 23, 1959, Encl. 1, p. 1.

[16] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 24. U.S. Embassy, New Delhi, India, State Department Dispatch 1237: Apr. 23, 1958, p. 1.

[17] U.S. Embassy, Tel Aviv, Israel, State Department Dispatch 533: Feb. 26, 1959, p. 10.

[18] Japan Trade Bulletin, Synthetic Nuclei Attacked by Pearl Cultivators: No. 219, Dec. 1, 1958, p. 4.

[19] Jewelers' Circular-Keystone, Japan Expects a Big Boost in Pearl Exports This Year: Vol. 129, No. 5, February 1959, p. 140.

[20] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, pp. 37–38.

[21] Mining Journal (London), vol. 251, No. 6428, Oct. 31, 1958, p. 478.

[22] Ilin, I. V., Kuryleva, N. A., Popugayeva, L. A., and Cigal, Ya. B. [Chrysolites From the Kimberlite Tubular Columns of Yakutiya as Precious Stones for Jewelry Industry]: Razvedka; Okhrana Nedr., No. 2, 1958, pp. 8–9; Library of Congress Ref. Card 132, Jan. 17, 1958.

[23] Mine and Quarry Engineering (London), New Diamondfield: Vol. 24, No. 8, August 1958, p. 343.

[24] Moyal, Maurice, Guinea's Mineral Wealth: Min. Mag. (London), vol. 252, No. 6446, Mar. 6, 1959, p. 255.

Liberia.—Diamond mining was established on a small scale by the Liberian Government in 1936. Real interest in diamond mining began in 1953, and in early 1957, 30,000 people were prospecting and mining around the Lofa River. Because of the disorder of the diamond rush and the loss of manpower for other activities the Government closed the diamond fields in April 1957. In July 1958 they were reopened to prospectors on a controlled basis, except for an area near the Lofa River which was withheld for future large-scale mining by concessionaires. By late 1958 more than 1,300 prospecting licenses and 400 mining licenses had been issued. Foreigners were excluded from mining or prospecting, except in concessions. No thorough geologic survey of the diamond field was made. Diamond production was difficult to estimate because of the great number of diamonds smuggled into Liberia from nearby countries. Illicit imports into Liberia were thought to be valued at $10 million in 1956 and $5 million in 1957. The reduction in 1957 was attributed to stricter export controls in Sierra Leone.[25]

Exports of diamond in 1957 were 800,000 carats valued at $1.5 million, but only 20,000 carats valued at $200,000 was gem quality.[26]

Rhodesia and Nyasaland, Federation of.—Samples of the emeralds found near the Belingwe Native Reserve, known as the Sandawana emeralds, were sent to the United States for valuation. The initial shipment weighed 1.27 ounces and produced 40 cut stones weighing 6.54 carats valued at $375. The second parcel, weighing 5.6 ounces, produced 200 carats of cut gems valued at about $6,000. Many other gem materials, including diamond, chrysoberyl, amethyst, and rose quartz, have been found in Southern Rhodesia.[27]

A second emerald discovery was reported near the initial Belingwe find. The emeralds in this deposit were of lower quality.[28]

South-West Africa.—Production and exports of gem stones in 1958 was reported as follows: [29]

TABLE 4.—Production and exports of gem stones, South-West Africa

Production	Exports	
	Quantity	Value
Diamond [1]	640,752 carats	$32,100,000
Amethyst (20.84 tons)	14.67 tons	7,400
Rose quartz (2 tons)	1.28 tons	616
Tiger's eye [1]	1 ton	560
Tourmaline (10,700 grams)	1,000 grams	420

[1] Data not available.

[25] U.S. Embassy, Monrovia, Liberia, State Department Dispatch 180: Jan. 6, 1959, pp. 16–17.
[26] Mining Journal (London), Liberia's Diamond Laws: Vol. 251, No. 6429, Nov. 7, 1958, p. 506.
[27] Jason, Lewis, Valuing Gems Stones Found in Rhodesia: Rhodesian Min. Eng. (Salisbury), vol. 23, No. 8, August 1958, p. 38.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, p. 35.
[29] U.S. Consulate, Johannesburg, South-West Africa, State Department Dispatch 245: Mar. 3, 1959, p. 2.

Tanganyika.—The De Beers Consolidated Mines, Ltd., and the Tanganyika Government became equal owners in the Williamson Diamond, Ltd., mine at Mwadui under terms of an agreement signed August 13, 1958.[30]

Diamond production from the Williamson mine was 515,762 carats valued at over $12 million, an alltime high and an increase of 143,160 carats over 1957 production. The recently constructed treatment plant of the Williamson Diamond, Ltd., operated at full capacity during the year.[31]

A mining claim acquired by Tanganyika Corundum, Corp., Ltd., in 1958 contained ruby of near precious quality and corundum associated with zoisite as an apple-green rock suitable for art objects. Early production was anticipated.[32]

The De Beers Consolidated Mines, Ltd., 71st Annual Report, 1958, included a statement by the chairman of the board that the most important development during 1958 was the purchase jointly with the Government of Tanganyika of the entire share capital of the Williamson Diamond, Ltd. For 50 percent interest about $7.1 million was paid and in addition a loan of nearly $3.7 million was made to the Tanganyika Government to assist them in financing their share of the business. This loan is repayable out of dividends received by the Government on its shareholding in Williamson Diamonds.

The financing of the sale of the Williamson mine was unusual in that it was based indirectly on an issue of Anglo American Corporation of South Africa, Ltd., bonds that were offered by the Deutsche Bank Aktiengesellschaft of Frankfurt, West Germany, for sale to the public in Germany. The capital thus raised was used to support a loan by the Anglo American Corporation to De Beers Consolidated Mines, Ltd. Details of the transaction were presented in a joint announcement by the Directors of De Beers and the Anglo American companies issued September 3, 1958.

Union of South Africa.—A new $4 million diamond treatment and recovery plant at the De Beers mine at Kimberley was opened by H. F. Oppenheimer, chairman of De Beers Consolidated Mines, Ltd., June 10, 1958. The plant was capable of handling 20,000 tons of ore a day. The plant will serve Du Toitspan, Bultfontein, and Wesselton mines, as well as the De Beers mine, should it come back into production.[33]

A diamond deposit discovered near Swartruggens, Transvaal, was described.[34]

OCEANIA

Australia.—Precious opal weighing 136 pounds was discovered in southern Australia. Three pieces of these opal in the rough, valued at $175,000 were shipped to the United States.[35] Another opal, weigh-

[30] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 30, 31.
[31] U.S. Consulate, Dar es Salaam, British East Africa, State Department Dispatch 272: Mar. 20, 1959, p. 3.
[32] Mining Magazine (London), Corundum (Ruby): Vol. 100, No. 3, March 1959, p. 149.
[33] Engineering and Mining Journal: Vol. 159, No. 7, July 1958, p. 159.
[34] Mining Magazine (London), Investigation of a Transvaal Diamond Occurrence: Vol. 100, No. 3, March 1959, pp. 181–182.
[35] Wall Street Journal, Unfinished Pieces of Largest Opal Stone Ever Found Arrive in U.S. From Australia: Vol. 152, No. 80, Oct. 16, 1958, p. 4.

ing 5 pounds, 14 ounces, was found in the Andamooka opal field. It contained about 2 pounds of precious opal valued at $337 an ounce.

Diamond prospecting and mining in Australia were discussed.[36] The government of Western Australia granted a temporary reserve in the Kimberley area for diamond prospecting. In New South Wales placer diamond mining has been active for a number of years. The diamonds are of high quality but small, and only a few are suitable for jewelry.

TECHNOLOGY

Geochemical prospecting for diamonds by testing soils and plants for nickel was noted as a possibility.[37]

The history, geology, and use of diamond found in India were published.[38]

A British Guiana Geological Survey publication reported a complete survey of the diamond resources of the colony.[39]

The history and geology of the Bubani Emerald mine, India, were published. The emeralds, found in pockets or lenses in a talc-actinolite-biotite schist in the vicinity of pegmatites, often are associated with apatite and green mica.[40]

A review of the gem-stone industry in California included mineralogy and geology, occurrences, locations of deposits, and a bibliography.[41]

Each monthly issue of the Mine and Quarry Engineering (London) journal beginning with October 1953 described a mineral, giving the synonyms, nomenclature, varieties, composition, crystallography, physical and optical properties, tests, diagnoses, occurrences, and uses. Each mineral was illustrated in color. In the 1958 issues the minerals in chronological order were: Vanadinite, wollastonite, pyromorphite, vivianite, monazite, graphite, magnesite, bauxite, garnet, lepidolite, dioptase, and sphaerocobaltite.

The method used by the Consolidated Diamond Mines of South-West Africa, Ltd., in developing its 240-mile-long diamond property on the sea coast was described. The report of the recovery procedures including sampling, overburden removed, excavation and tramming, and preliminary treatment of the diamondiferous gravels.[42]

A series of articles published in German on synthetic emeralds contained information on varieties produced, manufacturing methods, characteristic differences between American and German synthetic emeralds, and causes of cracks formed in production. All articles were illustrated.[43]

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[36] Mining Magazine (London), Diamonds: Vol. 99, No. 3, September 1958, p. 164.

[37] Mine and Quarry Engineering (London), Geochemical Prospecting for Diamonds: Vol. 25, No. 4, April 1959, p. 192.

[38] Kulkarni, M. G., Prosperity Through Diamonds: Malaney & Co., Bombay, India, 1958, 98 pp.

[39] Pollard, E. R., Dixon, C. G., and Dujardin, R. A., Diamond Resources of British Guiana: British Guiana Geol. Survey (Georgetown); Min. Mag. (London), vol. 98, No. 4, April 1958, pp. 195–196.

[40] Bagchi, T. C., The Geology of the Bubani Emerald Mine: Indian Min. Jour. (Calcutta), vol. 6, No. 3, March 1958, pp. 1–4, 11.

[41] California Division of Mines, Gem Stones: Min. Inf. Service, vol. 11, No. 6, June 1, 1958, pp. 1–7.

[42] Devlin, S. W., Mining Procedure and Method at C.D.M.: Jour. South African Inst. Min. and Met. (Johannesburg), vol. 59, No. 4, November 1958, pp. 184–201.

[43] Eppler, W. F., [Synthetic Emeralds] Deut. Goldschmiede Ztg., (Stuttgart), vol. 56, No. 4, April 1958, pp. 193–197; No. 5, May 1958, pp. 249–251; No. 6, June 1958, pp. 327–329; No. 7, July 1958, pp. 381–385; Ind. Diamond Abs., vol. 5, June 1958, p. A81; July 1958, p. A102; November 1958, p. A171; September 1958, p. A185.

Details were given on the synthesis of gems, differentiation of synthetic from natural stones, and the manufacture of rutile, quartz, emerald, and diamond.[44]

Information on the production of strain-free synthetic sapphire by a hydrothermal technique was given. The process involves dissolving and recrystallizing aluminum oxide from an aqueous solution under high pressure and temperature. Synthetic rubies also could be made, using the same process, if a small quantity of a chromate was added to the nutrient.[45]

Other articles on synthetic gem stones were published concerning the production and properties of synthetic corundum, quartz, and garnet; [46] the historical development of synthetic gems with references to optical and physical properties,[47] and methods of producing and crystallizing synthetic corundum.[48]

Processes used in the manufacture of synthetic crystals for industrial use were described.[49]

Synthetic lapis lazuli was made with color and appearance equal to the natural material but with the hardness and wear resistance of spinel.[50]

Black pearls were made by exposing white pearls to neutron bombardment in a reactor. The black luster was said to be permanent.[51]

The judging diamond with relation to origin, weight, luster, and color, and methods of cutting was discussed.[52]

A new system of calculating the weight of a cut gem stone was given.[53]

Ultrasonic methods used in cutting, drilling, and carving hard gem material were reviewed.[54]

It was determined that a small percentage of iron oxide—not chromium or vanadium—caused the colorization of green amazonite.[55]

Optical, electrical, and other physical tests were made on more than 1,000 gem diamonds to show adsorption by infrared light and to identify the variety of impurities.[56]

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[44] Espig, H., [Manufacture of Synthetic Precious Stones]: Chem. Tech. (Berlin), vol. 9, 1957, pp. 90–93; Ceram. Abs., vol. 41, No. 5, May 1, 1958, p. 132.

[45] Laudise, R. A., and Ballman, A. A., Hydrothermal Synthesis of Sapphire: Jour. Am. Chem. Soc., vol. 80, No. 11, June 5, 1958, pp. 2655–2657.

[46] Webster, R., Synthetic Gemstones: Gemmologist (London), vol. 27, No. 324, July 1958, pp. 124–129; No. 325, August 1958, pp. 146–152; No. 326, September 1958, pp. 170–173.

[47] Thomas, L. A., Synthetic Gems: Research (London), vol. 11, No. 12, December 1958, pp. 466–471; Ind. Diamond Abs., vol. 16, January 1959, p. A3.

[48] Barta, C., The Production and Properties of Synthetic Corundum: Ind. Diamond Rev., vol. 17, No. 201, August 1957, pp. 147–150.

[49] Hahn, Steven, Properties and Uses of Industrial Crystals: Product Eng., Design Digest Issue, October 1957, pp. C18–C21.

[50] Rocks and Minerals, Synthetic Lapis Lazuli Spinel: Vol. 34, No. 268, January-February 1959, p. 18.

[51] Jewelers' Circular-Keystone, News Notes "Briefly": Vol. 129, No. 6, March 1959, p. 160.

[52] Bagot, M., How to Judge the Value of a Jewel: Realites (Paris), vol. 99, February 1959, pp. 35–39; Ind. Diamond Abs., vol. 16, March 1959, p. A39.

[53] Schlossmacher, K., [Estimation of Weight of Faceted Colored Stones by Measurement]: Gold v. Silber (Hamburg), vol. 11, No. 11, November 1958, pp. 13–14; Ind. Diamond Abs., vol. 16, January 1959, p. A3.

[54] Schiebel, W., [Ultrasonic Methods for Working Gemstones]: Zeits. Dtsch. Ges. für Edelsteinkunde, vol. 19, 1957, pp. 7–11; Ind. Diamond Abs., vol. 15, March 1958, p. A48.

[55] Basett, R., The Coloring Agent in Amazonstone (Amazonite): Geol. Survey Tanganyika, Dar-es-Salaam, Records Geol. Survey Tanganyika, No. 3, 1956, pp. 97–100; Chem. Abs., vol. 52, No. 7, Apr. 10, 1958, column 5217g.

[56] Bunting, E. N., and Van Valkenburg, A., Some Properties of Diamond: Am. Mineral., vol. 43, No. 1–2, January-February 1958, pp. 102–106.

Foreign patents were issued on gem construction,[57] color improvement of pale diamonds,[58] and an apparatus for manufacturing synthetic jewels.[59]

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[57] Marks, R. V., Opalescent Gem Construction; Australian Patent 216,746, Official Jour., vol. 28, No. 29–34, August–September 1958; Ind. Diamond Abs., vol. 15, December 1958, p. A206.

[58] Custers, H. F. J., Dyer, H. B., and Ditchburn, R. W., Method for Improving the Colour of Pale Yellow or Brown Diamonds: Swiss Patent 332,126, Patentliste, No. 16–17, August–September 1958; Ind. Diamond Abs., vol. 15, December 1958, p. A206.

[59] General Electric Co., Ltd., Apparatus for Manufacturing Synthetic Jewels: British Patent 798,818, Official Journal (Patents), No. 3616, June 4, 1958; Ind. Diamond Abs., vol. 15, August 1958. p. A128.

Gold

By J. P. Ryan [1] and Kathleen M. McBreen [2]

MINE PRODUCTION of gold in the United States, continuing a downward trend since 1950, dropped 3 percent in 1958 to 1.7 million ounces valued at $61 million. This was the lowest output in 64 years, except for the war years 1943-46. In contrast, world gold production rose 2 percent to 40.4 million ounces, marking the fifth successive annual increase. Although domestic output from straight gold mines increased, the gain was more than offset by the drop in the output of byproduct gold from copper and other base-metal mines. The gain in world gold output was again due almost exclusively to continued expansion of production in the Union of South Africa. Consumption of gold in the arts and industry increased 26 percent to 1.8 million ounces valued at $64 million, about 5 percent more than domestic production.

A significant feature of the year was the record outflow of gold from United States reserve, which showed a net loss of $2.3 million—more than 10 percent of the entire reserve. Free-world monetary gold reserves at the end of the year were estimated at $39,865 million, a gain of $895 million over 1957.

Investments in gold by individuals, institutions, and some Governments increased sharply from 1.5 to 8.0 million ounces according to Samuel Montagu & Co. Ltd. Most gold purchases were made in Switzerland, London, and Canada.

LEGISLATION AND GOVERNMENT PROGRAMS

As in 1957, bills were introduced in the Congress to authorize free trading in gold and to limit 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. Joint resolutions were again introduced to establish a joint committee to study the domestic gold-mining industry and to recommend legislation needed to reestablish the industry as an integral part of the national economy. The resolutions were referred to the respective committees on Rules of the House of Representatives and Senate. Bills to raise the depletion allowance for gold mines from 15 to 23 percent were introduced in the Congress and referred to the committees on Ways and Means and Finance of the House of Representatives and Senate, respectively. No further action was taken on any of the proposed legislation.

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

TABLE 1.—Salient gold statistics

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Mine production..thousand ounces...	2,044	1,837	1,880	[1] 1,827	1,794	1,739
Value..................thousands..	$71,527	$64,306	$65,805	[1] $63,951	$62,776	$60,874
Ore (dry and siliceous) produced:						
Gold ore....thousand short tons..	2,821	2,249	2,234	2,255	2,359	2,411
Gold-silver ore..............do....	307	46	120	245	116	107
Silver ore......................do....	531	680	570	687	712	639
Percentage derived from—						
Dry and siliceous ores..............	42	43	41	42	43	47
Base-metal ores....................	34	34	37	39	38	32
Placers............................	24	23	22	19	19	21
Imports...........thousand ounces [2]..	10,300	1,083	2,930	3,730	7,701	8,120
Exports.........................do....	7,199	494	162	734	4,806	886
Monetary stocks (end of year) millions [3]..	....	$21,713	$21,690	$21,949	$22,857	$20,582
Net consumption in industry and the arts..............thousand ounces..	2,557	1,270	1,300	1,400	1,450	1,833
Price, average, per troy ounce [4]........	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00
World: Production thousand ounces (estimated)	33,000	[1] 35,000	[1] 36,300	38,400	[1] 39,600	40,400

[1] Revised figure.
[2] Excludes coinage.
[3] Owned by Treasury Department; privately held coinage not included.
[4] Price under authority of Gold Reserve Act of Jan. 31, 1934.

The Supreme Court reversed the Court of Claims decision that domestic gold miners had been deprived of their property by War Production Board Limitation Order L–208 and were entitled to recover compensation for losses suffered. A bill (H.R. 13253) giving the U.S. Court of Claims jurisdiction over claims arising from W.P.B. Order L–208 was introduced in the House of Representatives and referred to the Committee on the Judiciary without further action. This bill if enacted would have nullified the Supreme Court ruling.

TABLE 2.—Gold produced in the United States according to mine and mint returns, in troy ounces of recoverable metal

	1949–53 (average)	1954	1955	1956	1957	1958
Mine..........................	2,043,616	1,837,310	1,880,142	[1] 1,827,159	1,793,597	1,739,249
Mint..........................	2,000,477	1,859,000	1,876,830	1,865,200	1,800,000	1,759,000

[1] Revised figure.

DOMESTIC PRODUCTION

Mine production of recoverable gold dropped 3 percent to 1.74 million ounces, the third successive annual decline, and the lowest annual output, except for the war years 1943–46, since 1894. Again, as in 1957, the drop in production chiefly reflected curtailment of output of base-metal ores, chiefly copper, yielding byproduct gold, which more than offset production gains from straight gold-mining operations. Of the total domestic production in 1958, 47 percent was recovered from precious-metal ores, 21 percent from placers, and 32 percent as a byproduct of smelting and refining base-metal ores.

The leading States in gold production again were South Dakota, Utah, Alaska, and California, the same order of rank as in 1957.

TABLE 3.—Mine production of gold in the United States in 1958, by months

Month	Troy ounces	Month	Troy ounces
January	130,852	August	155,604
February	117,692	September	161,912
March	127,339	October	171,253
April	128,559	November	148,757
May	141,598	December	152,639
June	148,750		
July	154,294	Total	1,739,249

These four States supplied 72 percent of the total domestic production in 1958. As in preceding years, the gold output of South Dakota, Alaska, and California was obtained from straight gold mines; and most of the remainder of the domestic gold output was recovered as a byproduct of base-metal mining.

Of the 25 leading gold producers in the United States, 8 were lode mines, 6 placer mines worked by bucketline dredges, 8 copper mines, 2 lead-zinc mines, and 1 a copper-lead-zinc mine. The two leading mines, Homestake and Utah Copper produced nearly half of the entire domestic output. The 25 leading mines supplied about 88 percent of the domestic gold output.

Homestake Mining Co., the largest gold producer, reported an ore reserve at the yearend of 13.2 million tons with a grade of $12.30 a ton, compared with 14.1 million tons with a grade of $12.22 at the corresponding date in 1957.

Ore production, classification, methods of recovery, and metal yields, embracing all ores that yielded gold in the United States in 1958, are given in tables 6 to 9. The terminology used in classifying ores was described in detail in the Gold chapter of the 1954 Minerals Yearbook.

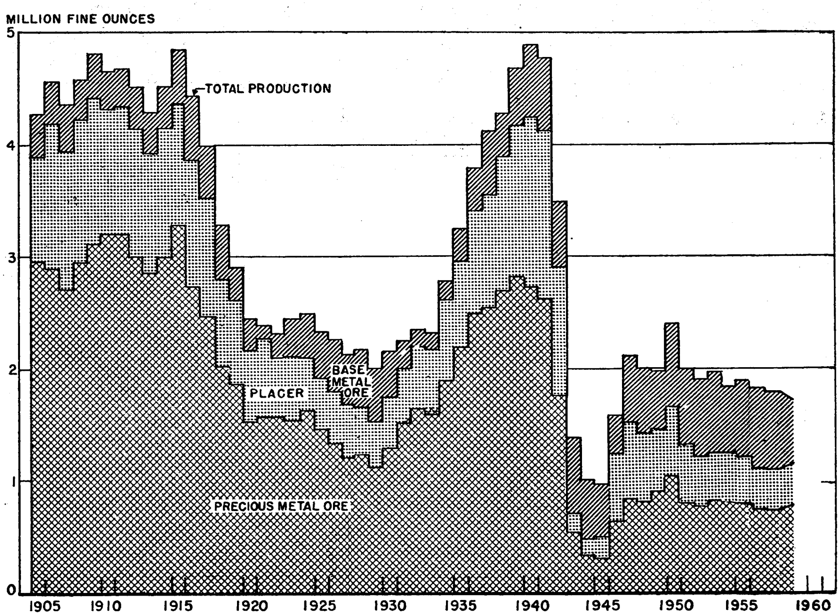

FIGURE 1.—Gold production in the United States, 1905–58.

TABLE 4.—Twenty-five leading gold-producing mines in the United States in 1958, 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	Yuba Unit	Yuba River	California	Yuba Consolidated Industries, Inc.	Dredge.
4	Knob Hill	Republic	Washington	Knob Hill Mines, Inc.	Gold ore.
5	Fairbanks Unit	Fairbanks	Alaska	U.S. Smelting, Refining & Mining Co.	Dredge.
6	Copper Queen-Lavender Pit.	Warren	Arizona	Phelps Dodge Corp.	Copper ore.
7	Round Mountain	Round Mountain	Nevada	Round Mountain Gold Dredging Corp.	Dredge.
8	Natomas	American River (Folsom).	California	The Natomas Co	Do.
9	Nome Unit	Nome	Alaska	U.S. Smelting, Refining & Mining Co.	Do.
10	New Cornelia	Ajo	Arizona	Phelps Dodge Corp.	Gold-silver, copper ores.
11	Iron King	Big Bug	do	Shattuck Denn Mining Co.	Lead-zinc 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	Gold King	Wenatchee River	Washington	Lovitt Mining Co., Inc.	Do.
15	Liberty Pit	Robinson	Nevada	Kennecott Copper Corp.	Copper ore.
16	San Manuel	Old Hat	Arizona	San Manuel Copper Corp.	Do.
17	Veteran Pit	Robinson	Nevada	Consolidated Copper Mines Corp.	Do.
18	Magma	Pioneer	Arizona	Magma Copper Co.	Do.
19	United States and Lark.	West Mountain (Bingham).	Utah	U.S. Smelting, Refining & Mining Co.	Silver, lead, lead-zinc ores.
20	Nyac	Aniak	Alaska	New York-Alaska Gold Dredging Co.	Dredge.
21	Siskon	Klamath River	California	Siskon Corp.	Gold ore.
22	Clinton-Portland Group.	Bald Mountain (Lead).	South Dakota	Bald Mountain Mining Co.	Do.
23	Goldacres	Bullion	Nevada	The London Extension Mining Co.	Do.
24	Blackbird	Blackbird	Idaho	Calera Mining Co.	Copper ore.
25	Cresson	Cripple Creek	Colorado	Cresson Consolidated Gold Mining & Milling Co.	Gold ore.

TABLE 5.—Mine production of recoverable gold in the United States, by States, in troy ounces

State	1949–53 (average)	1954	1955	1956	1957	1958
Alaska	250,503	248,511	249,294	209,296	215,467	186,435
Arizona	113,716	114,809	127,616	146,110	152,449	142,979
California	332,370	237,886	251,737	193,816	170,885	185,385
Colorado	118,665	96,146	88,577	97,668	87,928	79,539
Idaho	50,634	13,245	10,572	[1] 9,210	12,301	15,896
Montana	36,784	23,660	28,123	38,121	32,766	26,003
Nevada	129,777	79,067	72,913	[1] 68,040	76,752	105,087
New Mexico	3,237	3,539	1,917	3,275	3,212	3,378
North Carolina	2	214	190	882	1,373	876
Oregon	9,842	6,520	1,708	2,738	3,381	1,423
Pennsylvania	1,644	1,317	1,610	(2)	(3)	(3)
South Dakota	501,654	541,445	529,865	568,523	568,130	570,830
Tennessee	195	218	221	189	172	124
Texas	32					
Utah	424,552	403,401	441,206	416,031	378,438	307,824
Vermont	151	185	181	[2] 1,829	62	
Washington	69,770	66,740	74,360	70,669	[3] 89,708	[3] 113,353
Wyoming	80	407	52	762	573	117
Total	[4] 2,043,616	1,837,310	1,880,142	[1] 1,827,159	1,793,597	1,739,249

[1] Revised figure.
[2] Production in Pennsylvania and Vermont combined.
[3] Production in Pennsylvania and Washington combined.
[4] Includes 4 ounces from Georgia and 4 ounces from Maryland.

TABLE 6.—Ore, old tailings, etc., yielding gold, produced in the United States, and average recoverable content in troy ounces of gold per ton in 1958

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	40	4.950	--------	--------	--------	--------	7	--------	5	0.400	--------	--------	--------	--------	52	3.846
Arizona	7,221	.028	69,029	0.010	51,829	--------	56,292,640	0.002	6,571	.029	14,210	0.002	367,449	[1] 0.075	56,808,949	[1] .003
California	134,653	.346	--------	--------	322	0.143	4,332	[2] .107	1,643	.018	--------	--------	--------	--------	140,950	[2] .334
Colorado	108,260	.402	3,140	.089	477	.023	37,621	.085	20,952	.082	76	.013	698,377	.042	868,903	.090
Idaho	1,654	.363	13	3.077	461,253	.003	300,279	.033	87,874	.007	95,462	--------	734,116	.001	1,680,651	.008
Montana	14,260	.445	3,507	.224	28,895	.021	10,096,767	.001	13,598	.015	702,852	.004	666	.177	10,860,545	.002
Nevada	183,423	.093	1,031	.657	7,873	.086	9,573,143	.004	25,882	.276	--------	--------	162	.025	9,791,514	.007
New Mexico	4	1.000	17,300	.066	2	--------	5,744,149	--------	10,541	.001	107,477	.004	11,844	.008	5,891,317	.001
Oregon	1,097	.696	--------	--------	--------	--------	850	.135	--------	--------	--------	--------	--------	--------	1,947	.451
South Dakota	1,824,436	.313	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	1,824,436	.313
Utah	--------	--------	12,797	.067	88,050	.016	24,099,028	.012	13,969	.050	97,370	--------	[3] 567,754	[1 4] .043	[3] 24,878,968	[1 4] .012
Wyoming	3,080	.038	--------	--------	--------	--------	6	--------	--------	--------	--------	--------	--------	--------	3,086	.038
Undistributed [5]	133,306	.836	163	.031	171	--------	155,357	.006	111	--------	--------	--------	2,105,110	--------	[6] 2,394,218	[6] .047
Total	2,411,434	.331	106,980	.042	638,872	.006	106,304,179	.004	181,146	.058	1,017,447	.003	4,485,478	.018	115,145,536	.012

[1] Includes gold recovered from uranium ore.
[2] Includes gold recovered from tungsten ore.
[3] Includes 70,102 tons of iron (pyrite) tailings.
[4] Includes gold recovered from iron (pyrite) tailings.
[5] Includes North Carolina, Tennessee, and Washington.
[6] Excludes magnetite-pyrite-chalcopyrite ore and gold therefrom in Pennsylvania.

TABLE 7.—Mine and refinery production of gold in the United States in 1958, by States and sources, in troy 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	186,235	198	----------	2	--------	----------	186,435	188,000
Arizona	59	912	114,358	189	28	[2] 27,433	[2] 142,979	150,000
California	138,263	46,629	[3] 463	30	--------	----------	[3] 185,385	185,600
Colorado	1,647	43,803	3,194	1,709	1	29,185	79,539	86,700
Idaho	2,590	1,925	9,800	592	8	981	15,896	15,300
Montana	1,088	7,754	14,251	198	2,594	118	26,003	32,000
Nevada	40,453	18,487	39,008	7,135	--------	4	105,087	98,000
New Mexico	----------	1,139	1,717	6	426	90	3,378	3,620
North Carolina	----------	----------	876	--------	--------	----------	876	900
Oregon	545	763	115	--------	--------	----------	1,423	2,230
Pennsylvania [4]	----------	----------	----------	--------	--------	----------	----------	1,820
South Dakota	----------	570,830	----------	--------	--------	----------	570,830	575,250
Tennessee	----------	----------	----------	--------	--------	124	124	130
Utah	4	2,260	280,320	700	10	[2, 5] 24,530	[2, 5] 307,824	319,330
Washington [6]	92	111,393	1,868	--------	--------	----------	113,353	99,900
Wyoming	1	116	----------	--------	--------	----------	117	220
Total	370,977	806,209	465,970	10,561	3,067	82,465	1,739,249	1,759,000
Percent	21.3	46.4	26.8	.6	.2	4.7	100	----------

[1] U.S. Bureau of the Mint.
[2] Includes gold recovered from uranium ore.
[3] Includes gold recovered from tungsten ore.
[4] Included with Washington.
[5] Includes gold recovered from iron (pyrite) tailings.
[6] Includes gold recovered from magnetite-pyrite-chalcopyrite ores in Pennsylvania.

TABLE 8.—Gold produced in the United States from ore and old tailings, in 1958, 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 (troy ounces)	Cyanidation (troy ounces)	Concentrates (short tons)	Troy ounces	Short tons	Troy ounces
Alaska	52	40	157	----------	3	41	12	2
Arizona	56,808,949	56,188,380	13	3,086	1,853,529	106,682	620,569	33,139
California	140,950	138,725	26,818	12,057	3,103	7,721	2,225	526
Colorado	868,903	820,330	9,395	42,546	110,493	22,079	48,573	3,872
Idaho	1,680,651	1,580,909	235	----------	192,071	12,170	99,742	901
Montana	10,860,545	10,760,621	10	58	473,606	17,480	99,924	7,367
Nevada	9,791,514	9,665,264	1,145	16,300	203,828	37,410	126,250	9,779
New Mexico	5,891,317	5,818,654	----------	----------	186,937	2,226	72,663	1,152
Oregon	1,947	1,901	140	----------	115	700	46	38
South Dakota	1,824,436	1,824,436	408,952	161,875	(1)	3	----------	----------
Utah	24,878,968	24,615,899	----------	----------	755,511	299,166	263,069	8,654
Wyoming	3,086	3,080	19	----------	12	97	6	----------
Undistributed [2]	[3] 2,394,218	[3] 2,331,845	2	9,475	[3] 115,953	83,548	62,373	21,236
Total	115,145,536	113,750,084	446,886	245,397	3,895,161	589,323	1,395,452	86,666

[1] Less than 1 ton.
[2] Includes North Carolina, Pennsylvania, Tennessee, and Washington.
[3] Excludes magnetite-pyrite-chalcopyrite ore and concentrates therefrom in Pennsylvania.

TABLE 9.—Gold produced at amalgamation and cyanidation mills in the United States and percentage of gold recoverable from all sources

	Bullion and precipitates recoverable (troy ounces)		Gold from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [1]	Placers
1949-53 (average)	466,570	267,806	22.8	13.1	39.9	24.2
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
1958	446,886	245,397	25.7	14.1	38.9	21.3

[1] Both crude ores and concentrates

TABLE 10.—Gold production at placer mines in the United States, by method of recovery

Method	Mines producing	Washing plants (dredges)	Material treated (thousand cubic yards)	Gold recoverable		
				Thousand troy ounces	Value (thousand)	Average value per cubic yard
Bucketline dredging:						
1949-53 (average)	38	58	89,523	405	$14,173	$0.158
1954	22	44	62,082	356	12,461	.201
1955	25	20	53,352	348	12,185	.228
1956	19	32	48,955	295	10,310	.210
1957	18	33	45,489	297	10,402	.229
1958	17	31	43,693	287	10,038	.230
Dragline dredging:						
1949-53 (average)	23	21	2,829	13	445	.157
1954	15	15	554	4	146	.264
1955	19	7	480	3	103	.214
1956	16	7	774	3	88	.113
1957	13	14	[1] 378	2	55	.145
1958	11	11	[1] 132	1	40	.301
Suction dredging and Hydraulicking:						
1949-53 (average)	72	11	627	4	156	.250
1954	51	3	262	2	75	.285
1955	49	5	202	2	55	.272
1956	38	2	74	1	51	.697
1957	30	----------	100	2	75	.752
1958	52	3	351	3	116	.331
Nonfloating washing plants:						
1949-53 (average)	143	142	5,874	68	2,378	.405
1954	128	128	2,974	52	1,837	.618
1955	118	109	2,259	53	1,867	.826
1956	110	99	1,355	48	1,673	1.235
1957	94	111	[1] 2,188	40	1,381	.631
1958	107	118	[1] 2,601	77	2,698	1.037
Underground placer and small-scale hand methods:						
1949-53 (average)	213	----------	182	4	137	.753
1954	138	----------	182	4	127	.699
1955	98	----------	242	4	135	.560
1956	83	----------	103	2	83	.798
1957	73	----------	64	2	81	1.270
1958	102	----------	80	3	92	1.162
Grand total, placers:						
1949-53 (average)	489	----------	99,035	494	17,289	.175
1954	354	----------	66,054	[2] 420	[2] 14,698	.223
1955	309	----------	56,535	410	14,345	.254
1956	266	----------	51,261	349	12,205	.238
1957	228	----------	[1] 48,219	343	11,994	.249
1958	289	----------	[1] 46,857	371	12,984	.277

[1] Does not include commercial sand and gravel operations recovering byproduct gold.
[2] Includes 1,476 ounces of gold valued at $51,660 recovered from unclassified placers.

CONSUMPTION AND USES

Industry and the Arts.—Domestic industry and the arts absorbed 1.83 million ounces of gold, about 26 percent more than in 1957, according to data compiled by the Bureau of the Mint. This represented about 5 percent more than domestic mine production during the year.

According to estimates of a British bullion firm,[3] about 36.1 million ounces of new gold was sold in 1958; 18 million ounces went into Central Bank reserves, 5 million into industrial consumption, and 4 million into normal hoarding channels. The balance of about 8 million ounces was absorbed for investment by various organizations and individuals.

In addition to its traditional uses in jewelry and allied articles, and in various scientific instruments and chemical equipment, gold continued to find new industrial applications, particularly as protective and decorative coatings for other materials.

According to reports of producers to the Bureau of Mines, about 1,800 ounces of natural gold was sold on the open market, most of which was used for jewelry or decorative purposes. Prices received by the sellers were not reported.

Radioactive gold provided a source of heat in an experimental thermionic converter developed by General Electric Co. This new application of gold, if proved efficient, may lead to expanded use of the metal in designing miniature powerplants for space vehicles.

Significant progress was made in techniques of applying carat gold coatings on ceramics, porcelain enamel, and stainless steel. The development of a new and economical heat-treatment method will permit expanded applications of gold finishes at a cost that is expected to increase consumer demand. A gold coating, a few hundred-thousandths of an inch thick, on space-probing satellites provides a highly reflective surface that can withstand the temperature extremes encountered in outer space. A reflecting surface keeps delicate instruments from overheating, thus preventing their breakdown and insuring the reliability of information transmitted. The superior corrosion-resistant properties of gold led to its adoption for cladding the internal components of certain nuclear-power reactors using highly corrosive liquid fuel.

TABLE 11.—Net industrial[1] consumption of gold in the United States, in troy ounces

[U.S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1949–53 (average)	3,589,394	1,032,161	2,557,233
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
1958	2,602,512	769,261	1,833,251

[1] Including the arts.

[3] Samuel Montagu & Co., Ltd., Annual Bullion Review, 1958, p. 3.

Monetary.—Gold continued to function as a stabilizing factor in the world monetary system. The demand for gold coins continued active during the year, although premium prices tended to decline.

The position of the United States in world money markets was discussed by an American broker and financier,[4] and changes in fiscal policy were advocated. The author recommended a return to the gold standard, free worldwide convertibility, and the establishment of a realistic price for gold.

MONETARY STOCKS

U.S. gold stocks dropped sharply in 1958—a net loss of $2,275 million to $20,582 million—as a result of balance-of-payments transactions with foreign countries, according to the Federal Reserve Bulletin.

Notwithstanding the heavy withdrawals during the year, the U.S. gold position remained strong with holdings of over half the free-world monetary reserve. The ratio of gold reserve to Federal Reserve note and deposit liabilities was 42 percent at the end of 1958 as against 25 percent required for legal cover. In conjunction with the sharp decline in gold stocks much concern was expressed in various quarters[5] about the significance of the gold outflow and the large amount of short-term liabilities.

Analysis of U.S. foreign-exchange transactions reveals military expenditures abroad of $3 billion and an outflow of $5 billion in investments and foreign-aid grants compared with a net gain of $5 billion from commercial foreign trade. The $3-billion deficit was met in part by delivery of gold.

The withdrawal of gold from Treasury stocks resulted chiefly from purchases with acquired dollars rather than from conversion of short-term dollar assets. Thus net liabilities for foreign accounts increased only $700 million to $13,800 million at the end of 1958.

The estimated world gold reserve at the yearend, excluding the Soviet bloc, was $39,865 million according to the Federal Reserve Bulletin, a gain of $895 million for the year. The U.S. gold reserve thus was about 52 percent of the total free-world reserve.

Gold reserves of the principal free-world central banks and governments[6] outside the United States at the yearend, in million dollars, were: Federal Republic of Germany, 2,639; United Kingdom, 3,069; Switzerland, 1,925; Belgium, 1,248; Canada, 1,078; Netherlands, 1,050; France, 589; and International Monetary Fund, 1,332.

The quantity of gold acquired for private hoarding was estimated[7] to have dropped to 4 million ounces, less than half that in 1957. However, investments in gold by individuals, institutions, and some foreign-government bodies, and held by foreign banks, rose sharply from about 1.5 million ounces in 1957 to about 8 million ounces in 1958.

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[4] Taylor, Reid, Who's Afraid of Gold and Why? Western Min. and Ind. News, vol. 26, No. 11, November 1958, pp. 1, 3.

[5] Monthly Letter, First National City Bank, The Gold Outflow: December 1958, pp. 136–140.
American Metal Market, Our Continuing Loss of Gold: Vol. 65, No. 206, Oct. 24, 1958, p. 2.
The Wall Street Journal, The Outlook: Vol. 152, No. 103, Nov. 24, 1958, p. 1.

[6] Federal Reserve Bulletin, vol. 45, No. 3, March 1959, pp. 332–333.

[7] Work cited in footnote 3, p. 9.

Some economic problems of gold mining, and the outlook for gold production and additions to reserves under an unchanged price situation were discussed by an economist.[8] Additions to the total gold reserves of countries outside the Soviet bloc depend upon the amount of gold initially made available by new production, the sales of gold by the Soviet bloc to the rest of the world, the net amount of gold used for industrial and artistic purposes, and the amount of gold bought privately for saving or hoarding.

PRICES

The continuous outflow of gold from the United States prompted much speculation and discussion concerning the possibility of a higher price for gold. The U.S. Government was urged by some foreign countries to revalue gold to expand reserves and thus give greater liquidity in world trade.

The policy of the United States concerning the revaluation of gold was again stated at the 13th Annual Meeting of the Board of Governors of the International Monetary Fund at New Delhi, India, by Secretary of the Treasury Robert B. Anderson, as follows:

> In view of some of the comments which have been made with respect to the price of gold, I should make clear that my Government firmly adheres to the position that the price of gold in U.S. dollars should remain unchanged. The assured interchangeability of gold and dollars at $35 per ounce for the settlement of international accounts is a basic element of strength in the international financial structure . . .

Mint institutions of the U.S. Treasury and licensed private refiners continued to buy virtually all domestic production and to sell gold for industrial and artistic use at the official price plus or minus handling charges.

The London price of gold in terms of U.S. dollars followed a similar pattern to last year, fluctuating in a narrow range of about 17 cents an ounce between $34.98 and $35.15. According to a London bullion firm[9] the volume of transactions on the London market dropped about 25 percent in 1958, owing to the lack of Central Bank operations and the termination of the European Payments Union after convertibility declarations by most of its member countries at the end of last year.

Prices of bar gold in most of the world markets varied little from the London price except in markets where trading was in local inconvertible currencies that reflected local conditions and monetary habits. These prices computed in U.S. dollars are often misleading because of differences in official and free-market foreign-exchange rates.

Average price[1] of "free" gold bars (12.5 kg.) per fine troy ounces in 1958 was:[2]

Market:	*Price*
Manila	$36. 35
Hong Kong	38. 41
Bombay	57. 15
Tangier	35. 18
Beirut	$35. 23
Paris	36. 18
Buenos Aires	36. 18

[1] Prices quoted at "free" or black-market value of U.S. dollar in local markets.
[2] Engineering and Mining Journal, vol. 159, Nos. 2–12 February–December 1958; vol. 160, No. 1, January 1959; Markets section of each issue.

[8] Altman, Oscar L., A Note on Gold Production and Additions to International Gold Reserves, International Monetary Fund Staff Papers, April 1958.
[9] Work cited in footnote 3, p. 5.

FOREIGN TRADE[10]

Net imports of gold resulting from ordinary foreign trade continued to rise from $104.3 million in 1957 to $258.8 million in 1958. Imports of ore and base bullion and refined bullion increased $17.1 million, whereas exports dropped $137.3 million. Net imports plus domestic production continued to greatly exceed net consumption in the arts and industry. Canada supplied nearly two-thirds of the gold imports; Argentina and the Philippines supplied most of the remainder. Of the total gold exported, about 60 percent went to the United Kingdom and 30 percent to Canada.

TABLE 12.—Gold imported into the United States in 1958, by countries of origin

[Bureau of the Census]

Country of origin	In ore and base bullion		In refined bullion		Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value	
North America:					
Canada	663,797	$23,206,663	4,538,278	$158,830,543	
Costa Rica			310	10,859	
Cuba	804	28,140			
Dominican Republic	2,025	70,888			
El Salvador	3,639	127,627			
Honduras	2,163	75,770			
Mexico	72,413	2,522,823	233	8,146	
Nicaragua	143,381	5,012,084			
Panama	957	33,530			
Total	889,179	31,077,525	4,538,821	158,849,548	
South America:					
Argentina	1,695	59,168	1,428,666	50,003,314	
Bolivia	265	9,229			$830,000
Brazil	21	735			
British Guiana	1,439	50,410			
Chile	27,780	976,936			
Colombia	19,540	683,595	2,902	101,638	
Ecuador	18,992	659,611			
Peru	34,839	1,211,091	250,839	8,779,377	
Surinam			54,094	1,893,297	
Uruguay			470,519	16,468,189	
Venezuela	70	2,450			
Total	104,641	3,653,225	2,207,020	77,245,815	830,000
Europe:					
Germany, West	218	7,645			
Malta, Gozo, and Cyprus	2,125	75,193			
Portugal	18,190	636,580			
United Kingdom	8,768	306,681	571	19,896	
Total	29,301	1,026,099	571	19,896	
Asia:					
Korea, Republic of	11	376			
Philippines	59,459	2,109,369	272,930	15,151,066	
Turkey	551	19,237			
Total	60,021	2,128,982	272,930	15,151,066	
Africa:					
Rhodesia and Nyasaland, Federation of	4,452	154,657			
Union of South Africa	257	8,995			
Total	4,709	163,652			
Oceania: Australia	11,633	407,390	900	31,860	
Grand total	1,099,484	38,456,873	7,020,242	251,298,185	830,000

[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.

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TABLE 13.—Gold exported from the United States in 1958, by countries of destination

[Bureau of the Census]

Country of destination	In ore and base bullion		In refined bullion	
	Troy ounces	Value	Troy ounces	Value
North America:				
Canada	213	$7,453	243,015	$8,505,537
Cuba			169	6,305
El Salvador			875	32,230
Mexico	17,954	628,432		
Total	18,167	635,885	244,059	8,544,072
South America:				
Brazil			225	7,897
Chile			123	4,315
Colombia			4	138
Surinam			54,068	1,892,378
Venezuela			14,255	507,013
Total			68,675	2,411,741
Europe:				
Portugal			18,196	637,945
United Kingdom	8,762	308,891	527,455	18,460,149
Total	8,762	308,891	545,651	19,098,094
Asia:				
Ceylon			50	1,780
Turkey			607	21,288
Total			657	23,068
Grand total	26,929	944,776	859,042	30,076,975

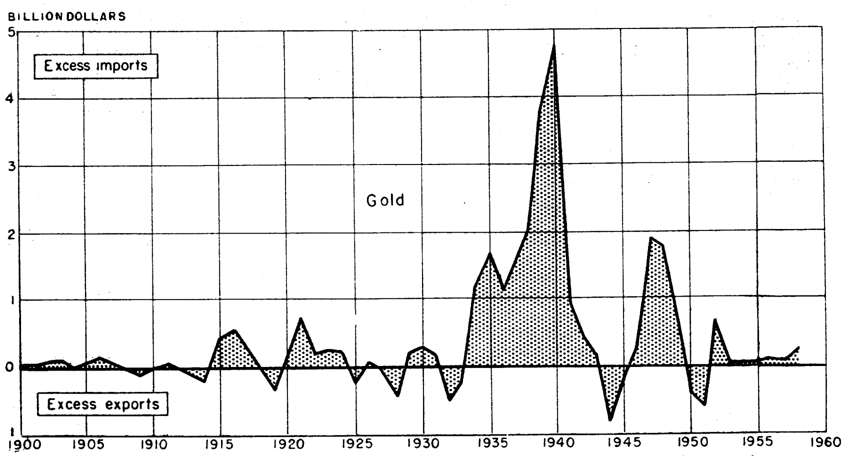

FIGURE 2.—Net imports or exports of gold, 1900–58.

WORLD REVIEW

World production of gold rose for the fifth successive year with a gain of 2 percent to 40.4 million ounces valued at $1,410 million, the highest output since the alltime peak year of 1940. Most of the gain was again attributed to expansion of mining in the Union of South Africa. Several countries continued to extend financial assistance in the form of subsidies or tax concessions to marginal producers to help offset rising costs of production.

Sales of gold by the U.S.S.R. were estimated at 6 million ounces. Most of the sales were made through Switzerland.

Australia.—Australia's gold output rose slightly in 1958 to about 1.10 million ounces. Western Australia mines continued to furnish more than three-fourths of the total output, and ore reserves were increased. Under the Commonwealth's Assistance to Gold Mining Act, allowances for development expenditures were increased to A£5 5s. an ounce in determining the cost of production.

Canada.—Gold production in Canada rose 2 percent to approximately 4.54 million ounces valued at $159 million, the highest level of output since 1955. The gain was attributed largely to increased output from the high-grade mines in the Red Lake area. The price of gold averaged about $33.98 in Canadian dollars for 1958 compared with $33.54 in 1957 and $34.45 in 1956.

Straight gold mines, both lode and placer, furnished about 87 percent of the total output; base-metal mines recovering gold as a byproduct supplied the remainder. About 16,600 persons were employed in the mines.

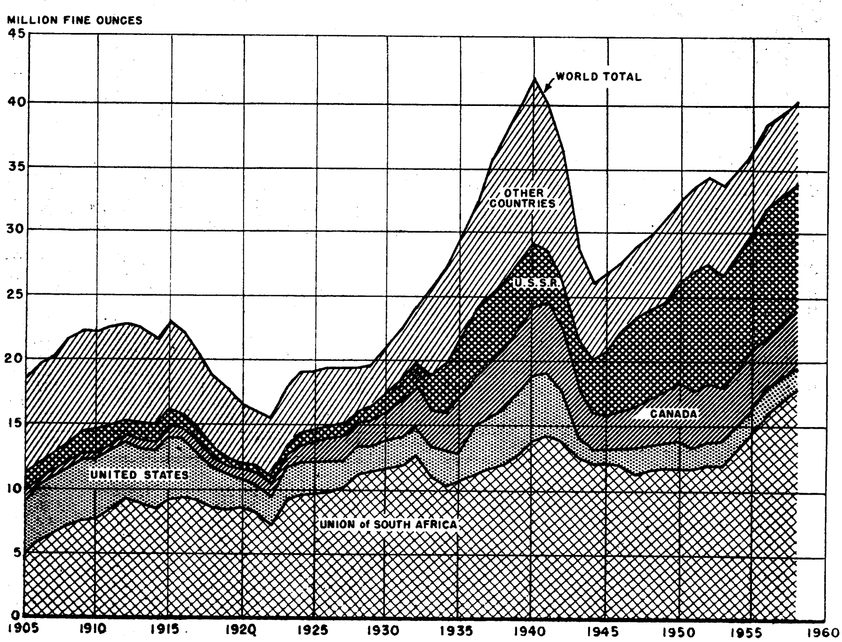

FIGURE 3.—World production of gold, 1905–58.

The geographical distribution of Canada's gold production was as follows:

Province or Territory:	Troy ounces 1957	Troy ounces 1958
British Columbia	221, 392	194, 168
Northwest Territories	338, 721	343, 969
Ontario	2, 569, 110	2, 693, 717
Prairie Provinces [1]	196, 908	176, 643
Quebec	1, 013, 347	1, 046, 565
Yukon	66, 429	67, 744
Newfoundland and Nova Scotia	12, 443	14, 201
Total	4, 418, 350	4, 537, 007

[1] Alberta, Saskatchewan, and Manitoba.

An amendment to the Emergency Gold Mining Assistance Act was passed, which extended the operation of the Act to the end of 1960 and increased by 25 percent the amount of cost aid payable. Mines with production costs exceeding $26.50 an ounce of gold were declared eligible for assistance under the act.

Canadian brokers and bankers commenced to sell gold on a deferred payment plan to foreigners seeking a hedge against inflation. Gold bars were available in two sizes, a 1-kilogram bar (about 32 ounces) for $1,123, and a 400-ounce bar for $14,080.

TABLE 14.—World production of gold, by countries,[1] in troy ounces [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	4, 296, 989	4, 366, 440	4, 541, 962	4, 383, 863	4, 433. 894	4, 537, 007
Central America and West Indies:						
Costa Rica [3]	80			535	705	310
Cuba [3]	3, 101	677	2, 024	1, 008	915	804
Dominican Republic	442			290	286	780
Guatemala [4]	140	300	300	360	360	370
Honduras	34, 617	20, 429	817	1, 611	[3] 1, 878	1, 714
Nicaragua	243, 216	232, 212	237, 376	217, 140	203, 636	241, 882
Panama	2, 737					
Salvador	26, 171	5, 326	3, 818	2, 983	2, 508	[3] 3, 639
Mexico	430, 106	386, 870	382, 883	350, 218	357, 369	[3] 332, 246
United States [5]	2, 000, 477	1, 859, 000	1, 876. 830	1, 865, 200	1, 800, 000	1, 759, 000
Total	7, 038, 000	6, 871, 000	7, 046, 000	6, 823, 000	6, 802, 000	6, 878, 000
South America:						
Argentina	6, 810	7, 202	7, 330	11, 381	7, 732	[4] 7, 700
Bolivia	15, 628	28, 614	31, 508	35, 549	27, 685	19, 129
Brazil [4]	177, 200	153, 000	145, 000	162, 000	151, 000	140, 000
British Guiana	17, 608	26, 938	23, 766	15, 815	16, 490	17, 500
Chile	170, 143	124, 970	136, 062	94, 459	103, 590	70, 860
Colombia	405, 827	377, 466	380, 824	438, 349	325, 114	371, 715
Ecuador	52, 184	18, 942	15, 289	15, 076	16, 247	19, 445
French Guiana	9, 974	1, 524	8, 713	5, 832	[6] 9, 549	20, 000
Peru	131, 623	147, 424	170, 747	159, 074	161, 831	132, 826
Surinam	5, 490	6, 771	7, 204	6, 736	6, 516	4, 258
Venezuela	26, 160	56, 074	61, 140	69, 826	89, 654	76, 009
Total [4]	1, 019, 000	949, 000	988, 000	1, 014, 000	915, 000	879, 000
Europe:						
Finland	16, 016	16, 976	18, 840	18, 229	21, 895	28, 499
France	64, 168	15, 947	30, 286	30, 608	29, 000	[4] 30, 000
Germany, West	2, 672	4, 665	3, 839	[4] 4, 500	[4] 4, 500	[4] 4, 000
Greece	[7] 2, 048	7, 620	6, 655	3, 504	7, 877	5, 787
Italy	12, 031	5, 208	5, 562	5, 337	5, 691	5, 977
Portugal	15, 400	18, 583	28, 807	22, 120	23, 777	[4] 14, 000
Spain	14, 704	9, 677	10, 449	11, 510	11, 901	[4] 11, 000
Sweden	76. 750	110, 277	98, 767	95, 745	97, 063	[4] 100, 000
U.S.S.R. [4 8]	8, 600. 000	9, 000, 000	9, 000, 000	10, 000, 000	10, 000, 000	10, 000, 000
Yugoslavia	34, 324	44, 785	41, 635	47, 808	51, 988	[4] 60, 000
Total [4]	9, 000, 000	9, 400, 000	9, 400, 000	10, 400, 000	10, 400, 000	10, 400, 000

See footnotes at end of table.

TABLE 14.—World production of gold, by countries,[1] in troy ounces [2]—Continued

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
Asia:						
Burma	242	170	124	179	104	[4] 100
Cambodia	--	--	--	482	1,608	322
India	212,826	239,168	210,880	209,251	179,182	170,090
Japan	165,539	243,149	240,732	241,422	252,563	258,653
Korea:						
North [4]	117,000	130,000	130,000	130,000	130,000	130,000
Republic of	12,494	52,336	47,676	49,903	66,578	73,135
Malaya	17,432	20,955	22,838	20,253	11,157	22,484
Philippines	393,094	416,052	419,112	406,163	379,982	422,833
Sarawak	1,036	531	463	599	883	864
Saudi Arabia	71,420	34,298	--	--	--	--
Taiwan	28,190	25,010	28,100	33,131	20,548	21,345
Total [4] [8]	1,170,000	1,370,000	1,310,000	1,350,000	1,300,000	1,460,000
Africa:						
Angola	128	36	57	34	--	26
Bechuanaland	673	1,216	560	590	190	215
Belgian Congo (incl. Ruanda-Urundi)	353,067	365,490	369,926	373,849	374,235	354,301
Egypt	13,106	17,387	6,524	7,697	3,026	[4] 3,000
Eritrea	1,204	1,484	161	3,215	4,501	6,430
Ethiopia	35,110	33,894	22,058	25,700	[4] 25,000	36,369
French Cameroon	5,031	685	556	463	10,899	2,009
French Equatorial Africa	54,191	45,307	46,548	40,703	30,768	23,708
French West Africa	30,362	675	579	431	331	3,200
Ghana	697,495	787,075	687,151	637,755	790,381	852,834
Kenya	16,519	6,607	9,528	13,843	7,388	7,753
Liberia	7,460	[6] 1,135	[6] 672	[9] 500	[9] 381	[4] 400
Madagascar	1,795	1,363	1,074	842	842	547
Morocco: Southern zone	1,883	3,566	4,270	265	--	--
Mozambique	1,238	2,027	1,248	1,247	1,080	695
Nigeria	1,671	730	681	439	389	646
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	1,821	2,648	2,234	3,367	3,296	3,673
Southern Rhodesia	504,808	535,852	524,701	536,392	536,849	554,838
Sierra Leone	2,633	2,254	474	[6] 452	--	--
Sudan	2,566	1,554	1,526	3,100	1,158	[4] 1,000
Swaziland	992	--	--	252	7	--
Tanganyika	66,856	71,447	68,892	59,293	54,088	56,299
Uganda (exports)	419	568	450	297	212	329
Union of South Africa	11,728,902	13,237,119	14,602,267	15,896,693	17,031,690	17,665,739
Total	13,530,000	15,120,000	16,350,000	17,610,000	18,880,000	19,570,000
Oceania:						
Australia	941,842	1,117,742	1,049,039	1,029,821	1,083,941	1,098,914
Fiji	91,269	72,200	70,100	67,475	75,150	86,794
New Guinea	102,046	86,195	73,980	79,085	68,564	43,254
New Zealand	66,865	41,713	26,443	26,063	30,195	24,981
Papua	355	318	873	391	466	558
Total	1,202,377	1,318,168	1,220,435	1,202,835	1,258,316	1,254,501
World total (estimate)	33,000,000	35,000,000	36,300,000	38,400,000	39,600,000	40,400,000

1 In addition to countries listed, gold is also produced in Austria, Bulgaria, China, Czechoslovakia, East Germany, Hungary, Indonesia, Rumania, and Thailand, but production data are not available; estimates are included in total. 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 exactly to totals shown because of rounding where estimated figures are included in the detail.

3 Imports into the United States.

4 Estimate.

5 Refinery production.

6 Exports.

7 One year only, as 1953 was first year of commercial production.

8 Output from U.S.S.R. in Asia included with U.S.S.R. in Europe.

9 Purchases. Production may be much greater.

A comprehensive economic study of gold-mining communities in Canada was made by a firm of consulting economists.[11] The study described the nature and scope of the problems facing municipalities dependent on gold mining for their existence and stated that continued Government price subsidies were essential for their survival.

Colombia.—Output of gold in Colombia increased about 14 percent in 1958 to 371,700 ounces. South American Gold & Platinum Co., the largest producer, reported a reserve of 69 million cubic yards of dredging gravel containing a recoverable content of 1.882 grains of crude gold and 0.566 grains of crude platinum a cubic yard together equivalent to 17.7 cents a cubic yard.[12] Six bucketline dredges were in operation during the year. The company lode mine also was active. The underground ore reserve at the end of 1958 was 442,300 mill tons with an average grade of 0.78 ounces of gold a ton, a slight decrease in quantity and grade from the corresponding date in 1957.

The 15-percent export tax imposed in 1957 remained in effect during the year, and most of the gold output was sold to the Banco de la Republica.

Ghana.—Despite the termination of the Government subsidy to marginal mines, output of gold in Ghana increased about 8 percent in 1958 to 852,800 ounces. Following a study of the gold-mining industry by an independent consultant with particular reference to marginal producers, the Government restated its intention to aid the gold-mining industry, including continued assistance to marginal mines. Excellent progress was reported in the training programs begun by the European staffs to help Africans acquire skills needed for the higher technical posts.

The ore reserves were increased at the Ashanti and Ariston mines, but reserves continued to decline at the Bremang and Konongo mines.

Philippines.—Reversing the declining trend of the past 2 years, gold production in the Philippines rose 11 percent in 1958 to 422,800 ounces, the highest level since 1953, and gold regained its position as the leading mineral product in terms of value. Twelve mines, including four copper mines recovering byproduct gold, supplied the production.

Buying of gold on the Manila market continued active by holders of "blocked pesos," and the price was reported to have reached a high of 147 pesos, equivalent to $73.50 an ounce compared with a high of 123 pesos in 1957.

Union of South Africa.—The gold-mining industry of South Africa established another production record with an increase of nearly 4 percent over 1957 to 17.7 million ounces, representing about 44 percent of the estimated world production. The gain in gold output again indicated the continued growth of the new mines in the Orange Free State, and the Far West Rand and Klerksdorp areas of the Transvaal, which greatly offset lower production on the Witwatersrand. A decline in tonnage milled was accompanied by increases of 0.228 dwt. in grade of ore and 1s. 7d. in working cost a ton. About 97 percent of the gold output came from 55 mines that were members of the Transvaal and Orange Free State Chamber of Mines.

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[11] William Lougheed Associates, The Gold Mining Community, April 1958.
[12] South American Gold & Platinum Co., 42nd Annual Report, 1958, p. 6.

Of major significance during the year was the start of large-scale ultradeep mining on the Central Rand at East Rand Proprietory mines, where mining operations were begun at 11,000 feet below surface after several years of planning to overcome the major problems of rock bursts and ventilation. The introduction of longwall stoping and techniques for destressing stope faces have greatly reduced the incidence of bursts; and the uses of high-pressure air and an extensive system of upcast airways in conjunction with larger and more efficient cooling plants has been the major factor in improved ventilation. The mines were reported to circulate 2 million cubic feet of air a minute—10 tons for each ton of ore hoisted.

On the Far West Rand the improved ore grade at Blyvooruitzicht and the remarkable progress in sinking the twin-shaft systems at Western Deep Levels were significant features. Large-scale underground development was started last year at Western Deep. The mine is scheduled to begin mining on the Carbon Leader at about 7,500 feet below surface and continue down dip to at least 12,500 feet, making it the deepest mine as well as the largest gold mine in the world. Spectacular ore developments in the new mines of the Orange Free State have aroused great interest in the area and prompted intensive exploration programs.

One new major mine, Winkelhaak, began producing during the year.

TABLE 15.—Salient statistics of the gold mining industry in the Union of South Africa

[Transvaal Chamber of Mines]

	1949–53 (average)	1954	1955	1956	1957	1958
Ore milled (tons)	58,862,910	62,534,500	65,950,700	67,524,700	[1] 66,114,000	65,542,350
Gold recovered (troy ounces)	[2] 11,629,537	[2] 12,682,328	[2] 14,093,668	[2] 15,373,680	[2] 16,540,817	17,665,739
Gold recovered (dwt. per ton)	3.823	4.068	4.274	4.553	5.000	5.228
Working revenue (gold) £	[3] 134,214,566	158,630,787	177,414,094	[1] 198,499,492	[1] 212,596,791	219,160,693
Working revenue per ton milled	45s.8d.	50s.11d.	53s.10d.	57s.3d.	62s.10d.	65s.9d.
Working cost £	93,590,221	120,435,001	133,161,104	144,763,823	149,871,972	153,826,721
Working cost per ton	31s.5d.	38s.8d.	40s.5d.	42s.11d.	45s.4d.	46s.11d.
Working cost per ounce of gold	166s.6d.	189s.11d.	189s.0d.	188s.4d.	181s.3d.	178s.9d.
Estimated working profit from gold £	40,655,748	38,195,786	44,252,990	48,450,407	57,833,593	61,356,212
Estimated working profit per ton from gold	13s.7d.	12s.3d.	13s.5d.	14s.4d.	17s.6d.	18s.10d.
Premium gold sales £		12,999	233,942	882,368	[1] 927,462	876,712
Uranium and thorium exports £		14,835,344	29,959,589	38,571,195	49,859,496	53,207,263
Estimated uranium profits £		8,105,744	17,558,208	24,662,054	[1] 33,308,195	37,742,059
Dividends £	20,736,126	19,127,166	22,361,887	28,177,343	36,699,373	42,570,991

[1] Revised figure.
[2] Excludes gold produced by nonmembers of Chamber of Mines.
[3] 1£ valued at $4.03 (approx. average) from Jan. 1, 1948, to Sept. 19, 1949; after that date, 1 £ valued at $2.80.

TECHNOLOGY

The trend toward adopting hydrocyclones for classification, thickening, and concentration continued as these machines replaced conventional bowl classifiers in several Canadian gold mills during the year, resulting in appreciable reduction in costs and increased efficiency.

The superior physical properties of some gold alloys, such as gold-chromium-nickel under high-temperature conditions were demonstrated and may lead to expanded use of gold in components of space vehicles, nuclear reactors, and supersonic aircraft. The high cost of gold alloys appears justified in structural applications where reliable high temperature performance of the assembly is of extreme importance.

Improvements in the application of ion exchange principles to extracting gold from cyanide solutions were reported,[13] and a new process was developed using a weak base resin containing a controlled amount of strong-base groups to absorb gold selectively. The gold is eluted with sodium thiocyanate solution and recovered by electrolysis.

A patent was issued for improving the cyanidation treatment of precious metal ores and increasing the recovery of precious metals by passing a low-voltage direct electric current through the leaching bath.[14]

A process was developed[15] for jointly concentrating gold and uranium from low-grade ore by flotation employing fatty acid and xanthate collectors.

Several other articles relating to the mining and treatment of gold ores were published during the year.[16]

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[13] Chemical Trade Journal and Chemical Engineer (London) Vol. 143, No. 3726, p. 1052.
[14] Haugen, O. W., Electrolytic Process for Leaching Precious Metals: U.S. Patent 2,843,538, July 15, 1958.
[15] Gaudin, A. M., and Dasher, J. (assigned to U.S. Government as represented by the Chairman of the Atomic Energy Commission), Process For Concentration of Ores Containing Gold and Uranium: U.S. Patent 2,838,369, June 10, 1958.
[16] McGrath, J. M., Cia. Minera Guadalupe, S. A.: Deco Trefoil, vol. 28, No. 2, March-May 1958, pp. 7–10.
The South African Mining and Engineering Journal, The Theory and Practice of Sorting on S. A. Gold Mines: Vol. 69, No. 3388 (pt. 1) Jan. 17, 1958, pp. 73–81.
Lovitt, E. H., and Skerl, H. C., Geology of the Lovitt Gold Mine, Wenatchee, Wash., Min. Eng. vol. 10, No. 9, September 1958, pp. 963–966.

Graphite

By Donald R. Irving [1] and Betty Ann Brett [2]

WORLD GRAPHITE production in 1958 receded from the all-time high established in 1957, mainly because of a sharp decrease in the output of amorphous graphite in the Republic of Korea, the largest producer. The 1958 total, however, was the second highest on record. Reduced output in Mexico, Madagascar, and Ceylon reflected, in part, the lower demand for graphite in the United States, especially by the steel industry.

TABLE 1.—Salient graphite statistics

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Natural graphite consumed:						
Short tons	27,500	33,000	45,200	40,400	41,000	28,800
Value	$3,932,000	$4,386,800	$6,289,400	$5,920,300	$5,568,000	$3,971,800
Imports:						
Short tons	44,800	40,800	48,800	47,900	41,500	27,100
Value	$2,404,100	$2,281,300	$2,386,600	$2,593,700	$2,106,800	$1,203,100
Exports:						
Short tons	1,600	800	1,400	1,100	1,300	1,200
Value	$187,900	$105,600	$199,400	$159,800	$225,500	$192,800
World production (estimated): Short tons	200,000	185,000	290,000	280,000	405,000	335,000

DOMESTIC PRODUCTION

Domestic graphite was produced in 1958 by Southwestern Graphite Co., Burnet, Tex. (crystalline flake) and Graphite Mines, Inc., Cranston, R.I. (amorphous). Graphite Corporation of America, Chester Springs, Pa., was formed in 1958 and announced plans to produce crystalline flake graphite beginning in 1959.

The output of manufactured (artificial) graphite powder and products came from plants of the following companies: National Carbon Co., Division of Union Carbide 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 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.

[1] Assistant chief, Branch of Ceramic and Fertilizer Materials.
[2] Statistical clerk.

CONSUMPTION AND USES

Reduced demand for graphite by the steel industry accounted for a 30-percent drop in consumption. Although reduced consumption was reported for all uses, four uses—foundry facings, steelmaking, lubricants, and crucibles—accounted for 96 percent of the decrease.

TABLE 2.—Consumption of natural graphite in the United States

Year	Short tons	Value	Year	Short tons	Value
1949–53 (average)	27,459	$3,932,000	1956	40,401	$5,920,300
1954	33,038	4,386,800	1957	41,029	5,568,000
1955	45,245	6,289,400	1958	28,823	3,971,800

TABLE 3.—Consumption of natural graphite in the United States in 1958, by uses

Use	Crystalline flake		Ceylon amorphous		Other amorphous [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Batteries	39	$21,680			1,229	$77,842	1,268	$99,522
Bearings	13	8,158	52	$29,594	58	18,117	123	55,869
Brake linings	309	114,849	236	69,088	149	39,893	694	223,830
Carbon brushes	122	55,935	234	120,039	111	18,712	467	194,686
Crucibles, retorts, stoppers, sleeves, and nozzles	2,538	487,539	23	5,093	2	225	2,563	492,857
Foundry facings	286	44,640	311	61,912	10,905	781,064	11,502	887,616
Lubricants	1,830	414,856	1,416	274,412	1,765	215,456	5,011	904,724
Packings	238	126,219	29	15,864	105	16,182	372	158,265
Paints and polishes			63	9,545	349	47,759	412	57,304
Pencils	279	84,835	533	190,302	749	113,621	1,561	388,758
Rubber	35	15,912			67	8,679	102	24,591
Steelmaking	135	21,894	50	11,128	4,299	385,738	4,484	418,760
Other [2]	110	26,198	31	16,377	123	22,427	264	65,002
Total	5,934	1,422,715	2,978	803,354	19,911	1,745,715	28,823	3,971,784

[1] Includes small quantity of mixtures of natural and manufactured graphite.
[2] Includes adhesives, carbon resistors, catalyst manufacture, chemical equipment and processes, 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, 85–87 percent carbon," $235 per short ton; special mesh, $260; special grade, 99 percent carbon, nominal. Amorphous graphite, Mexican, f.o.b. point of shipment (Mexico), per metric ton, $12 to $18. All of these prices remained unchanged during the year.

FOREIGN TRADE [3]

Imports of graphite into the United States from all major countries of origin were lower in 1958 than in 1957; exports were also lower. Total exports of natural graphite, 1954–56, were: 1954, 798 tons, $105,598; 1955, 1,394 tons, $199,383; 1956, 1,062 tons, $159,792.

TABLE 4.—Graphite (natural and artificial) imported for consumption in the United States

[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
1949–53 (average)	7,608	$1,099,561	163	$16,523	36,854	$1,276,934	188	$11,097	44,813	$2,404,115
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	7,264	997,746	171	34,707	40,370	[1] 1,555,828	83	5,427	47,888	2,593,708
1957										
North America:										
Canada							3	263	3	263
Mexico					25,789	562,836			25,789	562,836
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
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
Africa:										
British East Africa	168	19,081							168	19,081
Madagascar	4,858	527,982							4,858	527,982
Total	5,456	636,684	47	14,870	36,019	1,453,051	8	2,197	41,530	2,106,802
1958										
North America:										
Canada							2	203	2	203
Mexico					19,569	431,274			19,569	431,274
Europe:										
France	76	28,285							76	28,285
Germany, West	391	76,602	17	9,986	418	51,764	18	723	844	139,075
Netherlands	17	3,124							17	3,124
Norway					946	75,443			946	75,443
Switzerland							5	2,196	5	2,196
United Kingdom	(2)	119							(2)	119
Asia:										
Ceylon			84	11,904	1,811	231,019			1,895	242,923
Hong Kong					1,236	27,049			1,236	27,049
Africa:										
British East Africa	94	13,931			56	2,662			150	16,593
Madagascar	2,327	236,819							2,327	236,819
Total	2,905	358,880	101	21,890	24,036	819,211	25	3,122	27,067	1,203,103

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable to earlier years.
[2] Less than 1 ton.

[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 5.—Graphite exported from the United States, 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
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		
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
Europe:						
Denmark	11	1,813				
France	6	1,400				
Netherlands			(1)	630		
United Kingdom	128	20,005			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	902	93,465	167	57,162	280	74,909
1958						
North America:						
Canada	479	45,211	97	24,410	77	6,399
Cuba	28	4,600	5	2,155	10	1,600
Guatemala					1	1,580
Mexico	25	4,116	19	12,685	(1)	660
Panama	13	2,437	3	570		
South America:						
Argentina	11	4,732				
Brazil					55	9,130
Chile			5	1,013		
Colombia			25	5,260	13	3,233
Venezuela	46	9,498	4	820	22	4,940
Europe:						
Austria	5	952				
Czechoslovakia	22	3,423				
Denmark	11	1,834				
France	27	4,658			6	1,040
Italy					(1)	1,790
United Kingdom	95	14,350			29	6,263
Asia:						
India			1	762	11	1,834
Philippines	5	1,175	3	1,939	5	2,551
Saudi Arabia			2	2,783		
Taiwan					5	896
Oceania:						
Australia					1	1,560
Total	767	96,986	164	52,397	235	43,476

[1] Less than 1 ton.

WORLD REVIEW

World production of natural graphite in 1958 (335,000 short tons) was the second highest annual total ever recorded, being exceeded only by the 405,000 short tons (revised upward from 320,000 short tons) reported in 1957.

TABLE 6.—World production of natural graphite, by countries,[1] in short tons[2]

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

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	2,562	2,463	—	—	—	—
Mexico	30,028	24,013	32,342	32,655	25,938	21,564
United States	6,045	(3)	(3)	(3)	(3)	(3)
South America:						
Argentina	95	(4)	2	572	451	[5] 550
Brazil	678	1,008	855	579	890	[5] 880
Europe:						
Austria	18,013	19,184	19,637	20,597	20,857	23,318
Germany, West	8,590	10,448	11,556	12,878	12,554	12,021
Italy	5,128	4,165	2,595	3,262	3,649	4,420
Norway	3,360	3,993	5,970	5,562	6,266	4,905
Spain	428	451	349	331	304	[5] 550
Sweden	24	—	309	441	822	[5] 1,100
U.S.S.R.	(4)	(4)	(4)	(4)	[5] 50,000	[5] 50,000
Yugoslavia	151	—	1,033	—	1,102	992
Asia:						
Ceylon (exports)	11,774	8,654	11,064	10,312	9,223	6,342
Hong Kong	[6] 220	2,061	1,722	2,734	3,703	3,680
India	1,615	1,657	1,807	—	—	—
Japan	5,127	4,515	3,441	3,757	5,272	3,956
Korea, Republic of	25,396	15,344	99,228	67,367	162,703	103,807
Taiwan (Formosa)	154	—	—	2,285	987	915
Africa:						
Kenya	49	347	241	619	1,056	739
Madagascar	16,191	13,284	17,443	17,451	16,989	[5] 14,330
Morocco:						
Northern zone	8	—	129	137	—	—
Southern zone	87	—	—	—	—	—
Mozambique	77	—	—	—	—	—
South-West Africa	1,644	115	1,011	—	—	—
Tanganyika	10	—	—	26	—	—
Union of South Africa	310	1,396	1,829	1,862	1,750	875
Oceania:						
Australia	91	78	24	11	—	—
World total (estimate) [1,2]	200,000	185,000	290,000	280,000	405,000	335,000

[1] In addition to countries listed, graphite has been produced in China, Czechoslovakia, 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 exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Production included in total; Bureau of Mines not at liberty to publish.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Estimate.
[6] Average for 1 year only, as 1953 was first year of commercial production.

Ceylon.—The downward trend of graphite production in Ceylon that began in 1956 continued in 1958. Producers held large stocks of graphite for which there was no market. Ceylon wage regulations were more favorable to mechanized mines, and the number of small mines, worked entirely by hand labor, was declining. A larger proportion of the exports has been the higher priced grades. Representatives of the graphite producers were seeking a reduction in the export duty to stimulate graphite purchases by consuming countries. Ceylon graphite was exported mainly to the United States, the United Kingdom, and Japan.

TABLE 7.—Graphite exported from Ceylon, 1957–58 by countries of destination, in short tons[1]

[Compiled by Corra A. Barry]

Country	1957	1958	Country	1957	1958
North America:			Asia:		
Canada	185	56	India	385	332
United States	3,175	2,077	Japan	2,759	1,238
Europe:			Pakistan	99	32
France	160	247	Oceania:		
Germany, West	348	158	Australia	360	402
Netherlands	34	40	Other countries	20	33
United Kingdom	1,698	1,727			
			Total	9,223	6,342

[1] Compiled from Ceylon Customs Returns.

TABLE 8.—Exports of graphite from Ceylon to the United States, by grades, in 1958[1]

Grade	Short tons	Percent of total	Value per ton
97 percent C or higher	475	29.6	$179.05
90–96 percent C	1,005	62.6	138.95
Less than 90 percent C	125	7.8	124.32
Total	1,605	100.0	149.68

[1] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 5, May 1959, p. 26.

Czechoslovakia.—Discovery of a new deposit in the south Bohemia graphite area was reported.[4]

France.—Quantitative import restrictions on graphite from member countries of the Organization for European Economic Cooperation were removed.[5]

Germany, West.—The Graphitwerken Kropfmuhl, A.G., Munich, manufactured 20 tons of reactor-grade graphite for delivery to the Junta de Energia Nuclear of Spain (Spanish Atomic Energy Commission).[6]

Hong Kong.—Local brick plants were mixing lower grade amorphous graphite (from 50 to 80 percent carbon) with coal to produce more evenly burning fires. Hong Kong graphite production in 1958 included all graphite containing 50 percent or more carbon; production statistics for previous years included only graphite containing 80 percent or more carbon.[7]

India.—Graphite deposits were reported in the Neyyur area and Kusinchankulam, Tirunveli district, South India.[8]

Kenya.—Problems encountered in achieving commercial production at the graphite mine of Shah Vershi Devshi and Co., Ltd., Thika, were described.[9] The mine is in the Southern Kitui district, 175 miles

[4] Bureau of Mines, Mineral Trade Notes: Vol. 46. No. 6, June 1958, p. 39.
[5] Chemical Age (London), Some Import Restrictions Removed by France: Vol. 81, No. 2060, Jan. 3, 1959, p. 21.
[6] Chemical Trade Journal and Chemical Engineer (London), Germany Making Reactor-Grade Graphite: Vol. 144, No. 3735, Jan. 2, 1959, p. 44.
[7] U.S. Consulate, Hong Kong, State Department Dispatch 721: Mar. 31, 1959, p. 2.
[8] Mining Journal (London), vol. 250, No. 6392, Feb. 21, 1958, p. 214.
[9] Mining Journal (London), Graphite Production in Kenya: Vol. 251, No. 6436, Dec. 26, 1958, p. 720.

from Nairobi on the road to Mombasa. The deposit was discovered in 1950 and production began in 1953. Originally, water for beneficiation had to be brought in drums from the Athi River, 25 miles away, orders for repair parts for machinery took 2 or 3 days to reach Thika by automobile, a distance of 165 miles over bad roads, and during the rainy season the road from the plant to the railway station at Kibwezi frequently was flooded. Conditions were improved by moving the plant to the Tiva River, by constructing a new road that shortened the distance from the mine to the plant from 12 to 8 miles, and by providing radio-telephone communications between the mine and Thika. The Kenya Government built a bridge over the flood area of the Tiva River and improved the road to Kibwezi. The company employed 250 Africans and 8 Asians in 1958, and was producing at the rate of 100 tons of graphite per month. Grades of graphite ranged from 50 to 98 percent carbon, and from fine powder to large flake. It was reported that production could be increased to 2,000 tons a year if demand warranted.

Graphite deposits discovered north of Nanyuki were under study.[10]

Korea, Republic of.—Exports of graphite in 1957, virtually all to Japan, were 154,682 tons of amorphous valued at US $2,807,598 and 698 tons of crystalline valued at US$64,974.[11] The value of graphite exports during 1957 was exceeded among minerals only by that of tungsten (US$3.6 million). Factors aiding in increasing graphite exports were the granting of a 30 percent reduction in rail freight charges for amorphous graphite by the Ministry of Transportation,[12] and the exportation of some anthracite coal as amorphous graphite because exportation of anthracite coal was banned while that of amorphous graphite was permitted.

Estimated graphite reserves in South Korea were 3.3 million short tons of amorphous graphite containing 75 percent carbon, and 1.8 million tons of crystalline flake containing 75 to 87 percent carbon.[13] Principal deposits of amorphous graphite (85 percent C and up) were the Hamchang mine, Kyongsang Pukdo; the Wolmyong, Bougmyong, and Munbwa mines, Chungchong Pukdo; and the Kangnung mine, Kangwon Do. Principal deposits of crystalline graphite (75 to 87 percent C) were the Oryudong and Shiheung mines, Kyonggi Do, and the Namcheun mine, Cholla Namdo.[14] A modern graphite mill, financed by the United Nations Korean Reconstruction Agency (UNKRA), was completed in 1958 at the Sihung graphite mine in Kyonggi Do. The new mill had a capacity of 2,400 tons of crystalline graphite a year, and new markets were being sought for the additional potential output.

Madagascar.—The ratio of coarse flake (flake) to fine flake (fines) graphite produced in Madagascar was only 40 : 60 in the first 6 months of 1958, and has declined progressively since 1955 when it was 66 : 34.[15]

[10] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 31.
[11] Work cited in footnote 10.
[12] U.S. Embassy, Seoul, Korea, State Department Dispatch 624: Mar. 31, 1958, p. 2.
[13] U.S. Embassy, Seoul, Korea, State Department Dispatch 70: Aug. 9, 1958, p. 8.
[14] Work cited in footnote 13, p. 5, enclosure 1.
[15] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 29: Aug. 12, 1958, p. 1; Dispatch 75, Sept. 12, 1958, p. 1.

Pakistan.—Graphite was discovered in Chitral State, about 1 mile northeast of Shah-Salim, and ¼ mile west of Momi.[16]

Sweden.—Graphite deposits in the Masungsbyn area of Norrbotten Province, including Vittangi and Soppero, were estimated to contain 110 million short tons of ore containing 40 percent graphite. The Norrbottens Järnverk AB was reported to have produced a concentrate with 85 percent carbon from the ore.[17]

United Kingdom.—The nuclear graphite plant of Anglo-Great Lakes Corp., Ltd., Newcastle, England, began production in the spring of 1958.[18]

TECHNOLOGY

The interlayer spacings of Ceylon natural graphite, four manufactured graphites, and kish (flaky carbon particles resembling natural graphite that form on the surface of molten iron during the manufacture of steel) were compared.[19] Other articles on the structure of graphite were published.[20]

Crystalline flake graphite powder was pressed at 3,000 atmospheres to produce block graphite with a density of 2.07 grams per cubic centimeter.[21] Iron graphite mixtures containing 2.5 to 20 percent graphite, made by vacuum sintering and high pressure techniques, were used to produce porous bearing materials and friction materials (brake linings).[22] An expendable graphite mold suitable for casting molten titanium was described.[23]

Graphite was brazed to graphite and other materials, using a commercially available brazing alloy at temperatures of 1,800°–1,850° C.[24]

Large, pure, single crystals of graphite were prepared by the thermal decomposition of pure aluminum carbide at temperatures above 2,000° C.[25]

Some properties of graphite were reported.[26]

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[16] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 5, May 1958, p. 30.

[17] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 2, February 1959, pp. 32–33.

[18] Chemical Age (London), vol. 80, No. 2054, Nov. 22, 1958, p. 855.

[19] Walker, P. L., Jr., and Imperial, George, Structure of Graphites: Nature, vol. 180, No. 4596, Nov. 30, 1957, pp. 1184–1185.

[20] Yamazaki, Masatoshi, Electronic Band Structure in Graphite: Jour. Chem. Phys., vol. 26, No. 4, April 1957, pp. 930–934.

Roberts, L. E., Harper, E. A., and Small, C. T., Microstructure of Graphite: Atomic Energy Res. Estab. (Great Britain) Rept. C/R–882, 1958, 15 pp.

[21] Chemical Engineering, New Processes and Technology: Vol. 65, No. 9, May 5, 1958, p. 129.

[22] Kuz'min, V., and Myuyr, V., [Powder Metallurgy]: Promyshlenno-Ekonomi-Chaskaya Gazeta, No. 40(340), Apr. 2, 1958, p. 4. Scientific Inf. Rept., PB 131891–T3, Office of Tech. Services, U.S. Dept. of Commerce, Aug. 8, 1958, p. 81.

[23] Antes, H. W., Norton, J. T., and Edelman, R. E., Foundry Characteristics of a Rammed Graphitic Mold Material for Casting Titanium: Frankford Arsenal Rept. R–1432, January 1958, 27 pp.

[24] Aves, R., and Others, High Temperature Graphite Joints: Atomic Energy Res. Estab. (Great Britain), Rept. R/M165, April 1958, 3 pp.

[25] Foster, L. M., Long, G., and Stumpf, H. C., Production of Graphite Single Crystals by the Thermal Decomposition of Aluminum Carbide: Am. Mineral., vol. 43, No. 3–4, March–April 1958, pp. 285–296.

[26] Davidson, H. W., and Losty, H. H. W., Plasticity in Graphite: Nature, vol. 181, No. 4615, Apr. 12, 1958, pp. 1057–1059.

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Jefferson, T. B., Witzell, O. W., and Sibbitt, W. L., Thermal Conductivity of Graphite-Silicone-Oil and Graphite-Water Suspensions: Ind. Eng. Chem., vol. 50, No. 10, October 1958, pp. 1589–1592.

Lloyd, R. C., and Richey, C. R., Variation of Graphite Diffusion Length With Temperature: General Electric Co., Hanford Atomic Products Operation, Richland, Wash., Contract

Applications of manufactured graphite in nuclear reactors[27] and as a high temperature material in missiles and rockets[28] were discussed.

Reports dealing with manufactured graphite were declassified by the Atomic Energy Commission.[29]

Impurities are removed from natural graphite by heating in gases capable of forming volatile compounds with the impurities, according to a German patent.[30] Silica is removed by heating in hydrofluoric acid; iron and other metallic oxides are removed by heating in chlorine gas which may contain 1 to 5 percent by volume of carbon tetrachloride as a catalyst. About 1 percent of sodium chloride may be added as solid catalyst to the graphite and is removed by evaporation at 1,000° C. Other foreign patents reported during the year were for a flux to solder graphite-to-graphite and graphite-to-metal joints[31] and for the use of graphite in a compound for automobile friction discs and brake bands.[32]

W-31-109-eng-52, May 1957, 11 pp.; U.S. Govt. Res. Repts., Off. Tech. Services, U.S. Dept. of Commerce, vol. 30, No. 1, July 11, 1958, p. 46.

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Wagner, Paul, and Driesner, A. R., The Friction Coefficients of Graphite at Extreme Temperatures: Los Alamos Scientific Lab. of the Univ. of California, Los Alamos, N. Mex., Contract W-7405-eng-36, January 1958, 19 pp.; U.S. Govt. Res. Repts., Off. Tech. Services, U.S. Dept. of Commerce, vol. 29, No. 3, Mar. 14, 1958, p. 171.

[27] Goncharov, V. V., [Graphite in Reactor Construction]: Atomnaya Engergiya (Moscow), vol. 3, No. 11, November 1957, pp. 398–408. Consolidated Translation Survey, July 25, 1958, p. 106.

[28] Hove, J. E., Graphite as a High Temperature Material: Trans. Metallurgical Soc., AIME, vol. 212, No. 1, February 1958, pp. 7–13.

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[29] Boyd, G. E., Curtis, R. E., and Johnston, W. H., Graphite Purity Research Program: Univ. Chicago Metallurgical Lab., Chicago, Ill., Contract W-7401-eng-37, December 1943, 70 pp.; U.S. Govt. Res. Repts., Off. Tech. Services, U.S. Dept. of Commerce, vol. 30, No. 1, July 11, 1958, p. 43.

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Kanter, M. A., Impregnation of Graphite With Uranium Compounds for Use as Fuel Rod Materials: Argonne Nat. Lab., Lemont, Ill., Contract W-31-109-eng-38, February 1948, 33 pp.; U.S. Govt. Res. Repts., Off. Tech. Services, U.S. Dept. of Commerce, vol. 30, No. 1, July 11, 1958, p. 42.

Kraig, H. I., Corrosion Tests: Silver Loaded Graphite, Babbitt Loaded Graphite, II: Oak Ridge Nat. Lab., Oak Ridge, Tenn., Contract W-7405-eng-26, March 1952, 6 pp.; U.S. Govt. Res. Repts., Off. Tech. Services, U.S. Dept. of Commerce, vol. 29, No. 5, p. 299.

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[30] Ulrich, Helmut (assigned to Graphitwerk Krop-fmühl A-G), [Purification of Natural Graphite]: German Patent 924,690, Mar. 7, 1955; Chem. Abs., vol. 52, No. 9, May 10, 1958, p. 7636d.

[31] Kolenko, E. A., [Flux for Soldering Graphite]: U.S.S.R. Patent 102,948, June 25, 1956; Chem. Abs., vol. 52, No. 8, Apr. 25, 1958, p. 6738.

[32] Blagin, V. I., Kotava, N. V., Kaplanskaya, T. N., and Klement'ev, K. I., [Friction Material]: U.S.S.R. Patent 106,755, Oct. 25, 1957; Chem. Abs., vol. 52, No. 8, Apr. 25, 1958, p. 6674.

Patents were issued during the year for an electrostatic separation method applicable to graphite,[33] a refractory coating for graphite molds,[34] an improved method of increasing the density and imperviousness of graphite,[35] a process of preparing a uranium-impregnated graphite body,[36] and for the use of graphite in an erasable and nonsmudging drawing in,[37] a plastic refractory material for jacketing chemical processing equipment,[38] sintered copper friction elements,[39] and an improved nickel catalyst.[40]

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[33] Johnson, H. B. (assigned to Quaker Oats Co.), Electrostatic Separation Method: U.S. Patent 2,839,189, June 17, 1958.

[34] Stoddard, S. D. (assigned to the United States of America as represented by the Chairman of the Atomic Energy Commission), Refractory Coating for Graphite Molds: U.S. Patent 2,840,480, June 24, 1958.

[35] Bennett, G. A. (assigned to the United States of America as represented by the Chairman of the Atomic Energy Commission), Preparation of Impervious Graphite by Liquid Phase Impregnation: U.S. Patent 2,837,412, June 3, 1958.

[36] Kanter, M. A. (assigned to the United States of America as represented by the Chairman of the Atomic Energy Commission), Process of Preparing Uranium-Impregnated Graphite Body: U.S. Patent 2,835,608, May 20, 1958.

[37] Glaser, H. W. (assigned to the Western Union Telegraph Co.), Aqueous Graphite-Polyvinal Alcohol Ink Composition: U.S. Patent 2,833,736, May 6, 1958.

[38] Weidman, V. W. (assigned to E. I. du Pont de Nemours & Co.), Plastic Composition: U.S. Patent 2,836,500, May 27 1958.

[39] Batchelor, C. S., and Steck, R. E. (assigned to Raybestos-Manhattan, Inc.), Sintered Copper Friction Elements Containing a Mineral Filler: U.S. Patent 2,818,634, Jan. 7, 1958.

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Gypsum

By Leonard P. Larson [1] and Nan C. Jensen [2]

BUOYED by the high level of building activity in the fall of 1958, the domestic gypsum industry reached a near-record high in the output of crude gypsum and some of its manufactured products.

TABLE 1.—Salient statistics of the gypsum industry

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Active establishments [1]	89	86	83	88	84	85
Crude gypsum: [2]						
Mined......thousand short tons..	8,035	8,996	10,684	10,317	9,195	9,600
Value......thousands..	$22,230	$27,384	$33,938	$34,099	$29,871	$32,495
Imported...thousand short tons..	3,104	3,368	3,977	4,346	4,334	4,049
Apparent supply......do....	11,139	12,364	14,661	14,663	13,529	13,649
Calcined gypsum produced:						
Thousand short tons	6,921	7,618	8,848	8,608	7,801	8,122
Value......thousands..	$59,612	$76,171	$88,576	$91,336	$83,455	$91,402
Gypsum products sold: [3]						
Uncalcined uses:						
Thousand short tons	2,420	2,746	2,938	3,259	3,139	3,471
Value......thousands..	$8,783	$10,592	$11,435	$13,173	$13,120	$14,018
Industrial uses:						
Thousand short tons	255	250	299	334	319	250
Value......thousands..	$4,764	$5,384	$6,337	$7,310	$6,998	$5,850
Building uses: Value......do....	$200,352	$256,177	$301,551	$301,169	$280,977	[4] $309,202
Total value......do....	$213,899	$272,153	$319,323	$321,652	$301,095	$329,070
Gypsum and gypsum products:						
Imported for consumption thousands..	$3,747	$5,378	$7,276	$8,546	$8,514	$7,865
Exported......do....	$1,555	$1,601	$1,348	$1,216	$1,345	$2,465
World: Production thousand short tons..	[5] 25,660	[5] 30,820	[5] 35,370	[5] 36,310	[5] 36,430	36,660

[1] Each mine, calcining plant, or combination mine and plant is counted as 1 establishment.
[2] Excludes byproduct gypsum.
[3] Made from domestic, imported, and byproduct gypsum.
[4] Excludes tile in 1958.
[5] Revised figure.

DOMESTIC PRODUCTION

Crude.—Output of crude gypsum from mines in the United States totaled about 9.6 million tons, an increase of 4 percent over that of 1957. At the midpoint of the year, production was 2 percent below that reported for the corresponding period of the previous year.

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[1] Commodity specialist.
[2] Supervisory statistical assistant.

During the third and fourth quarters the production rate increased steadily and in the fourth quarter exceeded the volume of the same quarter of 1957 by 16 percent, 5 percent below the record fourth quarter of 1955. Gypsum was mined in 21 States, 13 of which reported increases for the year. Fifty-four percent of the total gypsum was mined in four States: California, 15 percent; Michigan, 14; Texas, 13; and Iowa, 12. More than half of California's crude production was sold for agricultural use; more than half of the crude output of the other three States was calcined. Of the 62 mines producing in 1958, 44 were open pit, 15 underground, and 3 combinations of the 2 types.

TABLE 2.—Crude gypsum mined in the United States, by States

State	1957			1958		
	Active mines	Short tons (thousands)	Value (thousands)	Active mines	Short tons (thousands)	Value (thousands)
California	12	1,268	$2,995	12	1,423	$3,184
Colorado	(1)	(1)	(1)	5	103	341
Iowa	4	1,124	3,773	4	1,230	4,491
Michigan	4	1,386	4,823	4	1,331	4,824
Nevada	(1)	(1)	(1)	3	686	2,306
New York	5	864	3,749	5	834	3,869
South Dakota	1	13	53	1	12	49
Texas	7	1,043	3,343	6	1,240	4,120
Washington	1	6	18	(1)	(1)	(1)
Wyoming	(1)	(1)	(1)	1	6	19
Other States [2]	27	3,491	11,117	21	2,735	9,292
Total	61	9,195	29,871	62	9,600	32,495

[1] Included with "Other States."
[2] Includes the following States to avoid disclosing individual company confidential data: Arkansas, Idaho, Louisiana, Virginia, Washington (1958 only), and Wyoming (1957), 1 mine each; Arizona, Indiana, Kansas, Montana, Ohio, and Utah, 2 mines each; Colorado (1957) and Nevada (1957), 3 mines each; and Oklahoma, 4 mines.

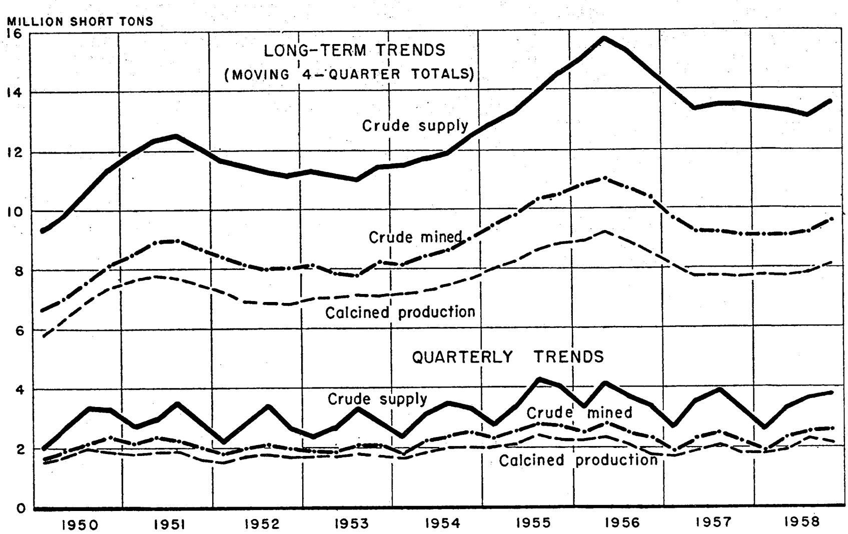

FIGURE 1.—Trends of new crude supply, domestic crude mined, and production of calcined gypsum, 1950–58, by quarters.

Calcined.—Calcined gypsum was produced from domestic and imported ores in the United States at 57 plants having 267 kettles and other pieces of calcining equipment. Oil, natural gas, propane, and coal were the fuels used to supply the heat necessary for converting gypsum to the calcined form in which most gypsum is used. Production of calcined gypsum in the United States in 1958 totaled 8.1 million tons, 4 percent above the output in 1957, and was valued at $91.4 million.

TABLE 3.—Calcined gypsum production in the United States, by States

State	1957					1958				
	Active plants	Short tons (thousands)	Value (thousands)	Calcining equipment		Active plants	Short tons (thousands)	Value (thousands)	Calcining equipment	
				Kettles	Other [1]				Kettles	Other [1]
California	6	672	$6,659	18	12	6	710	$6,883	21	10
Iowa	4	715	7,341	21	4	4	789	8,844	20	4
Michigan	4	518	5,190	20	3	4	511	5,673	17	4
New York	7	[2] 551	[2] 6,046	24	5	7	1,153	13,556	24	7
Texas	5	[3] 847	[3] 9,763	30	--------	5	798	9,742	30	--------
Other States [4]	31	4,498	48,456	97	39	31	4,161	46,704	94	36
Total	57	7,801	83,455	210	63	57	8,122	91,402	206	61

[1] Includes rotary and beehive kilns, grinding-calcining units, Holo-Flites, and Hydrocal cylinders.
[2] Western New York only; eastern New York included with "Other States" (1957).
[3] Includes Louisiana (1957).
[4] Comprises States and number of plants as follows: Arizona, 1 plant; Colorado, 3; Connecticut, 1; Florida, 1; Georgia, 1; Indiana, 3; Kansas, 2; Louisiana, 2; Maryland, 1; Massachusetts, 1; Montana, 1; Nevada, 2; New Hampshire, 1; New Jersey, 2; Ohio, 2; Oklahoma, 1; Pennsylvania, 1; Utah, 2; Virginia, 2; and Washington, 1.

Mine and Products-Plant Development.—Bestwall Gypsum Co. began constructing a new $7.5 million gypsum board, lath, and plaster plant at Brunswick, Ga. Designed capacity of the plant, scheduled for completion in late 1959, was 300 million square feet of gypsum board and lath products a year.[3] Bestwall also planned to construct a plant at the Wilmington Marine Terminal, Wilmington, Del., to process 200,000 tons of crude ore from its deposits in Nova Scotia or from the Dominican Republic and to manufacture 150 million square feet of gypsum board and lath products annually.[4]

In August, the United States Gypsum Co. authorized construction of a new gypsum-products plant at Sperry, Iowa. When completed in 1960, the plant will help supply the growing markets in eastern Iowa, northern Missouri, Illinois, Wisconsin, and Minnesota. Four new warehouses were completed, as part of the company's 1958 expansion program, and plans were underway for several others.[5]

At its new Tawas City, Mich., quarry, National Gypsum Co. began limited production of gypsum which was transported by lake ship to its new Waukegan, Ill., gypsum plant, scheduled for operation by mid-1959. Tawas gypsum also will be shipped to its future plant at Lorain, Ohio.

[3] Chemical and Engineering News, vol. 36, No. 35, Sept. 1, 1958, p. 34.
[4] Wall Street Journal, Bestwall Gypsum Plans Plant at Wilmington, Del.: Vol. 152, No. 123, Dec. 23, 1958, p. 15.
[5] Wall Street Journal, vol. 152, No. 49, Sept. 9, 1958, p. 29.

TABLE 4.—Gypsum products (made from domestic, imported, and byproduct crude gypsum) sold or used in the United States, by uses

Products	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Uncalcined:				
Portland cement retarder	2,273	$9,574	2,416	$10,213
Agricultural gypsum	831	3,121	1,021	3,365
Other uses [1]	35	425	34	440
Total	3,139	13,120	3,471	14,018
Calcined:				
Industrial:				
Plate-glass and terra-cotta plasters	67	986	48	723
Pottery plasters	46	952	41	870
Orthopedic and dental plasters	11	400	9	366
Industrial molding, art, and casting plasters	85	1,675	75	1,575
Other industrial uses [2]	110	2,985	77	2,316
Total	319	6,998	250	5,850
Building:				
Plasters:				
Base-coat	1,412	22,781	1,321	22,154
Sanded	617	14,465	578	13,950
To mixing plants	3	43	3	50
Gaging and molding	141	2,638	132	2,548
Prepared finishes	13	1,012	13	1,071
Roof-deck	469	7,363	404	6,491
Other [3]	22	2,002	24	2,222
Keene's cement	41	1,045	43	1,098
Total	2,718	51,349	2,518	49,584
Prefabricated products [4]	[5] 5,982	229,628	[5] 6,459	259,618
Total building		280,977		309,202
Grand total, value		301,095		329,070

[1] Includes uncalcined gypsum for use as filler and rock dust, in brewer's fix, in color manufacture, and for unspecified uses.
[2] Includes dead-burned filler, granite polishing, and miscellaneous uses.
[3] Includes joint filler, patching, painter's, insulating, and unclassified building plasters.
[4] Excludes tile in 1958.
[5] Includes weight of paper, metal, or other materials.

Verde Gypsum Co., Inc., Phoenix, Ariz., completed mine installations and began shipping agricultural gypsum to markets in Phoenix and central Arizona.[6]

CONSUMPTION AND USES

Outlays for new construction, both private and public, in the United States increased 2 percent from about $48.12 billion in 1957 to $48.98 billion in 1958, principally because expenditures for residential building and highway construction increased. New construction in terms of physical volume (expenditures adjusted for price changes), continued at about the same as in 1956 and 1957. As in the 1954 recovery, residential construction contributed to the expansive influence.[7]

Consumption of most gypsum products followed closely the pattern established by residential construction. Activity in the industry remained low until about middle of the second quarter when it recovered

[6] Rock Products, vol. 61, No. 2, February 1958, p. 68.
[7] Construction Review, vol. 5, No. 3, March 1959, 54 pp.

rapidly. By the closing months of the year most gypsum products were consumed in near-record quantities. Architectural changes in the design of new homes were reflected in the increased use of wallboard for interior construction. In each year since 1954 the use of this material increased 18, 15, 7, and 26 percent, respectively, over 1954. Base-coat plaster, on the other hand, declined almost as rapidly. Except 1955, when the tonnage of base-coat plaster sold or used was 5 percent over 1954, the use of base-coat plaster has declined each year by 8, 17, and 23 percent, compared with 1954.

STOCKS

Producers reported stocks of crude gypsum totaling 2.2 million short tons on hand December 31, 1958, compared with 2.3 million tons on the same date of each of the 2 preceding years.

TABLE 5.—Prefabricated products sold or used in the United States

	1957			1958		
	Thousand square feet	Short tons (thousands) [1]	Value (thousands)	Thousand square feet	Short tons (thousands) [1]	Value (thousands)
Lath:						
3/8-inch [2]	2,231,799	1,675	$56,738	2,121,627	1,593	$55,564
1/2-inch	22,007	23	672	32,994	33	1,033
Total	2,253,806	1,698	57,410	2,154,621	1,626	56,597
Wallboard:						
1/4-inch	199,498	130	6,250	141,681	79	4,290
3/8-inch [3]	1,836,752	1,436	62,433	2,001,352	1,530	69,868
1/2-inch	2,157,610	2,204	85,639	2,748,830	2,795	111,333
5/8-inch	109,527	147	6,002	159,067	208	8,862
Total	4,303,387	3,917	160,324	5,050,930	4,612	194,353
Sheathing	131,655	138	5,345	166,273	173	6,710
Laminated board	[4] 1,299	2	84	[4] 1,482	2	94
Formboard	50,498	53	2,152	44,034	46	1,864
Tile [5]	31,244	174	4,313	(6)	(6)	(6)
Grand total	6,771,889	5,982	229,628	7,417,340	6,459	259,618

[1] Includes weight of paper, metal, or other materials.
[2] Includes a small quantity of 1/4-inch lath.
[3] Includes a small quantity of 5/16-inch wallboard.
[4] Area of component board and not of finished product.
[5] Includes partition, roof, floor, soffit, shoe, and all other gypsum tiles and planks.
[6] Figures withheld to avoid disclosing individual company confidential data.

PRICES

According to reports from producers, the average value of crude gypsum mined in the United States in 1958 was $3.38 per ton compared with $3.25 in 1957 and $3.31 in 1956. Portland cement retarder rose 2 cents a ton; the average value of agricultural gypsum dropped 46 cents. The average value of industrial and building plasters increased by 7 and 4 percent, respectively. Wallboard and lath also increased in average values; other prefabricated gypsum products declined.

Based on 1947–49 averages equaling 100, prices of gypsum products, as reported by the U.S. Department of Labor and the U.S. De-

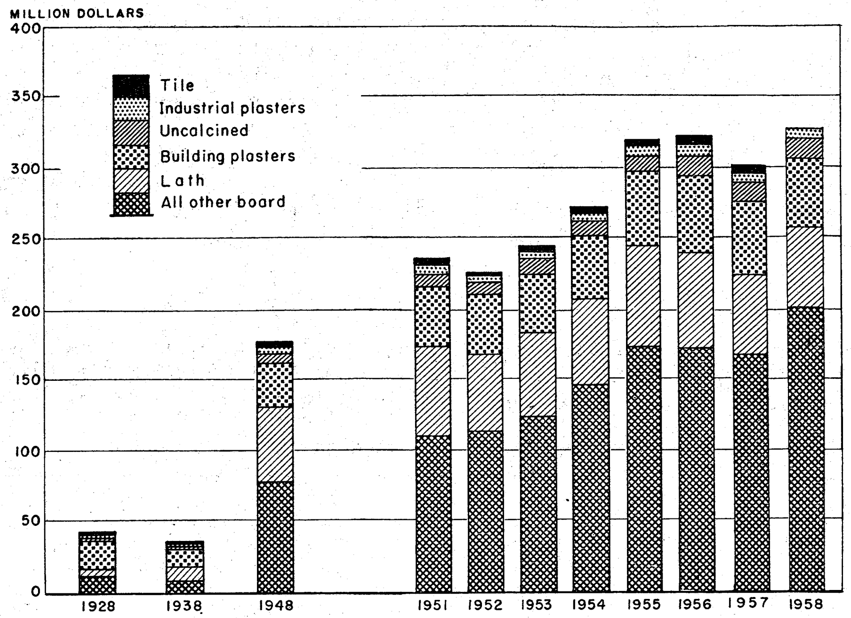

FIGURE 2.—Value of gypsum products sold or used in 1928, 1938, 1948, and 1951–58, by uses.

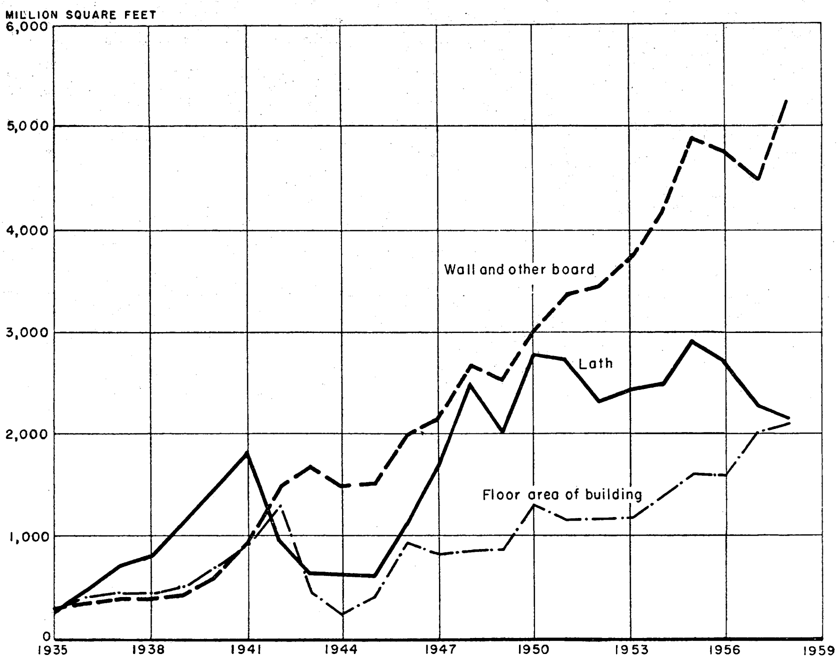

FIGURE 3.—Trends in sales of gypsum lath and wallboard and other boards (including wallboard, laminated board in terms of component board, formboard, and sheathing), compared with Dodge Corp. figures on combined floor area of residential and nonresidential buildings, 1935–58.

partment of Commerce, increased 5 percent during the year from 127.1 reported in January 1958 to 133.1 in January 1959. The indexes for lath and wallboard increased 4 percent during the year: Lath, 123.8 to 128.6, and wallboard, 124.9 to 130.4.

FOREIGN TRADE [8]

Imports of crude gypsum into the United States declined 7 percent from 4.3 million short tons in 1957 to 4 million tons in 1958. Canada supplied 2.9 million tons, 21 percent of the total U.S. supply.

TABLE 6.—Gypsum and gypsum products imported for consumption in the United States

[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			
1949–53 (average)	3,104,346	$3,408,202	879	$27,695	1	$162	$117,154	$194,087	$3,747,300
1954	3,368,133	[2] 4,878,405	684	[2] 25,438	11	433	[2] 210,503	[2] 262,931	[2] 5,377,710
1955	3,977,105	[2] 6,298,410	937	32,674	1	834	[2] 346,357	[2] 597,340	[2] 7,275,615
1956	4,346,135	[2] 7,814,223	1,146	39,333	------	------	[2] 415,973	[2] 276,590	[2] 8,546,119
1957	4,334,467	[2] 7,570,671	870	[2] 33,043	------	------	[2] 577,273	[2] 333,510	[2] 8,514,497
1958	4,048,735	6,865,577	787	32,680	------	------	611,726	354,962	7,864,945

[1] Includes imports of jet manufactures, which are believed to be negligible.
[2] Data known to be not comparable with other years.

TABLE 7.—Crude gypsum (including anhydrite) imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
North America:				
Canada	[1] 3,691	[1] $6,508	2,879	$4,628
Dominican Republic	57	152	39	106
Jamaica	167	537	668	1,712
Mexico	419	374	459	414
Total	4,334	7,571	4,045	6,860
Europe: United Kingdom	(2)	(2)	4	6
Grand total	4,334	[3] 7,571	4,049	6,866

[1] Revised figure.
[2] Revised to none.
[3] Data known to be not comparable with 1958.

[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 8.—Gypsum and gypsum products exported from the United States

[Bureau of the Census]

Year	Crude, crushed, or calcined		Plasterboard, wallboard, and tile		Other manufactures n.e.c.[1] (value) (thousands)	Total value (thousands)
	Short tons (thousands)	Value (thousands)	Square feet (thousands)	Value (thousands)		
1949–53 (average)	22	$554	31,565	$877	$124	$1,555
1954	22	762	20,969	689	150	1,601
1955	23	738	8,687	412	198	1,348
1956	21	711	7,027	364	141	1,216
1957	24	763	8,867	520	62	1,345
1958	29	921	(1)	(1)	1,544	2,465

[1] Effective Jan. 1, 1958, plasterboard, wallboard, and tile not separately classified, included in "gypsum manufactures, n.e.c."

WORLD REVIEW

NORTH AMERICA

Canada.—The two largest producers, Nova Scotia and Ontario, shipped 3.8 million and 400,000 short tons, respectively. The remainder of the shipments originated in Manitoba (183,708 tons), New Brunswick (93,249 tons), British Columbia (49,422 tons), and Newfoundland (29,465 tons). Eight companies reported mining at 13 locations. Eighty percent of their output was exported to the United States. Canada imported 92,139 tons of crude gypsum, mainly from Mexico for use in British Columbia. Exports of finished gypsum products amounted to only 23 short tons in 1957; imports totaled 17,424 tons.[9]

TABLE 9.—Output of gypsum products in Canada

[Canada Department of Mines and Technical Surveys, Ottawa]

Product	1956		1957	
	Quantity	Value [1] (thousands)	Quantity	Value [1] (thousands)
Wallboard .... thousand square feet	301,731	Can$11,779	304,591	Can$12,004
Lath .... do	372,262	11,168	322,402	9,744
Hard wall plasters .... thousand short tons	234	4,874	185	3,912
Other plasters .... do	63	1,641	85	2,285
All other products [2]		1,811		1,682
Total		31,273		29,627

[1] Selling value at works.
[2] Includes tile and blocks, and so forth.

[9] Dominion Bureau of Statistics, The Gypsum Industry 1957: Ottawa, Canada, 1958, 13 pp.

TABLE 10.—World production of gypsum, by countries,[1] in thousand short tons[2]

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

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada [3]	3,650	4,184	4,540	4,900	4,706	3,975
Cuba	[4] 26	[4] 33	[4] 35	24	[4] 45	[4] 45
Dominican Republic	16	29	64	84	80	84
Guatemala	----------	----------	----------	----------	7	17
Jamaica	40	186	92	140	212	672
United States	8,035	8,996	10,684	10,316	9,195	9,600
Total [1] [4]	11,831	13,538	15,525	15,574	14,355	14,503
South America:						
Argentina	152	164	132	193	169	[4] 165
Brazil	39	83	178	172	121	[4] 121
Chile	71	[4] 83	[4] 83	[4] 77	[4] 77	[4] 77
Colombia	5	17	24	55	55	66
Peru	45	[4] 65	72	70	70	70
Venezuela	2	----------	----------	----------	----------	----------
Total [1] [4]	314	412	489	567	492	499
Europe:						
Austria [3]	178	404	455	499	579	597
Czechoslovakia	(5)	179	233	192	233	[4] 233
France (salable) [3]	2,497	3,513	4,018	3,967	3,920	[4] 3,860
Germany:						
East	149	218	233	242	255	240
West [6]	810	943	999	1,046	982	1,127
Greece	18	22	17	19	[4] 19	28
Ireland	89	124	139	132	149	116
Italy	631	785	881	963	1,049	[4] 740
Luxembourg	14	2	3	6	8	[4] 9
Poland	90	340	364	390	[4] 390	[4] 390
Portugal	43	64	52	61	71	[4] 72
Spain	1,766	957	1,067	1,245	1,472	[4] 1,160
Switzerland	116	165	[4] 220	266	259	99
U.S.S.R	2,147	2,799	3,164	3,329	[4] 3,300	[4] 3,300
United Kingdom [3]	2,614	3,093	3,266	3,734	3,751	4,470
Yugoslavia	22	114	85	[4] 77	[4] 77	[4] 94
Total [1] [4]	11,380	13,810	15,290	16,260	16,600	16,620
Asia:						
Ceylon	(7)	(7)	(7)	1	1	(7)
China [4]	80	220	280	330	390	[8] 390
Cyprus [4]	130	220	180	140	160	165
India	347	686	773	952	1,033	884
Iran [4] [9]	254	220	739	551	551	551
Iraq [4]	275	275	275	275	275	275
Israel [4]	23	31	56	55	56	55
Japan	200	372	374	417	527	526
Pakistan	25	35	31	41	49	74
Philippines	1	----------	----------	----------	----------	2
Syria [10]	4	1	1	2	[4] 2	[4] 3
Taiwan	4	4	11	14	7	11
Thailand	(7)	----------	----------	----------	2	10
Total [1] [4]	1,340	2,060	2,720	2,780	3,050	2,950
Africa:						
Algeria	67	80	132	84	[4] 84	[4] 84
Angola	6	10	3	22	8	11
Belgian Congo	5	10	11	11	12	[4] 11
Egypt	133	157	432	225	1,042	[4] 1,100
Kenya	1	1	1	2	5	12
Morocco: Southern Zone	15	23	16	28	[4] 28	[4] 28
Sudan	4	4	3	[4] 2	[4] 2	[4] 2
Tanganyika	[11] 1	5	9	11	11	10
Tunisia	26	33	38	15	[4] 17	[4] 17
Union of South Africa	138	174	178	209	180	256
Total	396	497	823	609	[4] 1,390	[4] 1,530

See footnotes at end of table.

TABLE 10.—World production of gypsum, by countries,[1] in thousand short tons [2]—Continued

Country [1]	1949-53 (average)	1954	1955	1956	1957	1958
Oceania:						
Australia	379	492	526	524	536	[4] 560
New Caledonia	16	3				
Total	395	495	526	524	536	[4] 560
World total (estimate) [1 2]	25,660	30,820	35,370	36,310	36,430	36,660

[1] In addition to the countries listed, gypsum is produced in Bulgaria, Finland, Korea, Mexico, and Rumania, but production data are not available. Estimates for these countries are included in the totals. Production in Ecuador is negligible.
[2] This table incorporates a number of revisions of data published in previous "Gypsum" chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Includes anhydrite.
[4] Estimate.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Crude production estimates based on calcined figures.
[7] Less than 500 tons.
[8] Data represents 1957 production; however, 1958 production was probably much greater.
[9] Year ended March 20 of year following.
[10] Some pure, some 80 percent gypsum and 20 percent limestone.
[11] Average for 1952-53.

Jamaica.—Jamaica's gypsum industry continued to expand during 1958, as the annual production of crushed gypsum rock rose to 671,542 short tons compared with 211,860 short tons produced in 1957. Of this total 658,290 tons was exported to the United States, and 13,252 tons was sold locally to cement producers and others. The high export figure, three times that of 1957, was attributed to the labor strikes in other producing countries, resulting in a greater market for Jamaican gypsum. Production in 1959 was expected to return to normal, about 250,000 tons.[10]

Mexico.—Gypsum was quarried on San Marcos Island, Baja California, by Compañía Occidental Mexicana, S.A., of Guaymas, Sonora. During 1956 facilities on the island were expanded to increase the annual production capacity to 1.1 million short tons. Conveyor-loading capacity also was increased, from 825 tons to 1,875 tons per hour. The Island is reported to contain reserves of 220 million tons of crude ore having a 97 percent $CaSO_4 \cdot 2H_2O$ content.[11]

EUROPE

Ireland (Erie).—Production of gypsum by the Gypsum Industries, Ltd., at Kingscourt, County Gavin, totaled approximately 116,000 short tons in 1958, a slight decline from the 1957 figure.[12]

United Kingdom.—The Minister of Housing and Local Government announced a public inquiry into proposals to extend gypsum mining in the Brightling area of east Sussex. Underground workings of some 6,000 acres and a new mine at Rounden Wood were planned by the mining company, which stated that the area could not be worked from the existing minehead at Mountfield.[13]

[10] Mining World, Annual Review 1959, vol. 21, No. 5, Apr. 25, 1959, p. 145.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, p. 35.
[12] Mining World, Annual Review 1959, vol. 21, No. 5, Apr. 25, 1959, p. 138.
[13] Chemical Trade Journal and Chemical Engineer (London), Gypsum Mining in Sussex: Vol. 143, No. 3729, Nov. 21, 1958, p. 1220.

ASIA

Israel.—Gypsum production was derived from two main areas, Galilee and Wadi Ramon. Until a few years ago, the Galilee area produced most of the domestic supply. During 1958 the Ramon Gypsum Works, a supplier also of raw gypsum, was erecting a calcining plant of 60-ton-per-day capacity. Kibbutz Gesher, Israel's second largest producer, increased its production of gypsum in the Jordan Valley south of the Sea of Galilee.[14]

Thailand.—Test production was begun by the Thai Cement Co. in 1957 on a deposit of gypsum in the north central Province of Pichit. In January 1958, the Ministry of Economic Affairs announced that gypsum would be placed on the protected list and imports controlled as local production meets and exceeds domestic demands.[15]

AFRICA

British Somaliland.—According to a report issued by the Somaliland Protectorate Information Office during the latter part of 1958, drilling to a depth of about 300 feet had begun near Berbera, at the Suria Malableh gypsum deposit, which is being tested under the supervision of the Geological Survey Department of the Somaliland Government. The examination of these new borings, combined with the complete analyses of many surface samples, will aid in determining the reserves of both gypsum and anhydrite of varying qualities.[16]

An article [17] describing the deposit and surrounding area reported that part of the Suria Malableh ridge has probable reserves of 6.5 million tons of massive and bedded gypsum, with a grade of 90 percent and only 3 percent carbonates. A bed of anhydrite, 7½ feet thick, comprises nearly 400,000 tons of over 95 percent purity. As the area mapped and sampled was only about one-fifth of the three segments of the ridge, the conclusion was that a 30-million-ton reserve of high-grade sulfates is possible.

OCEANIA

Australia.—The National Bank of Australasia, Ltd., in its publication, Monthly Summary of Australian Conditions, stated in an article on gypsum that Australia's production of gypsum has risen by about one-third since 1953.[18] South Australia produced more than half the output and was the source of Australia's export trade with New Zealand. Exports to that country, the principal outlet, totaled 44,800 short tons in 1957. Production of gypsum in South Australia has risen considerably since 1954. There were marked fluctuations in the output of other producing States.

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[14] Mining World, Annual Review 1959: Vol. 21, No. 5, Apr. 25, 1959, p. 134; Israel Plans Increased Gypsum Potash Production: Vol. 20, No. 5, May 1958, p. 85.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, p. 39.
[16] American Consulate, Aden, Aden, State Department Dispatch 47: Sept. 22, 1958, p. 1. American Consulate, Aden, Aden, State Department Dispatch 65: Nov. 3, 1958, p. 3. Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 5, May 1959, p. 27.
[17] Warden, A. J., and Pallister, J. W., A Gypsum Anhydrite Deposit in Somaliland: Min. Mag. (London), vol. 98, No. 6, June 1958, pp. 333–337.
[18] Industrial and Mining Standard (Melbourne), Australian Gypsum: Vol. 93, No. 2862, Aug. 7, 1958, p. 21.

Of the Australian deposits worked, the most notable were Stenhouse Bay and Lake Macdonnell in South Australia. Other deposits, such as those in Western Queensland, have not been fully investigated. The deposits are in areas of South Australia where less than 20 inches of rain falls a year. Reserves of high-quality gypsum in Australia amount to many millions of tons and should be adequate to meet any foreseeable demand.

TECHNOLOGY

According to an Oklahoma Geological Survey report,[19] a 59-square-mile tract in central western Oklahoma in the southeastern part of Custer County between the towns of Weatherford and Clinton contains one of the nation's major gypsum deposits. The gypsum deposits are in a single thick bed of evaporites in the lower part of the Cloud Chief formation. Geological mapping and exploratory drilling has shown the gypsum in the Cloud Chief formation to have a maximum thickness of 92 feet and an average drilled thickness of 40 feet and to extend in workable thickness over an area of 24 square miles. Over the workable deposits, the overburden varies in thickness up to 25 feet and averages 7 feet.

A report was published on the use of automatic controls at Fibreboard Paper Products Corp. plant near Florence, Colo. Mining method, mine, and mill equipment were discussed.[20]

Specifications.—The activity of Committee C-11 on Gypsum during 1958 included further refinement of methods of testing gypsum as well as developing specifications to cover new gypsum products. Approved were a specification for gypsum backing board and a change in the specification for annular ringed nails for gypsum wallboard to cover the length of nails for application of gypsum. New projects under development included a specification for joint tape and cement and a friability test for perlite aggregate.[21]

Byproduct Anhydrite.—Production of synthetic anhydrite from industrial waste of hydrofluoric acid manufacture may be started in Canada by the International Anhydrite Corp. The process to be used, a European development, results in a calcium sulfate binder for wall plasters, floor mixes, and wallboard manufacture.[22]

An article discussed using sulfates for color control in the glass batch, the influence of furnace atmosphere on sulfate usage, the properties of a good sulfate, and an empirical method of calculating an oxidizing-reduction number for a given glass batch.[23]

Patents.—A patent disclosed a new set dense cementitious composition characterized by a fire-resistant rating of at least 60 minutes. The cementitious composition consists essentially of a set mass of interlaced gypsum crystals in an intimate admixture of 1 to 5 percent expanded perlite having a bulk density of 5 to 15 pounds per cubic foot, a particle size almost entirely less than 0.0937 inch in diameter

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[19] Ham, William E. and Curtis, Neville M. Jr., Gypsum in the Weatherford-Clinton District, Oklahoma: Oklahoma Geol. Survey Mineral Rept. 35, June 1958, 32 pp.
[20] Pit and Quarry, Automatic Control in Board-Lath Plant Use Latest Techniques: Vol. 50, No. 11, May 1958, pp. 84–86, 90.
[21] American Society for Testing Materials, Gypsum: Bull. 235, January 1959, p. 9.
[22] Rock Products, vol. 61, No. 8, August 1958, p. 11.
[23] Manring, W. H., and Hopkins, R. W., Use of Sulfates in Glass: The Glass Industry, vol. 39, No. 3, March 1958, pp. 139–142, 170.

and at least 0.0059 inch in diameter. The material also contains one-fifth to one-half percent of vitreous fibers having a length of one-half to 3 inches and an average diameter of 0.00015 to 0.0006 inch. The composition should not contain more than 0.5 percent organic fibrous material.[24]

A patent was issued for a gypsum product of increased compressive strength that consists essentially of a set mass of gypsum crystals through which is uniformly dispersed 0.05 percent to 1 percent on a dry basis of at least one of the following materials: Waste sulfite liquor, lignone sulfonate, lignin material acid-precipitated from black liquor and the water-soluble soap of the acid-precipitated black liquor lignin, and alkali lignin.[25]

A method of producing a lightweight, cellular gypsum composition was patented. The method consists of adding a predetermined quantity of a foam formed by a gas combined under super-atmospheric pressure with a proteinaceous solution of a foam-forming liquid. The liquid contains an alkali metal sulfate as an additive to control the set time of the foamed slurry.[26]

A rotating drum and batch process method for efficiently dehydrating or calcining gypsum at high speeds to produce an improved product was described in recently issued patents.[27]

A patent was issued for an improved wall plaster containing calcined gypsum plaster, lime, boric acid, and rice flour, with or without an inert aggregate. The addition of boric acid serves to retard the set and prevents the plaster from peeling off as it is applied with a trowel. By including starch in the mix, a larger proportion of gypsum plaster may be used.[28]

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[24] Riddell, Wallace C., and Kirk, George B., assignors to United States Gypsum Co., Cementitious Composition: U.S. Patent 2,853,394, Sept. 23, 1958.

[25] Kirk, George B., assignor to Kaiser Gypsum Co., Inc., Cementitious Compositions and Method of Making: U.S. Patent 2.856,304, Oct. 14, 1958.

[26] Dixon, J. S., Jr., and Koloseus. E. J., assignors to National Foam Systems, Inc., Manufacture of Foamed Gypsum and the Like: U.S. Patent 2.862.829, Dec. 2, 1958.

[27] Compton, C. E., Dehydrating Apparatus: U.S. Patent 2.848.209, Aug. 19, 1958; Dehydrating Gypsum and the Like: U.S. Patent 2.848,210, Aug. 19, 1958.

[28] Busatti, V. G. (by Busatti, Josephine, Administratrix), Plaster: U.S. Patent 2,833,660, May 6, 1958.

Iodine

By Henry E. Stipp[1] and James M. Foley[2]

CONSUMPTION and imports of iodine declined substantially in the United States. Noteworthy technical achievements were an ion exchange process for extracting iodine from brines, a new method for producing tetraethyl lead using an iodine compound, and the development of a process for producing iodide chromium.

DOMESTIC PRODUCTION

Production of iodine in the United States during 1958 decreased approximately 13 percent compared with 1957. Iodine was extracted from oil-well brines by the Dow Chemical Co., at Seal Beach, Venice, and Inglewood, Calif., and the Deepwater Chemical Co., Ltd., at Compton, Calif. Domestic producers furnished a substantial part of national requirements. Approximately 31 firms produced refined iodine and iodine compounds from domestic and imported crude iodine. The following firms offered commercial quantities of these iodine compounds for the first time in 1958: Dow Chemical Co., Midland, Mich., potassium iodate U.S.P.; J. T. Baker Chemical Co., Phillipsburg, N.J., calcium iodate; and George Uhe Co., New York, N.Y., ethyl and methyl iodide.

In addition to natural iodine, radioactive iodine isotopes were recovered in 1958. Approximately 100 firms processed and distributed radioisotopes. Oak Ridge National Laboratory, Oak Ridge, Tenn., shipped large quantities of iodine 131 isotopes to consumers.

CONSUMPTION AND USES

United States consumption of iodine and iodine compounds decreased 28 percent compared with 1957. Iodine was consumed chiefly in medicine, sanitation, and agriculture. It was widely used in tincture of iodine and was also used in producing high-purity metals including silicon, chromium, hafnium, and zirconium. Potassium iodide was incorporated in many medicinal preparations. It was also used in iodized salt for human consumption, photoengraving and photographic film processes, analytical reagents, and catalysts. Iodophors, mixtures of iodine and a carrier, were used for sanitizing and cleaning purposes. Sodium iodide, potassium and calcium iodate, or cuprous iodide was added to livestock feed and mineral mixes.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

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Ethyl and methyl iodide were used in organic synthesis. Radioactive iodine, a byproduct of uranium decomposition material, was used in medicine for physical therapy and examinations of the human body. Industrially radioactive iodine served in process control and research.

TABLE 1.—Crude iodine consumed in the United States, 1957–58

Compound manufactured	1957 [1]			1958		
	Number of plants	Crude iodine consumed		Number of plants	Crude iodine consumed	
		Pounds (thousand)	Percent of total		Pounds (thousand)	Percent of total
Resublimed iodine	5	134	8	4	158	13
Potassium iodide	11	846	51	12	532	45
Sodium iodide	7	120	7	5	42	3
Other inorganic compounds	12	203	12	12	190	16
Organic compounds	17	364	22	19	273	23
Total	[2] 27	1,667	100	[2] 31	1,195	100

[1] Corrected figures.
[2] A plant producing more than 1 product is counted once.

PRICES

The price of iodine and iodine compounds varied throughout 1958. Crude iodine dropped to a new low of 95 cents a pound in March. The following prices were quoted by the Oil, Paint and Drug Reporter: Crude iodine, in kegs, $1.10 per pound from January through March and $0.95 per pound from March through December; resumblimed iodine, U.S.P., bottles, drums, $2.30–$2.32 per pound from January through May, $2.00 per pound from May through June and $2.00–$2.02 per pound from June through December; amonium iodide, N.F., drums, bottles, $4.26–$4.38 per pound throughout the year; potassium iodide, U.S.P., drums, $1.90–$1.95 per pound from January through May, $1.43 per pound from May through September and $1.40 per pound from September through December; sodium iodide, U.S.P., bottles, drums, $2.42–$2.54 per pound from January through May and $1.98 per pound in 300-pound drums from May through December.

FOREIGN TRADE [3]

United States imports of crude iodine in 1958 decreased about 42 percent as compared with 1957. Iodine imported from Chile decreased approximately 35 percent, while imports from Japan decreased about 70 percent. The accumulation of large stocks as a result of near record imports of iodine in 1957 and the reduced domestic consumption resulted in the decline in 1958 imports.

United States exports of iodine and iodine compounds in 1958 were 198,762 pounds valued at $314,439.

[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, 1949–53 (average) and 1954–58, by countries

[Bureau of the Census]

Country	1949–53 (average)		1954		1955	
	Pounds (thousand)	Value (thousand)	Pounds (thousand)	Value (thousand)	Pounds (thousand)	Value (thousand)
Chile	557	$905	616	$667	868	$1,035
Japan	206	308	330	367	364	478
Total	763	1,213	946	1,034	1,232	1,513

Country	1956		1957		1958	
	Pounds (thousand)	Value (thousand)	Pounds (thousand)	Value (thousand)	Pounds (thousand)	Value (thousand)
Chile	1,002	$1,226	2,149	$2,049	1,401	$1,180
Japan	703	954	536	720	160	149
Total	1,705	2,180	2,685	2,769	1,561	1,329

TABLE 3.—Iodine, iodide, and iodates exported from the United States, 1949–53 (average) and 1954–58

[Bureau of the Census]

Year	Pounds (thousand)	Value (thousand)	Year	Pounds (thousand)	Value (thousand)
1949–53 (average)	288	$523	1956	505	$750
1954	338	488	1957	233	335
1955	244	357	1958 [1]	199	314

[1] Data not strictly comparable to earlier years.

WORLD REVIEW

Chile.—Production of iodine totaled 3 million pounds in 1957, compared with 1.4 million pounds (revised figure) in 1956. During 1958 Anglo-Lantaro Nitrate Co. rebuilt its iodine plant at oficino Pedro de Valdivia and began building another plant to be completed in 1959.[4]

Indonesia.—In 1957, iodine production totaled 5.9 million pounds.[5]

Italy.—Iodine production totaled 32,000 pounds in 1957, the same as 1956.[6]

Japan.—Production of iodine in 1957 totaled 1.4 million pounds compared with 1.3 million pounds in 1956.[7]

TECHNOLOGY

The antibacterial effectiveness of iodine tincture (U.S.P. xv), iodine solution (N.F. x), six iodophor preparations, and sodium hypochlo-

[4] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, p. 34.
[5] U.S. Embassy, Djakarta, Indonesia, State Department Dispatch 229: Oct. 9, 1958, p. 1.
[6] U.S. Embassy, Rome, Italy, State Department Dispatch 1360: Apr. 30, 1958, p. 2.
[7] U.S. Embassy, Tokyo, Japan, State Department Dispatch 1214: Apr. 11, 1958, p. 3.

rite solution were tested.[8] Studies revealed that iodine was considerably more efficient than chlorine and quaternary compounds. Iodine solutions containing more than 10 p.p.m. free iodine were as effective in 10 seconds exposure time as in 1 minute.

A method for recovering water and a concentrated solution of hydrogen iodide and iodine in water from a dilute solution of hydrogen iodide and iodine in water was patented.[9]

Adrenocortical hormones were produced commercially by treating 20-ketosteroids with iodine in the presence of calcium carbonate.[10]

An efficient method for producing tetraethyl lead consisted of reacting lead acetate with triethyl aluminum in the presence of cadmium acetate, ethyl iodide, and excess triethyl aluminum.[11] The lead was almost completely converted to tetraethyl lead.

A composition for bedding in animal stalls, consisting of plus-¼-inch exfoliated African vermiculite treated with iodine, a polyhydric alcohol, or a mixture of iodine and a polyhydric alcohol, was patented.[12]

Chromalloy Corp. and Chilean Nitrate Sales Corp. completed a license agreement for research and development by Chromalloy of a new form of chromium made by an iodide process.[13] Chromium samples produced at Battelle Memorial Institute for Chilean Nitrate Sales Corp. contained about 10 parts per million impurities. Iodide chromium was expected to be competitive in cost with other metals of similar grade. Alloying of high purity chromium with other metals could improve the metal's high temperature properties, facilitating its use in gas turbines and nuclear reactors.

The Dow Chemical Co. at Inglewood, Calif., installed an ion exchange process for extracting iodine from oilwell brines.[14]

Radioactive Iodine.—Iodine 131 standards, simulated by combining barium 133 and cesium 137 with special absorbers, were made available by New England Nuclear Corp.[15]

Mock iodine 270, developed at Oak Ridge Institute of Nuclear Studies, is composed of barium 133 and cesium 127 in ratios of about 5.7:1 to 14:1; its half-life is about 10 years. The iodine is useful in thyroid-uptake calibrations.[16]

Iodine 131 was used to investigate the design of cooling ponds for power stations at Maitland, Australia.[17] The circulation of the water was traced by adding iodine 131 to the warm water fed into the reservoir from the power station.

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[8] Gershenfeld, Louis, and Wittin, Bernard, Iodine for Quick Acting Sanitizers: Soap and Chemical Specialties, vol. 34, No. 7, July 1958, pp. 67–75.

[9] Baumgartner, H. J., and Gable, C. M. (assigned to Shell Development Co., New York, N.Y.), Resolution of Mixtures of Hydrogen Iodide, Water, and Iodine: U.S. Patent 2,833,700, May 6, 1958.

[10] Chemical Engineering News, New Steroid Process: Vol. 36, No. 11, Mar. 17, 1958, p. 26.

[11] Chemical Engineering News, Production Toward Cheaper TEL: Vol. 37, No. 17, Apr. 28, 1958, pp. 66, 68.

[12] Combs, J. T. (assigned to Clifford Carlock, Betterton, Md.), Animal Bed: U.S. Patent 2,848,976, Aug. 26, 1958.

[13] Chemical Engineering News, New Way to Iodide Chromium: Vol. 36, No. 42, Oct. 20, 1958, p. 32.

[14] Chemical Engineering, New Iodine Process: Vol. 65, No. 20, Oct. 6, 1958, p. 43.

[15] Chemical Engineering News, Simulated Iodine 131 Standards: Vol. 36, No. 7, Feb. 17, 1958, p. 55.

[16] Chemical Engineering News, Mock Iodine 270: Vol. 36, No. 25, June 23, 1958, p. 45.

[17] Chemistry and Industry (London), Iodine 131 In Power Station Investigation: No. 22, May 31, 1958, p. 660.

Iron Ore

By Horace T. Reno [1] and Helen E. Lewis [2]

IRON-ORE OUTPUT in the United States in 1958 was the lowest in 20 years. For the first time in history imports comprised more than one-fourth the total iron ore available to domestic consumers. Exploration and development in iron-ore deposits throughout the world was undiminished as iron and steel producers vigorously sought to assure their future ore supply. Direct reduction of iron ore was again the item of principal technologic interest, but preliminary reports of a U.S. delegation that inspected iron and steel plants in the Soviet Union stimulated much domestic activity in blast furnace technology.

TABLE 1.—Salient statistics of iron ore in the United States, in thousands

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Iron ore (usable; [1] less than 5 percent Mn):						
Production [2]	[3] 101,080	78,129	103,003	97,877	106,148	67,947
Shipments [4]	102,312	76,126	105,241	96,945	104,157	66,525
Value [4]	$576,539	$525,818	$748,625	$750,354	$865,703	$572,735
Average value per ton at mine Dec. 31	$5.64	$6.91	$7.11	$7.47	$8.31	$8.61
Stocks at mines Dec. 31	5,579	7,078	4,281	5,465	[5] 6,776	7,459
Imports	9,329	15,792	23,472	30,411	[5] 33,651	27,530
Value	$63,968	$119,459	$177,457	$250,490	[5] $285,051	$231,553
Exports	3,736	3,146	4,517	5,508	5,002	3,439
Value	$26,239	$24,784	$36,993	$48,805	[5] $47,543	$34,427
Consumption	106,686	94,229	[6] 125,028	125,171	129,375	91,900
Stocks at consuming plants Dec. 31	40,253	43,139	44,358	47,292	53,175	53,599
Stocks at Lake Erie Docks Dec. 31	6,333	6,591	4,918	4,558	5,160	5,577
Manganiferous iron ore (5 to 35 percent Mn):						
Shipments	1,007	499	814	566	865	465
Value	$5,220	$3,079	$5,128	(7)	$5,413	$3,532
World: Production	276,685	300,933	363,543	388,513	422,633	397,036

[1] Direct shipping ore, washed ore concentrates, agglomerates, and byproduct pyrites cinder and agglomerates.
[2] Includes byproduct ore.
[3] Includes Puerto Rican ore—39,000 tons in 1951 and 139,000 tons in 1952.
[4] Byproduct ore excluded.
[5] Revised figure.
[6] Includes 1,119,704 tons of manganiferous ore.
[7] Figure withheld to avoid disclosure of individual company confidentia ldata.

[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 1957, by districts and States

District and State	Employment					Production [1]									
	Average number of men employed	Average number of days	Time employed			Crude ore (thousand long tons)	Usable ore			Average per man					
			Total man shifts (thousand)	Man-hours			Thousand long tons	Iron contained		Crude ore		Usable ore			
				Average per shift	Total (thousand)			Thousand long tons	Natural (percent)	Per shift	Per hour	Per shift	Per hour	Iron contained	
														Per shift	Per hour
Lake Superior:															
Michigan	6,944	241	1,673	8.00	13,385	15,138	13,742	7,157	52.08	9.05	1.13	8.21	1.03	4.28	.53
Minnesota	11,844	270	3,194	8.00	25,567	107,386	68,899	36,080	52.37	33.62	4.20	21.57	2.69	11.29	1.41
Wisconsin	1,119	250	280	8.00	2,241	1,618	1,618	847	52.35	5.78	.72	5.78	.72	3.02	.38
Total	19,907	259	5,148	8.00	41,193	124,142	84,259	44,084	52.32	24.12	3.01	16.37	2.05	8.56	1.07
Southeastern States: Alabama and Georgia	2,717	206	561	8.13	4,561	12,068	6,749	2,589	38.36	21.52	2.65	12.04	1.48	4.62	.57
Northeastern States:															
New Jersey	233	254	59	8.00	473	1,710	885	577	65.20	28.91	3.61	14.96	1.87	9.76	1.22
New York and Pennsylvania	1,330	305	405	8.00	3,241	10,406	4,076	2,519	61.80	25.68	3.21	10.06	1.26	6.22	.78
Total	1,563	297	464	8.00	3,714	12,116	4,961	3,096	62.41	26.10	3.26	10.68	1.34	6.67	.83
Western States:															
California, Colorado, and Idaho	175	190	33	8.00	266	3,147	2,513	807	32.11	94.73	11.84	75.64	9.46	24.29	3.04
Missouri and Nevada	517	168	87	8.30	721	1,692	1,439	589	40.93	19.47	2.35	16.56	1.99	6.78	.82
Utah and Wyoming	689	242	167	8.00	1,333	4,981	4,981	2,552	51.23	29.89	3.74	29.89	3.74	15.31	1.91
Total	1,381	208	287	8.09	2,320	9,820	8,933	3,948	44.20	34.24	4.23	31.15	3.85	13.77	1.70
Other [2]	94	211	20	8.29	165	4,052	1,164	575	49.40	203.88	24.61	58.57	7.07	28.93	3.49
Grand total [3]	25,662	252	6,479	8.02	51,953	162,198	106,066	54,292	51.19	25.03	3.12	16.37	2.04	8.38	1.05

[1] Includes manganese-bearing ore in the Lake Superior district.
[2] Mississippi, Tennessee, Montana, New Mexico, Oregon, Texas, and Washington.
[3] Man-hour data for South Dakota not available; therefore, production data are excluded from all totals.

EMPLOYMENT

The average number of men employed in the iron mines in 1957 decreased despite a substantial gain in ore output. The average output of crude ore per man increased slightly to set a new record. The iron-ore mining industry attempts to maintain a stable labor force; therefore, the rate of production per man from year to year is more a function of the quantity of ore produced than of change in productivity, unless the industry pattern is changed through other influence. Increased output per man shift, almost double that in 1945, has resulted in response to greatly increasing imports and higher domestic production from low-grade deposits. Competition from open-pit mines and high-grade imports that has been closing underground iron mines also has helped to increase the overall average domestic output per man-hour.

Minnesota iron mining operations were free of fatal accidents during 1958 for the first time in the 43 years that mining safety records have been kept. This record was established with 14,806 men working a total of 26,484,765 man-hours.

DOMESTIC PRODUCTION

Iron-ore output in the United States in the first half of 1958 was greatly reduced compared with the rate of production in 1957, owing to low demand, large accumulations of stocks at mine and mills, and the late start of the shipping season on the Great Lakes. Most of the major mines operated only 4 days a week until after the last of August or the first part of September. Underground mines in the Lake Superior district, which had been operated at capacity for several years to meet the demand for premium grade ore for open hearth steel furnaces, also cut back production as the market for open hearth ore apparently was satiated early in the year. Reduced output of iron ore at the traditional mines was offset partly by beginning capacity production at the Erie Mining Company's huge taconite operation at Aurora, Minn. Total mine output, except for the usual seasonal decline, increased during the last half of the year.

Crude ore is the mine product that may have been crushed, screened, or sized, but has not been subjected to any treatment that would remove the waste constituents. Crude ore output, although much less than in 1957, was sustained to some extent by the demand for better grade, or higher iron content material for blast furnace feed. The average grade of iron ore deposits being mined has been decreasing steadily for the last 20 years; therefore, more crude ore was needed to obtain the same quantity of iron.

Iron ore is classified as hematite, brown ore, or magnetite, according to the iron mineral constituent that predominates, but the classification is seldom precise as most iron ores contain several types of minerals. The quantity of magnetite ore mined was a much greater percentage of the whole than in previous years because all the newly developed Minnesota taconite mines are in the predominantly magnetite section of the Mesabi range. Low-grade jaspilite mines in Michigan, however, are in areas where the principal mineral is specular-hematite.

TABLE 3.—Crude iron ore mined in the United States, by districts and varieties, in thousand long tons

(Exclusive of ore containing 5 percent or more manganese)

District and State	1957					1958				
	Number of mines	Hematite	Brown ore	Magnetite	Total	Number of mines	Hematite	Brown ore	Magnetite	Total
Lake Superior:										
Michigan	33	15,022	-----	-----	15,022	29	9,042	-----	-----	9,042
Minnesota	143	87,611	(1)	18,517	106,128	95	31,627	-----	42,625	74,251
Wisconsin	3	1,618	-----	-----	1,618	2	1,152	-----	-----	1,152
Total	179	104,251	-----	18,517	122,768	126	41,821	-----	42,625	84,445
Southeastern States:										
Alabama	[2] 47	4,916	5,448	-----	10,364	[2] 30	3,207	1,972	-----	5,179
Georgia	23	-----	1,704	-----	1,704	11	-----	719	-----	719
Tennessee	3	(3)	(3)	-----	(3)	-----	-----	-----	-----	-----
Total	73	4,916	7,152	-----	12,068	41	3,207	2,691	-----	5,898
Northeastern States:										
New Jersey	4	(1)	-----	1,710	1,710	} 6	2,657	-----	(1)	2,657
Pennsylvania	} 6	-----	-----	10,406	10,406					
New York						4	-----	-----	6,009	6,009
Total	10	-----	-----	12,116	12,116	10	2,657	-----	6,009	8,666
Western States:										
Arkansas	1	-----	7	-----	7	1	-----	(3)	-----	(3)
California	6	(3)	-----	(3)	(3)	2	(1)	(3)	(1)	(3)
Colorado	2	-----	(3)	-----	(3)	1	-----	(3)	-----	(3)
Idaho	1	-----	-----	(3)	(3)	1	-----	-----	6	6
Mississippi	1	-----	(4)	-----	(4)	1	-----	(4)	-----	(4)
Missouri	42	440	281	-----	721	26	(1)	589	-----	589
Montana	2	26	-----	9	35	3	(1)	-----	15	15
Nevada	11	(1)	-----	971	971	8	(1)	-----	831	831
New Mexico	2	-----	-----	1	1	2	-----	-----	(4)	(4)
Oregon	1	-----	(4)	-----	(4)	-----	-----	-----	-----	-----
South Dakota	1	(3)	-----	-----	(3)	-----	-----	-----	-----	-----
Texas	4	-----	(3)	-----	(3)	4	-----	(3)	-----	(3)
Utah	10	4,245	-----	(1)	4,245	9	2,948	6	616	3,570
Washington	1	4	-----	-----	4	1	4	-----	(4)	4
Wyoming	2	702	-----	34	736	2	499	-----	58	557
Total	87	5,417	288	1,015	6,720	61	3,451	595	1,526	5,572
Undistributed	-----	61	3,969	3,123	7,153	-----	-----	5,221	-----	5,221
Grand total [5]	349	114,645	11,409	34,771	160,825	238	51,136	8,507	50,160	109,802

[1] Varieties of ore not shown separately are combined with other varieties in the same State.
[2] Excludes an undetermined number of small pits. Output of these pits included with tonnage given.
[3] Included with "Undistributed" to avoid disclosing individual company data.
[4] Less than 1,000 tons.
[5] In some instances table does not add because of rounding figures.

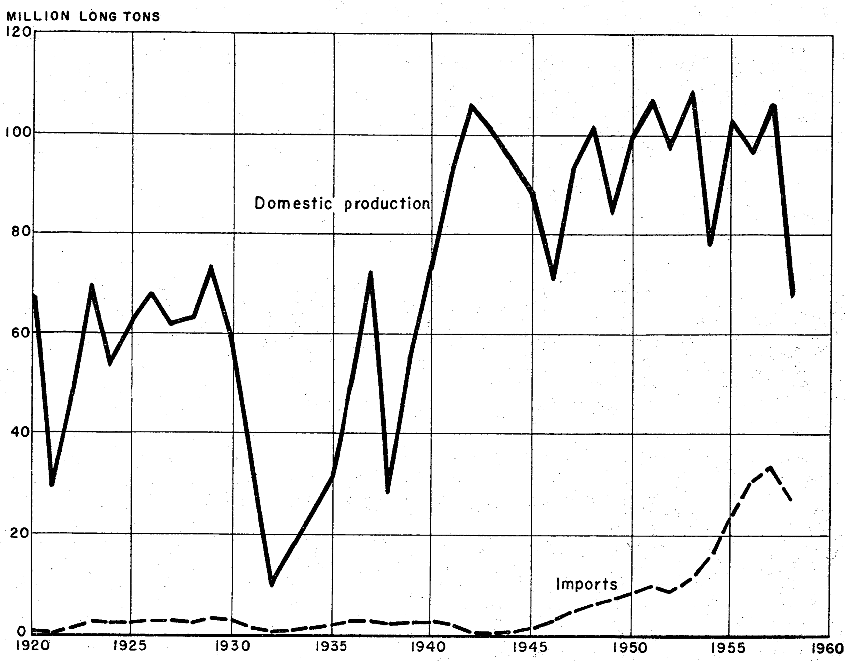

FIGURE 1.—Production of iron ore in the United States and iron-ore imports for consumption, 1920–1958.

TABLE 4.—Crude iron ore mined in the United States, by States and mining methods, in thousand long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1957			1958		
	Open pit	Underground	Total	Open pit	Underground	Total
Alabama	5,549	4,815	10,364	2,052	3,127	5,179
Arkansas	7	----------	7	(1)	----------	(1)
California	(1)	(2)	(2)	(1)	----------	(1)
Colorado	(1)	----------	(1)	(1)	----------	(1)
Georgia	1,704	----------	1,704	719	----------	719
Idaho	(1)	----------	(1)	6	----------	6
Michigan	(3)	15,022	15,022	(3)	9,042	9,042
Minnesota	103,529	2,599	106,128	72,484	1,767	74,251
Mississippi	(4)	----------	(4)	(4)	----------	(4)
Missouri	283	438	721	589	(2)	589
Montana	36	----------	36	15	----------	15
Nevada	971	----------	971	831	----------	831
New Jersey	----------	1,710	1,710			
Pennsylvania	6,709	3,697	10,406	----------	2,657	2,657
New York				6,009	(2)	6,009
New Mexico	1	----------	1	(4)	----------	(4)
Oregon	(4)	----------	(4)	----------	----------	----------
South Dakota	(1)	----------	(1)	----------	----------	----------
Tennessee	(1)	----------	(1)	----------	----------	----------
Texas	(1)	----------	(1)	(1)	----------	(1)
Utah	4,245	----------	4,245	3,570	----------	3,570
Washington	4	----------	4	4	----------	4
Wisconsin	(3)	1,618	1,618	----------	1,152	1,152
Wyoming	34	702	736	58	499	557
Undistributed	7,152	----------	7,152	5,221	----------	5,221
Total	130,224	30,601	160,825	91,558	18,244	109,802

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Included with open pit.
[3] Included with underground.
[4] Less than 1,000 tons.

TABLE 5.—Crude iron ore shipped from mines in the United States, by States and disposition, in thousand long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1957			1958		
	Direct to consumers	To beneficiation plants	Total	Direct to consumers	To beneficiation plants	Total
Alabama	3,564	6,770	10,334	2,123	3,051	5,174
Arkansas	---	7	7	---	(1)	(1)
California	(1)	(1)	(1)	(1)	(1)	(1)
Colorado	(1)	---	(1)	(1)	---	(1)
Georgia	(2)	1,704	1,704	(2)	719	719
Idaho	(1)	---	(1)	6	---	6
Michigan	14,547	(3)	14,547	8,675	(3)	8,675
Minnesota	37,281	68,439	105,720	19,214	55,224	74,438
Mississippi	---	(4)	(4)	---	(4)	(4)
Missouri	---	721	721	---	589	589
Montana	36	---	36	15	---	15
Nevada	539	427	966	831	(3)	831
New Jersey	(2)	1,791	1,791	(2)	2,692	2,692
Pennsylvania	(2)	10,520	10,520			
New York				(2)	6,012	6,012
New Mexico	(4)	---	(4)	(4)	---	(4)
Oregon	(4)	---	(4)	---	---	---
South Dakota	(1)	---	(1)	---	---	---
Tennessee	(1)	(1)	(1)	---	---	---
Texas	---	(1)	(1)	---	(1)	(1)
Utah	4,156	---	4,156	3,514	---	3,514
Washington	4	---	4	4	---	4
Wisconsin	1,576	---	1,576	1,152	---	1,152
Wyoming	702	34	736	499	58	557
Undistributed	1,586	5,563	7,149	184	5,021	5,205
Total	63,991	95,976	159,967	36,217	73,366	109,583

1 Included with "Undistributed" to avoid disclosing individual company confidential data.
2 Included with ore shipped to beneficiation plants.
3 Included with direct shipping ore.
4 Less than 1,000 tons.

Usable iron ore is that produced from mines, beneficiation, and agglomeration plants; measured as either direct-shipping ore, iron-ore concentrate, or iron-ore agglomerate; or the form in which it is shipped to the consumer. Iron-bearing agglomerates produced at consuming plants are excluded from usable iron-ore production to prevent duplication because the iron ore in these agglomerates is measured at the mines.

High-grade iron-ore agglomerates made from taconite ore comprised a significant part of the total quantity of usable iron ore produced. Such agglomerates were offered for sale on the open market for the first time in 1958. Heretofore, taconite agglomerates have not been for sale because the producers used them for research in their own blast furnaces and to maintain a high rate of pig iron production. In 1958, however, there was no need to operate blast furnaces at capacity; integrated company commitments for use of direct-shipping iron ore and iron-ore concentrates together with the large quantities of pellets produced resulted in a surplus of over a million tons of the pellets being made available to independent pig iron producers.

TABLE 6.—Usable iron ore produced in the United States, by districts and varieties, in thousand long tons

(Exclusive of ore containing 5 percent or more manganese)

District and State	1957				1958			
	Hematite	Brown ore	Magnetite	Total	Hematite	Brown ore	Magnetite	Total
Lake Superior:								
Michigan	13,626	-----	-----	13,626	8,404	-----	-----	8,404
Minnesota	61,293	(1)	6,993	68,286	33,499	-----	8,722	42,221
Wisconsin	1,618	-----	-----	1,618	1,152	-----	-----	1,152
Total	76,537	-----	6,993	83,530	43,055	-----	8,722	51,777
Southeastern States:								
Alabama	4,851	1,440	-----	6,291	3,140	493	-----	3,633
Georgia	-----	458	-----	458	-----	194	-----	194
Tennessee	(1 2)	(1)	-----	(2)	-----	-----	-----	-----
Total	4,851	1,898	-----	6,749	3,140	687	-----	3,827
Northeastern States:								
New Jersey	(1)	-----	886	886	} 1,285			
Pennsylvania	} -----		4,076	4,076		-----	(1)	1,285
New York		-----			-----	-----	2,127	2,127
Total	-----	-----	4,962	4,962	1,285	-----	2,127	3,412
Western States:								
Arkansas	-----	7	-----	7	-----	(2)		(2)
California	(2)	-----	(2)	(2)	(1)	(2)	(1)	(2)
Colorado	-----	(2)	-----	(2)	-----	(2)		(2)
Idaho	-----	-----	(2)	(2)	-----	-----	6	6
Mississippi	-----	(3)	-----	(3)	-----	(3)	-----	(3)
Missouri	249	281	-----	530	(1)	387	-----	387
Montana	26	-----	9	35	(1)	-----	15	15
Nevada	(1)	-----	909	909	(1)	-----	639	639
New Mexico	-----	-----	1	1	-----	-----	(3)	(3)
Oregon	-----	(3)	-----	(3)	-----	-----	-----	-----
South Dakota	(2)	-----	-----	(2)	-----	-----	-----	-----
Texas	-----	(2)	-----	(2)	-----	(2)	-----	(2)
Utah	4,245	-----	(1)	4,245	2,948	6	616	3,570
Washington	4	-----	-----	4	4	-----	(3)	4
Wyoming	702	-----	34	736	499	-----	58	557
Total	5,226	288	953	6,467	3,451	393	1,334	5,178
Undistributed	77	1,064	2,489	3,630	-----	3,014	-----	3,014
Total all districts	86,691	3,250	15,397	105,338	50,931	4,094	12,183	67,208
Byproduct ore [4]	-----	-----	-----	810	-----	-----	-----	739
Grand total	86,691	3,250	15,397	106,148	50,931	4,094	12,183	67,947

[1] Varieties of ore not shown separately are combined with other varieties produced in the same State.
[2] Included with "Undistributed" to avoid disclosing individual company confidential data.
[3] Less than 1,000 tons.
[4] Cinder and sinter obtained from treating pyrites.

TABLE 7.—Iron ore produced in the United States, by States and types of product, in thousand long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1957				1958			
	Direct shipping ore	Agglomerates [1]	Concentrates	Iron content (natural percent)	Direct shipping ore	Agglomerates [1]	Concentrates	Iron content (natural percent)
Alabama	4,123	725	1,443	38.10	2,687	(2)	947	37.69
Arkansas	-	-	7	42.06	-	-	(3)	46.10
California	(3)	-	(3)	(3)	(3)	-	(3)	(3)
Colorado	(3)	-	-	(3)	(3)	-	-	(3)
Georgia	(2)	-	458	42.01	(2)	-	194	46.56
Idaho	(3)	-	-	-	6	-	-	57.99
Michigan	13,626	(2)	(2)	52.16	8,319	(2)	86	53.07
Minnesota	37,997	7,273	23,017	52.49	19,066	8,857	14,298	53.98
Mississippi	-	-	(4)	39.38	-	-	(4)	-
Missouri	-	-	530	49.36	-	-	387	52.48
Montana	36	-	-	59.62	15	-	-	42.67
Nevada	543	-	366	60.15	639	-	(2)	59.70
New Jersey	(2)	-	885	65.21	(2)	(2)	1,285	62.15
Pennsylvania	(2)	3,582	494	61.79				
New York					(2)	(2)	2,127	62.05
New Mexico	1	-	-	60.92	(4)	-	-	-
Oregon	(4)	-	-	-	-	-	-	-
South Dakota	(3)	-	-	(3)	-	-	-	-
Tennessee	(3)	-	(3)	(3)	-	-	-	-
Texas	(3)	(2)	(3)	(3)	(3)	(2)	(3)	(3)
Utah	4,245	-	-	52.08	3,570	-	-	49.62
Washington	4	-	-	-	4	-	-	59.99
Wisconsin	1,618	-	-	52.32	1,152	-	-	53.43
Wyoming	702	-	34	46.27	499	-	58	41.74
Undistributed	1,608	-	2,021	37.41	272	-	2,742	52.50
Total	64,503	11,580	29,255	51.27	36,229	8,857	22,124	53.01
Byproduct ore [5]	-	810	-	66.77	-	739	-	66.93
Grand total	64,503	12,390	29,255	51.39	36,229	9,596	22,124	53.16

[1] Exclusive of agglomerates produced at consuming plants.
[2] Types of ore not shown separately are combined with other types in the same State.
[3] Included with "Undistributed" to avoid disclosing individual company confidential data.
[4] Less than 1,000 tons.
[5] Cinder and sinter obtained from treating pyrites.

TABLE 8.—Shipments of iron ore in the United States in 1958, by States and uses, in thousand 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 (thousand)
Mined ore:								
Alabama	2,123	(2)	1,536				3,659	$23,393
Arkansas			(3)				(3)	(3)
California	(3)		(3)				(3)	(3)
Colorado	(3)				(2)		(3)	(3)
Georgia	(2)		209				209	1,008
Idaho	1			(2)			1	14
Michigan	8,111	(2)	(2)		(2)		8,111	69,845
Minnesota	19,214	8,829	14,460	(2)		(2)	42,503	354,528
Mississippi			(4)				(4)	(4)
Missouri			387				387	3,820
Montana				10		4	14	(3)
Nevada	239		(2)			355	594	3,149
New Jersey / Pennsylvania	(2)	(2)	1,182				1,182	22,393
New York	(2)	1,677	267	(2)	(4)	(3)	1,944	25,683
New Mexico	(4)			(4)			(4)	(3)
Texas	(3)		(3)	(2)			(3)	(3)
Utah	3,496			12		6	3,514	25,202
Washington				4		(4)	4	(3)
Wisconsin	867						867	(3)
Wyoming	499					58	557	(3)
Undistributed	223		2,756				2,979	43,700
Total	34,773	10,506	20,797	26		423	66,525	572,735
Byproduct ore [5]							671	8,682
Grand total	34,773	10,506	20,797	26		423	67,196	581,417

[1] Exclusive of agglomerates produced at consuming plants.
[2] Uses not shown separately are combined with other uses in the same State; quantity used cannot be disclosed.
[3] Included with "Undistributed" to avoid disclosing individual company data.
[4] Less than 500 tons and less than $500.
[5] Cinder and sinter obtained from treating pyrites.

The ratio of crude ore to usable ore (concentration ratio) was 1.6:1 compared with 1.5:1 in 1956 and 1957, and 1.4:1 in 1954 and 1955. The marked increase was principally the result of taconite and jaspilite deposits being brought into production, but consumer insistence on higher grade ore was also a significant factor. Usable iron ore produced domestically in 1958 contained an average of 53.2 percent iron, compared with 51.4 percent in 1957, 51.5 percent in 1956, 51.2 percent in 1955, 50.9 percent in 1954, and 50.4 percent in 1953.

Values of iron-ore shipments shown in table 8 are as reported by producers at the mines, exclusive of transportation costs but including all costs of mining, concentration, and agglomeration. Shipments are classified by use according to data submitted by the producer; therefore, the classification may not be precise because the shipper does not always control the end use.

The number of active iron-ore mines in the United States, exclusive of many small open-pit mines that operated intermittently, decreased from 349 in 1957 to 238 in 1958.

1958 production by size group	Number of mines	Crude ore, percent	Usable ore, percent
Less than 100,000 short tons	118	3	3
100,000 to 500,000 do	73	17	22
500,000 to 1,000,000 do	18	11	13
1,000,000 and over do	29	69	62
Total	238	100	100

TABLE 9.—Iron ore produced in the Lake Superior district, by ranges, in thousand long tons

(Exclusive after 1905 of ore containing 5 percent or more manganese)

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1953	273, 345	241, 730	286, 085	89, 455	1, 925, 568	52, 332	2, 868, 515
1954	4, 671	3, 640	3, 931	1, 372	45, 725	1. 497	60, 836
1955	5, 413	4, 126	4, 360	1, 454	64, 860	2, 771	82, 984
1956	5, 869	4, 349	4, 377	1, 285	59, 346	2, 242	77, 468
1957	6, 557	4, 250	4, 437	(1)	65, 886	[2] 2, 400	83, 530
1958	4, 111	2, 896	2, 549	(1)	40, 860	[2] 1, 360	51, 777
Total	299, 966	260, 991	305, 739	93, 566	2, 202, 245	62, 602	3, 225, 110

[1] Included with Mesabi range to avoid disclosing individual company confidential data.
[2] Includes production from the Spring Valley district not in the true Lake Superior district.

TABLE 10.—Average analyses of total tonnages (bill-of-lading weights) of all grades of iron ore from all ranges of Lake Superior district

[Lake Superior Iron Ore Association]

Year	Long tons	Content (natural), percent				
		Iron	Phosphorus	Silica	Manganese	Moisture
1949–53 (average)	82, 779, 144	50. 37	0. 095	9. 96	0. 76	11. 02
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	83, 264, 900	52. 14	. 089	9. 39	. 65	9. 83
1958	52, 243, 820	53. 78	. 086	8. 76	. 53	8. 49

TABLE 11.—Beneficiated iron ore shipped from mines in the United States, in thousand long tons

(Exclusive of ore containing 5 percent or more manganese)

Year	Beneficiated	Total	Proportion of beneficiated to total (percent)
1949–53 (average)	28, 192	102, 312	27. 6
1954	27, 756	76, 126	36. 5
1955	36, 182	105, 241	34. 4
1956	38, 260	96, 945	39. 4
1957	42, 027	104, 157	40. 3
1958	19, 782	66, 525	29. 7

CONSUMPTION AND USES

Total iron-ore consumption, excluding consumption of iron-ore agglomerates, was 29 percent less than in 1957; but consumption in agglomerating plants was only 4 percent and in blast and ferroalloy furnaces 40 percent less than in 1957. The relatively slight decline in use of iron ore to produce agglomerates was due to high output of fine-grain concentrate at the mines and to increased preparation of blast-furnace burden at the steel mills.

Magnetite lump ore was used as coarse aggregate in concrete for covering underwater pipelines, for shielding in nuclear reactors, and other speciality uses requiring high-density or magnetic properties, but demand for the lump ore in excess of supply in the Eastern United States apparently did not develop as in recent years.

Agglomerate (Sinter).—The term "agglomerate" includes all iron-bearing fine-grained material that has been massed to form lumps. That formed from iron-ore fines and iron-ore concentrate is designated iron-ore agglomerate. Agglomerates are commonly formed by sintering, nodulizing, pelletizing or briquetting processes, and the lumps so formed are designated individually as sinter, nodules, pellets, and briquets, respectively. Several types of agglomerates produced in 1958 had not yet been given a commonly accepted name.

TABLE 12.—Consumption of iron ore in the United States in 1958, 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, Kentucky, Tennessee, Texas	5,285,286	487,295	2,556,236					8,401,809
Alabama				--------	23,654	--------	--------	
Kentucky				--------	--------	--------	--------	
Tennessee				--------	(1)	--------	--------	
Texas				--------	49,338	--------	--------	
California, Colorado, Utah	3,186,211	499,441	2,308,490					6,036,950
California				--------	42,808	--------	--------	
Colorado				--------	--------	--------	--------	
Utah				--------	(1)	--------	(1)	
Delaware, Maryland, West Virginia	3,971,680	784,556	4,244,936					9,001,172
Delaware				--------	--------	--------	--------	
Maryland				--------	(1)	--------	--------	
West Virginia				--------	(1)	--------	--------	
Illinois, Indiana	14,211,420	1,123,730	2,174,178					17,509,328
Illinois				--------	(1)	--------	--------	
Indiana				--------	--------	--------	--------	
Massachusetts, New York	2,411,996	387,084	2,525,991					5,344,067
Massachusetts				--------	--------	--------	--------	
New York				(1)	18,996	(1)	(1)	
Michigan, Minnesota	3,437,896	362,559	11,064,361					14,864,816
Michigan				--------	--------	--------	--------	
Minnesota				--------	--------	--------	(1)	
Ohio, Pennsylvania	19,969,031	2,456,681	7,590,171					30,052,142
Ohio				(1)	(1)	(1)	--------	
Pennsylvania				(1)	36,259	(1)	--------	
Undistributed [2]	--------	--------	--------	158,798	83,531	13,279	433,649	689,257
Total	52,473,520	6,101,346	32,464,363	158,798	254,586	13,279	433,649	91,899,541

[1] Included with "Undistributed."

[2] Includes States indicated by footnote 1 plus the following: For cement, Virginia, Georgia, Florida, Louisiana, Iowa, Missouri, South Dakota, Kansas, Oklahoma, Arkansas, Montana, Idaho, Oregon, and Washington; for paint, Virginia and Georgia; for other uses, Montana, Nevada, and Washington; also, for ferroalloy furnaces, Oregon.

TABLE 13.—Production and consumption of agglomerates in the United States in 1958, by States, in thousand long tons

State	Agglomerate produced	Agglomerate consumed [1] In blast furnaces	Agglomerate consumed [1] In steel furnaces
Alabama, Kentucky, Tennessee, Texas	2,669	3,166	
Alabama, Kentucky			37
Tennessee			----
Texas			----
California, Colorado, Utah	2,323	2,318	----
Delaware, Maryland, West Virginia	4,382	4,568	
Delaware			----
Maryland			----
West Virginia			(2)
Illinois, Indiana	3,222	4,146	467
New York	2,849	2,455	(2)
Michigan, Minnesota	10,797	1,956	
Michigan			(2)
Minnesota			----
Ohio, Pennsylvania	9,633	14,058	527
Total	35,875	32,667	1,126

[1] Includes 1,505,242 long tons of agglomerates produced in foreign countries.
[2] Included in total.

In table 13 the 35.9 million long tons of agglomerates produced included 26.6 million tons of sinter, 8.5 million tons of pellets, 66,000 tons of briquets, 1,000 tons of nodules, and 685,000 tons of unclassified agglomerate. Agglomerates consumed in blast furnaces included 25.7 million tons of sinter, 5 million tons of pellets, 67,000 tons of briquets, 31,000 tons of nodules, and 1.9 million tons of unclassified and foreign agglomerate. Agglomerates consumed in steel furnaces included 499,000 long tons of sinter, 251,000 tons of nodules, 65,000 tons of pellets, 9,000 tons of briquets, and 301,000 tons of unclassified and foreign agglomerate.

STOCKS

The U.S. stock of usable iron ore at mines, docks, and consuming plants was an essential factor in modulating iron-ore output in 1958. The year began with stocks much above normal, and despite the small domestic iron-ore output and decreased imports, stocks on December 31, 1958 totaled 67.7 million long tons, 2 million tons more than at the same time in 1957.

Stocks at consuming plants, totaling 54.7 million long tons, were composed of 49.6 million tons of iron ore, 4.0 million tons of iron-ore agglomerates, and 1.1 million tons of manganiferous iron ore; and according to the American Iron Ore Association, stocks of ore at U.S. docks (principally Lake Erie docks) totaled 5.6 million tons on December 31, 1958.

TABLE 14.—Stocks of usable iron ore at mines, Dec. 31, by States, in thousand long tons

State	1957	1958	State	1957	1958
Alabama	97	70	New Jersey	[2] 41	(1)
California	(1)	(1)	New Mexico	[2] 0	----
Colorado	----	(1)	New York	(1)	(1)
Georgia	15	----	Pennsylvania	(2)	----
Idaho	----	5	Texas	(1)	(1)
Michigan	2,658	2,953	Utah	472	528
Minnesota	2,904	2,622	Wisconsin	205	490
Montana	----	1			
Nevada	[2] 0	45	Total	[2] 6,776	7,459

[1] Included in the United States total. [2] Revised figure.

PRICES

The average value of domestic usable iron ore per long ton f.o.b. mines, excluding byproduct ore, was $8.61 in 1958, compared with $8.31 in 1957, $7.47 in 1956, and $7.11 in 1955. 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. The average value increase was due to the appreciable increase in the average grade of usable ore because Lake Erie prices were not changed, and these prices are the basis for valuing Lake Superior district ore. Variations in iron-ore value in other districts were not enough to affect the average, inasmuch as Superior district ore comprised 76 percent of the total.

E&MJ Metal and Mineral Markets quoted Lake Superior iron ore, 51.5 percent iron, a long ton, lower lake ports, in 1958 as follows: Mesabi Non-Bessemer $11.45, Old Range Non-Bessemer $11.70, Mesabi Bessemer $11.60, Old Range Bessemer $11.85. The same publication quoted Eastern ores, foundry and basic, at 17 and 18 cents a long ton delivered; Swedish ore, 60 to 68 percent iron, term contracts, at 25 cents plus a short ton unit, depending on grade; Brazilian ore a long ton, 68.5 percent iron, f.o.b. port of shipment, at $14.60, premium for low-phosphorus ore, effective January 1 and April 1, 1958, smaller sellers, $11.50 to $12.00.

TABLE 15.—Average value a long ton of iron ore at mines in the United States in 1958

State	Direct-shipping ore			Iron-ore concentrates			Iron-ore agglomerates
	Hematite	Brown ore	Magnetite	Hematite	Brown ore	Magnetite	
Alabama	$6.53	$5.23		$6.61	$5.40		$6.61
Michigan	8.44			9.61			10.83
Minnesota	7.74			7.95			10.29
Utah	7.17	7.56	$7.18				
Other States	8.63	4.25	8.24	10.46	7.76	$13.37	14.70
United States	7.74	4.51	7.57	8.20	7.09	13.37	11.11

Freight Rates.—Federal transportation tax of 3 percent effective December 1, 1942, was cancelled July 31, 1958. Freight charges from the Mesabi range to the Pittsburgh-Wheeling district via the Great Lakes effective February 15, 1958, totaled $6.56 per long ton compared with the $6.23 total effective August 26, 1957, and the $5.64 total in 1957 before the change. Component charges in 1958 were: $1.47, Mesabi range to Duluth, including $0.19 dock handling charge; $2.28, Duluth to Lake Erie ports, including $0.28 handling charge for hold to rail of vessel; and $2.81, Lake Erie ports to the Pittsburgh-Wheeling district, including $0.19 handling charge from rail of vessel to car.

TRANSPORTATION

Preliminary data indicate that ocean shipments of iron ore were not decreased as much in 1958 compared with 1957 as were both world-wide iron-ore production and consumption. This was principally because a large percentage of the iron ore that enters world trade is sold on long-term contracts or is produced in foreign countries by integrated iron and steel companies for their own use. Many shipments were continued, however, because of demand for high-grade ore in nearly all consuming centers and availability of surplus ocean ore carriers. In fact, these circumstances enabled some iron-ore producers in the Western Hemisphere to establish new trade with consumers in Europe.

Domestic transportation of iron ore followed past patterns despite the recession in the iron and steel industry and the opening of the St. Lawrence Seaway to shallow draft ships. Very little iron ore was moved to consuming plants by truck; railroad shipments were greatly curtailed; and fewer ore carriers operated during a shortened Great Lakes shipping season.

Great Lakes.—Iron-ore carriers loaded at Marquette, Mich., and Silver Bay, Minn., on April 26 opened the Great Lakes shipping season. The last ship of the season was loaded December 7 at Marquette, Mich. An average of less than 170 vessels out of a total carrier fleet of 250 operated throughout the season. Many of the ore carriers started late and quit 3 weeks or more before the season's end.

Greak Lakes shipments from U.S. ports were 38 percent less and from Canadian ports, 35 percent less than in 1957. May shipments were only 30 percent of those in May 1957, but from then on the percentage increased each month to 74 percent in October and 111 percent in November, thus accurately reflecting decreasing business activity in the last half of 1957 and accelerating recovery in the last half of 1958.

Taconite Harbor, the new ship-loading facility on the Minnesota shore of Lake Superior, which was built by Erie Mining Company to serve its plant at Aurora, handled 2.7 million tons of iron-ore agglomerate in its first full season of operation. Reserve Mining Company's taconite agglomerate loading facilities at Silver Bay handled 5 million tons, about 100,000 tons less than in 1957.

St. Lawrence Seaway.—U.S. Seaway facilities were officially opened to 14-foot-draft ships on July 4. With these facilities operating the Great Lakes-St. Lawrence waterway system provided 34-foot controlling depth from the Atlantic Ocean to Montreal, Canada, 14-foot controlling depth from Montreal to Ogdensburg, N. Y., and 21-foot controlling depth upbound and 25-foot downbound from Ogdensburg to the head of the Great Lakes, a distance of about 2,300 miles. Freight on the Seaway section, Montreal to Lake Ontario, from July 4 until the shipping season ended on December 16, totaled 8 million tons of which 1.1 million tons was iron ore.

Toll Committees of Canada and the United States in complete agreement submitted identical recommendations on the tolls that should be assessed for operating and maintenance costs of the St. Lawrence Seaway to amortize the capital cost over a period not to exceed 50 years. Because only certain sections of the Seaway were operating and these only for part of the season, tolls were not collected in 1958.

RESERVES

Iron-ore reserves of Michigan and Minnesota, given in tables 16 and 17, are recalculated each year as deposits are explored and mined and represent only taxable and State-owned reserves, excluding jaspilite and taconite resources.

TABLE 16.—Iron ore reserves in Michigan, Jan. 1, in thousand long tons

[Michigan Department of Conservation]

Range	1950–54 (average)	1955	1956	1957	1958	1959
Gogebic	31, 361	31, 326	30, 810	26, 209	25, 187	23, 547
Marquette	65, 773	69, 549	63, 820	64, 464	64, 027	58, 719
Menominee	60, 189	59, 322	58, 284	63, 536	60, 877	58, 535
Total Michigan	157, 323	160, 197	152, 914	154, 209	150, 091	140, 801

TABLE 17.—Unmined iron-ore reserves in Minnesota, May 1, in thousand long tons

[Minnesota Department of Taxation]

	1949–53 (average)	1954	1955	1956	1957	1958
Mesabi	880, 042	825, 292	787, 992	739, 971	697, 267	618, 606
Vermilion	12, 347	12, 063	11, 307	10, 449	9, 641	9, 044
Cuyuna	41, 831	58, 903	58, 859	54, 518	52, 337	44, 416
Total Lake Superior district (taxable)	934, 220	896, 258	858, 158	804, 938	759, 245	672, 066
Fillmore County	645	573	666	926	1, 125	2, 088
Morrison County	29					
Aitkin County	340	870	870	825	825	825
Mower County		118	118	118	118	173
Olmsted County						28
State ore (not taxable)	2, 360	117	117	2, 352	2, 629	1, 134
Total Minnesota	937, 594	897, 936	859, 929	809, 159	763, 942	676, 314

FOREIGN TRADE[3]

Iron ore imported for consumption in the United States was 18 percent less than in 1957, thus reversing a 5-year trend of rapidly increasing iron-ore imports. Despite the decrease, for the first time in history imported ore accounted for more than one-fourth of the total domestic supply.

Chile was the only major supplier that increased the quantity of iron ore shipped to the United States—shipments totaled 3.3 million tons, 22 percent more than in 1957. Venezuela displaced Canada as the principal supplier by a wide margin as Canadian shipments declined 34 percent, but Venezuela's were only 2 percent less than in 1957. Iron-ore trade with both Chile and Venezuela was sustained because the ore went to consuming plants in the southeastern and eastern districts where iron-ore stocks had not been built up to abnormally high levels in 1957, as were the stocks in other districts. Moreover, Canadian iron-ore shipments to eastern markets were greatly curtailed, and much Canadian ore that normally would have been sent to the United States was directed to Europe. Among the other major suppliers, Brazil's shipments to the United States declined 43 percent, Peru's 29 percent, and Liberia's 20 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.

TABLE 18.—Iron ore[1] imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1949–53 (average)		1954		1955		1956		1957		1958	
	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)
North America:												
Canada	1,819	$13,561	3,537	$28,623	10,077	$79,058	13,723	$117,666	12,537	[2] $111,777	8,293	$77,354
Costa Rica	(3)	1										
Cuba	66	571	32	314	43	329	93	910	33	346		
Dominican Republic	20	229	89	1,067	102	1,173	163	2,043	149	2,025	21	298
Mexico	177	534	141	418	176	574	133	447	236	[2] 744	221	739
Panama							(3)	3			14	164
Total	2,082	14,896	3,799	30,422	10,398	81,134	14,112	121,069	12,955	[2] 114,892	8,549	78,555
South America:												
Argentina	(3)	5										
Brazil	712	7,452	596	7,016	1,011	11,216	1,223	15,416	1,431	20,275	832	12,004
Chile	2,445	8,578	1,664	7,866	1,035	5,380	1,564	10,813	2,741	20,641	3,257	25,876
Peru	169	1,191	1,932	15,595	1,559	13,691	1,840	16,405	[2] 2,373	[2] 20,859	1,666	16,758
Venezuela	886	7,084	5,210	36,035	7,160	45,549	9,254	61,929	[2] 12,291	[2] 87,733	12,170	87,915
Total	4,212	24,310	9,402	66,512	10,765	75,836	13,881	104,563	[2] 18,836	[2] 149,508	17,925	142,553
Europe:												
Spain	20	167	(3)	5							(3)	6
Sweden	2,161	19,007	1,544	14,241	1,221	12,335	999	11,914	677	9,575	113	1,640
United Kingdom	(3)	25	(3)	30	2	58	1	39	(3)	35	1	53
Other Europe	1	14					(3)	4	(3)	4	(3)	5
Total	2,182	19,213	1,544	14,276	1,223	12,393	1,000	11,957	677	9,614	114	1,704
Asia:												
Iran	2	140	3	201			4	266			2	167
Philippines	2	18					23	381			54	1,131
Total	4	158	3	201			27	647			56	1,298
Africa:												
Algeria	289	1,796	29	339	20	245	11	86				
British West Africa	191	1,202	251	1,404	138	800	162	1,053	170	1,253	49	351
Liberia	279	1,895	764	6,305	928	7,049	1,218	11,115	1,013	9,784	837	7,092
Other Africa	90	498							(4)	(4)		
Total	849	5,391	1,044	8,048	1,086	8,094	1,391	12,254	[2] 1,183	[2] 11,037	886	7,443
Grand total	9,329	63,968	15,792	[5] 119,459	23,472	177,457	30,411	250,490	[2] 33,651	[2] 285,051	27,530	231,553

[1] In addition, pyrites cinder (byproduct iron ore) were imported as follows: 1949–53 (average), 11,040 long tons ($44,564); 1954, 898 tons ($3,556); 1955, 3,879 tons ($15,801); 1956, 1,430 tons ($5,972); 1957, 567 tons ($2,222); 1958, 2,721 tons ($9,212) all from Canada: 1955 and 1957.

[2] Revised figure.

[3] Less than 1,000.

[4] Revised to none.

[5] Data known to be not comparable with other years.

TABLE 19.—Iron ore exported from the United States, by countries of destination

[Bureau of the Census]

Country	1949–53 (average)		1954		1955		1956		1957		1958	
	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)	Long tons (thousand)	Value (thousand)
Canada	3,141	$20,472	2,813	$21,669	4,232	$34,077	4,529	$39,272	3,958	[1] $36,871	2,943	$29,229
Japan	594	5,752	332	3,065	285	2,874	974	9,313	1,041	10,532	493	5,044
Mexico	(2)	(2)	(2)	2			3	41	1	8	(2)	4
Philippines	1	8			(2)	40					(2)	2
Union of South Africa			1	44			2	143	2	125	3	140
Other countries	(3)	7	(3)	4	(3)	2	(3)	36	(3)	7	(3)	8
Total	3,736	26,239	3,146	24,784	4,517	36,993	5,508	48,805	5,002	[1] 47,543	3,439	34,427

[1] Revised figure.
[2] Less than 1,000.
[3] Includes countries less than 1,000 tons each.

WORLD REVIEW

The statistical pattern of iron-ore transactions in international trade in the past have not emerged with enough accuracy to balance until 2 years after the close of the period. This year, however, enough foreign iron ore statistics were available within 18 months to achieve a satisfactory balance. World iron-ore export-import statistics, therefore, are presented for both 1956 and 1957.

International trade in iron ore was much less than in either 1956 or 1957. Preliminary estimates indicate, however, that demand for high-grade ore in West Germany, Italy, Great Britain, Poland, Hungary, and Yugoslavia sustained the level of world trade above the relative level of U.S. iron-ore imports. Furthermore, some iron-ore trade, such as that between Canada and United Kingdom, and Sweden and United Kingdom and West Germany, was sustained by long-term purchase contracts, and in 1958 Brazilian iron ore was sold in European countries, thus consumating negotiations that were started in 1956.

TABLE 20.—World trade of iron ore, iron-ore concentrates, iron-ore agglomerates, in 1956, in thousand long tons

[Compiled by Corra A. Barry and Berenice B. Mitchell]

Exports by countries of origin	Fe (percent)[1]	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, East	Europe: Germany, West	Europe: Italy	Europe: Netherlands	Europe: Poland	Europe: Saar	Europe: Spain	Europe: United Kingdom	Asia: Japan	Other countries
North America:																				
Canada	55	19,954	18,094	------	13,736	------	------	------	------	------	------	1,445	21	[2] 83	------	------	------	2,505	304	(3)
Cuba	62	135	134	------	122	------	------	------	------	------	------	------	------	11	------	------	------	1	------	------
Dominican Republic	66	161	160	------	160	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Mexico	68	801	133	(3)	133	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
United States	49	97,877	5,508	4,529	------	------	------	------	------	------	------	------	------	------	------	------	------	------	974	5
South America:																				
Brazil	68	4,011	2,702	60	1,295	9	3	72	------	6	------	508	49	55	34	------	------	563	48	------
Chile	64	2,624	2,039	------	1,695	------	------	------	------	------	------	305	------	27	------	------	------	------	12	------
Peru	62	2,604	2,631	------	[2] 1,840	------	------	------	------	------	------	------	------	------	------	------	------	------	330	461
Venezuela	61	10,930	11,163	------	9,667	------	------	------	------	------	------	575	170	------	------	------	------	669	82	------
Europe:																				
Austria	32	3,207	53	------	------	------	------	53	------	------	------	------	------	------	------	------	------	------	------	------
Belgium-Luxembourg	28	7,616	608	------	------	------	------	------	------	59	------	549	------	------	------	------	------	------	------	(3)
Finland	36	203	312	------	------	------	------	11	------	------	14	41	17	10	155	------	------	61	------	3
France	33	51,872	21,298	------	------	------	12,435	------	------	------	------	581	------	103	------	7,577	------	599	------	3
Germany, West	27	16,661	332	------	------	280	2	2	------	1	------	------	2	4	------	37	------	------	------	4
Greece	49	323	403	------	------	90	------	------	------	------	------	200	103	------	------	------	------	------	------	10
Italy	29	1,648	41	------	------	------	------	------	------	------	------	41	------	------	------	------	------	------	------	------
Norway	65	1,526	1,242	------	------	130	39	28	9	3	------	788	------	2	131	------	------	111	------	1
Portugal	50	233	236	------	------	------	------	------	------	------	------	106	5	2	------	------	------	123	------	(3)
Spain	45	4,410	3,207	------	------	[2] 50	12	------	2	142	------	[2] 1,726	26	[2] 157	------	------	------	893	------	199
Sweden	60	18,648	17,032	------	975	123	2,933	83	129	205	6	7,131	206	368	515	------	------	4,340	------	18
Switzerland	40	129	135	------	------	------	------	------	------	1	------	134	------	------	------	------	------	------	------	------
U.S.S.R.	55	76,900	8,980	------	------	------	------	2,869	------	------	1,254	------	------	------	3,365	------	------	------	------	1,492
United Kingdom	30	16,245	1	------	(3)	------	------	------	------	------	------	------	------	------	------	------	------	------	------	1
Yugoslavia	45	1,698	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

Asia:																			
China	50	[1] 8,900	[4] 198					(4)							187				11	
Hong Kong	45	123	124																120	4
India	53	4,858	1,693				6	406				32			115				1,037	97
Malaya	45	2,445	2,376															3	2,364	9
Philippines	54	1,417	1,501	15	22								4					1	1,454	5
Portuguese India	55	2,505	2,041			87						388	416		19				1,103	28
Turkey	60	915	235			1						102	130							2
Africa:																				
Algeria	52	2,587	2,451			114	48			58		526	114	198				1,393		
French Guinea	53	840	820				37					81			101			601		
Liberia	68	2,108	2,027	31	1,185		14					344	21	[2] 112				310		10
Morocco:																				
Northern Zone	67	1,356	1,431				5			103		588		[2] 71			393	271		
Southern Zone	45	482	381			3				1		65	(3)	1				311		
Sierra Leone	60	1,311	1,328		152							463	19	11				683		
Tunisia	53	1,151	1,139			42				46		80	86	69	27			789		
Union of South Africa	62	2,031	28									14	(2)	2					12	
Oceania: Australia	60	3,924																		
Other countries		[1] 11,144	(5)																	
Total		388,513	114,217	4,635	30,982	929	15,534	3,524	140	625	1,274	16,813	1,389	1,286	4,649	7,614	393	14,227	7,851	2,352

[1] Estimate.
[2] Imports.
[3] Less than 500 tons.
[4] Trade agreements between China and Czechoslovakia indicate shipments of iron ore from China, but the quantity is unknown.
[5] Data not available.

TABLE 21.—World trade of iron ore, iron-ore concentrates, iron-ore agglomerates, in 1957, in thousand long tons

[Compiled by Corra A. Barry and Berenice B. Mitchell]

Exports by countries of origin	Fe (percent)[1]	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, East	Europe: Germany, West	Europe: Hungary	Europe: Italy	Europe: Netherlands	Europe: Poland	Europe: Saar	Europe: United Kingdom	Asia: Japan	Other countries
North America:																				
Canada	55	19,886	17,973		12,613		146			[2] 130		[2] 1,272		109	[2] 67			3,047	336	253
Cuba	62	105	103		31							[2] 3								69
Dominican Republic	66	180	147	(3)	147															
Mexico	68	[1] 935	235	(3)	235							(3)								
United States	49	106,148	5,002	3,958								(3)							1,041	3
South America:																				
Brazil	68	4,898	3,481	207	1,473			183		43		486	18	52	85	99		704	131	
Chile	64	2,638	3,005		2,688							263		8	34				12	
Peru	62	3,522	3,619		[2] 2,359							[2] 794							358	108
Venezuela	60	15,054	15,215		12,152		8					1,015		672				1,346	22	
Europe:																				
Austria	32	3,441	49					49				(3)		(3)						(3)
Belgium-Luxembourg	28	7,855	504							132		372								(3)
Finland	36	207	315					33			11	11	1	19	10	160		60		10
France	33	56,865	22,070				12,362					1,048			57		7,985	618		(3)
Germany, West	27	18,031	365			298	1	(3)		1				2	[2] 4		58			1
Greece	49	424	404			137						151		102						14
Italy	29	1,562	69			33						30			6					
Norway	65	1,478	1,224			80	38	28	12	3		710			13	123		211		6
Portugal	50	281	248									113						135		
Spain	45	5,291	3,408			63	11			192		[2] 1,560		39	[2] 158			1,021		364
Sweden	60	19,609	17,191		685	157	3,016	93	123	252		7,509	13	216	[2] 286	571		4,262		8
Switzerland	40	114	101							(3)		101								
U.S.S.R.	55	82,900	10,603					3,500			1,503		1,121			3,930				549
United Kingdom	30	16,902	1		(3)							[2] 1								
Yugoslavia	45	1,846	69										69							
Asia:																				
China	50	[1] 10,800	[4] 191					(4)								191				
Hong Kong	45	94	104																102	2
India	53	5,074	2,216					477			13	8	23	104	4	138			1,347	102
Malaya	45	2,972	2,920												25				2,877	18

Philippines	54	1,325	1,287																1,287	
Portuguese India	55	2,901	2,625			95		46		4		645	9	385	32	55		49	1,305	(3)
Turkey	60	1,146	500		18	5						297		180						
Africa:																				
Algeria	52	2,746	2,702		8	44	47			134		632		[2] 217	113	19		1,488		
French Guinea	53	1,074	1,003				15					223				176		589		
Liberia	68	1,935	2,129	31	1,002							329			[2] 132			331		304
Morocco:																				
Norther Zone	67	[5] 1,439	1,439							126		652		8	111			230		312
Southern Zone	45	461	469							3		86						380		
Sierre Leone	60	1,324	1,487		160	28						342			[2] 150			737		70
Tunisia	53	1,156	1,164			86				55		108		116	20	23	7	749		
Union of South Africa	62	2,047	10									2							8	
Oceania: Australia	60	3,806																		
Other countries		[1] 12,161	(6)																	
Total		422,633	125,647	4,196	33,571	1,026	15,644	4,409	135	1,075	1,527	18,763	1,254	2,229	1,307	5,485	8,050	15,957	8,826	2,193

[1] Estimate.
[2] Imports.
[3] Less than 500 tons.
[4] Trade agreements between China and Czechoslovakia indicate shipments of iron ore from China, but the quantity is unknown.
[5] Exports.
[6] Data not available.

TABLE 22.—World production of iron ore, iron-ore concentrates, and iron-ore agglomerates, by countries, in thousand long tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	4,240	6,573	14,539	19,954	19,886	14,160
Cuba	65	25	129	135	105	[2] 145
Dominican Republic	[3] 55	105	99	161	180	30
Guatemala	[2] 2	[2] 2	[2] 3	[2] 3	4	5
Mexico	456	514	705	801	[2] 935	[2] 955
United States	103,080	78,129	102,999	97,877	106,148	67,947
Total	107,898	85,348	118,474	118,931	127,258	83,242
South America:						
Argentina	[2] 54	60	74	64	66	138
Brazil	2,571	3,023	3,329	4,011	4,898	[2] 5,155
Chile	2,789	2,164	1,512	2,624	2,638	3,700
Colombia	----------	82	344	388	584	543
Peru	[4] 985	2,188	1,703	2,604	3,522	2,550
Venezuela	[5] 1,411	5,304	8,306	10,930	15,054	15,240
Total	7,810	12,821	15,268	20,621	26,762	27,326
Europe:						
Albania	(6)	(6)	(6)	(6)	(6)	87
Austria	2,190	2,678	2,793	3,207	3,441	3,357
Belgium	79	81	104	142	136	122
Bulgaria	[2] 59	116	111	232	267	[2] 295
Czechoslovakia	1,635	2,158	2,451	2,499	2,766	[2] 2,700
Finland	[4] 17	132	182	203	207	212
France	35,411	43,134	49,517	51,872	56,865	58,516
Germany:						
East	[2] 640	1,447	1,638	1,729	1,455	1,482
West	12,389	12,830	15,436	16,661	18,031	17,704
Greece	64	76	189	323	424	295
Hungary	334	421	347	344	273	300
Italy	666	1,074	1,372	1,648	1,562	1,263
Luxembourg	5,516	5,794	7,091	7,474	7,719	6,533
Norway	563	1,078	1,236	1,526	1,478	1,529
Poland	925	1,550	1,827	1,942	1,963	[2] 2,120
Portugal	[7] 84	110	187	233	281	214
Rumania	[2] 490	590	627	683	634	[2] 690
Spain	2,409	2,869	3,709	4,410	5,291	4,831
Sweden	15,089	15,083	17,080	18,648	19,609	18,104
Switzerland	84	100	127	129	114	[2] 77
U.S.S.R. [8]	[2] 45,200	63,300	70,800	76,900	82,900	87,400
United Kingdom	14,637	15,557	16,175	16,245	16,902	14,614
Yugoslavia	713	1,093	1,376	1,698	1,846	1,965
Total [8]	139,194	171,271	194,374	208,748	224,164	224,410
Asia:						
Burma	----------	3	4	2	4	4
China [2]	3,200	7,200	6,900	8,900	10,800	29,500
Hong Kong	128	91	115	123	94	105
India	3,444	4,308	4,678	4,858	5,074	5,908
Iran [9]	[7] 11	10	[2] 10	10	11	[2] 11
Japan [10]	1,147	1,605	1,492	1,882	2,200	2,003
Korea:						
North	(6)	[2] 500	(6)	(6)	(6)	[2] 980
Republic of	[7] 30	31	29	62	182	257
Lebanon	[3] 17	49	42	41	41	[2] 15
Malaya	695	1,213	1,466	2,445	2,972	2,795
Philippines	839	1,402	1,410	1,417	1,325	1,082
Portuguese India	423	1,359	2,176	2,505	2,901	[11] 2,466
Thailand	[5] 5	4	5	6	9	15
Turkey	325	573	760	915	1,146	932
Total [8]	10,323	18,348	20,072	24,151	27,744	46,073
Africa:						
Algeria	2,837	2,881	3,541	2,587	2,746	2,278
Angola	----------	----------	----------	----------	104	282
Egypt	----------	----------	----------	130	250	[2] 245
French Guinea	[4] 393	583	640	840	1,074	408
Liberia	[7] 774	1,238	1,870	2,108	1,935	2,218
Morocco:						
Northern Zone	925	916	1,017	1,356	[11] 1,439	----------
Southern Zone	470	329	305	482	461	1,514

TABLE 22—World production of iron-ore, iron-ore concentrates, and iron-ore agglomerates, by countries, in thousand long tons [1]—Continued

Country	1949-53 (average)	1954	1955	1956	1957	1958
Africa—Continued						
Rhodesia and Nyasaland,						
Federation of: Northern Rhodesia	2	1	2			
Southern Rhodesia	57	63	83	114	133	142
Sierra Leone	1,186	817	1,235	1,311	1,324	[11] 1,420
Tunisia	871	935	1,122	1,151	1,156	1,086
Union of South Africa	1,492	1,863	1,967	2,031	2,047	2,177
Total	9,007	9,626	11,782	12,110	12,669	11,770
Oceania:						
Australia	2,449	3,519	3,573	3,924	3,806	3,925
New Caledonia	4			28	230	290
Total	2,453	3,519	3,573	3,952	4,036	4,215
World total (estimate)[1]	276,685	300,933	363,543	388,513	422,633	397,036

[1] This table incorporates a number of revisions of data published in previous Iron Ore chapters.
[2] Estimate.
[3] Average for 1952–53.
[4] Average for 1 year only, as 1953 was the first year of commercial production.
[5] Average for 1950–53.
[6] Data not available for Albania and North Korea; estimate for North Korea only is included in the total.
[7] Average for 1951–53.
[8] U.S.S.R. in Asia included with U.S.S.R. in Europe.
[9] Year ending March 21 of year following that stated.
[10] Includes iron sand production as follows: 1949–53 (average), 226,487 tons; 1954, 501,439 tons; 1955, 541,890 tons; 1956, 846,153 tons; 1957, 1,063,085 tons; and 1958, 854,998 tons.
[11] Exports.

NORTH AMERICA

Canada.[4]—Canada's iron-ore production did not decrease in the same proportion as that of the United States because of the relative greater stability of the Canadian steel industry and sustained exports to Europe. Canadian activity in exploration and development of iron-ore deposits was especially significant in 1958. Properties that were being developed will bring Canadian annual production capacity to approximately 35 million tons by 1962, and more than 100 separate companies conducted exploration programs.

British Columbia.—The Supreme Court of the Provincial Government of British Columbia on July 17 ruled that assessments made under the Provincial Mineral Act, which abolished the system of crown granted mineral claims and imposed maximum and minimum taxes on iron-ore exports, were invalid. The British Columbia government appealed the decision in October.

Texada Mines, Ltd., continued shipping magetite concentrates to Japan, and Empire Development Co., Ltd., resumed production in May and sent its first shipment to Japan in July.

Newfoundland-Quebec.—Quebec Cartier Mining Co. contracted for a beneficiation plant, 193 miles of railway, a hydroelectric power dam, and other surface facilities for exploiting its Lac Jeannine deposit. Several hundred million tons of specularite (32 percent iron) are contained in this deposit, and the company continued exploration and development on other claims in the Mount Reed and Mount Wright areas, a few miles north and northeast, respectively.

[4] Elver, R. B., Mineral Resources Division, Canadian Mineral Industry—1958 (Preliminary), Review 12: Dept. of Mines and Technical Surveys, Ottawa, Canada, 1958, 16 pp.

Iron Ore Company of Canada continued to explore and develop iron-bearing deposits on leases from Hollinger North Shore Exploration Company Ltd. and Labrador Mining and Exploration Co., Ltd. Several hundred million tons of 37 percent iron in magnetite-specularite formations have been proved in the Wabush Lake area of Labrador.

Quebec Iron and Titanium Corporation suspended smelting operations in October despite the strong market for its remelt iron. A sharp drop in demand for titanium-rich slag, a coproduct of the operation, forced suspension.

Ontario.—Iron-ore exploration was intensive and widespread throughout Ontario. Anaconda Iron Ore (Ontario) Ltd., Cliffs of Canada, Ltd., El Sol Gold Mines Ltd., Iron Bay Mines Ltd., Panther International Mining Co. Ltd., and The Steel Company of Canada, Ltd., were among the active participants.

Steep Rock Iron Mines, Ltd., continued development of the new Hogarth underground mine and the "G" open pit. The company built two concentration plants to meet the increasing demand for tailored ores.

Algoma Ore Properties, Ltd. began production of siderite ore in the Sir James open-pit mine early in the year. Underground development of the lower level of the Helen and Victoria mines continued, and the company's sinter plant was expanded to an annual capacity of 2 million tons.

Lowphos Ore Ltd. completed its beneficiation plant but deferred production until 1959. The new plant has an annual rated capacity of 550,000 tons.

Mexico.—The Mexican Government announced that El Cerro De Mercado iron-ore deposit in the State of Durango had been placed in the National Mineral Reserve but that present concessions were not affected in any way. El Cerro Del Mercado, the iron mountain rising about 700 feet above the surrounding planes, contains an estimated 600 million tons of hematite averaging 60–67 percent iron.

Consejo de Recursos Naturalesno Renovables, a Mexican Federal Government Agency, in exploring the municipality of La Huerta, Jalisco, found iron deposits covering about 30 square miles.[5] The grade and extent of the deposits were not determined.

Minera Ducro, S.A., an American and Mexican owned mining concern, was granted two 50-hectare (247 acres) and three 100-hectare (741 acres) claims 7 miles from Colima and 40 miles from the port of Manzanilla, in Colima, Mexico, in an area reported to contain 54 million tons of magnetite ore.[6]

SOUTH AMERICA

Brazil.—The M. A. Hanna Co. of Cleveland, Ohio (through its subsidiary, Hanna Coal and Ore Corp.), with Leo Model and Associates of New York, N. Y., assumed direction of the St. John del Rey Mining Co., a British corporation that operated Brazil's largest gold mine for many years. The St. John del Rey Mining Co. owns the largest high-grade iron-ore reserve in Brazil. Reserves extend over

[5] U.S. Consulate, Guadalahara, Jalisco, Mexico, State Department Dispatch 23: Dec. 31, 1958.
[6] Engineering and Mining Journal, vol. 159, No. 11, November 1958, p. 204.

an area of more than 100 square miles, 200 air miles north of Rio de Janeiro. Before the St. John del Rey iron-ore deposits can be exploited, a new transportation line to the ocean and dock and loading facilities will have to be built.

The Government owned Vale do Rio Doce Co. maintained its price of $14.60 per long ton f.o.b. at Vitoria, based on 68½ percent iron and announced plans to continue its expansion program to permit shipping 5 million tons annually by 1960 to 1962.[7] The company's high-grade ore was shipped to the United States for open-hearth steel furnace feed and also was a significant factor in Brazil's trade with the Soviet Bloc countries, Czechoslovakia, Poland, and Hungary.

Chile.—The Mining Company of Nahuelbuta, Corporation of Chile, Chilean Mining Bank, and Krupp-Renn formed a company with capital of $16 million to develop an iron-ore deposit near Lake Lleu Lleu, Canet, Province of Arauco. The company will construct a Krupp-Renn iron-ore direct-reduction plant with capacity to produce 270,000 tons of 96 percent iron "luppen" annually.[8]

The Chilean Ministry of Economy authorized the Canadian Foreign Ore Development Corporation of Ottawa, Canada to invest $5 million in equipment to be used by the Cia. Minera Santa Fe in its mining operations. Most of the machinery purchased was for equipping the ports of Caldera and Chanaral with mechanical ore-dressing facilities.[9]

A significant iron mineral discovery was made in the interior of Antofagasta Province of Chile, close to the Argentine frontier.[10]

United States, West Germany, Czechoslovakia, Netherlands, Japan and Belgium were recipients of iron ore exported from Chile by independent iron-ore producers. The principal iron-ore producer in Chile was the Bethlehem Chile Iron Mines Company, which is required by the Chilean Government to supply all iron ore needed by the Compania de Acera del Pacifico before exporting any ore.

Peru.—Marcona Mining Co., the sole iron-ore producer in Peru, received a $10 million credit from the Export Import Bank to assist the company in undertaking a $25 million construction and expansion program. The new facilities will enable Marcona to produce high-grade iron concentrate from the low-grade deposits at San Juan.[11]

Venezuela.—Iron-ore mining in Venezuela was only slightly affected by the business recession as Iron Mines Co. of Venezuela and Orinoco Mining Co. maintained the operating levels reached in 1957.

Minero Ferroviaria de Venezuela, C.A., a company formed in 1957 to develop the El Trueño deposits southwest of Ciudad Bolivar, under a profit-splitting agreement on a concession owned by Trans Western de Venezuela, C.A., was completely inactive.

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[7] Skillings' Mining Review, vol. 45, No. 51, Mar. 22, 1958, p. 11.
[8] Mining World, vol. 20, No. 10, September 1958, p. 132.
[9] U. S. Embassy, Santiago, Chile, State Department Dispatch 807: Feb. 14, 1958.
[10] Mining Journal (London), vol. 251, No. 6426, Oct. 17, 1958, p. 422.
[11] American Embassy, Lima, Peru, State Department Dispatch 744: Apr. 8, 1958.

EUROPE

Austria.—Alpine Montan A.G., Austria's largest iron-ore mining company, reported that it found a mineral deposit containing about 4 million tons of high-grade iron ore in the Huettenberg area of Styria Province.[12]

France.—The High Authority of the European Coal and Steel Community requested the French Government to eliminate discriminatory freight rates on shipments from western mines to other parts of France and on export shipments to coal and steel community countries.[13] Action on the request was not reported, but in order to meet competition from community members, French iron-ore producers cut prices 8 to 10 percent in a new schedule that was effective January 1, 1958.

A new iron-ore mine was officially opened in Saizerais, near Nancy, in a deposit estimated to contain 100 million tons of ore. After beneficiation, the iron content of the ore ranges from 32–34 percent.[14]

Germany, West.—The High Authority of the European Coal and Steel Community directed the Deutsche Bundesbahn to suspend preferential freight rates on the transport of certain German-mined iron ore. The order was issued to eliminate preferential rates which in reality constituted Governmental subsidization of uneconomic enterprise.[15]

West German iron-ore production declined slightly, but much less than in many other countries.

Italy.—Italian steel companies have tended to increase the percentage of imported iron ore in the charges to the blast furnaces, principally to meet competition because higher purity imported ore requires less coke and thus reduces the cost of producing pig iron. Abolishment of the last protective barriers within the European Coal and Steel Community accentuated this tendency. Venezuela, Portugal, India, and Algeria, in that order, were the principal suppliers of foreign iron ore to the Italian industry.[16]

Norway.—Inasmuch as most iron ore produced in Norway was sold on contract, producers there were not seriously affected by the lower world demand for iron and steel.[17]

Spain.—Exploitation of an iron mine, at Cohegin, Murcia, abandoned since 1932, was resumed. Some 3 million tons of iron ore were obtained since the beginning of the century. Reserves are estimated at more than that quantity. The ore was shipped from the ports of Alicante, Cargegeha, and Aguilas (Murcia) at the rate of 300 tons daily.[18]

Sweden.—A Swedish-Polish trade protocol establishing quotas for commodity exchange between the two countries during the year ending April 30, 1959, raised the quota of Swedish iron-ore exports to Poland to 700,000 tons from the previous quota of 650,000 tons.

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[12] Engineering and Mining Journal, vol. 159, No. 8, August 1958, p. 222.
[13] American Embassy, Paris, France, State Department Dispatch 1425: Feb. 18, 1958.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 4, October 1958, pp. 15–16.
[15] American Consul, Stuttgart, Germany, State Department Dispatch 55: Feb. 28, 1958.
[16] U. S. Embassy, Rome, Italy, State Department Dispatch 658: Nov. 26, 1958.
[17] Mining Journal (London), vol. 250, No. 6404, May 16, 1958, p. 271.
[18] American Consulate, Valencia, Spain, State Department Report, Oct. 10, 1958.

Luossavaara-Kiirunavaara A.B. negotiated a new contract with the Swedish State Railways for revised freight rates valid from July 1, 1958 to December 31, 1962.[19]

U.S.S.R.—A delegation of U.S. iron-ore and steel industry representatives that made a 1-month tour of Soviet iron and steel producing facilities reported that the Soviet operating techniques are comparable, and in some instances superior, to those in the United States.

The Soviet Union considers research an important part of its iron-ore and steel industry. Members of the U.S. delegation were particularly impressed with the rapid dissemination of information and almost instant adoption of new developments throughout the Soviet Union as soon as they are proved.

The Soviets use 60–100 percent self-fluxing sinter in their blast furnaces and consequently get more furnace production than is obtained in equal sized furnaces in the United States. The U.S. delegation reported that the Soviet Union steel plant operation was limited by the iron-ore supply, which had slowed down the industry's planned rate of expansion. This was the result of depletion and deterioration of the grade of the iron-ore deposits at Krivoi Rog in the West and Magnitogorsk in the East.

Yugoslavia.—The Chamositic iron-ore deposits near Tajmiste, Western Macedonia, Yugoslavia were described. These deposits are believed to be the largest in Western Macedonia and were investigated as preparation for an iron and steel industry to be launched by the people's Republic of Macedonia.[20]

ASIA

China.—Communist China, as part of a campaign to industrialize rapidly, authorized 10,000 new small iron works, which would produce 20 million tons of iron annually.[21]

The search continued for industrial raw materials in China, and an iron-ore deposit containing at least 4.6 billion and possibly 10 billion tons of ore reportedly was discovered in the province of Kweichow.[22]

India.—The State Trading Corporation of India contracted to supply a total of 2.3 million tons of iron ore to Japan, Czechoslovakia, Italy, Poland, Hungary, Yugoslavia, and East and West Germany in the period July 1957–June 1958.[23]

The first shipment of iron ore was made through the port of Karwar on the Arabian Sea when the Turkish freighter, S. S. Haran, loaded 11,000 tons reportedly destined for Czechoslovakia. Opening this port made it possible to export the rich hematite iron ore from the Hospet area of the Bellary district, Mysore.

Tata Iron & Steel Company began operating a new iron-ore mine at Joda in the Keonjhar district of Orissa in October 1958.[24]

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[19] Metal Bulletin (London), No. 4313, July 22, 1958, p. 17.
[20] Page, B. M., Chamositic Iron Ore Deposits Near Tajmiste, Western Macedonia, Yugoslavia: Econ. Geol., vol. 53, No. 1, January-February 1958., pp. 1–21.
[21] East Europe, 10,000 Small Iron Works: Vol. 7, No. 11, November 1958, p. 13.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 4, October 1958, p. 15.
[23] Indian Mining Journal (Calcutta), vol. VI, No. 3, March 1958, p. 22.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, January 1959, p. 17.

Japan.—The Ministry of International Trade and Industry estimated that Japan would need to import 21 million dry tons of iron ore by 1965. In that year it is estimated that from known resources: India will be the principal source of supply with 4,500,000 tons; Malaya will supply 3,750,000 tons; Communist China and Goa, 2,300,000 tons each; the United States and South American countries, 1,100,000 tons each; and Canada, 1,000,000 tons. Other countries and new sources in the Philippines and Malaya will supply the remainder.[25]

A FluoSolid roast-leach-electrowinning process in use in Japan, which permits economical mining of pyrite and pyrrhotite, producing sulfuric acid, sintered iron-ore and cement copper, was described.[26]

The Mitsubishi group was active in developing Chilean iron-ore deposits near Copiapo, in the State of Atacama.[27] Japanese companies also explored the possibility of obtaining iron ore from Alaska and Communist China.

A Japanese steel mission and the Government of India reached agreement in March 1958 on joint development of Indian iron-ore deposits in the Rourkela area. Under this agreement the ore pricing formula provides for a base price, determined principally by the weighted average price of Indian exports of ore to destinations other than Japan, minus a rebate subject to annual renegotiation. Shipments of ore from the deposits to Japan are not expected until 1964, when mine development and rail transportation and port facilities will be completed.[28]

Malaya.—Eastern Mining & Metals Co. began development of its Ulu Rompin property in Southern Pahang. The major single item in developing the mine will be construction of a 47-mile narrow-gauge railroad connecting the mine with the coast at Menchali, north of the mouth of the Rompin River. The company's currently producing Dungun mine has an estimated 8 million tons of ore remaining, enough for 4 years at the present rate of production, and will be closed coincident with completed development of the Rompin property.[29]

Smaller shipments of Malayan iron ore to Japan were offset to some extent by increased exports to the Netherlands and West Germany.

AFRICA

Algeria.—An increase in Algerian iron-ore production of 50–65 percent was predicted by a work-group of Government and university officials in a paper entitled, "Perspectives Decennales de Developpement Economique de l'Algerie", published by the Ministere de l'Algerie in March 1958. The group forecast that about half of the increased output will come from Ouenza, which has accounted for more than 60 percent of the total Algerian iron-ore output.

[25] U.S. Embassy, Tokyo, Japan, Foreign Service Dispatch 1236: Apr. 15, 1958.
[26] Kurushima, Hidesaburo, and Foley, R. M., FluoSolids Roasting of Dowa's Yanahara Sulfides: Min. Eng., vol. 10, No. 10, October 1958, pp. 1057–1061.
[27] Mining Journal (London), vol. 251, No. 6433, Dec. 5, 1958, p. 638.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 5, May 1958, pp. 9–10.
[29] U.S. Embassy, Kuala Lumpur, Malaya, State Department Dispatch 134: Oct. 9, 1958.

Ouenza reserves have been estimated at 90–100 million tons. Improved transportation facilities would permit production of 5 million tons annually from the Ouenza properties. According to the Algerian Service des Mines, however, increased current production was not planned, as the projected Bone steel center scheduled to begin operating in 1962 will use Ouenza ore.[30]

Liberia.—The Liberia Mining Co. celebrated the 1,000th shipload of iron ore exported through the Freeport of Monrovia. The company dedicated a new beneficiation plant at its Bomi Hills iron mine on April 10, 1958.[31]

Liberian Enterprises, Ltd., a new iron-ore mining company, was organized to exploit an iron-ore deposit on the Mano River in the Western Province under a concession agreement approved by the Liberian Government in 1957.

The Government of Liberia granted the Gewerkschaft Exploration (a mining company controlled by leading German steel producers) a concession to explore and possibly exploit iron-ore deposits in the Bong Hills, north of Kakata. Terms of the concession agreement followed those in the general arrangements between Liberia and the Liberia Mining Co. and Liberia and the Liberian-American-Swedish Mineral Co.

The Liberian-American-Swedish Mineral Co. continued preliminary development of its iron-ore deposit in the Nimba Mountain.[32]

TECHNOLOGY

Iron-ore technological studies and pilot plant and prototype plant operations either were continued or expanded. The principal scientific interest, as in 1957, was in direct iron-ore reduction. This interest was sustained by increasing success in large-scale pilot plants and beginning commercial application of direct reduction processes in foreign countries. Reports of successful metallurgical and mechanical refinements and innovations in foreign blast furnaces stimulated research in the United States. Commercially successful application of new iron-ore beneficiating and agglomerating techniques in the United States led to more studies in foreign countries. Research in iron-ore mining methods was continued as several companies, after gaining experience in exploiting large low-grade deposits, sought new ways to reduce costs.

Systematic studies of drilling methods, drill hole patterns, explosive charges, and detonation timing at the Reserve Mining Company's Peter Mitchell taconite mine resulted in a drilling and blasting pattern, which in one of the largest blasts on record produced 99 percent effective fragmentation. More than 1.1 million long tons of taconite was broken and more than 50 percent was minus 3½ inches. Success of the newly developed drilling and blasting pattern was shown by doubled through-put at the primary crusher with life of the concaves and mantle improved 70 percent,

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[30] U.S. Consulate General, Algiers, Algeria, State Department Dispatch 87: Oct. 3, 1958.
[31] U.S. Embassy, Monrovia, Liberia, State Department Dispatch 40: Aug. 1, 1958.
[32] U.S. Embassy, Monrovia, Liberia, State Department Dispatch 126: Oct. 15, 1958.

and 91 percent increase in shovel loading efficiency with bucket life between rebuilds improved 300 percent.[33]

Preparation and storage of iron-ore materials was the theme of a mining symposium at Duluth in January sponsored by the University of Minnesota. Washing, scrubbing, and screening, the elementary ore-dressing processes, were the principal subjects for discussion. Of the three, scrubbing received the most attention. Four papers were presented on the subject.[34] It was agreed that scrubbing makes it possible to concentrate ores that otherwise would not be amenable to concentration. Furthermore, scrubbing has become increasingly important in ore-dressing since the advent of heavy medium concentrating processes and has been applied more widely to beneficiating iron ore as the grade of crude ore produced has declined.

Research in iron-ore beneficiation was marked by announcement of successful laboratory and semi-pilot-plant tests of concentrating iron ore with a high-tension separator.[35] Grades of concentrate and recovery of iron achieved in tests on hematite, magnetite, and martite ores compared favorably with commercial beneficiation of magnetite minerals by magnetic separation and of specular hematite minerals by flotation, but the high-tension separator was of little use in concentrating iron minerals containing water of hydration. The process may have significant application in concentrating mixed hematite-magnetite ores and in areas where there is not an ample supply of water.

Studies to develop methods for beneficiating limonite and siderite ore and mixtures of hematite and magnetite minerals in silicious gangue rock, which comprise a large percentage of the low-grade iron resources, were again a significant part of Bureau of Mines and industrial research programs. Processes in which hematite is reduced so that all the contained iron can be recovered as magnetite received most attention. Bureau of Mines researchers reported iron recoveries ranging from 60 to 80 percent in treating limonite-siderite ores in a controlled carbon-monoxide-atmosphere roast followed by magnetic separation. The concentrate produced by this method contained about 50 percent iron compared with less than 40 percent iron and only 50 percent recovery using conventional mineral dressing methods. The Bureau was concerned with basic scientific studies on hematite-magnetite complex ores. Industry, however, studied these ores in laboratory-scale experiments using fluidized-bed reducing gas techniques and announced recoveries of 90 to 98 percent in concentrates containing from 53 to 69 percent iron.[36] On the basis of these results, experiments in a 1-ton per-hour pilot plant were started in cooperation with iron-ore producing companies.

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[33] Ransome. W. E., Largest Open-Pit Blast on Record: The Explosives Engineer, vol. 36, No. 6, November-December 1958, pp. 167–172. (Pres. at Am. Min. Cong., San Francisco, Calif., September 1958.)

[34] Ferguson. R. C., The History and Theory of Scrubbing; Engstrom, R. C., Scrubbing and Examples from Iron Ore Fields; Kimball, Don, Heavy Media Feed Preparation by Other Than Rotary Scrubbers; Glumac, George, The Scrubbing of Painty Iron Ores: Papers presented at 19th Ann. Min. Symposium, AIME, January 1958.

[35] Barthelemy, R. E., Iron Ore Beneficiation and High Tension Separation: Unpublished paper pres. at Am. Min. Cong. Meet., September 1958.

[36] Priestly, R. J., Upgrading Iron Ore by Fluidized Magnetic Conversion: Blast Furnace and Steel Plant, vol. 46, No. 3, March 1958, pp. 303–306.

Heavy-medium ore-dressing processes were further refined in 1958 and a method of using measured and computed analyses and sink-float data for establishing standards to determine the theoretical optimum process control was developed.[37]

Interrelationship between air flow, heat transfer, and combustion and the significance of heat transfer in iron-ore sintering operations was demonstrated in experiments that the British Iron and Steel Research Association has been conducting over the last several years.[38] It was shown that during sintering: The fuel requirements are related to the heat requirements of the process; the air requirements are more dependent on the heat capacity of the sinter mix than on the oxygen requirement of the fuel; and that a series of fronts—water evaporation, calcination, heat transfer, and combustion—travel down the bed.

Pelletizing processes used at the three major low-grade iron mining operations (taconite and jaspilite) in the Lake Superior district were described.[39] Specular hematite, minus-325-mesh flotation concentrate derived from Michigan jaspilite is pelletized in an up-draft, traveling-grate furnace by the Marquette Iron Mining Co. at Eagle Mills. Magnetite, minus-150-mesh (75 to 85 percent, minus-325-mesh) magnetic concentrates derived from Minnesota taconite are pelletized in a down-draft traveling-grate furnace by Reserve Mining Co. at Silver Bay and in a shaft furnace by Erie Mining Co. at Aurora. The three processes were developed to do the same thing, but they are basically different, and each has advantages and disadvantages. All are reasonably efficient and only long experience will show which is the more economic.

Smelting tests using self-fluxing sinter conducted since April 1956 in an 18-foot hearth diameter blast furnace by the Steel Company of Canada indicated an increase of 17 percent pig iron production and a decrease of 23 percent in coke consumption.[40] Self-fluxing sinter is used in all Soviet Union blast furnaces, according to members of the American delegation that inspected some of the principal iron and steel plants of the Soviet Union in 1958.

Development of techniques for analyzing iron-bearing agglomerates has paralleled the development of new processes and techniques for producing the agglomerates. The long-range objective of agglomerate analyses studies is to develop reproducible standardized methods. In a progress report on a study of blast furnace sinters at the University of Pittsburgh the instability of wustite (FeO_x) and lack of a reliable chemical method for determining FeO were cited as the principal impediments to achieving the objective.[41]

The Bureau of Mines moved its experimental blast-furnace unit and pyrometallurgical laboratory from Pittsburgh to Bruceton, Pa.

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[37] Wuerker, R. G., Distribution Curves for Sink-and-Float Separation: Min. Eng., vol. 10, No. 7, July 1958, pp. 788–791.

[38] Voice, E. W., and Wild, R., How Theory Can Help Make More Sinter: Jour. Metals, vol. 10, No. 2, February 1958, pp. 105–110.

[39] Violetta, D. C., Updraft Pelletizing of Specular-Hematite Concentrates: English, Alan, and Morgan, M. F., Downdraft Taconite Pellet Hardening: and DeVaney, F. D., Pelletizing in Shaft Furnaces: Jour. Metals, vol. 10, No. 2, February 1958, pp. 118–128.

[40] McMahan, J. S., Production of Self-Fluxing Sinter: Blast Furnace and Steel Plant, vol. 46, No. 4, April 1958, pp. 373–375, and vol. 46, No. 5, May 1958, pp. 497–498.

[41] Berger, J. A., and Klinvex, S. H., Problems Involved in Analyzing Iron Ore Sinters: Blast Furnace and Steel Plant, vol. 46, No. 7, July 1958, pp. 698–704.

The furnace was rebuilt in the move and put on blast at Bruceton for a shakedown run April 18, 1958. Experiments conducted in the rebuilt furnace in cooperation with the United States Steel Corp. were directed to determine the effect of enriching the blast with oxygen and steam, the effect of a high-driving rate, and the effect of coke size. Western States iron ores were used, and western coke fuels were compared with eastern coke. The rebuilt furnace operated satisfactorily on larger coke particles than had normally been used, and preliminary results indicated that blast enrichment and higher driving rates can be applied to obtain more pig iron in a given unit, provided proper care is exercised to compensate for the sensitivity of the smelting zone to abnormal conditions.

A world-wide review of the current status of technology for exploiting titaniferous iron-ore deposits indicated that much greater progress had been made in Europe than in North America.[42] Titaniferous ores can be smelted and accretions in the hearth and viscous slags can be prevented by proper temperature and slag control. Reduction must be made at low temperatures, and the slag must be acidic and fluid at the temperature of reduction. The Soviets claim to have smelted titaniferous iron ores without trouble for many years. In the United States and Canada, however, titaniferous ores were still blended to obtain a blast furnace feed containing less than 1 percent titania. Apparently the technology advanced faster in Europe because the economics were more favorable, and titaniferous iron ore was not smelted in the United States because iron could be obtained at less cost from other raw material.

European iron-ore industry economics also stimulated research to conserve coke. Self-fluxing sinters and carefully prepared burdens were used widely, especially throughout the Soviet Bloc countries. Hungarian experiments in supplying reducing gas as well as air through the tuyeres of a blast furnace to replace some of the coke needed to make pig iron were reported in 1957.[43] The Russians in parallel experiments using coke gas reported a saving of 65 kilograms (143.3 pounds) of coke for each 100 cubic meters (353.1 cu ft) of coke gas introduced to the furnace per metric ton (0.984 long ton) of pig iron.[44] Experience with self-fluxing sinter in Swedish blast furnaces indicated that it is worthwhile to grind, concentrate, and sinter iron ore even if the beneficiation does not appreciably increase the iron content of the burden.[45]

Blast furnace technology continued to advance in the United States principally through better preparation of raw materials and beginning automation of charging and control. Automatic charging controls installed on a new furnace at the United States Steel Corp. Fairless works probably carried automation as far as knowledge of

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[42] Ross, H. U., Smelting Titaniferous Ores: Jour. Metals, vol. 10, No. 5, June 1958, pp. 407–411.
[43] Revue de l'Industrie Minerale (Paris): Vol. 39, No. 5, May 1957, pp. 423–535.
[44] Shopovalov, M. A., The Introduction of Reducing Gases Into the Hearth of a Blast Furnace, Stal (Moscow), No. 5, 1958, pp. 385–390.
[45] Notini, Ulf, Experience with Sinter Burden in Swedish Blast-furnaces: Jour. Iron and Steel Inst. (London) vol. 189, pt. 4, August 1958, pp. 322–326.

blast furnace operation as an art would permit.[46] Application of automation to blast furnace operation as a science was not significant. However, a study was started of research on the scientific aspects of blast furnace operation conducted by the Bureau of Mines in the last 40 years. The results of this study, which will be published in a Bureau of Mines Bulletin, may be significant in future automation of scientific blast-furnace operation.

Direct reduction process technology advanced markedly in 1958 as successful pilot plant scale tests of newly developed processes were announced. The R-N process, in which iron ore is reduced in a rotary kiln with an excess of carbonaceous fuel at a carefully controlled temperature below the melting point of all constituents, was used to treat over 100,000 tons of iron ore in a 175-ton per day pilot plant.[47] Most of the iron in the ore is reduced to the metallic-state in the R-N kiln and discharged as such. Then it is separated from the gangue materials magnetically and pressed into briquets for blast, open-hearth, or electric furnace feed. The R-N process can be used for ores with a wide range of iron content, and for ores high in titanium, sulfur, and phosphorous.

Strategic Materials Corporation and Koppers Company, Inc., demonstrated a patented method of direct iron-ore reduction (the Strategic-Udy process) in a prototype plant at Niagara Falls, Ontario. A rotary kiln also is used in this process, but the kiln discharges directly into the reducing zone of an electric furnace. Complex ores can be used for raw material; the carbon content of the pig iron can be controlled; and power costs are less than in an electric furnace without any pre-reduction.

Continuous direct reduction of iron ore with carbon monoxide in a fluidized bed—the Stetting process named after Otto Stetting, professor of industrial chemistry at the Royal Institute of Technology, Sweden—was further investigated in a 100 kg. of reduced iron per day pilot plant. The Stetting process operates at atmospheric pressure without cooling or heating cycles for reducing gas, and produces cementite, a material that does not exhibit pyrophoric properties.[48]

A small-scale process for direct reduction of iron ore using carbon as the reductant and electrical energy as the source of heat was developed and tested in a 1-ton pilot plant at the University of Ghent, Belgium. The process operates in a double hearth induction furnace; although the furnace contains a single metal bath, one section operates under strongly reducing conditions and the other operates under strongly oxidizing conditions. Carbon is added to the reducing section; high-grade iron ore is added to the oxidizing section. Low-grade ore cannot be treated by this process.[49]

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[46] Curtis, S. P., Schramm, R. F., and Fath, D. W., Automatic Charging Control for No. 3 Fairless Blast Furnace: Iron and Steel Eng., vol. 35, No. 7, July 1958, pp. 73–84.

[47] Stewart, Alex and Work, H. K., R-N Direct Reduction Process: Jour. Metals, vol. 10, No. 7, July 1958, pp. 460–464.

[48] Unterweiser, P. M., New Process Reduces Iron Ores with Carbon Monoxide: Iron Age, vol. 181, No. 5, Jan. 30, 1958, pp. 93–95.

[49] deSy, Albert, New Process Yields Quality Pig: Iron Age, vol. 182, No. 12, Sept. 18, 1958, pp. 92–94.

Commercial production of sponge iron was begun in a 200-ton per day natural gas reduction plant by Fierro Esponja, an affiliate of Hojalata y Lamina, Monterrey, Mexico.[50] The plant has five reactors, each of which holds about 15 tons of ore; the reaction cycle is 4 hours with 30 minutes additional required for dumping and charging, and approximately 25,000 cubic feet of natural gas is used per ton of ore produced. Re-oxidization of the sponge iron has not been a problem.[51]

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[50] Chemical Engineering Progress, Commercial Scale Direct Reduction of Iron Ore: Vol. 47, No. 10, October 1958, p. 10

[51] Cavanagh, P. E., Direct Iron Ore Reduction: Jour. Metals, vol. 10, No. 12, December 1958, pp. 804–809.

Iron and Steel

By James C. O. Harris [1]

DOMESTIC steel production dropped sharply in 1958 after 3 years of record output. Steel output, totaling 85.3 million short tons, was the lowest since 1949 and 24 percent less than 1957. The operating rate, 56.5 percent of capacity in January, dropped to a low of 47.8 percent in April, and then gradually recovered (except for a decline in July) to over 70 percent of capacity in the last quarter. This upturn resulted in an outlook for steel production of about 120 million tons in 1959, barring a long steel strike.

Blast-furnace pig-iron production dropped 27 percent from the record 78.4 million tons in 1957 to 57.2 million net tons in 1958. The average price of scrap dropped $18 per ton, contributing to the change in the ratio of scrap to pig iron—50–50 compared with 49–51, respectively, in 1957.

At yearend blast- and steel-furnace capacities reached new highs of 94.6 and 147.6 million tons, respectively. Steelmaking capacity increased 6.9 million tons compared with 7.2 in 1957, and blast furnace capacity increased 3.6 million tons compared with 4.2 in 1957.

Blast-furnace capacity was increased mainly through enlargement of existing furnaces and increased productivity through improved technology. A new furnace was placed in operation in Trenton, Mich., and another in Birmingham, Ala. The Bethlehem Steel Co., Sparrows Point, Md., plant was again the world's largest steel plant with a capacity of 8.2 million tons a year. Capacity at the Gary, Ind., works of the United States Steel Corp. was increased 800,000 tons to 8 million tons, and remained second largest in the world.

Technological developments progressed rapidly and included: Increased use of self-fluxing sinter in the blast furnace, fourfold increase in oxygen steelmaking capacity, vacuum-casting for quality steel (ingots as large as 250 tons), progress in direct iron reduction processes, the new Prolerized scrap process for scrap preparation (which among other benefits removes contaminants), improved coking coal beneficiation, and increased use of continuous annealing for tin plate. The Weirton Steel Co. set the world's record for stationary open-hearth steel output—585.9 tons of steel in 5 hours and 35 minutes or 105 tons per hour. U.S. Steel developed the new sandwich process

[1] Commodity specialist.

for rolling thin stainless steel sheets (0.033 inch thick). Despite the substantial drop in steel output, the steel industry used a record 28.8 billion cubic feet of oxygen. More oxygen was used in blast furnaces and in open hearths with all basic roofs; more steel was made in the oxygen converter.

United States and U.S.S.R. delegations exchanged visits to iron and steel industries. The observations of the American delegation are summarized in the World Review section.

Shipments of steel in 1958 including exports totaled 59.9 million tons, compared with 79.9 million tons in 1957 and 83.3 million in 1956. Receipts by all segments of the consuming industry decreased except: Contractors products, appliances, utensils and cutlery, agricultural equipment (excluding machinery), and cans and closures. The automotive industry continued to be the leading consumer, receiving 10.1 million tons or 18 percent of domestic shipments, but 29 percent less than in 1957. The largest decrease, 65 percent, was in rail transportation. Oil and gas drilling and mining dropped 53 percent. Steel exports in 1958 totaled 2.4 million tons, compared with 4.6 million in 1957.

Average weekly hours worked per employee in the steel industry during 1958 was 37.5, compared with 39.1 in 1957. The average number of employees for the year was 437,000 compared with 538,000, and the average hourly wage was $2.88 in 1958, compared with $2.68 for the preceding year.

The average composite price of finished steel, as published by Iron Age, was 6.06 cents a pound compared with 5.8 in 1957.

TABLE 1.—Salient iron and steel statistics in the United States, in short tons

	1949–53 (Average)	1954	1955	1956	1957	1958
Pig iron:						
Production	64, 852, 561	57, 947, 551	76, 848, 509	75, 030, 249	78, 404, 266	57, 154, 909
Shipments	64, 638, 633	57, 782, 686	77, 300, 681	75, 109, 714	76, 886, 551	56, 917, 937
Imports	588, 228	290, 716	283, 559	326, 700	225, 387	209, 743
Exports	25, 520	10, 247	34, 989	269, 477	882, 342	103. 348
Steel: [1]						
Production of ingots and castings:						
Open-hearth:						
Basic	85, 952, 467	80, 019, 628	104, 804, 570	102, 167, 989	101, 027, 725	75, 501, 789
Acid	647, 151	307. 866	554, 847	672, 596	630, 051	377, 605
Bessemer	4, 150, 308	2, 548, 104	3, 319, 517	3, 227, 997	2, 475, 138	1, 395, 985
Electric [2]	6, 208, 445	5, 436, 054	8, 357, 151	9, 147, 567	8, 582, 082	7, 979, 506
Total	96, 958, 371	88, 311, 652	117, 036, 085	115, 216, 149	112, 714, 996	85, 254, 885
Capacity, annual, Jan. 1	105, 175, 704	124, 330, 410	125, 828, 310	128, 363, 090	133, 459, 150	140, 742, 570
Percent of capacity	92. 2	71. 0	93. 0	89. 8	84. 5	60. 6
Production of alloy steel:						
Stainless	843, 679	852, 021	1, 222, 316	1, 255, 725	1, 046, 919	895, 629
Other	7, 967, 362	6, 340, 842	9, 437, 775	9, 072, 343	7, 864, 904	5, 768, 560
Total	8, 811, 041	7, 192, 863	10, 660, 091	10, 328, 068	8, 911, 823	6, 664, 189
Shipments of steel products:						
For domestic consumption	68, 524, 194	60, 618, 843	81, 134, 367	79, 628, 741	75, 325, 782	57, 485, 284
For export	2. 959, 957	2, 533. 883	3. 583, 077	3. 622, 427	4, 568, 795	2. 429, 149
Total	71, 484, 151	63, 152, 726	84, 717, 444	83, 251, 168	79, 894, 577	59, 914, 433

[1] American Iron and Steel Institute.
[2] Includes a very small quantity of crucible steel and oxygen converter steel for 1954–58.

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron, exclusive of ferroalloys, was the lowest since 1949 and 27 percent below 1957. Blast-furnace operating rate averaged 63.5 percent of capacity—lowest in April at 51.2 percent and highest in November at 79.5 percent. Pig-iron production decreased in all States: Pennsylvania, Ohio, and Indiana led and ranked second and third respectively, supplying 25, 17, and 14 percent, respectively, compared with 27, 19, and 11 percent in 1957.

Blast furnaces also produced 27.4 million short tons of blast-furnace slag or 887 pounds per ton of pig iron (1,040 pounds in 1957) and 5.3 million tons of flue dust recovered or 185 pounds per ton (204 pounds in 1957).

McLouth Steel Corp., Trenton, Mich., and United States Pipe and Foundry Co., Birmingham, Ala., each added a new blast furnace during the year, or a combined increase of 1 million tons in furnace capacity. The remaining capacity was increased 3.2 million tons by

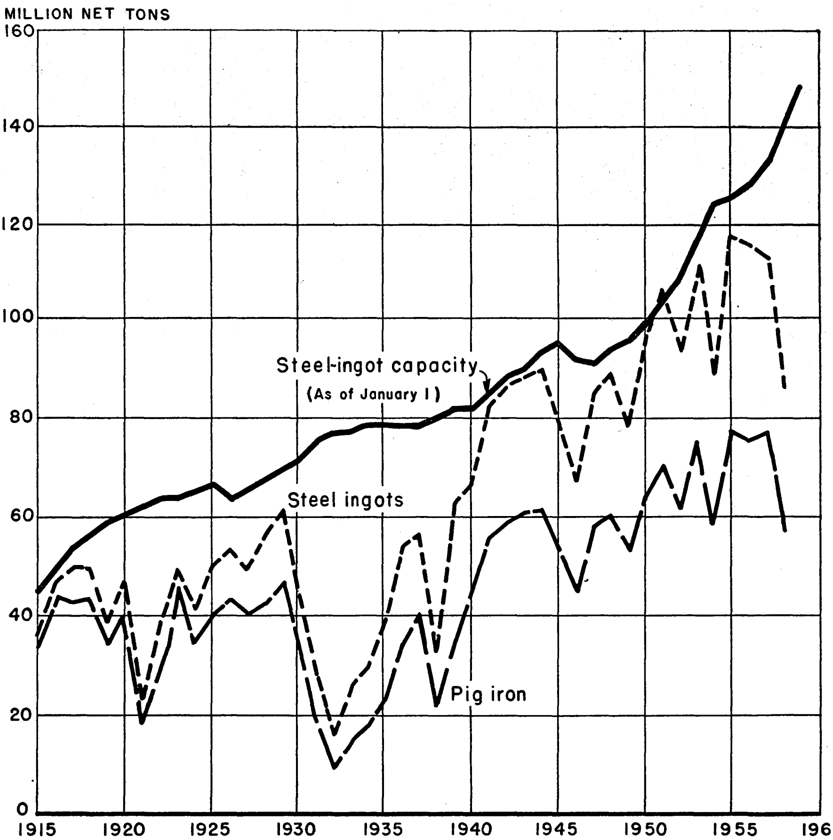

FIGURE 1.—Trends in production of pig iron and steel ingots and steel-ingot capacity in United States.

technical advancements and enlargement and modernization of furnaces. Of 77 furnaces, which were idle on December 31, 1958 (table 5), 5 were being rebuilt and 11 were off for relining. U.S. Steel abandoned a 280,800-ton annual capacity blast furnace at Youngstown, Ohio.

Shipments of pig iron (including on-site transfers) were the lowest since 1949. The values of pig iron shown in tables 2 and 4 are largely estimated and do not agree with prices published in trade journals because handling charges, selling, commission, freight costs, and other related items are excluded. Over 90 percent of all pig iron made in the United States was used in the molten state for making steel ingots, castings, and iron castings. Therefore, value figures for a large part of pig-iron output were not readily available.

Metalliferous Materials Used.—The production of pig iron, excluding coke and fluxes, required 96.7 million short tons of iron, manganiferous ores, and agglomerates; 2.8 million tons of scrap; 0.2 million ton of flue dust; and 6.5 million tons of miscellaneous materials, or 1.855 tons of material per ton of pig iron made. The scrap charge consisted of 972,565 short tons of purchased scrap and 1,828,907 tons of home

TABLE 2.—Pig iron produced and shipped in the United States, by States

State	Produced		Shipped from furnaces			
	1957	1958	1957		1958	
	Short tons		Short tons	Value (thousands)	Short tons	Value (thousands)
Alabama	4,903,627	3,414,901	4,693,224	$253,161	3,411,954	$188,150
Illinois	6,308,891	4,200,153	6,195,023	359,569	4,217,898	258,661
Indiana	9,007,611	7,773,794	8,991,482	524,510	7,757,011	453,049
Ohio	14,979,958	9,562,739	14,683,645	820,587	9,609,594	556,662
Pennsylvania	21,031,230	14,502,484	20,610,846	1,221,275	14,348,322	869,097
California, Colorado, Utah	3,941,135	3,341,253	3,929,547	225,702	3,291,070	189,352
Kentucky, Tennessee, Texas	1,967,259	1,581,311	1,915,912	104,179	1,622,598	87,602
Maryland, West Virginia	6,669,910	6,086,534	6,538,592	415,751	6,044,353	391,937
Michigan, Minnesota	4,197,654	3,316,851	4,118,061	239,157	3,274,239	182,647
New York, Massachusetts	5,396,991	3 374,889	5,210,219	328,409	3,340,898	215,151
Total	78,404,266	57,154,909	76,886,551	4,492,300	56,917,937	3.392,308

TABLE 3.—Foreign iron ore and manganiferous iron ore consumed in manufacturing pig iron in the United States, by sources of ore, in short tons

Source	1957	1958	Source	1957	1958
Africa	50,438	34,547	Sweden	169,038	(1)
Canada	8,311,912	4,795,894	Venezuela	5,464,336	4,542,104
Chile	122,790	593,829	All other	[2] 261,154	9,039
Mexico	213,014	107,456			
Peru	1,385,199	814,328	Total	15,977,881	10,897,197

[1] Included with "All other."
[2] Includes 220,753 tons unclassified.

scrap, including 524,218 tons of home-slag scrap. Miscellaneous materials consumed include 2.8 million tons of mill cinder and scale, 3.6 million tons of open-hearth and Bessemer slag, 51,284 tons of other metalliferous materials, and 182,541 tons of nonmetalliferous materials. Net totals shown in table 6 were computed by deducting 5.3 million tons of flue dust recovered and 0.7 million ton of scrap produced at blast furnaces.

The agglomerate charge consisted of 29,538,889 tons of sinter, 6,066,795 tons of pellets, 142,613 tons of briquets, and 838,816 tons of other agglomerates; 1,360,603 tons of the total came from foreign sources. Canada, Venezuela, and Peru supplied 44, 42, and 7 percent, respectively, of foreign iron and manganiferous ores used in blast furnaces. According to the American Iron and Steel Institute, 5.9 million cubic feet of oxygen was used at blast-furnace plants.

TABLE 4.—Pig iron shipped from blast furnaces in the United States, by grades [1]

Grade	1957			1958		
	Short tons	Value		Short tons	Value	
		Total (thousands)	Average a ton		Total (thousands)	Average a ton
Foundry	2,077,003	$117,301	$56.48	1,619,453	$92,387	$57.05
Basic	64,197,669	3,762,501	58.61	47,674,412	2,847,545	59.73
Bessemer	6,204,829	362,539	58.43	3,701,059	218,973	59.16
Low-phosphorus	814,399	47,491	58.31	1,363,387	78,283	57.42
Malleable	3,239,745	182,082	56.20	2,302,762	140,629	61.07
All other (not ferroalloys)	[2] 352,906	20,386	[2] 57.77	256,864	14,491	56.42
Total	76,886,551	4,492,300	58.43	56,917,937	3,392,308	59.60

[1] Includes pig iron transferred directly to steel furnaces at same site.
[2] Revised figures.

TABLE 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States

[American Iron and Steel Institute]

State	Dec. 31, 1957			Dec. 31, 1958		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	15	6	21	13	9	22
California	3	1	4	3	1	4
Colorado	2	2	4	3	1	4
Illinois	11	11	22	15	7	22
Indiana	17	6	23	22	1	23
Kentucky	2	1	3	2	1	3
Maryland	9	1	10	7	3	10
Massachusetts	1		1	1		1
Michigan	7	1	8	8	1	9
Minnesota	2	1	3	3		3
New York	13	4	17	11	6	17
Ohio	28	25	53	35	17	52
Pennsylvania	49	30	79	54	25	79
Tennessee	1	2	3	1	2	3
Texas	2		2	2		2
Utah	4	1	5	4	1	5
Virginia	1	1	2	1	1	2
West Virginia	4	1	5	4	1	5
Total	171	94	265	189	77	266

TABLE 6.—Iron ore and other metallic materials, coke, and fluxes consumed and pig iron produced in the United States, by States, in short tons

State	Metalliferous materials consumed: Iron and manganiferous ores: Domestic	Metalliferous materials consumed: Iron and manganiferous ores: Foreign	Metalliferous materials consumed: Agglomerates	Metalliferous materials consumed: Net ores and agglomerates [1]	Metalliferous materials consumed: Net scrap [2]	Metalliferous materials consumed: Miscellaneous [3]	Metalliferous materials consumed: Net total	Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made: Net ores and agglomerates [1]	Metalliferous materials consumed per ton of pig iron made: Net scrap [2]	Metalliferous materials consumed per ton of pig iron made: Miscellaneous [3]	Metalliferous materials consumed per ton of pig iron made: Total	Coke and fluxes consumed per ton of pig iron: Net coke	Coke and fluxes consumed per ton of pig iron: Fluxes
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	0.049	0.028	2.122	0.956	0.309
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	1.685	.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)	(4)	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	(4)	(4)	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	(4)	(4)	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	5,396,991	1.631	.030	.098	1.759	.856	.358
Total	83,459,312	15,977,881	35,630,795	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

1958																	
Alabama	4, 534, 478	374, 600	2, 146, 754	6, 743, 410	192, 210	146, 966	7, 082, 586	3, 229, 665	1, 023, 042	3, 414, 901	1. 975	. 056	. 043	2. 074	. 946	. 300
Illinois	5, 391, 397	20, 304	1, 686, 385	6, 640, 345	219, 755	565, 076	7, 425, 176	3, 376, 176	1, 173, 797	4, 200, 153	1. 581	. 052	. 135	1. 768	. 804	. 279
Indiana	10, 329, 382	241, 674	2, 957, 005	12, 606, 964	121, 112	1, 045, 729	13, 773, 805	6, 103, 794	2, 281, 182	7, 773, 794	1. 622	. 015	. 135	1. 772	. 785	. 293
Ohio	6, 990, 217	2, 199, 395	6, 095, 204	14, 659, 746	494, 086	1, 247, 330	16, 401, 162	7, 715, 347	2, 979, 320	9, 562, 739	1. 533	. 052	. 130	1. 715	. 807	. 312
Pennsylvaia	9, 908, 844	3, 708, 069	9, 650, 162	22, 042, 168	698, 116	1, 994, 660	24, 734, 944	11, 652, 032	4, 612, 568	14, 502, 484	1. 520	. 048	. 138	1. 706	. 803	. 318
California, Colorado, Utah	(4)	(4)	2, 595, 681	6, 033, 467	55, 568	128, 562	6, 217, 597	2, 465, 909	685, 351	3, 341, 253	1. 806	. 017	. 038	1. 861	. 738	. 205
Kentucky, Tennessee, Texas	582, 773	447, 691	1, 399, 195	2, 376, 940	104, 862	240, 096	2, 721, 898	1, 211, 445	531, 436	1, 581, 311	1. 503	. 066	. 152	1. 721	. 766	. 336
Maryland, West Virginia	(4)	(4)	5, 115, 993	9, 287, 947	99, 258	635, 214	10, 022, 419	4, 472, 274	1, 402, 635	6, 086, 534	1. 526	. 016	. 105	1. 647	. 735	. 230
Michigan, Minnesota	(4)	(4)	2, 190, 762	5, 843, 919	30, 522	163, 191	6, 037, 632	2, 836, 978	1, 128, 906	3, 316, 851	1. 762	. 009	. 049	1. 820	. 855	. 340
New York, Massachusetts	2, 588, 131	438, 124	2, 749, 972	5, 411, 527	88, 613	339, 872	5, 840, 012	2, 712, 553	998, 004	3, 374, 889	1. 603	. 026	. 101	1. 730	. 804	. 296
Total	49, 224, 350	10, 897, 197	36, 587, 113	91, 646, 433	2, 104, 102	6, 506, 696	100, 257, 231	45, 776, 173	[5] 16, 816, 241	57, 154, 909	1. 603	. 037	. 114	1. 754	. 801	. 294

[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.
[4] Included in U.S. total.
[5] Excludes 1,761,527 tons of limestone used in agglomerate production at or near steel plants and an unknown quantity of limestone used in making agglomerates at mines.

PRODUCTION AND SHIPMENTS OF STEEL

Domestic steel production was 85.3 million short tons or 60.6 percent of capacity; the AISI index was 101.8 (1947–49=100). The corresponding figures for 1957 were 112.7, 84.5, and 134.6, respectively.

Operations ranged from 52 to 66 percent of capacity for the first 9 months, except in April when it dropped to 47.8 percent. In the last quarter it rose to 73.5 percent and monthly rates did not vary over 1 percent.

The percentages of total steel made by the several processes were as follows: Open hearth, 89; electric, 9 (includes oxygen-converter output and operating rate); and Bessemer, 2. Corresponding figures for 1957 were 90, 8, and 2, respectively. Pennsylvania, Ohio, Indiana, and Illinois led and ranked second, third, and fourth in steel production, supplying 24, 16, 15, and 8 percent, respectively, compared with 27, 18, 13, and 8 percent in 1957.

New steelmaking capacities by type of process and gain or loss, in millions of short tons, were: Open hearth, 126.5, plus 4.2; electric, 13.5 plus 0.2; oxygen, 4.0 plus 2.9; and Bessemer, 3.6 minus 0.5. 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 is not included in the production data.

Expansion included 15 new electric furnaces, the completion of a new oxygen steelmaking plant at Fontana, Calif., and another plant under construction in the Chicago area. Although the number of open hearths decreased by 6 to 290, new open hearths were built, and others were modernized. Some 20 rolling mills of various types were either completed, started, or in progress. These included blooming mills, slabbing mills, hot strip mills, structural mills and cold-rolled sheet and strip mills. Also five new continuous annealing lines were added. The projects for the most part involved the latest advances in automation.

Table 11 shows that shipments of steel products decreased 20 million tons. All categories decreased, except contractors products, cans and closures, appliances, utensils and cutlery, and agricultural uses other than machinery.

Hawaiian Western Steel, Ltd., was constructing a steel plant in Hawaii to produce concrete reinforcement bars. The plant will consist of a rolling mill and an electric furnace for melting scrap. Semifinished steel from Canada will also be rolled into concrete rods in this mill. Estimated cost for building this plant was $1.5 million. The eventual production of 25,000 tons of finished steel annually was planned.[2]

[2] Madsen, I. E., Developments in the Iron and Steel Industry During 1958: Iron and Steel Eng., vol. 36, No. 1, January 1959, p. 120.

Alloy Steel.[3]—Domestic alloy-steel production was 6,622,321 short tons, 6,579,431 tons of ingots, and 42,890 tons, castings, a decrease of 26 percent from 1957; it supplied 8 percent of total steel output, the same as in 1957.

Stainless-steel ingot production (13 percent of the total alloy-steel output) was 892,984 tons, 14 percent below 1957 and 26 percent below 1956. The production of austenitic stainless steel AISI 300 (nickel-bearing) and 200 series (manganese-nickel-bearing), representing 61 percent of total stainless-steel production, was 14 percent below 1957; the ferritic and martensitic, straight chromium types, AISI 400 series, decreased 23 percent. Production of AISI 200 series (16,262 short tons) decreased 36 percent. The output of type 501, 502, and other high-chromium, heat-resisting steels included in the stainless-steel-production figure decreased 65 percent.

Production of all grades of alloy steel, other than stainless (5,724,936 short tons), decreased 27 percent. Production of molybdenum, manganese-molybdenum, and nickel-chromium steels decreased the most. Output of all grades decreased except the straight nickel type, which increased 33 percent to 42,668 short tons. Alloy high-strength steel production (609,098 tons) dropped 38 percent.

The percentages of alloy steel produced in the basic open hearth, acid open hearth, and electric furnaces were 59, 1, and 40 percent, respectively, compared with 64, 2, and 34 percent, respectively, in 1957.

TABLE 7.—Steel capacity, production, and percentage of operations, in the United States, in thousand short tons[1]

[American Iron and Steel Institute]

Year	Annual capacity, Jan. 1	Production				
		Open hearth	Bessemer	Electric [2]	Total	Percent of capacity
1949-53 (average)	105,176	86,600	4,150	6,208	96,958	92.2
1954	124,330	80,328	2,548	5,436	88,312	71.0
1955	125,828	105,359	3,320	8,357	117,036	93.0
1956	128,363	102,841	3,228	9,147	115,216	89.8
1957	133,459	101,658	2,475	8,582	112,715	84.5
1958	140,743	75,879	1,396	7,980	85,255	60.6

[1] Includes only that part 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 oxygen converter steel and a very small quantity of crucible steel for 1954–58.

[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 percentages: Manganese in excess of 1.65 percent, silicon in excess of 0.60 percent, and copper in excess of 0.60 percent. It also includes 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.

Stainless steel includes all grades of steel that contain 10 percent or more of chromium with or without other alloys or a minimum combined content of 18 percent of chromium and other alloys. Valve or bearing steels, high temperature alloys, or electrical grades with analyses meeting the definition for stainless steels are included. All tool steel grades are excluded.

Heat-resisting steel includes all steel containing 4 percent or more but less than 10 percent of chromium (excluding tool steel grades).

TABLE 8.—Open-hearth steel ingots and castings manufactured in the United States, by States, in thousand short tons [1]

[American Iron and Steel Institute]

State	1949-53 (average)	1954	1955	1956	1957	1958
Massachusetts, Rhode Island, Connecticut	466	327	469	379	239	140
New York	4,786	4,596	6,304	6,045	6,225	3,899
Pennsylvania	24,875	20,549	29,358	29,218	28,646	18,785
New Jersey, Delaware, Maryland	5,107	5,583	6,351	5,987	6,471	6,244
West Virginia, Kentucky	3,333	3,069	3,810	3,935	3,738	3,521
Georgia, Alabama	3,793	3,452	4,265	3,440	4,103	2,939
Ohio	15,318	13,662	18,447	18,240	16,723	11,749
Indiana	11,255	12,331	15,033	14,324	14,856	12,586
Illinois	6,847	5,963	8,025	8,065	7,353	5,916
Michigan, Minnesota	4,362	4,248	5,464	5,319	5,056	3,592
Missouri, Oklahoma, Colorado, and Texas	2,589	2,869	3,480	3,251	3,361	2,567
Utah, Washington, California	3,869	3,679	4,353	4,638	4,887	3,941
Total	86,600	80,328	105,359	102,841	101,658	75,879

[1] Includes only that part 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, by States, in thousand short tons [1]

[American Iron and Steel Institute]

State	1949-53 (average)	1954	1955	1956	1957	1958
Ohio	2,043	1,658	2,269	2,210	1,735	1,057
Pennsylvania	1,051	452	589	593	740	339
Other States	1,056	438	462	425		
Total	4,150	2,548	3,320	3,228	2,475	1,396

[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, in thousand short tons [1]

[American Iron and Steel Institute]

Year	Ingots	Castings	Total [2]	Year	Ingots	Castings	Total [2]
1949-53 (average)	6,118	90	6,208	1956	9,090	57	9,147
1954	5,382	54	5,436	1957	8,514	68	8,582
1955	8,307	50	8,357	1958	7,929	51	7,980

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes oxygen converter steel and a very small quantity of crucible steel for 1954-58.

Metalliferous and Other Materials Used in Steelmaking.—Pig iron and scrap consumed in steelmaking furnaces totaled 94.3 million short tons; the percentage of each was 54 and 46, respectively, compared with 55 and 45 in 1957 and 52 and 48 in 1956 (see table 13); consumption of foreign iron ore dropped because of decreasing steel output. The principal foreign sources of iron ore consumed were: Chile, 44 percent; Venezuela, 17 percent; Brazil, 16 percent; and Liberia, 14 percent. According to the American Iron and Steel Institute, other materials used in steelmaking, excluding independent foundries, included 3.9 million short tons of limestone, 1.2 million tons of lime, 180,000 tons of fluorspar, and 214,000 tons of other fluxes. Oxygen consumption at steel plants, exclusive of blast furnaces, reached a record 22.9 million cubic feet. The uses break down as follows: Steelmaking, 13 million; conditioning, 6 million; scrap preparation, 1.0 million; other burning and welding, 2 million; and all other, 0.8 million.

TABLE 11.—Shipments of steel products by market classifications, all grades including carbon, alloy, and stainless, in thousand short tons

[American Iron and Steel Institute]

Market classification	1957		1958	
	Shipments	Percent of total	Shipments	Percent of total
Steel for converting and processing [1]	3,396	4.5	2,855	5.0
Forgings	1,056	1.4	767	1.3
Bolts, nuts, rivets, and screws	1,149	1.5	879	1.5
Warehouses and distributors:				
Oil and gas industry	2,324	3.1	1,004	1.8
All other	12,183	16.2	9,898	17.2
Total	14,507	19.3	10,902	19.0
Construction, including maintenance:				
Rail transportation	71	.1	43	.1
Oil and gas	3,469	4.6	2,100	3.7
All other	8,983	11.9	6,580	11.4
Total	12,523	16.6	8,723	15.2
Contractor's products	3,404	4.5	3,467	6.0
Automotive:				
Passenger cars, trucks, parts, etc	13,895	18.5	9,850	17.1
Forgings	332	.4	275	.5
Total	14,227	18.9	10,125	17.6
Rail transportation:				
Railroad rails, trackwork, and equipment	1,406	1.9	584	1.0
Freight cars, passenger cars, and locomotives	2,703	3.6	867	1.5
Street railways and rapid transit systems	40		21	.1
Total	4,149	5.5	1,472	2.6
Shipbuilding and marine equipment	1,278	1.7	797	1.4
Aircraft	100	.1	62	.1
Oil and gas drilling	701	.9	306	.5
Mining, quarrying, and lumbering	329	.4	179	.3
Agriculture:				
Agricultural machinery	915	1.2	903	1.6
All other agricultural	183	.3	290	.5
Total	1,098	1.5	1,193	2.1
Machinery, industrial equipment, and tools	4,512	6.0	3,181	5.5
Electrical machinery and equipment	2,086	2.8	1,772	3.1
Appliances, utensils, and cutlery	1,559	2.1	1,590	2.8
Other domestic and commercial equipment	1,838	2.4	1,716	3.0
Containers:				
Cans and closures	4,831	6.4	5,252	9.1
Barrels, drums, and shipping pails	818	1.1	800	1.4
All other containers	589	.8	516	.9
Total	6,238	8.3	6,568	11.4
Ordnance and other military	356	.5	239	.4
Shipments of nonreporting companies	820	1.1	692	1.2
Total domestic	75,326	100.0	57,485	100.0
Export	4,569		2,429	
Total shipments	79,895		59,914	

[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, by processes, in thousand short tons [1]

[American Iron and Steel Institute]

Process	1949-53 (average)	1954	1955	1956	1957	1958
Open hearth:						
Basic	5,784	4,528	6,735	6,289	5,746	3,946
Acid	174	131	186	201	170	65
Electric [2]	2,853	2,534	3,739	3,838	2,996	2,653
Total	8,811	7,193	10,660	10,328	8,912	6,664

[1] Includes only that steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes oxygen converter steel and a very small quantity of crucible steel for 1954-58.

CONSUMPTION OF PIG IRON

Although all the States used some pig iron, 92 percent was consumed in steelmaking centers in the East North Central, Middle Atlantic, South Atlantic, and East South Central States. Pennsylvania (the leading consumer) used 25 percent of the total; Ohio (second), 16 percent; and Indiana (third), 14 percent; corresponding figures for 1957 were 27, 18, and 13 percent, respectively.

TABLE 13.—Metalliferous materials consumed in steel furnaces in the United States, in short tons

Year	Iron ore: Domestic	Iron ore: Foreign	Sinter [1]	Pig iron	Ferro-alloys [2]	Iron and steel scrap
1949-53 (average)	3,622,610	2,202,164	1,499,171	56,770,650	1,370,000	51,985,017
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
1958	2,092,340	4,741,751	[4] 1,260,763	51,299,102	1,115,000	43,023,625

[1] Excludes consumption in steelmaking furnaces at plants that do not have blast furnaces.
[2] Includes ferromanganese, spiegeleisen, silicomanganese, manganese briquets, ferrosilicon, and ferrochromium alloys.
[3] Includes other agglomerates (nodules, pellets, etc.) and 106,602 tons of foreign origin.
[4] Includes 601,509 tons of sinter, 238,040 tons of pellets, 281,390 tons of nodules, and 139,824 tons of other agglomerates. (325,268 tons of foreign origin.)

TABLE 14.—Consumption of pig iron in the United States, by types of furnace

Type of furnace or equipment	1957		1958	
	Short tons	Percent of total	Short tons	Percent of total
Open hearth	64,997,545	85.1	48,407,537	84.5
Bessemer [1]	3,494,883	4.6	2,635,906	4.6
Electric [2]	275,124	.4	255,659	.5
Cupola	4,660,016	6.1	3,709,415	6.5
Air	244,552	.3	189,672	.3
Direct castings	2,681,006	3.5	2,064,147	3.6
Total	76,353,126	100.0	57,262,336	100.0

[1] Includes pig iron used in oxygen converter steel process.
[2] Includes small quantity of pig iron consumed in crucible furnaces.

TABLE 15.—Consumption of pig iron in the United States, by districts and States, in short tons

District and State	1957	1958
New England:		
Connecticut	41,506	27,310
Maine; New Hampshire	6,881	5,447
Massachusetts	135,025	87,269
Rhode Island	38,381	33,706
Vermont	8,961	4,852
Total	230,754	158,584
Middle Atlantic:		
New Jersey	168,947	158,293
New York	4,000,712	2,702,089
Pennsylvania	20,450,516	14,355,285
Total	24,620,175	17,215,667
East North Central:		
Illinois	5,771,407	4,190,537
Indiana	9,589,218	7,960,282
Michigan	4,333,789	3,321,133
Ohio	14,101,850	9,446,795
Wisconsin	232,338	191,935
Total	34,028,602	25,110,682
West North Central:		
Iowa	70,060	71,767
Kansas; Nebraska	3,959	4,033
Minnesota; North Dakota; South Dakota	500,217	405,532
Missouri	51,932	36,257
Total	626,168	517,589
South Atlantic:		
Delaware; District of Columbia; Maryland	4,642,440	4,133,280
Florida; Georgia	19,448	13,737
North Carolina	25,061	21,793
South Atlantic—Con.		
South Carolina	13,297	13,116
Virginia; West Virginia	2,133,902	2,120,942
Total	6,834,148	6,302,868
East South Central:		
Alabama	4,168,930	2,981,431
Kentucky; Mississippi; Tennessee	1,017,233	866,548
Total	5,186,163	3,847,979
West South Central:		
Arkansas; Louisiana; Oklahoma	7,972	6,393
Texas	913,087	773,124
Total	921,059	779,517
Mountain:		
Arizona; Nevada; New Mexico	195	110
Utah and Colorado	2,448,029	2,044,046
Montana; Idaho; Wyoming	542	412
Total	2,448,766	2,044,568
Pacific:		
California	1,436,691	1,280,159
Oregon; Washington	20,600	4,723
Total	1,457,291	1,284,882
Total United States	76,353,126	57,262,336

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, requiring wage increases on July 1 each year.

The weighted average annual price of pig iron, as published by Iron Age, was $59.33 per short ton compared with $58.17 in 1957. The Iron Age composite price of finished steel for 1958 was 6.06 cents per pound, compared with 5.80 cents per pound in 1957. Prices increased in August and September. The price of most steel products increased in July and August. Tinplate prices increased in November. Stainless steel sheet type 304 averaged 50 cents a pound, less than the last half of 1957.

FOREIGN TRADE [4]

Imports of steel products increased. A number of product groups were imported at prices of $20 to $40 per ton below the American prices. Since World War II, Japan and Western Europe have rap-

[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 16.—Average value of pig iron at blast furnaces in the United States, by States, per short ton

State	1949–53 (average)	1954	1955	1956	1957	1958
Alabama	$42.33	$46.97	$47.89	$50.23	$53.94	$55.14
California						
Colorado	48.13	51.08	53.82	50.67	57.44	57.53
Utah						
Illinois	46.02	50.09	51.21	54.52	58.04	61.32
Indiana	45.80	50.16	50.79	53.09	58.33	58.41
New York	47.07	50.60	51.54	54.54	63.09	64.48
Ohio	45.51	48.92	49.35	52.42	55.88	57.93
Pennsylvania	46.81	50.52	51.30	55.01	59.25	62.45
Other States [1]	46.89	50.61	50.78	54.19	60.37	60.53
Average	46.16	49.93	50.68	53.58	58.43	59.60

[1] Comprises Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Tennessee, Texas, and West Virginia.

TABLE 17.—Average monthly prices of chief grades of pig iron, per short ton

[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	
	1957	1958	1957	1958	1957	1958	1957	1958
January			$56.25		$56.70		$55.80	
February								
March	$52.68		57.87		58.31		57.42	
April								
May			58.04		58.48		57.59	
June		$55.80		$59.38		$59.82		$58.93
July	55.23		58.64		59.09		58.20	
August								
September								
October	55.80		59.38		59.82		58.93	
November								
December								
Average	54.20	55.80	58.33	59.38	58.78	59.82	57.88	58.93

TABLE 18.—Free on board value of steel mill products in the United States in cents per pound [1]

Product	1957 [2]				1958			
	Carbon	Alloy	Stainless	Average	Carbon	Alloy	Stainless	Average
Ingots	4.216	9.012	37.063	9.505	4.570	8.834	50.076	[3] 16.001
Semifinished shapes and forms	5.447	9.224	36.135	6.164	5.673	10.135	39.627	6.508
Plates	6.244	11.772	62.287	6.816	6.468	14.651	62.093	7.265
Sheets and strips	6.869	14.551	56.407	7.883	7.095	14.121	51.183	8.131
Tin-mill products	8.879			8.879	8.930			8.930
Structural shapes and piling	6.074	7.756		6.091	6.268	8.521		6.288
Bars	7.190	13.538	64.399	8.724	7.502	13.658	64.902	8.882
Rails and railway-track material	6.985			6.985	7.360			7.360
Pipes and tubes	9.946	18.011	155.581	10.968	10.412	20.187	165.622	11.587
Wire and wire products	12.027	35.087	84.714	13.025	12.534	37.186	81.276	13.506
Other rolled and drawn products	8.904	35.844	59.985	12.155	9.790	43.370	60.820	13.716
Average total steel	7.438	13.932	61.605	8.268	7.777	14.437	59.325	8.648

[1] Computed from figures supplied by the U.S. Department of Commerce, Bureau of the Census.
[2] Revised figures.
[3] The increase in the value of all ingots was almost entirely due to an increase in the shipments of higher price alloy and stainless steel from 28 percent of the total in 1957 and 45 percent of the total in 1958, with a corresponding decrease in carbon steel ingots.

idly built up and modernized their steel industries, and much of their equipment is superior to that of older U.S. plants. This expansion and modernization together with the lower wage rates in these countries contribute to their strong competitive position for United States markets.

Total imports of iron and steel products were 40 percent over 1957 and the largest since 1951. Wire and wire products (wire rods—181,283 tons, nails—201,225, other wire products—281,593), concrete reinforcement bars (473,018), structural iron and steel (304,127), and pipes and tubes (212,226) furnished 91 percent of imports (excluding advanced manufactures). Exports dropped 44 percent and were the lowest since 1954.

Exports of pig iron (103,348 short tons valued at $6,724,789) dropped sharply from the alltime record 882,342 tons exported in 1957. India (54,006 tons) and the European Coal and Steel Community received 86 percent of the exports. Pig-iron imports dropped slightly; Canada supplied 87 percent of the total.

TABLE 19.—Pig iron imported for consumption in the United States, by countries, in short tons

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America: Canada	204,430	203,303	260,741	303,121	221,166	182,128
South America:						
Brazil	6,787			19,621		2
Chile	13,480					
Total	20,267			19,621		2
Europe:						
Austria	31,096					
Belgium-Luxembourg	8,685					
France	15,129					
Germany [1]	115,700	31,854			34	13,933
Netherlands	78,872	7,914	1,232	112		1,125
Norway	5,985	3,482	224	339		334
Spain	12,787	11,704	3,000			7,867
Sweden	23,557	1,203	2,466	1,852	3,135	1,615
Other Europe	1,452					
Total	293,263	56,157	6,922	2,303	3,169	24,874
Asia:						
India	15,412	7,470	11,217	336		
Turkey	7,442					
Total	22,854	7,470	11,217	336		
Africa:						
Rhodesia and Nyasaland, Federation of [2]	1,321	1,944	241			
Union of South Africa	4,108	5,517	1,425	128		
Total	5,429	7,461	1,666	128		
Oceania: Australia	41,985	16,325	3,013	1,191	1,052	2,739
Grand total: Short tons	588,228	290,716	283,559	326,700	225,387	209,743
Value	$25,162,646	$13,315,255	$14,563,612	$17,842,357	$13,527,813	$12,040,551

[1] Effective 1953 classified as West Germany.
[2] Classified as Southern Rhodesia through June 30, 1954; 1,562 short tons January through June 1954.

TABLE 20.—Major iron and steel products imported for consumption in the United States[1]

[Bureau of the Census]

Products	1957 Short tons	1957 Value	1958 Short tons	1958 Value
Semimanufactures:				
Steel bars:				
Concrete reinforcement bars	160,374	[2] $15,903,262	473,018	$34,964,272
Solid and hollow, n.e.s	26,369	[2] 3,879,629	80,405	7,193,567
Hollow and hollow drill steel	1,466	[2] 385,582	674	193,400
Bar iron, iron slabs, blooms, or other forms	113	[2] 35,559	68	19,942
Wire rods, nail rods, and flat rods up to 6 inches in width	54,371	6,712,135	181,283	18,481,263
Boiler and other plate iron and steel, n.e.s	[3] 30,434	[2][3] 5,030,197	27,528	2,942,576
Steel ingots, blooms, and slabs; billets, solid and hollow	7,787	[2] 1,145,998	17,938	1,786,182
Die blocks or blanks, shafting, etc	243	94,595	300	111,621
Circular saw plates	50	[2] 51,140	36	31,255
Sheets of iron or steel, common or black and boiler or other plate iron or steel	1,430	216,997	4,660	517,586
Sheets and plates and steel, n.s.p.f	[3] 793	[2][3] 280,086	2,268	611,848
Tinplate, terneplate, and taggers' tin	45	[2] 17,352	57	26,003
Total	[3] 283,475	[2][3] 33,752,532	788,235	66,879,515
Manufactures:				
Structural iron and steel	[3] 437,415	[2][3] 61,499,143	304,127	35,406,108
Rails for railways	4,853	442,706	4,626	328,267
Rail braces, bars, fishplates, or splice bars and tie plates	193	[2] 23,194	175	20,060
Pipes and tubes:				
Cast-iron pipe and fittings	8,765	[2] 1,891,397	12,181	2,066,257
Other pipes and tubes	190,837	[2] 36,298,717	200,045	30,767,614
Wire:				
Barbed	63,109	[2] 9,361,129	59,253	7,951,961
Round wire, n.e.s	70,763	[2] 11,555,551	133,687	20,041,559
Telegraph, telephone, etc., except copper, covered with cotton jute, etc	1,667	1,289,843	1,424	736,127
Flat wire and iron and steel strips	16,208	[2] 8,433,649	30,472	7,386,783
Rope and strand	[3] 10,825	[2][3] 5,805,783	16,932	7,168,465
Galvanized fencing wire and wire fencing	30,157	4,369,296	39,825	5,744,792
Iron and steel used in card clothing	(4)	743,344	(4)	471,388
Hoop and band iron and steel, for baling	13,866	1,906,046	15,941	2,143,307
Hoop, band and strips, or scroll iron or steel, n.s.p.f	15,472	[2] 1,985,972	5,555	674,870
Nails	137,558	[2] 21,816,051	201,225	20,277,853
Castings and forgings, n.e.s	[3] 9,731	[2] 3,450,616	5,290	1,788,808
Total	[3] 1,011,419	[2][3] 170,872,437	1,030,758	152,974,219
Advanced manufactures:				
Bolts, nuts, and rivets	26,779	[2] 8,666,612	28,751	9,125,023
Chains and parts	2,985	[2] 1,830,899	3,699	2,533,711
Hardware, builders'		[2] 553,733		619,574
Hinges and hinge blanks		[2] 1,065,794		1,003,906
Screws (wholly or chiefly of iron or steel)		[2][3] 1,225,457		1,190,627
Tools		[2] 10,494,579		12,184,130
Other		[2] 208,955		222,465
Total		[2][3] 24,046,029		26,879,436
Grand total		[2][3] 228,670,998		246,733,170

[1] Revisions Minerals Yearbook 1957, p. 629, 1956, Manufactures: Structural iron and steel should read $76,965,713; total manufactures $161,262,153; grand total $226,711,578.
[2] Data known to be not comparable with 1958.
[3] Revised figure.
[4] Weight not recorded.

TABLE 21.—Major iron and steel products exported from the United States

[Bureau of the Census]

Products	1957		1958	
	Short tons	Value	Short tons	Value
Semimanufactures:				
Steel ingots, blooms, billets, slabs, and sheet bars	510,350	$55,364,534	28,001	$3,560,670
Iron and steel bars and rods:				
Carbon steel bars, hot rolled, and iron bars	548	183,185	[1] 76,199	[1] 12,585,733
Concrete reinforcement bars	84,720	11,129,096	24,729	3,619,983
Other steel bars	129,361	26,010,215	[1] 22,170	[1] 7,377,157
Wire rods	13,696	1,743,632	16,711	2,380,484
Iron and steel plates, sheets, skelp, and strips:				
Plates, including boiler plate, not fabricated	604,093	92,699,415	248,709	39,112,479
Skelp iron and steel	197,120	23,697,814	79,614	9,990,415
Iron and steel sheets, galvanized	[2] 126,257	[2] 26,062,989	84,166	17,081,025
Steel sheets, black, ungalvanized	968,868	178,737,374	684,444	122,594,124
Strip, hoop, band, and scroll iron and steel:				
Cold-rolled	33,846	18,421,917	19,919	9,478,100
Hot-rolled	25,511	6,662,679	20,457	5,786,104
Tin plate and terneplate	[2] 700,748	[2] 133,835,273	371,630	65,376,290
Total	3,395,118	574,548,123	1,676,749	298,942,564
Manufactures—steel-mill products:				
Structural iron and steel:				
Water, oil, gas, and other storage tanks (unlined), complete and knockdown material	81,566	24,114,277	41,110	14,490,092
Structural shapes:				
Not fabricated	452,544	62,003,769	[1] 368,452	[1] 40,816,934
Fabricated	220,256	33,905,305	112,687	40,879,147
Plates, sheets, fabricated, punched, or shaped	37,184	8,976,266	66,485	13,887,930
Metal lath	2,343	838,067	1,625	594,989
Frames, sashes, and sheet piling	20,596	4,410,352	14,899	3,518,299
Railway-track material:				
Rails for railways	196,950	23,441,927	139,000	14,925,484
Rail joints, splice bars, fishplates, and tie plates	33,957	6,961,875	40,439	8,558,110
Switches, frogs, and crossings	5,359	2,205,961	3,138	1,296,260
Railroad spikes	2,035	458,611	2,550	569,439
Railroad bolts, nuts, washers, and nut locks	1,168	459,111	1,063	482,229
Tubular products:				
Boiler tubes	31,168	13,183,912	13,024	8,113,595
Casing and line pipe	991,196	222,326,839	474,555	113,331,541
Seamless black and galvanized pipe and tubes, except casing, line and boiler, and other pipes and tubes	52,822	13,330,529	32,775	8,508,287
Welded black pipe	31,782	7,528,116	44,210	10,345,605
Welded galvanized pipe	13,054	3,187,784	4,470	1,139,776
Malleable-iron screwed pipe fittings	1,927	1,835,139	1,733	1,757,906
Cast-iron pressure pipe and fittings	38,608	6,165,829	17,737	3,621,782
Cast-iron soil pipe and fittings	13,517	2,674,944	10,269	2,199,020
Iron and steel pipe, fittings, and tubing, n.e.c.	70,678	53,028,415	[1] 58,527	[1] 43,455,288
Wire and manufactures:				
Barbed wire	1,340	256,767	1,179	239,049
Galvanized wire	7,490	2,085,275	5,894	1,736,098
Iron and steel wire, uncoated	17,992	5,078,252	[1] 17,993	[1] 5,588,495
Spring wire	3,803	2,432,133	[1] 1,470	[1] 892,530
Wire rope and strand	19,063	10,816,919	12,042	7,385,694
Woven-wire fencing and screen cloth	3,107	[3] 2,042,013	2,499	[3] 1,917,630
All other	32,179	14,197,186	[1] 24,835	[1] 11,797,929
Nails and bolts, iron and steel, n.e.c.:				
Wire nails, staples, and spikes	3,737	2,659,596	[1] 3,645	[1] 2,703,669
All other nails, staples, spikes, and tacks	2,048	1,256,815	[1] 1,341	[1] 841,936
Bolts, screws, nuts, rivets, and washers, n.e.c.	19,813	17,765,012	14,453	14,509,732
Castings and forgings: Iron and steel, including car wheels, tires, and axles	112,340	29,608,891	91,477	26,707,724
Total	2,521,622	579,235,887	1,625,576	406,812,199
Advanced manufactures:				
Buildings (prefabricated and knockdown)		[2] 6,198,499		[1] 7,141,606
Chains and parts	8,896	9,793,130	8,971	10,378,384
Construction material	8,544	[2] 5,498,652	8,313	6,053,079
Hardware and parts		22,298,745		[1] 22,495,919

See footnotes at end of table.

TABLE 21.—Major iron and steel products exported from the United States—Con.

Products	1957		1958	
	Short tons	Value	Short tons	Value
Manufactures—steel-mill products—Continued				
Advanced manufactures—Continued				
House-heating boilers and radiators		$8,611,624		$9,660,059
Oil burners and parts		8,916,897		8,035,405
Plumbing fixtures and fittings		7,358,955		[1] 7,873,899
Tools		55,924,783		60,528,362
Utensils and parts (cooking, kitchen, and hospital)	1,533	4,815,857	1,160	3,833,850
Other		[3] 39,786,358		34,771,002
Total		[2] 169,203,500		[1] 170,771,565
Grand total		[2] 1,322,987,510		[1] 876,526,328

[1] Owing to changes in classifications by Bureau of the Census, data not strictly comparable to 1957.
[2] Revised figure.
[3] Includes wire cloth as follows—1957: $1,158,144 (6,601,139 square feet); 1958: $1,088,675 (5,442,270 square feet).

WORLD REVIEW

World production of pig iron, including ferroalloys and steel output, were 5.8 percent and 6.2 percent, respectively, lower than in 1957. The United States, the European Coal and Steel Community, and the Soviet Union ranked first, second and third, respectively, in both pig-iron and steel production. The United States produced 27 percent of world pig iron and 28 percent of steel compared with 35 percent of both commodities in 1957.

NORTH AMERICA

Canada.—Canadian production of pig iron and steel declined 20 and 14 percent, respectively, from 1957. The decline was attributed partly to lower demand but mostly to a strike that lasted 3 months at Stelco (The Steel Company of Canada, Ltd.), largest steel plant in Canada. Expansion resulted mostly from augmenting blast furnace capacity at the Algoma Steel plant, Sault Ste. Marie, Ontario, to 1.5 million tons and from installing two basic oxygen steelmaking converters; the total steelmaking capacity of this plant became 1.6 million net tons. The capacity of blast furnace and steelmaking plants at the end of 1958 was 4.3 million and 6.4 million net tons, respectively.

New steel plants were planned or under construction: The Interprovincial Steel Corporation, Ltd., Regina, Saskatchewan, $15 million plant; J. A. Brusset, president of Western Canadian Magnetic Ores, Ltd., announced a plant in Alberta; and the Koppers Company, Inc., $7 million to $10 million plant in Montreal, which will employ the Strategic-Udy Process described in the Technology section of this chapter.

TABLE 22.—World production of pig iron, (including ferroalloys), by countries,[1] in thousand short tons[2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	2,750	2,327	3,405	3,808	3,923	3,171
Mexico	276	297	356	455	473	547
United States	66,861	59,752	79,263	77,670	80,920	58,867
Total	69,887	62,376	83,024	81,933	85,316	62,585
South America:						
Argentina	28	44	39	32	37	32
Brazil	821	1,222	1,198	1,291	1,400	[3] 1,500
Chile	204	336	282	406	421	408
Colombia	------	97	109	128	158	164
Total	1,053	1,699	1,628	1,857	2,016	2,104
Europe:						
Austria	1,162	1,493	1,660	1,915	2,161	2,004
Belgium	4,700	5,092	5,941	6,350	6,158	6,084
Bulgaria	[4] 9	8	9	11	62	[3] 60
Czechoslovakia	2,421	3,075	3,287	3,618	3,928	[3] 4,100
Denmark	43	44	61	62	65	[3] 65
Finland	99	82	126	114	142	111
France	9,647	9,868	12,198	12,831	13,310	13,378
Germany:						
East	602	1,453	1,672	1,735	1,833	1,957
West	11,429	13,792	18,168	19,375	20,236	18,360
Hungary	586	945	973	847	922	[3] 1,200
Italy	1,075	1,484	1,911	2,200	2,431	2,388
Luxembourg	3,048	3,086	3,401	3,655	3,713	3,621
Netherlands	561	672	739	730	773	1,006
Norway	277	271	392	388	624	560
Poland	1,918	2,935	3,430	3,865	4,059	[3] 4,145
Rumania	388	473	630	650	756	812
Saar	2,330	2,752	3,174	3,341	3,492	3,420
Spain	795	1,004	1,093	1,100	1,030	1,513
Sweden	1,053	1,103	1,375	1,555	1,701	1,382
Switzerland	41	39	60	45	50	37
U.S.S.R.[5]	24,251	33,100	36,700	39,500	40,800	43,700
United Kingdom	11,373	13,309	13,966	14,750	16,024	14,552
Yugoslavia	278	406	585	713	812	860
Total [5]	78,086	96,486	111,551	119,350	125,082	125,315
Asia:						
China	1,680	3,265	4,000	5,265	[3] 6,060	10,470
India	1,953	2,197	2,122	2,194	2,141	2,389
Japan	3,387	5,237	5,981	6,905	7,864	8,493
Korea, North [3]	25	------	125	200	300	450
Taiwan (Formosa)	7	10	11	20	22	19
Thailand	[6] 7	2	2	4	4	6
Turkey	180	216	223	244	239	251
Total [5]	7,239	10,927	12,464	14,832	16,630	22,078
Africa:						
Rhodesia and Nyasaland, Fed. of: Southern Rhodesia	37	41	63	66	88	[3] 88
Union of South Africa	1,014	1,319	1,433	1,495	1,574	1,745
Total	1,051	1,360	1,496	1,561	1,662	1,833
Oceania: Australia	1,582	2,079	2,013	2,324	2,472	2,528
World total (estimate)	158,900	174,900	212,200	221,900	233,200	216,440

[1] Pig iron is also produced in Belgian Congo and Indonesia, but quantity produced is believed insufficient to affect estimate of world total.
[2] This table incorporates a number of revisions of data published in previous Iron and Steel chapters. Data do not add to totals shown owing to rounding where estimated figures are included.
[3] Estimate.
[4] Average for 1952–53.
[5] U.S.S.R. in Asia included with U.S.S.R. in Europe.
[6] Average for 1950–53.

TABLE 23.—World production of steel ingots and castings, by countries, in thousand short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	3,592	3,194	4,535	5,301	5,068	4,345
Mexico	504	686	838	969	1,136	1,144
United States [2]	96,958	88,312	117,036	115,216	112,715	85,255
Total	101,054	92,192	122,409	121,486	118,919	90,744
South America:						
Argentina [3]	151	205	240	[4] 340	[4] 400	269
Brazil	916	1,450	1,402	1,640	1,523	1,672
Chile	181	354	320	420	428	430
Colombia	9	---------	85	99	130	130
Total	1,257	2,009	2,047	2,499	2,481	2,501
Europe:						
Austria	1,135	1,822	2,010	2,291	2,766	2,638
Belgium	4,904	5,462	6,504	7,035	6,917	6,626
Bulgaria	[5] 14	68	82	143	175	233
Czechoslovakia	3,859	4,707	4,932	5,381	5,695	6,098
Denmark	159	219	261	265	289	298
Finland	140	193	195	217	230	207
France	10,667	11,627	13,831	14,770	15,540	16,100
Germany:						
East	1,597	2,569	2,765	3,020	3,191	3,354
West	14,553	19,218	23,519	25,561	27,014	25,116
Greece	33	62	73	83	[3] 83	125
Hungary	1,367	1,644	1,796	1,571	1,521	1,793
Ireland [3]	20	33	33	33	28	31
Italy	3,200	4,637	5,947	6,512	7,481	6,913
Luxembourg	2,967	3,117	3,555	3,810	3,850	3,725
Netherlands	667	1,030	1,080	1,157	1,306	1,585
Norway	100	133	188	320	386	403
Poland	3,174	4,353	4,879	5,527	5,847	6,204
Rumania	678	693	844	859	952	1,027
Saar	2,594	3,092	3,489	3,719	3,791	3,814
Spain	947	1,296	1,427	1,365	1,526	1,734
Sweden	1,705	2,028	2,342	2,644	2,737	2,653
Switzerland [6]	157	165	183	188	247	256
U.S.S.R. [7]	34,083	45,636	49,935	53,572	56,218	60,517
United Kingdom	18,259	20,742	22,165	23,137	24,303	21,918
Yugoslavia	499	692	903	993	1,173	1,252
Total [7]	107,478	135,238	152,938	164,173	173,266	174,620
Asia:						
China	1,056	2,453	3,145	4,922	5,497	8,820
India	1,647	1,887	1,909	1,947	1,916	2,030
Japan	6,415	8,543	10,371	12,242	13,856	13,358
Korea:						
North [3]	28	60	150	210	310	400
Republic of	3	1	12	11	19	22
Philippines	---------	---------	---------	---------	63	73
Taiwan (Formosa)	15	28	44	68	96	66
Thailand	[8] 7	2	4	4	6	6
Turkey	146	187	207	213	194	176
Total [7]	9,317	13,161	15,842	19,617	21,957	24,951
Africa:						
Egypt [3]	13	78	95	117	110	110
Rhodesia and Nyasaland, Fed. of: Southern Rhodesia	29	36	55	64	72	66
Union of South Africa	1,054	1,577	1,742	1,769	1,915	2,019
Total	1,096	1,691	1,892	1,950	2,097	2,195
Oceania: Australia	1,707	2,476	2,465	2,915	3,260	3,424
World total (estimate)	221,900	246,800	297,600	312,650	322,000	298,400

[1] This table incorporates a number of revisions of data published in previous Iron and Steel chapters. Data do not add exactly 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] Average for one year only, as 1953 was the first year of commercial production.
[6] Including secondary.
[7] U.S.S.R. in Asia included with U.S.S.R. in Europe.
[8] Average for 1950–53.

SOUTH AMERICA

Argentina.—Expansion of the Argentina iron and steel industry was well under way. The General Mamal N. Sonio steel plant at Punta Agerich, about 130 miles from Buenos Aires, was scheduled for completion in 1961; it will be Argentina's first integrated steel plant with an annual capacity of 660,000 tons. Sociedad Mixta Metallurgia Argentina (Somisa) was to produce structural shapes, sheets, and tubes at the plant.

Fabricaciones Militares signed a purchase contract with the German firm DEMAG for blast furnaces to expand the company's small pig iron plant in Zapla. The company plans to develop a steel center in Zapla to serve northern Argentina. The blast-furnace capacity of about 35,000 tons actually was to be augmented by 100,000 tons. A rolling mill with an annual capacity of 120,000 tons was also to be installed. The blast furnaces and the rolling mills were expected to begin producing in 1961.

Talleres Metallurgicas San Martin S.A. (TAMET), the leading metallurgical company and steel producer, contemplated expanding its primary steel productive capacity from 30,000 to 66,000 short tons a year. Rolling facilities for wire rods and bars were to be increased from 38,000-ton to 66,000-ton capacity a year. Cost of the development was estimated at about 120 million pesos (in 1958 60.7 pesos equaled $1 in United States money).

La Cantabrica, one of the leading primary steel producers, installed the 20-inch mill for rolling bars and structural shapes during the latter part of 1957. The investment in this expansion was about 50 million pesos. The new mill began producing in the first half of 1958; its rolling capacity was about 50,000 tons, annually.

In July Rosati y Cristafero (RYCSA), producer of primary steel, installed a semiautomatic mill for rolling angles, rods, T-bars, and other structural shapes. This 50-million peso investment added 40,000 tons of rolling facility capacity.[5]

Brazil.—The Henry J. Kaiser Co. was awarded the contract to construct a $170-million steel plant, which was to be built on 1,200 acres in Piacaguera for Compania Siderurgica Paulista, Sao Paulo. The annual capacity of this second largest steel-ingot works in Brazil was to be 550,000 short tons. These facilities were to be included: Coal-handling equipment, 25 miles of railroad track, sinter plant, 53 coke ovens, a blast furnace, an oxygen plant, two 65-ton basic oxygen converters, soaking pits, slab and plate mills, a 66-inch hot-strip mill, cold-reduction mill, continuous pickling line, and galvanizing equipment. Iron ore and limestone crushing and screening units and a 30,000-kilowatt, steam-powerplant were to be constructed.[6]

Chile.—Compania De Acero Del Pacifico, S.A. (CAP), Chile's primary steel producer, continued enlarging and modernizing its plant at Huachipato-Talcahuano, Chile. The program was aimed at improving hot-strip production, and it included manipulators for the 32-inch blooming mill to enable edging work, a new 3-high, roughing mill

[5] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 4, April 1959, pp. 8–9.
[6] Metal Bulletin (London), No. 4341, Oct. 31, 1958, p. 13.
Foreign Commerce Weekly, vol. 60, No. 26, Dec. 29, 1958, p. 11.
Engineering News Record, vol. 162, No. 2, Jan. 15, 1959, p. 108.

and a vertical edger, a 40-high, reversing, hot-strip mill, a shearing line, and a slitting line. The plant also included a 220-ton open hearth, a new slab-reheating furnace, a 3-stand tandem mill, a 4-high temper mill, annealing furnaces, aand miscellaneous auxiliary equipment. The completed plant was to have an annual capacity of about 475,000 tons of ingots and 330,000 tons of finished-steel products. The number of metallurgical plants built since CAP started production in 1958 exceeds 200.[7]

EUROPE

The European Coal and Steel Community.—Industrial production in the Community increased by about 3 percent compared with 6 percent in 1957. Real consumption of steel appeared to increase, but actual output was 3 percent below 1957. During the last 6 months of 1958, dealers and consumers reduced their stocks. Exports were at an alltime high. Based on a May 1953 price index of 100, the price index for steel products from the Community open-hearth plant declined from 111 to 105; at the same time, the U.S. price index rose from 135 to 140.

Community pig-iron (including ferroalloys) and steelmaking capacities reached new highs, increasing 5 percent to 55 million short tons and 6 percent to 74.5 million tons, respectively. Output of pig iron and steel was 50 and 63.8 million short tons, respectively. Steel output in the Netherlands increased 21 percent and also rose in France and the Saar. Production decreased in all other countries.

Steel was produced by three principal processes—Thomas, Martin (open hearth), and electric. The Community planned greater expansion in electric-furnace output than for the Martin process, which was to be emphasized more than the Thomas. Production of Bessemer steel is about 0.5 percent of the total and is rapidly decreasing. About 1.3 percent of the Steel Community output is produced by new processes—L–D, Rotor, Kaldo, and others.

During the first 10 months output of rolled steel products was 1.9 percent below that for the same period in 1957. Production increased by 6 percent in France and by 11.7 percent in the Netherlands. Output in West Germany, Belgium, Luxembourg, and Italy decreased from 4 to 10 percent.

The increased supply of iron ore and coke has permitted a considerable reduction in the consumption of scrap iron in the blast furnace. From 1953 to 1956, 200 pounds of scrap iron was used per short ton of pig iron; in 1957, 174 pounds; and in 1958, 146 pounds per ton. About 836 pounds of scrap per ton of steel was consumed in steelmaking in 1957 and in the first 6 months of 1958. In the second half of 1958, the quantity of scrap was reduced to 800 pounds per ton of steel.

The investment at blast-furnace and steel plants was $665 million (estimated), compared with $710 million in 1957, breaking down to the following 1958 figures: Pig iron, $224 million; steel furnaces,

[7] U.S. Consul, Santiago, Chile, State Department Dispatch 368, Oct. 14, 1958.

$101 million; rolling mills, $221 million; and auxiliary services, $119 million.[8]

Information on technical developments is presented for the European Coal and Steel Community under Technologic Developments.

U.S.S.R.—A 19-man delegation of executives from the U.S. iron and steel industries visited the U.S.S.R. from May 21 to June 21 in exchange for a similar visit of Soviet industry representatives to the United States. The U.S. group included 15 steel industry representatives, editors of "Steel" and "Iron Age" magazines, a university professor, and a Federal Bureau of Mines research scientist.

The information obtained disproved many previous conceptions of the Soviet Steel industry. The Soviets planned to expand by building 5,000-ton-a-day blast furnaces and 1,000-ton-per-heat open-hearth and coke ovens, larger by 50 percent in capacity.

The Soviet Union used coke-oven and blast-furnace gases widely as fuels for open hearths; the United States uses mainly fuel oil and tar. Tar was considered too valuable to use as an open hearth fuel. The Soviets use a larger proportion of hot metal (65-percent hot metal to 35-percent scrap) in open hearths. The open hearths are constructed with an all-basic roof, which withstands higher temperatures and faster firing rates than the acid roof (silica bricks) commonly used in the United States. The roof life reported at Magnitogorsk was 426 to 450 heats on the 440-ton furnaces and 650 to 700 on the 220- and 275-ton furnaces.[9]

Production per man-hour in the Soviet iron and steel industry was found to be 20 to 35 percent less than in the United States.

Some of the expansion under way or planned by the Soviet steel industry included three plants, each reported to be planned for a capacity of 4 million tons a year or more. One project near Stalinsk was to consist of four blast furnaces and was to use 550-ton open hearths, Bessemer converters, oxygen converters, hot and cold strip mills, electrolytic tin lines, and a structural mill. Another plant was scheduled for completion in 1964; this Karaganda Iron and Steel Works was an integrated operation for making hot and cold sheets and strip and tin plate. The Lake Baikal Steel Works, about 1,200 miles east of Stalinsk, was to start producing plate sheet and structural steel in 1959.

A high rate of pig iron production per unit is achieved in the U.S.S.R. owing to the 60- to 100-percent sinter (lime-bearing) used in the blast-furnace charge, high top pressures on 80 percent of blast furnaces, constant and uniform hot-blast temperatures up to 1,650° F., moisture control in the blast, and continuous full-wind blowing—no checking even during casts. At several places, the delegation observed the charging of hot sinter directly into a blast furnace.

As in the United States more than 90 percent of Soviet steel was made in open hearths. Attaining high production was greatly emphasized per unit; the delegation was impressed with the production rate of 20 to 41 net tons per hour at 66 open hearths. However, they

[8] European Iron and Steel Community [Seventh General Report on the Activities of the Community] (in French): Pub. Dept., Feb. 1, 1959, 409 pp. (Trans. by Bernadette Michalski.)

[9] American Iron and Steel Institute, Steel in the Soviet Union: General Report of the Visit of Representatives of the American Steel and Iron Ore Industries to the U.S.S.R., September 1958, 376 pp.

saw methods used which were below American standards, because of working conditions and less regard for safety.

Although handicapped by shortages of fuel oil and tar, the Soviet technicians were able to maintain relative high rates of open-hearth production through the use of fast firing rates and oxygen for combustion. At Zaporozhstal, a reported 20-percent increase in the steel production above rated capacity was claimed to be gained from the use of approximately 700 cubic feet of 96 percent oxygen for combustion per ton of ingot produced.

Soviet plants have considerably more standby machinery than American equivalents, to avoid delay in steelmaking. For example, the No. 2 plant of Magnitogorsk with 13 open hearths has 9 pit cranes, 7 charging machines, and 4 floor cranes—about double most U.S. plants. The Soviets emphasize heavy steel for construction—60 percent compared with 23 percent in the United States. In the United States, the emphasis was on flat-rolled steel for consumer products—51 percent compared with 19 percent in the Soviet Union.

The U.S.S.R. did not appear to be as far advanced in production of alloy and stainless steel as in output of carbon steel at open-hearth furnaces. The surface quality of stainless steel observed was inferior by U.S. standards.

The oxygen steelmaking plants visited had converters somewhat smaller than those used in the United States. The Soviets expected to expand this process but do not expect it to supply more than 10 percent of total steel output.

Soviet rolling mills observed were similar to U.S. mills installed before World War II, mostly resembling designs of 1910–30. The Soviets recognized this deficiency and planned greater attention to this phase of the industry in their next stage of planning and expansion.

Research is considered of great importance to the Soviets. The Mechanobr Research Institute, employing 800 scientists at Leningrad, planned to increase this number to 1,200 in expansion under way. Research fields included concentrating and agglomerating ores and some basic studies in mineralogy and methods of sampling and analyzing ores. This laboratory designed and built mobile equipment for sampling and analyzing samples at mine sites. Staff specialists at the laboratory used spectroscopic methods for analyzing ores. This laboratory also studied the effect of flotation reagents on mineral surfaces. Fine equipment for infrared spectrophotometry was in use. Seven hundred employees of this Institute were engaged in designing new equipment, constructing models, working with machine building plants, and acting as advisors in starting new plants. In the Soviet Union experiments on direct reduction of iron ore were under way, but scientists did not envision that such a process would make the blast furnace obsolete.

Outside Moscow at Tula a pilot plant for developing promising research projects has a small blast furnace for studying production of ferromanganese and a Junghans-type continuous casting machine that can produce 8- by 8-inch steel billets at a rate of about 3 feet per minute.

The U.S.S.R. has an extensive long-range program for expanding its steel industry. Its steel production, 61 million short tons of ingots, was to be increased to at least 70 million tons by 1960, to 100 million by 1965, and to over 125 million by 1975, according to announced plans.

ASIA

China.[10]—The first plan for a modern iron and steel industry in China was laid in 1907. Progress was slow, however, until the Japanese expanded the Anshan plant in Manchuria during the 1930's. The peak Chinese output achieved during the Japanese occupation in 1943 was approximately 2 million short tons of pig iron and 1 million tons each of crude steel and rolled steel. Very little was done in the early post-World War II years to rehabilitate the greatly damaged iron and steel facilities. Reconstruction began when the Communist regime gained control of mainland China. Soon after, the U.S.S.R. returned some key equipment to Anshan and also provided considerable technical assistance and new equipment to Anshan and to other iron and steel enterprises. Meanwhile, the Chinese Communists had become more proficient in operating iron and steel plants and in making and building the necessary equipment. Rehabilitation steadily gained momentum and by 1952 production was already as large as the maximum of the Japanese occupation. New plant capacity was later added so that by 1957 output had tripled that of 1952.

The "Leap forward" year of 1958 marked another turning point in the iron and steel industry for, according to Communist Chinese reports, output was nearly twice that of 1957. Chinese Communist news reports placed production of pig iron and crude steel at 10.5 million and 8.8 million short tons, respectively; the country had become seventh among world producers. The goal for 1959 was 13.2 million tons of steel. The rapid expansion in 1958, particularly during the last half of the year, included completion of additional plant facilities, improvements in the efficiency, the installation of small simple native-type furnaces, and a mass drive to collect scrap. About 5.8 million tons of scrap was said to have been collected. Major plants played a much more important role than small plants. However, over five hundred thousand native-type melting and smelting furnaces, many since discarded or consolidated, provided about 2 million tons of steel and 3–4 million tons of pig iron, largely was of poor quality, and excluded from the data above. The mass drive served to assemble considerable iron and steel materials and furnish information and experience for establishing new iron and steel centers in the future.

Anshan, the principal iron and steel industry center in 1958, produced about 4.5 million metric tons of pig iron, 5.0 million tons of crude steel, and 3.3 million tons of rolled steel during 1958. A 2,500-ton-a-day blast furnace and two large open-hearth furnaces, all claiming to be among the world's largest, were added at Anshan. The first of two large blast furnaces (nearly the same size as the new Anshan furnace) was also completed at the Wuhan iron and steel complex in the Hankow area. At the Paotou iron and steel complex in Inner

[10] Prepared by Dr. K. P. Wang, Far East specialist, Division of Foreign Activities, Bureau of Mines.

Mongolia, work proceeded smoothly and the first of two blast furnaces with a working volume of 53,000 cubic feet was scheduled for completion by the end of 1959. There were many less important centers in existence or under construction in various parts of China.

The larger plants, efficient by world standards, were somewhat weak in fabrication. At blast furnaces, the feed was carefully controlled for size and iron content, steam was used to humidify the blast, and agglomerates were self-fluxing—a Soviet practice. At open hearths, oxygen was used to accelerate steel refining (also in convertors); work schedules were streamlined; three-trough tapping was introduced; and heats were reduced to about 5 hours in many instances. The net effect was to increase production per furnace by 20–30 percent.

Iran.—A steel plant, under construction at Teheran, will have an annual capacity of 132,000 tons.[12]

Iraq.—Mackenzie Engineering, Ltd., a British consulting firm, was awarded a contract to design and draw specifications for a steel plant at Baghdad. The plant was planned to consist of one 18-ton electric furnace with an annual capacity of 30,000 tons utilizing a 100 percent charge steel scrap for steelmaking. It was also to include a rolling mill for producing small shapes (up to 4 inches in diameter); its annual capacity was to be about 60,000 tons. The plant layout provides for later expansion of both steelmaking and rolling mill facilities. Production was scheduled to start within 2 years after approval of the plans.[11]

Japan.—Since World War II the Japanese steel industry has been modernized and expanded. Steel production increased from 1 million net tons in 1947 to over 13.1 million tons in 1958 (13.9 in 1957). The industry in 1958 was in the middle of the "second rationalization program," which started in 1956 and was to terminate in 1962. This program calls for an outlay of $1.5 billion to construct new integrated steel plants and renovate older plants. Under the program annual capacities will be raised to 13 million tons of pig iron and 22 million tons of steel ingot or double the 1956 capacity figures. New facilities to be added include 10 blast furnaces (with pig iron capacities from 1,100 to 1,650 tons per day) and 22 converters (basic oxygen), a 4.8 million increase in annual steelmaking capacity. Open-hearth steel production will be increased 2 million tons to 13 million tons. The larger expansion in oxygen steelmaking is based on the assumption that the availability of scrap will decrease. Other plants to be installed will be as follows:

Blooming mills	5
Hot strip mills	4
Continuous cold reduction mills	1
Reversible cold reduction mills	8
Sendzimir cold strip mills	8
4-high plate mills	1
Electric welding medium pipe mills	2

The program is partly financed by loans from the Export-Import Bank ($97 million) and the World Bank ($73 million). The World Bank loaned Kawasaki Steel Corp. $8 million; Sumitomo Metal In-

[11] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 2, February 1958, pp. 9–12.
[12] Madsen, I. E., Developments in the Iron and Steel Industry During 1958: Iron and Steel Eng., vol. 36, No. 1, January 1959, p. 122.

dustries, $33 million; Kobe Steel Works, $10 million; and Nippon Kokan K. K., $22 million. The Export-Import Bank of Washington loaned Yawata Iron and Steel Co. $26 million; and Toyo Kohan Co. $71 million.

The use of steel in consumer's goods was only about 25 percent of total Japanese demand—a low rate compared with the 45 percent in the United States. Shipbuilding took about 15 percent; machinery engineering, 14 percent; and builders, nearly 19 percent. Demand from all these industries was expected to increase. The use and sale of motor cars, electrical appliances and canned goods have been increasing.

Apparent consumption of steel per capita in Japan in 1956 was 245 pounds compared with 1,325 pounds in the United States. Considering the increases since then it was forecast there will probably be a tremendous increase in Japanese per capita consumption during 1959–69.[13]

AFRICA

Egypt.—The Helwan Iron and Steel Co. plant, Egypt's first integrated iron and steel works, was inaugurated in July near Helwan. Its beginning capacity was 265,000 tons of ingot steel annually, with plans for increasing to 500,000 tons at a later date. The completed part of the plant comprised two blast furnaces, three basic Bessemer converters, two electric furnaces, one 2-high reversing blooming mill with soaking pits, another three-stand blooming and high-finishing mill, a three-high heavy- and medium-plate mill, a two-high stand for sheets, and auxiliary plants. Surplus gas available at the works was used for power generation. Ore for the plant comes from near Aswan, 600 miles to the south, and coke principally from West Germany.[14]

Union of South Africa.—The South African Iron and Steel Industrial Corporation planned to increase its steelmaking capacity from 1.5 million short tons in 1958 to 2.4 million short tons by 1960. A new blast furnace was placed in operation at Pretoria in 1958 increasing pig iron production from 12,500 tons to 22,500 tons a week. Major expansion of steel manufacturing facilities at Vanderbijlpark was underway to handle the increased pig iron output.[15]

OCEANIA

Australia.—The Australian iron and steel industry maintained production at capacity throughout 1958. The demand for steel exceeded supply and was expected to do so for several years. By enlarging and adding blast and open-hearth furnaces annual steelmaking capacity will be increased 1 million tons to 4 million tons by 1960. The Broken Hill Proprietary Company tinplate output was to be increased by 57 percent by adding four hot-dip tinning stands. At Port Kembla, No. 4 blast furnace was being enlarged and a fourth open-hearth furnace was under construction. Five new wire-drawing

[13] Metal Bulletin (London), March 1959, pp. 21–22.
[14] Blast Furnace and Steel Plants, vol. 46, No. 8, August 1958, p. 877.
Bureau of Mines Mineral Trade Notes: Vol. 48, No. 4, April 1959, p. 6.
[15] South African Mining and Engineering Journal, vol. 69, No. 3427, Oct. 17, 1958, p. 767.

machines began producing at Newcastle. A cold-rolling and finishing stainless steel sheet and strip mill was under construction near Port Kembla. A modern Sendzimir cold-rolling mill was to be installed at this plant. The mill, first of its type in Australia, was being built under license from the Sendzimir Co. of the United States.[16]

New Zealand.—Colvilles and Stewarts & Lloyds were actively interested in a project approved by the Government in 1958 to build a steel mill. This steel works was to use scrap and to have an annual capacity between 40,000 and 50,000 tons of merchant rods, bars, and flats.[17]

TECHNOLOGY

The steel industry continued to emphasize changes in blast-furnace practice that would increase output. Some of these changes were: More sinter per ton of pig iron, the use of self-fluxing sinter by more companies, the use of hot blast temperatures up to 1,600° F., and employment of high top pressure. Computers were used for analysis, programming, and charging. At the U.S. Steel Gary No. 3 furnace, an automatic wind proportioner was installed to equalize the blast to each of the 20 tuyeres. Better distribution of the gases should improve shaft efficiency.[18]

A U.S.S.R. report on blast furnaces claimed that by changing the burden from 20 percent regular sinter plus 20 percent self-fluxing sinter to 85 percent self-fluxing sinter that pig iron output was increased 14 percent and coke consumption was reduced 11 percent.

A report from Sweden indicated coke requirements may be reduced 25 percent by charging a 100 percent sinter burden with a further 10 to 15 percent reduction in coke consumption by using an all self-fluxing sinter charge.

In research on a blast furnace at the Azov plant near Rostov, U.S.S.R., an electronic computer was employed to control furnace operations. The program included 39 variables many of which were subject to rapid changes. The computer analyzes deviations from optimum conditions and promptly feeds back information needed to restore the furnace to proper smelting conditions. Control units tested include an ultrasonic device for measuring the level of the stockline. Other devices measure the temperatures of the hearth, molten iron, slag tapped, and the flow and weight of the charge on the skip hoist.[19]

In a blast furnace at Debrecen, Hungary, carbon monoxide (92–95 percent from waste gases) was used to partly replace coke in a small blast furnace (16.5 feet in height and 27.5 inches in diameter). It was claimed that 67 percent of the coke could be replaced by carbon monoxide; the remaining 33 percent was used only for heating the furnace. Thermodynamic studies of blast-furnace reactions show that the overall reduction of iron ore with carbon monoxide was an

[16] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 4, April 1959, pp. 10–11.
[17] Metals Bulletin (London), No. 4365, Jan. 27, 1959, p. 13.
[18] Madsen, I. E., Developments in the Iron and Steel Industry During 1958: Iron and Steel Eng., vol. 36, No. 1, January 1959, pp. 112–158.
[19] Iron Age, Computer Guides Blast Furnace: Vol. 182, No. 5, July 31, 1958, p. 70.

exothermic reaction, but hydrogen, although an effective reducing agent, reacts endothermically.

A new method for controlling the operation of a blast furnace, based on bustle pipe pressure, was tried in the United States. The rate of pressure increase in the bustle pipe foretold furnace conditions before hanging occurred. An instrument, showing the rate of pressure change in the hot blast line, was connected to an automatic control device that reduced or increased the hot blast temperature and wind rate. This arrangement prevented hanging and enabled the blast furnace to operate near the critical point.

Colorado Fuel & Iron Co. used photography to check blast furnace linings: The camera was mounted in a space box and lowered into the furnace; the resulting pictures gave vital information on the furnace lining.

In the field of direct reduction, attention was given to the Strategic-Udy process, a pilot plant located at Niagara Falls, Canada (summary of other direct processes was presented in the 1957 Iron and Steel chapter). The first stage consisted of feeding a mixture of iron ore, flux, and coal into a rotary kiln. The ore was heated and partly reduced (40 to 45 percent of the oxygen removed), and the limestone was calcined. Natural gas and exhaust gases (high in carbon monoxide) from the electric furnace supplemented coal for firing the kiln. The temperature of the discharged free-flowing material from the kiln was maintained between 1,800° F. and 2,300° F., depending on the type of ore. Coal that was not consumed in the prereduction in the kiln was "coked" and passed to the electric furnace for a reductant in the smelting step. To save thermal and electrical energy, hot prereduced material from the kiln was charged directly into a 1,000-kilovolt-ampere electric smelting furnace; in this phase, enough carbon was added for complete reduction. Smelting was completed in 3 to 4 hours. The carbon content of the pig iron or steel produced can be varied from 0.2 percent to 3.5 percent. Reported power requirements were 1,000 to 1,500 kilowatt-hours per ton.

Another direct process for making and charging hot sponge iron into an electric furnace was developed by Hojalata Y Lamina S.A., at Monterrey, Mexico, where a 200-ton-per-day plant was operating. In this process, iron ore, sinter, or pellets are charged into a reaction vessel similar to a steel ladle. Hot gases are blown through the ore or agglomerate bed to heat it to a reaction temperature of about 2,000° F. Reformed natural gas methane converted to carbon monoxide and hydrogen was then fed into a bed of hot ore; when the desired degree of reduction was achieved, the vessel was lifted and the sponge iron was dumped into the top-charge electric furnace. Estimated operating cost for a 1,000 ton per day plant of this type in the Gulf Coast area of Mexico was about $34 per ton of pig iron.

The Ontario Research Foundation, near Toronto, Canada, experimented with two direct processes—the O.R.F. Direct Steel or Continuous Strip process and the Jet Smelter process. In the Direct Steel process, a bed of fine concentrated magnetite (0.5 percent maximum gangue) was laid on pallets in an enclosed traveling grate furnace. The bed was reduced by gases to metallic iron and rolled directly into strip. Annealed cold-rolled sheets made from the strip have excellent deep drawing qualities. The Jet Smelter process, for making iron and steel from iron ore in one step, was designed particularly for Northern Ontario iron ore. The objective is to secure a rapid rate of reduction, using natural gas instead of coal. Magnetite and lime are fed through the top of a cylindrical furnace, passed through an oxidizing gas and then through a reducing gas into a molten iron bath. Because this process avoids impingement of iron oxide on the refractories (a major problem in the Cyclosteel process) reasonable refractory life may be possible. The high carbon metal produced is suitable for use in open hearths and for limited use in the electric furnace.[20]

Ferrocoke received further attention. One eastern plant made a satisfactory ferrocoke out of 80 percent high volatile coal and 20 percent flue dust. At one plant, the use of a blast furnace fuel charge of equal parts of regular and ferrocoke resulted in increased pig iron output and a 41 pound per ton saving in total coke requirement.

Oxygen was more widely used in steelmaking. The Kaiser Steel Corp. new oxygen steelmaking facilities at Fontana, Calif., became the third producer of this type of steel in the Nation; the combined annual capacity was 4 million tons. More residual manganese was retained in the metal for low carbon heats than in the open hearth. Some 25 percent of the original manganese charged to the oxygen converter reportedly remained in the steel, but only 10 percent was retained in an open hearth. Some companies used oxygen injected through the roof of open-hearth furnaces and increased production as much as 50 percent.

U.S. Steel Corporation developed a new process for rolling wide and thin stainless-steel sheets known as the Sandwich process. The method consisted of sandwiching stainless steel or alloy steel plate between heavier plates of ordinary carbon steel, and then closing the assembly with welded-in side and end bars. After heating, the sandwich was hot-rolled. By such an arrangement a stainless plate 5/16 inch thick can be rolled to the nominal thickness of 0.033 inch. The width of the sheet depends on the type of mill. Sheets as much as 90 inches wide were made, and sheets over 200 inches wide were considered possible.[21]

The High Authority of the European Coal and Steel Community subsidized about 50 percent of the cost of research on the Liege low-shaft furnace. Results indicated that the low-shaft furnace functioned satisfactorily as an experimental unit.

The first part of the program was concerned with a systematic series of tests designed to show the influence of high-top pressure. To eliminate the influence of variations in particle size, the experiments were made with small coke and with Lorraine ores from 1/5 inch to 1 inch. When compared with runs that used the same type of charge without high-top pressure, coke consumption decreased 40 percent and was accompanied by changes in the driving rate, top-gas temperature, and a reduced quantity of flue dust. The indirect reduction of

[20] Journal of Metals, Direct Iron Ore Reduction: Vol. 10, No. 12, December 1958, pp. 804–809.

[21] Madsen, I. E., Developments in the Iron and Steel Industry During 1958: Iron and Steel Eng., vol. 36, No. 1, January 1959, pp. 112–158.

iron by carbon monoxide was also improved. The application of 22 pounds a square inch top pressure had a decided effect. The consumption of coke was reduced 15 percent, the indirect reduction increased from 48 to 55 percent. At the same time flue dust rate decreased.

The second part of the test program was concerned with using sinter with coke screened between ½ and 1 inch; this sizing was needed to adjust the size of the sinter to the dimensions of the furnace because of the heat exchange factor. In the experiment, consumption of coke was decreased 10 percent by screening out particles under ⅒ inch and greater than 1¼ inch. In spite of a very low basicity $\left(\frac{CaO+MgO}{SiO_2+Al_2O_3}=1.0\right)$, the operation of the equipment was excellent, and coke consumption was reduced. This pointed to the significance of agglomerating the entire charge and using agglomerates of the self-fluxing type. When the top pressure was 22 pounds per square inch, coke consumption decreased 13 percent, and the indirect reduction by carbon monoxide exceeded 60 percent. At the Cockerill-Ougré plant, experiments also were made with charges of 100 percent of the same sinter used in a commercial furnace without high-top pressure. It was thus possible to establish agreement between the results obtained from this furnace and the low-shaft furnace under top pressure (the same coke consumption rate, 1,340 pounds per net ton and the same percent of indirect reduction).

Results demonstrated that the low-shaft furnace was comparable in actual principle to a conventional high-shaft commercial furnace, provided a suitable top pressure is applied and the size of the particles in the charge have been suitably selected.

The original program for the Liege short-shaft blast furnace, which included a study of the injection of water vapor, was changed by the High Authority to a study of the injection of atomized fuel oil through the tuyeres, using a 100-percent self-flux sintered burden. To maintain adequate thermal input, at the same thermal level, the blast was increased to 24 percent oxygen (when using 125 pounds of fuel oil per short ton of pig iron). The injection of fuel oil decreased coke-carbon consumption about 14 percent and total carbon, about 5 percent (coke-carbon plus fuel oil carbon). However, with top pressure the fuel oil did not reduce coke consumption because the fuel oil carbon was only partly used. The operation with 22 pounds per square inch top pressure (without fuel oil) resembled that which had been previously shown to be a maximum for the low-shaft furnace at Liege. Subsequent experiments definitely confirmed these preliminary conclusions with respect to the sinter and finally the value of experimental data for improving the operation of conventional blast furnaces.

The 1958 experiments with the short-shaft blast furnace demonstrated the similarity of the high and low furnace, which was a definite objective of the High Authority. It was proved that data from the experimental furnace could be used for extrapolating the production rate of a commercial blast furnace. Finally, the equipment at Liege was well adapted for conducting fundamental research and for investigating those novel technical methods, which if carried out in a conventional blast furnace would be time-consuming, intricate, burdensome, and expensive.

In view of the high cost of metallurgical coke in the Community, the High Authority, which in 1957 had made a broad survey of direct-reduction processes, allocated $1.2 million for experiments by two direct reduction methods—using the shaft furnace and the rotary kiln or combinations of the rotary kiln with other furnaces. The High Authority believed that the supply of metallurgical coal in the Community could not be improved. Therefore, the novel direct-reduction processes, using noncoking coal and other fossil fuels, might provide new sources of metallics for steelmaking. On the other hand, new types and sources of energy (atomic and fossil fuel) that might be used for direct iron reduction were constantly being found, further emphasizing the necessity for research.

In addition to the foregoing direct processes, the High Authority was equally interested in fluidized-bed treatment of fine mineral concentrates. In these processes, natural gas or gases, resulting from industrial operations or from petroleum refinement, would be used as the means for supplying heat and as reducing agents.

Other programs of the High Authority were concerned with a survey of the fuel, iron ore, and manganese resources of the Community. A grant of $5 million was made to the account of the Bureau minier de la France d'outre-mer to promote and speed this raw material study. It is also concerned with the problem of atmospheric pollution as the result of industrial operations, particularly in the basic converter when blown with oxygen.[22]

[22] European Iron and Steel Community [Seventh General Report on the Activities of the Community] (in French): Pub. Dept., Feb. 1, 1959. (Trans. Percy H. Royster.)

Iron and Steel Scrap

By James E. Larkin [1]

LOWER PRICES and demand, improved technology in steel-furnace operations, and a 56-percent decrease in exports were some of the causes for apprehension in the iron and steel scrap industry. The price of No. 1 Heavy-Melting scrap at Pittsburgh was at a yearly low of $32.75 per gross ton in January. Some improvement in price occurred during the next 2 months, but after dropping again in April the price increased to a high for the year of $45 in October. The price then declined to $42.50 (estimate) per ton in December.

TABLE 1.—Salient statistics of ferrous scrap and pig iron in the United States, in short tons

	1957	1958
Stocks, December 31: Ferrous scrap and pig iron at consumers' plants:		
Total scrap	8,949,386	9,593,600
Pig iron	3,816,699	3,964,269
Total	12,766,085	13,557,869
Consumption: Ferrous scrap and pig iron charged to:		
Steel furnaces: [1]		
Total scrap	56,764,733	43,023,625
Pig iron	68,767,552	51,299,102
Total	125,532,285	94,322,727
Iron furnaces: [2]		
Total scrap	15,647,882	12,431,359
Pig iron	7,585,574	5,963,234
Total	23,233,456	18,394,593
Miscellaneous uses [3] and ferroalloy production: Total scrap	1,136,208	904,951
All uses:		
Total ferrous scrap	73,548,823	56,359,935
Pig iron	76,353,126	57,262,336
Grand total	149,901,949	113,622,271
Imports of scrap (including tinplate scrap)	238,610	332,622
Export of scrap: Iron and steel	[4] 6,765,992	2,954,969
Average prices per long ton:		
Scrap:		
No. 1 Heavy Melting, Pittsburgh [5]	$47.53	[6] $39.42
For export	[4] $54.55	$36.93

[1] Includes open-hearth, Bessemer, electric furnaces, crucible, and basic oxygen process.
[2] Includes cupola, air, and blast furnaces; also direct castings.
[3] Includes rerolling, reforging, copper precipitation, nonferrous, and chemical uses.
[4] Revised figure.
[5] Iron Age.
[6] Estimate.

[1] Commodity specialist.

The decreased demand for domestic scrap that began in the last 2 months of 1957 continued through the first 9 months of 1958, when steel mills operated at a monthly average of 56.1 percent of the annual rated capacity. During April scrap consumed for all purposes totaled 3.8 million short tons—the lowest rate, exclusive of strike months, since July 1949; scrap requirements fluctuated each month for the remainder of the year and showed some recovery during the last quarter, when increased demand resulted from steel mills operating at an average of 73.5 percent of rated capacity. The peak month for consumption during the year was in this period, when 5.1 million short tons of scrap was consumed for all purposes during October.

A 24-percent drop in steel output as compared with 1957 resulted in the lowest consumption each of scrap and pig iron in steelmaking furnaces since 1949. Ferrous scrap used in 1958 in these furnaces comprised 46 percent of the combined total of scrap and pig iron, slightly higher percentagewise than during the preceding year; however, the daily consumption rate for scrap decreased from 156,000 short tons in 1957 to 118,000 in 1958.

LEGISLATION AND GOVERNMENT PROGRAM

On February 21, 1958, the U.S. Department of Commerce issued a supplement to its original report transmitted to Congress on February 1, 1957, in accordance with Public Law 631 of the 84th Congress. The supplement was based primarily on additional material from the Battelle Memorial Institute and verified the original Department of Commerce conclusion that, on an overall basis, there is an adequate supply of obsolete scrap but still a possible depletion of Heavy-Melting-scrap reserves, depending on the future trend in production of steel products.

The Bureau of Foreign Commerce, U.S. Department of Commerce, continued to issue licenses for the exportation of scrap on an open-end basis with no quantitative limitations. Although no shortages of scrap were anticipated, the Bureau of Foreign Commerce continued to keep supply and demand under close scrutiny, particularly the Heavy-Melting grades.

On June 12, 1958, the Bureau of Foreign Commerce announced that rerolling rails (regardless of weight, pounds per yard) could be exported on an open-end basis.

With approval of Public Law 85-466 on June 25, 1958, the Export Control Act was extended from June 30, 1958, to June 30, 1960. This regulation permits the U.S. Department of Commerce to maintain control over export of materials considered of strategic nature, including scrap.

AVAILABLE SUPPLY

Consumers of iron and steel scrap had a net supply made available at their plants of 57 million short tons during 1958, a 24-percent decrease from the supply made available during the previous year. Home scrap produced and scrap received from dealers and other sources decreased 23 and 26 percent, respectively.

TABLE 2.—Ferrous scrap supply[1] available for consumption in 1958, by districts and States, in short tons

District and State	Home production	Receipts from dealers and all others	Total new supply	Shipments[2]	New supply available for consumption
Connecticut	65,866	50,945	116,811	10,237	106,574
Maine and New Hampshire	8,609	12,602	21,211	3,239	17,972
Massachusetts	133,392	158,712	292,104	30,969	261,135
Rhode Island	34,741	39,732	74,473	355	74,118
Vermont	5,644	5,774	11,418	140	11,278
Total, New England: 1958	248,252	267,765	516,017	44,940	471,077
1957	334,947	411,733	746,680	40,927	705,753
New Jersey	159,487	420,623	580,110	22,364	557,746
New York	1,395,414	1,103,825	2,499,239	75,466	2,423,773
Pennsylvania	8,071,703	4,232,607	12,304,310	555,869	11,748,441
Total, Middle Atlantic: 1958	9,626,604	5,757,055	15,383,659	653,699	14,729,960
1957	13,917,759	9,457,685	23,375,444	1,127,481	22,247,963
Illinois	2,849,113	2,874,397	5,723,510	174,390	5,549,120
Indiana	4,376,669	2,651,793	7,028,462	100,816	6,927,646
Michigan	2,264,135	1,980,042	4,244,177	51,555	4,192,622
Ohio	5,758,204	3,631,820	9,390,024	317,014	9,073,010
Wisconsin	388,976	369,210	758,186	95,370	662,816
Total, East North Central: 1958	15,637,097	11,507,262	27,144,359	739,145	26,405,214
1957	20,224,509	14,938,706	35,163,215	987,879	34,175,336
Iowa	126,302	194,734	321,036	3,778	317,258
Kansas and Nebraska	27,194	67,267	94,461	2,176	92,285
Minnesota, North Dakota, and South Dakota	210,689	248,484	459,173	4,487	454,686
Missouri	179,435	730,129	909,564	[3] 1,852	911,416
Total, West North Central: 1958	543,620	1,240,614	1,784,234	8,589	1,775,645
1957	609,977	1,310,524	1,920,501	35,009	1,885,492
Delaware, District of Columbia, and Maryland	2,138,946	427,517	2,566,463	13,507	2,552,956
Florida and Georgia	48,766	150,287	199,053	1,623	197,430
North Carolina	26,730	40,843	67,573	7,741	59,832
South Carolina	10,282	8,640	18,922	343	18,579
Virginia and West Virginia	730,135	698,365	1,428,500	29,960	1,398,540
Total, South Atlantic: 1958	2,954,859	1,325,652	4,280,511	53,174	4,227,337
1957	3,295,834	1,493,995	4,789,829	82,158	4,707,671
Alabama	1,381,505	1,186,118	2,567,623	179,254	2,388,369
Kentucky, Mississippi, and Tennessee	510,330	749,193	1,259,523	32,312	1,227,211
Total, East South Central: 1958	1,891,835	1,935,311	3,827,146	211,566	3,615,580
1957	2,304,418	2,185,793	4,490,211	360,377	4,129,834
Arkansas, Louisiana, and Oklahoma	34,133	154,167	188,300	1,207	187,093
Texas	578,538	746,920	1,325,458	8,029	1,317,429
Total, West South Central: 1958	612,671	901,087	1,513,758	9,236	1,504,522
1957	800,056	1,260,560	2,060,616	32,162	2,028,454
Arizona, Nevada, and New Mexico	12,456	57,076	69,532	2,681	66,851
Colorado and Utah	1,029,758	428,418	1,458,176	15,435	1,442,741
Idaho and Montana	4,541	12,794	17,335	41	17,294
Total, Rocky Mountain: 1958	1,046,755	498,288	1,545,043	18,157	1,526,886
1957	1,274,842	639,302	1,914,144	14,965	1,899,179
California	1,045,389	1,293,415	2,338,804	66,411	2,272,393
Oregon	40,297	155,036	195,333	4,756	190,577
Washington	66,156	228,028	294,184	9,226	284,958
Total, Pacific Coast: 1958	1,151,842	1,676,479	2,828,321	80,393	2,747,928
1957	1,233,967	2,163,386	3,397,353	94,881	3,302,472
Total, United States: 1958	33,713,535	25,109,513	58,823,048	1,818,899	57,004,149
1957	43,996,309	33,861,684	77,857,993	2,775,839	75,082,154

[1] New supply available 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. The plus or minus differences in stock levels at the beginning and end of the year are not taken into consideration.
[2] Includes scrap shipped, transferred, or otherwise disposed of during the year.
[3] Data shown in shipments column are plus figures owing to adjustments in accounting procedures.

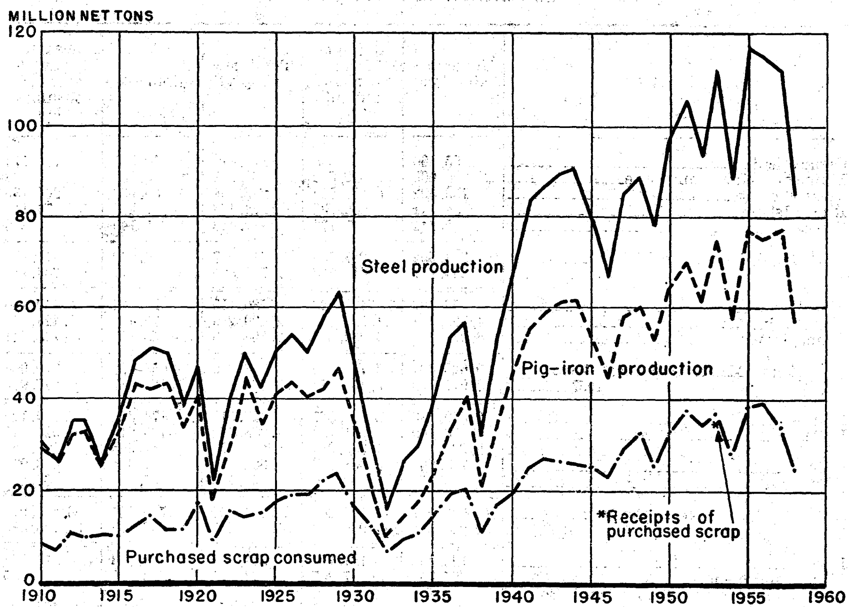

FIGURE 1.—Consumption of purchased scrap in the United States, 1910–52, and output of pig iron and steel, 1910–58. Figures on consumption of purchased scrap for 1910–32 are from State of Minnesota vs. Oliver Iron Mining Co., et al., Exhibits, vol. 5, 1935, p. 328; those for 1933–34 are estimated by authors; and those for 1935–52 are based on Bureau of Mines records. Data for 1953–58 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.—Consumption of ferrous scrap and pig iron in the United States in 1958, 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	Total scrap and pig iron
Open-hearth	33,892,370	48,336,938	82,229,308	449,696	70,599	520,295	------	------	------	34,342,066	48,407,537	82,749,603
Bessemer [3]	619,542	2,634,888	3,254,430	9,808	615	10,423	2,007	403	2,410	631,357	2,635,906	3,267,263
Electric [4]	6,695,395	216,265	6,911,660	1,203,716	23,874	1,227,590	151,091	15,520	166,611	8,050,202	255,659	8,305,861
Total steelmaking furnaces	41,207,307	51,188,091	92,395,398	1,663,220	95,088	1,758,308	153,098	15,923	169,021	43,023,625	51,299,102	94,322,727
Cupola	574,107	455,444	1,029,551	383,874	17,015	400,889	7,695,847	3,236,956	10,932,803	8,653,828	3,709,415	12,363,243
Air	26,382	10,308	36,690	195,345	35,011	230,356	698,505	144,353	842,858	920,232	189,672	1,109,904
Blast [5]	2,857,299	------	2,857,299	------	------	------	------	------	------	2,857,299	------	2,857,299
Direct castings	------	1,261,134	1,261,134	------	------	------	------	803,013	803,013	------	2,064,147	2,064,147
Ferroalloys	------	------	------	------	------	------	192,526	------	192,526	192,526	------	192,526
Miscellaneous	168,945	------	168,945	------	------	------	543,480	------	543,480	712,425	------	712,425
Total: 1958	44,834,040	52,914,977	97,749,017	2,242,439	147,114	2,389,553	9,283,456	4,200,245	13,483,701	56,359,935	57,262,336	113,622,271
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

[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 small quantities of scrap and pig iron consumed in crucible furnaces.
[5] Includes consumption in all blast furnaces producing pig iron.

TABLE 4.—Proportion of ferrous scrap and pig iron used in furnaces in the United States, in percent

Type of furnace	1957		1958	
	Scrap	Pig iron	Scrap	Pig iron
Open-hearth	41.7	58.3	41.5	58.5
Bessemer [1]	10.0	90.0	19.3	80.7
Electric [2]	97.3	2.7	96.9	3.1
Cupola	68.9	31.1	70.0	30.0
Air	82.5	17.5	82.9	17.1

[1] Includes oxygen-steel process.
[2] Includes crucible furnaces.

CONSUMPTION BY DISTRICTS AND STATES

The use of domestic scrap for all purposes decreased in all nine geographical areas; the largest decrease—34 percent—occurred in both the New England and Middle Atlantic districts. As in previous years, the largest consuming districts, for scrap, were East North Central, Middle Atlantic, and South Atlantic. The States consuming the largest quantities of scrap, with the percentages consumed, were Pennsylvania, 20 (24 in 1957); Ohio, 16 (16 in 1957); Indiana, 12 (11 in 1957); and Illinois, 10 (9 in 1957).

TABLE 5.—Consumption of ferrous scrap and pig iron in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
Connecticut	107,424	27,310	134,734
Maine and New Hampshire	17,598	5,447	23,045
Massachusetts	272,044	87,269	359,313
Rhode Island	73,575	33,706	107,281
Vermont	12,333	4,852	17,185
Total, New England: 1958	482,974	158,584	641,558
1957	732,387	230,754	963,141
New Jersey	556,184	158,293	714,477
New York	2,377,096	2,702,089	5,079,185
Pennsylvania	11,489,204	14,355,285	25,844,489
Total, Middle Atlantic: 1958	14,422,484	17,215,667	31,638,151
1957	21,794,682	24,620,175	46,414,857
Illinois	5,609,827	4,190,537	9,800,364
Indiana	6,925,950	7,960,282	14,886,232
Michigan	4,198,484	3,321,133	7,519,617
Ohio	8,846,968	9,446,795	18,293,763
Wisconsin	664,470	191,935	856,405
Total, East North Central: 1958	26,245,699	25,110,682	51,356,381
1957	33,408,645	34,028,602	67,437,247
Iowa	311,403	71,767	383,170
Kansas and Nebraska	91,126	4,033	95,159
Minnesota, North Dakota, and South Dakota	454,834	405,532	860,366
Missouri	896,231	36,257	932,488
Total, West North Central: 1958	1,753,594	517,589	2,271,183
1957	1,951,747	626,168	2,577,915
Delaware, District of Columbia, and Maryland	2,575,632	4,133,280	6,708,912
Florida and Georgia	195,836	13,737	209,573
North Carolina	60,847	21,793	82,640
South Carolina	24,670	13,116	37,786
Virginia and West Virginia	1,411,449	2,120,942	3,532,391
Total, South Atlantic: 1958	4,268,434	6,302,868	10,571,302
1957	4,502,109	6,834,148	11,336,257
Alabama	2,428,840	2,981,431	5,410,271
Kentucky, Mississippi, and Tennessee	1,197,909	866,548	2,064,457
Total, East South Central: 1958	3,626,749	3,847,979	7,474,728
1957	3,989,923	5,186,163	9,176,086
Arkansas, Louisiana, and Oklahoma	161,153	6,393	167,546
Texas	1,294,062	773,124	2,067,186
Total, West South Central: 1958	1,455,215	779,517	2,234,732
1957	2,019,792	921,059	2,940,851
Arizona, Nevada, and New Mexico	59,440	110	59,550
Colorado and Utah	1,448,914	2,044,046	3,492,960
Idaho, Montana, and Wyoming	19,739	412	20,151
Total, Rocky Mountain: 1958	1,528,093	2,044,568	3,572,661
1957	1,877,868	2,448,766	4,326,634
California	2,127,276	1,280,159	3,407,435
Oregon	190,196	1,621	191,817
Washington	259,221	3,102	262,323
Total, Pacific Coast: 1958	2,576,693	1,284,882	3,861,575
1957	3,271,670	1,457,291	4,728,961
Total, United States: 1958	56,359,935	57,262,336	113,622,271
1957	73,548,823	76,353,126	149,901,949

TABLE 6.—Consumption of ferrous scrap and pig iron by districts and States, by type of manufacturers, 1958, in short tons

District and State	Steel ingots and castings [1]		Steel castings [2]		Iron foundries and miscellaneous users	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
Connecticut	17,252		4,648	153	85,524	27,157
Maine and New Hampshire			1,826	62	15,772	5,385
Massachusetts	65,617	26,308	27,244	4,302	179,183	56,659
Rhode Island	41,978	19,130			31,597	14,576
Vermont					12,333	4,852
Total, New England:						
1958	124,847	45,438	33,718	4,517	324,409	108,629
1957	263,840	77,843	41,456	5,332	427,091	147,579
New Jersey	140,893	29,901	43,504	993	371,787	127,399
New York	1,835,327	2,544,391	92,187	6,931	449,582	150,767
Pennsylvania	10,503,965	13,759,706	355,805	43,804	629,434	551,775
Total, Middle Atlantic:						
1958	12,480,185	16,333,998	491,496	51,728	1,450,803	829,941
1957	19,245,094	23,458,479	799,494	109,973	1,750,094	1,051,723
Illinois	4,409,546	3,753,932	259,833	14,324	940,448	422,281
Indiana	6,293,604	7,745,684	137,801	12,667	494,545	201,931
Michigan	2,626,687	2,775,464	119,973	2,521	1,451,824	543,148
Ohio	7,408,859	8,860,237	330,630	36,546	1,107,479	550,012
Wisconsin			169,950	4,422	494,520	187,513
Total, East North Central:						
1958	20,738,696	23,135,317	1,018,187	70,480	4,488,816	1,904,885
1957	26,357,524	31,408,340	1,547,133	132,912	5,503,988	2,487,350
Iowa			28,615	529	282,788	71,238
Kansas and Nebraska			41,500	462	49,626	3,571
Minnesota, North Dakota, and South Dakota	297,987	365,855	24,916	178	131,931	39,499
Missouri	686,950	5,134	73,660	4,878	135,621	26,245
Total, West North Central:						
1958	984,937	370,989	168,691	6,047	599,966	140,553
1957	1,021,159	453,822	220,403	13,051	710,185	159,295
Delaware, District of Columbia, and Maryland	2,479,709	4,093,252	27,001	220	68,922	39,808
Florida and Georgia	154,990		10,198	131	30,648	13,606
North Carolina					60,847	21,793
South Carolina					24,670	13,116
Virginia and West Virginia	1,114,495	2,028,348	54,735	7,175	242,219	85,419
Total, South Atlantic:						
1958	3,749,194	6,121,600	91,934	7,526	427,306	173,742
1957	3,941,627	6,621,803	132,025	10,740	428,457	201,605
Alabama	1,624,222	2,285,148	43,429	189	761,189	696,094
Kentucky, Mississippi, and Tennessee	803,543	665,798	39,702	1,350	354,664	199,400
Total, East South Central:						
1958	2,427,765	2,950,946	83,131	1,539	1,115,853	895,494
1957	2,677,866	4,148,624	131,856	2,744	1,180,201	1,034,795
Arkansas, Louisiana, and Oklahoma	84,828	791	38,234	788	38,091	4,814
Texas	927,794	746,424	82,123	522	284,145	26,178
Total, West South Central:						
1958	1,012,622	747,215	120,357	1,310	322,236	30,992
1957	1,521,238	884,595	167,631	1,921	330,923	34,543
Arizona, Nevada, and New Mexico			26,385	65	33,055	45

See footnotes at end of table.

TABLE 6.—Consumption of ferrous scrap and pig iron by districts and States, by type of manufacturers, 1958, in short tons—Continued

District and State	Steel ingots and castings [1]		Steel castings [2]		Iron foundries and miscellaneous users	
	Scrap	Pig iron	Scrap	Pig iron	Scrap	Pig iron
Colorado and Utah	1,302,619	1,998,298	23,874	826	122,421	44,922
Idaho, Montana, and Wyoming					19,739	412
Total, Rocky Mountain:						
1958	1,302,619	1,998,298	50,259	891	175,215	45,379
1957	1,606,355	2,398,022	72,426	853	199,087	49,891
California	1,684,567	1,210,902	117,120	1,745	325,589	67,512
Oregon	123,131		37,700	174	29,365	1,447
Washington	205,477	274	29,846	1,157	23,898	1,671
Total, Pacific Coast:						
1958	2,013,175	1,211,176	184,666	3,076	378,852	70,630
1957	2,617,058	1,357,782	229,312	3,335	425,300	96,174
Total, United States:						
1958	44,834,040	52,914,977	2,242,439	147,114	9,283,456	4,200,245
1957	59,251,761	70,809,310	3,341,736	280,861	10,955,326	5,262,955

[1] Includes only those castings made by companies producing steel ingots.
[2] Excludes companies that produce both steel ingots and steel castings.

TABLE 7.—Consumption of ferrous scrap and pig iron in open-hearth furnaces in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
Massachusetts, New Jersey, and Rhode Island	252,700	77,412	330,112
New York	1,605,393	2,544,335	4,149,728
Pennsylvania	8,142,654	12,352,563	20,495,217
Total, New England and Middle Atlantic: 1958	10,000,747	14,974,310	24,975,057
1957	16,469,684	22,053,873	38,523,557
Illinois	3,137,806	3,380,661	6,518,467
Indiana	6,193,281	7,750,244	13,943,525
Michigan and Wisconsin	1,340,271	1,930,839	3,271,110
Ohio	5,424,613	7,493,691	12,918,304
Total, East North Central: 1958	16,095,971	20,555,435	36,651,406
1957	19,995,245	27,832,556	47,827,801
Minnesota and Missouri	619,705	375,339	995,044
Total, West North Central: 1958	619,705	375,339	995,044
1957	715,486	459,689	1,175,175
Delaware, Maryland, and West Virginia	3,214,114	6,102,484	9,316,598
Total, South Atlantic: 1958	3,214,114	6,102,484	9,316,598
1957	3,282,403	6,345,960	9,628,363
Alabama, Kentucky, Tennessee, and Texas	1,946,664	3,399,388	5,346,052
Total, East and West South Central: 1958	1,946,664	3,399,388	5,346,052
1957	2,635,227	4,762,981	7,398,208
California, Colorado, Utah, and Washington	2,464,865	3,000,581	5,465,446
Total, Rocky Mountain and Pacific Coast: 1958	2,464,865	3,000,581	5,465,446
1957	3,340,592	3,542,486	6,883,078
Total United States: 1958	34,342,066	48,407,537	82,749,603
1957	46,438,637	64,997,545	111,436,182

TABLE 8.—Consumption of ferrous scrap and pig iron in Bessemer[1] converters in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
Connecticut and New Jersey	965	78	1,043
Pennsylvania	248,801	792,223	1,041,024
Total, New England and Middle Atlantic: 1958	249,766	792,301	1,042,067
1957	88,664	638,072	726,736
Illinois, Michigan, and Ohio	373,688	1,835,517	2,209,205
Total, East North Central: 1958	373,688	1,835,517	2,209,205
1957	291,292	2,580,957	2,872,249
Delaware, Maryland, and Louisiana	5,266	78	5,344
Total, South Atlantic and West South Central: 1958	5,266	78	5,344
1957	7,060	275,841	282,901
California,[2] Colorado, and Washington	2,637	8,010	10,647
Total, Rocky Mountain and Pacific Coast: 1958	2,637	8,010	10,647
1957	462	13	475
Total, United States: 1958	631,357	2,635,906	3,267,263
1957	387,478	3,494,883	3,882,361

[1] Includes scrap and pig iron used in oxygen steel process.
[2] California not included in 1957.

TABLE 9.—Consumption of ferrous scrap and pig iron in electric[1] steel furnaces in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
Connecticut and New Hampshire	27,616	479	28,095
Massachusetts	24,883	833	25,716
Total, New England: 1958	52,499	1,312	53,811
1957	127,286	1,403	128,689
New Jersey	22,531	1,465	23,996
New York	148,508	3,096	151,604
Pennsylvania	1,388,008	22,311	1,410,319
Total, Middle Atlantic: 1958	1,559,047	26,872	1,585,919
1957	1,747,296	30,261	1,777,557
Illinois	1,165,853	94,903	1,260,756
Indiana	86,478	1,450	87,928
Michigan	779,537	43,446	822,983
Ohio	1,189,412	8,654	1,198,066
Wisconsin	117,064	2,801	119,865
Total, East North Central: 1958	3,338,344	151,254	3,489,598
1957	4,828,006	188,915	5,016,921
Iowa, Kansas, and Nebraska	70,115	991	71,106
Minnesota	15,063	178	15,241
Missouri	409,655	383	410,038
Total, West North Central: 1958	494,833	1,552	496,385
1957	469,904	6,779	476,683
Delaware, District of Columbia, and Maryland	97,160	1,118	98,278
Florida and Georgia	165,188	131	165,319
Virginia and West Virginia	113,594	182	113,776
Total, South Atlantic: 1958	375,942	1,431	377,373
1957	474,966	3,793	478,759
Alabama	385,403	65,004	450,407
Kentucky, Mississippi, and Tennessee	396,895	1,556	398,451
Total, East South Central: 1958	782,298	66,560	848,858
1957	617,066	29,794	646,860
Arkansas, Louisiana, and Oklahoma	115,529	788	116,317
Texas	361,886	2,400	364,286
Total, West South Central: 1958	477,415	3,188	480,603
1957	626,839	10,223	637,062
Arizona, Colorado, Nevada, and Utah	46,196	936	47,132
Total, Rocky Mountain: 1958	46,196	936	47,132
1957	70,072	922	70,994
California	557,674	2,042	559,716
Oregon	158,157	174	158,331
Washington	207,797	338	208,135
Total, Pacific Coast: 1958	923,628	2,554	926,182
1957	977,183	3,034	980,217
Total, United States: 1958	8,050,202	255,659	8,305,861
1957	9,938,618	275,124	10,213,742

[1] Includes small quantities of scrap and pig iron consumed in crucible furnaces.

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TABLE 10.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
Connecticut	45,260	21,887	67,147
Maine and New Hampshire	13,737	4,280	18,017
Massachusetts	152,215	54,973	207,188
Rhode Island	31,597	14,576	46,173
Vermont	12,334	4,851	17,185
Total, new England: 1958	255,143	100,567	355,710
1957	351,350	138,878	490,228
New Jersey	304,709	126,512	431,221
New York	360,779	145,105	505,884
Pennsylvania	492,395	208,192	700,587
Total, Middle Atlantic: 1958	1,157,883	479,809	1,637,692
1957	1,420,845	635,562	2,056,407
Illinois	714,421	194,527	908,948
Indiana	436,848	193,144	629,992
Michigan	1,679,497	640,057	2,319,554
Ohio	1,081,025	397,844	1,478,869
Wisconsin	443,180	167,578	610,758
Total, East North Central: 1958	4,354,971	1,593,150	5,948,121
1957	5,474,874	2,164,996	7,639,870
Iowa	207,352	68,775	276,127
Kansas and Nebraska	49,627	3,571	53,198
Minnesota, North Dakota, and South Dakota	136,938	37,064	174,002
Missouri	119,833	24,508	144,341
Total, West North Central: 1958	513,750	133,918	647,668
1957	564,270	151,025	715,295
Delaware and Maryland	74,443	58,358	132,801
Florida	6,966	3,017	9,983
Georgia	22,262	10,589	32,851
North Carolina	60,794	21,793	82,587
South Carolina	23,120	13,116	36,236
Virginia	233,899	36,113	270,012
West Virginia	17,254	47,978	65,232
Total, South Atlantic: 1958	438,738	190,964	629,702
1957	439,258	199,798	639,056
Alabama	723,304	700,519	1,423,823
Kentucky and Mississippi	93,941	141,530	235,471
Tennessee	258,179	136,212	394,391
Total, East South Central: 1958	1,075,424	978,261	2,053,685
1957	1,136,689	1,113,898	2,250,587
Arkansas, Louisiana, and Oklahoma	41,347	5,605	46,952
Texas	308,908	86,341	395,249
Total, West South Central: 1958	350,255	91,946	442,201
1957	359,737	87,279	447,016
Colorado	62,350	29,355	91,705
Utah	68,285	40,972	109,257
Idaho and Montana	12,378	411	12,789
Total, Rocky Mountain: 1958	143,013	70,738	213,751
1957	163,943	73,358	237,301
California	313,584	66,128	379,712
Oregon	28,498	1,447	29,945
Washington	22,569	2,487	25,056
Total, Pacific Coast: 1958	364,651	70,062	434,713
1957	413,760	95,222	508,982
Total, United States: 1958	8,653,828	3,709,415	12,363,243
1957	10,324,726	4,660,016	14,984,742

Table 11.—Consumption of ferrous scrap and pig iron in air furnaces in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
Connecticut	32,122	4,927	37,049
Massachusetts and New Hampshire	12,537	4,179	16,716
Total, New England: 1958	44,659	9,106	53,765
1957	49,872	10,867	60,739
New Jersey and New York	23,276	9,431	32,707
Pennsylvania	109,366	35,195	144,561
Total, Middle Atlantic: 1958	132,642	44,626	177,268
1957	177,811	57,949	235,760
Illinois	146,568	18,848	165,416
Indiana	75,831	14,990	90,821
Michigan	89,735	9,581	99,316
Ohio	296,019	55,925	351,944
Wisconsin	65,461	19,071	84,532
Total, East North Central: 1958	673,614	118,415	792,029
1957	839,373	154,623	993,996
Iowa, Minnesota, and Missouri	10,203	6,646	16,849
Total, West North Central: 1958	10,203	6,646	16,849
1957	12,774	8,548	21,322
Delaware, North Carolina, and West Virginia	14,426	7,911	22,337
Total, South Atlantic: 1958	14,426	7,911	22,337
1957	16,983	8,699	25,682
Alabama and Texas	33,603	1,865	35,468
Total, East and West South Central: 1958	33,603	1,865	35,468
1957	43,294	2,569	45,863
California	11,085	1,103	12,188
Total, Pacific Coast: 1958	11,085	1,103	12,188
1957	12,216	1,297	13,513
Total, United States: 1958	920,232	189,672	1,109,904
1957	1,152,323	244,552	1,396,875

TABLE 12.—Consumption of ferrous scrap in blast furnaces in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
Massachusetts and New York	152,525	Alabama	189,066
Pennsylvania	1,020,784	Kentucky, Maryland, Tennessee, Texas, and West Virginia	317,081
Total, New England and Middle Atlantic:		Total, South Atlantic, East and West South Central:	
1958	1,173,309	1958	506,147
1957	1,761,872	1957	690,850
Illinois	277,976	California, Colorado, and Utah	58,870
Indiana	129,088	Total, Rocky Mountain and Pacific Coast:	
Michigan and Minnesota	53,504	1958	58,870
Ohio	658,405	1957	78,076
Total, East North Central and West North Central:		Total, United States:	
1958	1,118,973	1958	2,857,299
1957	1,640,035	1957	4,170,833

TABLE 13.—Consumption of ferrous scrap by ferroalloy producers in the United States, in 1958, by districts, in short tons

District	Total scrap	District	Total scrap
Middle Atlantic: 1958	19,840	East South Central: 1958	53,417
1957	34,681	1957	77,651
East North Central: 1958	32,652	Pacific Coast: 1958	8,034
1957	70,656	1957	9,081
West North Central: 1958	72,818	United States: 1958	192,526
1957	132,986	1957	337,570
South Atlantic: 1958	5,765		
1957	12,515		

TABLE 14.—Consumption of ferrous scrap in miscellaneous uses in the United States in 1958, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
Connecticut and Massachusetts	15,527	Georgia, Virginia, and West Virginia	12,398
Total, New England: 1958	15,527	Total, South Atlantic: 1958	12,398
1957	15,513	1957	31,991
New Jersey	89,626	Alabama and Texas	58,523
New York	67,920		
Pennsylvania	86,854	Total, East South Central and West South Central: 1958	58,523
Total, Middle Atlantic: 1958	244,400	1957	59,296
1957	282,194		
Illinois	166,434	Arizona, Idaho, and Montana	35,945
Indiana	4,424	Colorado and Utah	4,784
Michigan and Wisconsin	11,212	Total, Rocky Mountain: 1958	40,729
Ohio	81,656	1957	44,709
Total, East North Central: 1958	263,726	California and Washington	41,078
1957	282,120		
Minnesota	300	Total, Pacific Coast: 1958	41,078
Missouri	35,744	1957	39,445
Total, West North Central: 1958	36,044	Total, United States: 1958	712,425
1957	43,370	1957	798,638

STOCKS

Complete iron- and steel-scrap figures covering 1958 yearend stocks are not available; producers (railroads and manufacturers) were not canvassed; dealers, brokers, and automobile wreckers were canvassed and reported on a voluntary basis.

Consumers' Stocks.—Total iron- and steel-scrap stocks held by consumers during 1958 fluctuated between a low for the year of 8.8 million short tons at the end of June to a level of 9.6 million short tons on December 31, 1958, a record high and an increase of 7 percent over stocks held at the beginning of the year. Increases occurred in five of the nine districts; the largest increase—299,000 tons—was in the Middle Atlantic district. Stocks of pig iron held by consumers on December 31, 1958, were 4 percent greater than those on hand December 31, 1957.

Suppliers' Stocks.—Stocks of iron and steel scrap in the hands of a combined total of 931 dealers, brokers, and automobile wreckers, as reported voluntarily to the Bureau of Mines, totaled 1,427,000 short tons on December 31, 1958.

TABLE 15.—Consumers' stocks of ferrous scrap and pig iron on hand in the United States, by districts and States, in short tons

District and State	December 31, 1957		December 31, 1958	
	Total scrap	Pig iron	Total scrap	Pig iron
Connecticut	16,605	6,825	16,897	5,011
Maine and New Hampshire	2,199	751	1,578	165
Massachusetts	42,747	102,290	32,827	68,279
Rhode Island	8,361	4,695	10,014	4,873
Vermont	3,423	1,601	2,023	556
Total, New England	73,335	116,162	63,339	78,884
New Jersey	80,823	28,409	82,338	33,820
New York	677,141	375,114	727,497	408,042
Pennsylvania	1,901,301	812,319	2,148,016	1,001,960
Total, Middle Atlantic	2,659,265	1,215,842	2,957,851	1,443,822
Illinois	1,040,359	272,955	989,465	250,594
Indiana	1,009,868	146,204	1,009,923	165,723
Michigan	424,813	335,300	410,010	283,014
Ohio	1,252,334	683,521	1,464,214	676,217
Wisconsin	67,210	29,323	64,039	21,578
Total, East North Central	3,794,584	1,467,303	3,937,651	1,397,126
Iowa	31,638	19,617	38,568	21,297
Kansas and Nebraska	14,020	358	14,565	555
Minnesota, North Dakota, and South Dakota	127,725	104,554	131,861	85,784
Missouri	187,220	14,848	202,057	29,023
Total, West North Central	360,603	139,377	387,051	136,659
Delaware, District of Columbia, and Maryland	350,555	182,699	329,380	193,296
Florida and Georgia	13,075	2,081	16,156	1,481
North Carolina	6,393	3,877	5,398	1,631
South Carolina	2,027	2,575	2,349	2,464
Virginia and West Virginia	187,685	18,277	169,624	23,905
Total, South Atlantic	559,735	209,509	522,907	222,777
Alabama	275,050	297,102	242,424	325,999
Kentucky, Mississippi, and Tennessee	164,081	149,973	192,335	90,774
Total, East South Central	439,131	447,075	434,759	416,773
Arkansas, Louisiana, and Oklahoma	17,592	1,395	37,801	1,515
Texas	327,424	48,857	356,454	29,331
Total, West South Central	345,016	50,252	394,255	30,846
Arizona, Nevada, and New Mexico	13,659	118	21,098	63
Colorado and Utah	189,154	93,500	183,273	167,334
Idaho, Montana, and Wyoming	7,853	378	5,396	218
Total, Rocky Mountain	210,666	93,996	209,767	167,615
California	369,751	75,864	518,231	68,737
Oregon	45,085	221	47,257	114
Washington	92,215	1,098	120,532	916
Total, Pacific Coast	507,051	77,183	686,020	69,767
Total, United States	8,949,386	3,816,699	9,593,600	3,964,269

TABLE 16.—Consumers' stocks, production, receipts, consumption, and shipments of ferrous scrap, by grades, in 1958, in short tons

Grades of scrap	Total stocks on hand Jan. 1, 1958	Scrap produced	Receipts from dealers and all others	Total consumption	Shipments	Total stocks on hand Dec. 31, 1958
No. 1 Heavy-Melting steel	2,911,684	14,145,242	4,119,525	18,209,178		3,071,854
No. 2 Heavy-Melting steel	910,138	1,518,280	2,945,280	4,543,463		804,638
No. 1 and electric-furnace bundles	743,514	946,647	3,713,742	4,450,416	75,384	916,146
No. 2 and all other bundles	695,279	245,301	2,855,160	2,996,926		793,179
Low-phosphorus scrap	534,026	971,572	2,366,549	3,138,896		621,859
Cast-iron scrap other than borings	1,114,724	5,291,874	3,843,363	8,679,762	308,162	1,262,037
All others	2,040,021	10,594,619	5,265,894	14,341,294	1,435,353	2,123,887
Total, all grades	8,949,386	33,713,535	25,109,513	56,359,935	1,818,899	9,593,600

TABLE 17.—Dealers, brokers, and automobile wreckers'[1] shipments of ferrous scrap to consumers and others in 1958, by grades, by districts and States, in short tons

District and State	No. 1 Heavy-Melting steel	No. 2 Heavy-Melting steel	No. 1 and electric-furnace bundles	No. 2 and all other bundles	Low phosphorus scrap	Cast-iron scrap, other than borings	All others	Total all grades
Connecticut	14,179	12,799	4,484	7,404	14,462	10,475	193,693	257,496
Maine	2,030	2,919	68	1,680	82	2,176	2,822	11,777
Massachusetts	12,084	21,374	1,540	15,027	3,089	20,129	76,189	149,432
New Hampshire	1,591	2,227	362	347	207	1,994	1,482	8,210
Rhode Island	9,625	11,759	3,219	14,879	5,617	21,251	3,706	70,056
Vermont	705	651	159	253		1,605	212	3,585
Total, New England	40,214	51,729	9,832	39,590	23,457	57,630	278,104	500,556
New Jersey	56,689	24,531	7,649	20,429	7,504	31,973	24,134	172,909
New York	107,821	75,757	13,209	140,959	5,343	82,645	49,975	475,709
Pennsylvania	175,652	61,813	27,915	66,886	27,793	53,211	97,764	511,034
Total, Middle Atlantic	340,162	162,101	48,773	228,274	40,640	167,829	171,873	1,159,652
Illinois	55,352	45,779	29,359	21,838	22,486	41,848	153,310	369,972
Indiana	18,335	9,843	15,545	12,194	3,067	17,096	60,611	136,691
Michigan	21,481	9,569	20,869	27,943	39,410	28,170	95,544	242,986
Ohio	56,783	50,662	21,209	46,027	40,909	56,278	87,833	359,701
Wisconsin	14,025	26,059	12,968	56,971	32,158	50,292	74,540	267,013
Total, East North Central	165,976	141,912	99,950	164,973	138,030	193,684	471,838	1,376,363
Iowa	2,569	17,855	2,905	16,499	4,988	20,212	30,763	95,791
Kansas	5,101	21,046	841	16,720	2,280	9,279	13,733	69,000
Minnesota	71,383	28,346	1,542	25,915	4,072	20,923	61,358	213,539
Missouri	9,564	31,074	3,933	17,165	4,026	18,742	24,073	108,577
Nebraska	2,935	10,711	725	7,814	1,759	7,404	4,192	35,540
North Dakota	529	673		2,543		4,117	8,151	16,013
South Dakota	1,055	3,127		4,818	28	2,426	11,066	22,520
Total, West North Central	93,136	112,832	9,946	91,474	17,153	83,103	153,336	560,980
Delaware	1,149	5,057	16	1,527	19	2,390	931	11,089
District of Columbia	331	3,198		6,525		2,240	487	12,781
Florida	13,367	13,089	337	7,303	45	6,426	3,962	44,529
Georgia	6,494	22,080	3,279	17,502	1,225	14,374	13,447	78,401
Maryland	104,006	22,548	25,963	23,893	3,616	12,942	12,969	205,937
North Carolina	7,820	5,889	2,132	11,964	5,852	17,943	2,540	54,140
South Carolina	3,246	5,560		4,265	156	7,153	10,867	31,247
Virginia	21,970	23,813		17,827	3,458	16,004	11,982	95,054
West Virginia	7,925	12,227	1,686	11,642	1,448	6,894	4,761	46,583
Total, South Atlantic	166,308	113,461	33,413	102,448	15,819	86,366	61,946	579,761

See footnote at end of table.

TABLE 17.—Dealers, brokers, and automobile wreckers'[1] shipments of ferrous scrap to consumers and others in 1958, by grades, by districts and States, in short tons—Continued

District and State	No. 1 Heavy-Melting steel	No. 2 Heavy-Melting steel	No. 1 and electric-furnace bundles	No. 2 and all other bundles	Low phosphorus scrap	Cast-iron scrap, other than borings	All others	Total all grades
Alabama	4,283	11,765	12,411	10,896	41,188	53,156	34,622	168,321
Kentucky	10,120	13,128	2,299	16,160	4,486	15,837	8,530	70,560
Mississippi	345	2,024	--------	28	--------	1,452	894	4,743
Tennessee	22,659	22,712	16,195	36,022	17,312	23,890	52,934	191,724
Total, East South Central	37,407	49,629	30,905	63,106	62,986	94,335	96,980	435,348
Arkansas	981	6,701	--------	3,005	1,644	5,510	1,345	19,186
Louisiana	36,542	26,978	8,936	20,628	1,402	14,278	6,583	115,347
Oklahoma	6,311	16,168	113	11,870	2,863	8,368	3,432	49,125
Texas	77,564	171,370	12,136	76,229	26,775	60,618	105,533	530,225
Total, West South Central	121,398	221,217	21,185	111,732	32,684	88,774	116,893	713,883
Arizona, Nevada, and New Mexico	2,234	3,843	--------	1,940	928	2,564	890	12,399
Colorado and Utah	7,175	23,244	--------	47,614	248	8,364	16,933	103,578
Idaho, Montana, and Wyoming	1,256	14,929	999	4,196	410	7,091	2,092	30,973
Total, Rocky Mountain	10,665	42,016	999	53,750	1,586	18,019	19,915	146,950
California	53,388	78,042	9,048	84,304	5,462	23,701	47,219	301,164
Oregon and Washington	17,470	16,161	467	17,489	1,797	9,035	22,622	85,041
Total, Pacific Coast	70,858	94,203	9,515	101,793	7,259	32,736	69,841	386,205
Total, United States	1,046,124	989,100	264,518	957,140	339,614	822,476	1,440,726	5,859,698

[1] Reported by a monthly average of 1,011 companies shipping approximately 36 percent of purchased scrap received by domestic consumers, exported, and adjusted for imports.

TABLE 18.—Stocks of ferrous scrap held by dealers, brokers, and automobile wreckers',[1] on December 31, 1958, by grades, by districts and States, in short tons

District and State	No. 1 Heavy-Melting steel	No. 2 Heavy-Melting steel	No. 1 and electric-furnace bundles	No. 2 and all other bundles	Low phosphorus scrap	Cast-iron scrap, other than borings	All others	Total all grades
Connecticut	853	2,673	382	1,340	569	1,542	11,315	18,674
Maine	748	943		637		750	1,365	4,443
Massachusetts	1,627	3,161	250	11,928	555	2,146	41,752	61,419
New Hampshire	537	1,026		331		925	1,128	3,947
Rhode Island	211	597	161	5,087	62	497	8,738	15,353
Vermont	417	1,460	45	1,398		1,046	652	5,018
Total, New England	4,393	9,860	838	20,721	1,186	6,906	64,950	108,854
New Jersey	4,157	5,857	705	14,781	152	1,629	18,192	45,473
New York	19,491	14,532	71	16,558	2,269	10,714	15,913	79,548
Pennsylvania	26,601	19,260	5,384	18,703	4,974	5,489	120,554	200,965
Total, Middle Atlantic	50,249	39,649	6,160	50,042	7,395	17,832	154,659	325,986
Illinois	3,373	3,894	672	3,005	3,246	2,972	68,165	85,327
Indiana	3,626	1,083	372	4,985	553	913	14,633	26,165
Michigan	5,434	2,625	436	12,566	6,912	3,086	33,744	64,803
Ohio	12,820	20,304	224	2,855	2,826	4,865	92,897	136,791
Wisconsin	474	1,727	112	1,179	552	4,602	31,032	39,678
Total, East North Central	25,727	29,633	1,816	24,590	14,089	16,438	240,471	352,764
Iowa	861	2,080		822	97	643	8,287	12,790
Kansas	1,023	911		899	852	418	1,957	6,060
Minnesota	4,697	3,982		8,632	617	17,536	39,706	75,170
Missouri	1,146	2,261	920	628	750	1,980	7,276	14,961
Nebraska	90	760		1,378	73	590	3,904	6,795
North Dakota						33	3,667	3,700
South Dakota		369		363	8	101	7,094	7,935
Total, West North Central	7,817	10,363	920	12,722	2,397	21,301	71,891	127,411
Delaware	15	243	144			127	106	635
District of Columbia	2	7				8	144	161
Florida	2,152	3,674		8,161		765	9,316	24,068
Georgia	3,987	5,013		5,162	33	505	11,668	26,368
Maryland	7,739	7,567	3,518	1,416	507	194	55,887	76,828
North Carolina	4,828	4,973	17	4,022	17	708	10,855	25,420
South Carolina	1,155	889		339		114	18,525	21,022
Virginia	6,381	3,342		15,241		1,548	13,185	39,697
West Virginia	1,242	492		174	2,240	283	4,932	9,363
Total, South Atlantic	27,501	26,200	3,679	34,515	2,797	4,252	124,618	223,562
Alabama	93	379			246	192	25,994	26,904
Kentucky	2,777	1,595		1,411	534	310	6,678	13,305
Mississippi	31	942		1,474		195	38	2,680
Tennessee	1,607	1,485	246	1,821	843	491	24,059	30,552
Total, East South Central	4,508	4,401	246	4,706	1,623	1,188	56,769	73,441
Arkansas	1,984	4,404		2,632	560	544	2,523	12,647
Louisiana	2,851	3,937	81	5,777	93	502	8,153	21,394
Oklahoma	1,225	216		361	179	669	9,285	11,935
Texas	5,353	17,246	3,102	22,344	1,698	3,385	44,543	97,671
Total, West South Central	11,413	25,803	3,183	31,114	2,530	5,100	64,504	143,647
Arizona, Nevada, and New Mexico	1	1,130		1,661		120	145	3,057

See footnote at end of table.

TABLE 18.—Stocks of ferrous scrap held by dealers, brokers, and automobile wreckers',[1] on December 31, 1958, by grades, by districts and States, in short tons—Continued

District and Stat	No. 1 Heavy-Melting steel	No. 2 Heavy-Melting steel	No. 1 and electric-furnace bundles	No. 2 and all other bundles	Low phosphorus scrap	Cast-iron scrap, other than borings	All others	Total all grades
Colorado and Utah	881	396	--------	6	6	339	6,798	8,426
Idaho, Montana, and Wyoming	759	1,210	--------	2	22	215	2,741	4,949
Total, Rocky Mountain	1,641	2,736	--------	1,669	28	674	9,684	16,432
California	3,085	3,419	--------	11,319	518	1,045	6,044	25,430
Oregon and Washington	2,301	678	5	5,914	617	958	18,923	29,396
Total, Pacific Coast	5,386	4,097	5	17,233	1,135	2,003	24,967	54,826
Total, United States	138,635	152,742	16,847	197,312	33,180	75,694	812,513	1,426,923

[1] Reported by 931 companies representing approximately 25 percent of the scrap collection industry with or without processing and preparation equipment, as shown in the 1954 Census of Business, Wholesale Trade.

TABLE 19.—Consumption and stocks, December 31, 1958, of ferrous scrap, by grades, by districts and States, in 1958, in short tons

District and State	No. 1 Heavy-Melting steel		No. 2 Heavy-Melting steel		No. 1 and electric-furnace bundles		No. 2 and all other bundles		Low-phosphorus scrap		Cast-iron scrap, other than borings		All others		Total all grades	
	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks
Connecticut	4,440	481	765	-------	1,629	50	227	22	18,810	4,228	32,318	4,091	49,235	8,025	107,424	16,897
Maine and New Hampshire	2,062	244	410	62	-------	-------	-------	-------	188	6	13,054	1,024	1,884	242	17,598	1,578
Massachusetts	44,539	1,019	513	155	12,610	40	-------	-------	29,596	3,126	137,330	16,662	47,456	11,825	272,044	32,827
Rhode Island	422	25	21,042	5,007	2,990	34	-------	-------	10,322	56	18,136	2,517	20,663	2,375	73,575	10,014
Vermont	1,597	168	297	-------	-------	-------	-------	-------	-------	-------	10,439	1,855	-------	-------	12,333	2,023
Total, New England	53,060	1,937	23,027	5,224	17,229	124	227	22	58,916	7,416	211,277	26,149	119,238	22,467	482,974	63,339
New Jersey	11,398	6,580	17,356	3,161	36,224	8,839	24,861	3,274	39,782	17,886	280,125	26,963	146,438	15,635	556,184	82,338
New York	901,609	295,085	39,200	2,425	109,128	65,304	194,836	168,979	98,558	19,378	328,653	69,019	705,112	107,307	2,377,096	727,497
Pennsylvania	4,502,481	791,859	538,383	87,059	954,998	209,275	406,140	91,132	635,593	184,443	1,187,639	202,526	3,263,970	581,722	11,489,204	2,148,016
Total, Middle Atlantic	5,415,488	1,093,524	594,939	92,645	1,100,350	283,418	625,837	263,385	773,933	221,707	1,796,417	298,508	4,115,520	704,664	14,422,484	2,957,851
Illinois	1,363,921	319,297	902,026	66,699	490,515	53,227	464,928	138,172	316,061	72,469	677,603	94,553	1,394,773	245,048	5,609,827	989,465
Indiana	3,414,822	584,401	184,352	22,156	943,217	124,557	292,987	30,120	152,546	34,167	579,466	93,265	1,358,560	121,257	6,925,950	1,009,923
Michigan	638,224	77,025	2,935	71	549,704	128,017	226,480	19,655	491,328	52,206	979,065	63,749	1,310,748	69,287	4,198,484	410,010
Ohio	2,518,699	423,005	493,388	27,635	851,303	249,615	307,571	78,696	729,652	148,849	1,134,987	105,639	2,811,368	430,775	8,846,968	1,464,214
Wisconsin	45,204	6,832	11,640	261	-------	-------	25,341	406	163,203	22,298	260,019	18,647	159,063	15,595	664,470	64,039
Total, East North Central	7,980,870	1,410,560	1,594,341	116,822	2,834,739	555,416	1,317,307	267,049	1,852,790	329,989	3,631,140	375,853	7,034,512	881,962	26,245,699	3,937,651
Iowa	13,636	1,703	7,361	3,176	-------	-------	2,040	7	28,615	2,195	156,720	15,020	103,031	16,467	311,403	38,568
Kansas and Nebraska	2,636	58	-------	-------	-------	-------	-------	-------	29,498	4,254	44,877	8,280	14,115	1,973	91,126	14,565
Minnesota, North Dakota, and South Dakota	114,664	25,752	69,665	30,517	1,702	198	44,619	20,773	14,202	1,729	135,122	12,133	74,860	40,759	454,834	131,861
Missouri	18,875	5,255	602,910	88,182	-------	-------	9,718	1,605	19,955	2,919	182,148	55,906	62,625	48,190	896,231	202,057
Total, West North Central	149,811	32,768	679,936	121,875	1,702	198	56,377	22,385	92,270	11,097	518,867	91,339	254,631	107,389	1,753,594	387,051

Delaware, District of Columbia, and Maryland	1,336,333	145,077	70,313	7,421	151,772	779	95,770	2,205	34,589	7,384	198,009	138,489	688,846	28,025	2,575,632	329,380
Florida and Georgia	48,651	4,726	79,110	7,094					1,607	29	25,151	1,323	41,317	2,984	195,836	16,156
North Carolina		358							1,186	134	56,691	4,546	2,970	360	60,847	5,398
South Carolina											19,219	869	5,451	1,480	24,670	2,349
Virginia and West Virginia	44,394	1,560	105,367	16,735	27,846	2,055	280,137	40,939	48,344	14,513	234,764	37,259	670,597	56,563	1,411,449	169,624
Total, South Atlantic	1,429,378	151,721	254,790	31,250	179,618	2,834	375,907	43,144	85,726	22,060	533,834	182,486	1,409,181	89,412	4,268,434	522,907
Alabama	797,218	58,967	134,660	15,105	72,091	20,204	210,419	23,416	53,304	8,098	721,728	65,325	439,420	51,309	2,428,840	242,424
Kentucky, Mississippi, and Tennessee	387,421	81,091	106,747	24,138	80,803	13,432	101,853	31,781	45,457	1,036	285,920	23,183	189,708	17,674	1,197,909	192,335
Total, East South Central	1,184,639	140,058	241,407	39,243	152,894	33,636	312,272	55,197	98,761	9,134	1,007,648	88,508	629,128	68,983	3,626,749	434,759
Arkansas, Louisiana, and Oklahoma			56,671	27,503			29,066		33,453	2,902	31,998	4,411	9,965	2,985	161,153	37,801
Texas	28,860	2,989	697,170	231,845	8,690	2,130	54,258	22,082	62,430	6,744	336,482	57,629	106,172	33,035	1,294,062	356,454
Total, West South Central	28,860	2,989	753,841	259,348	8,690	2,130	83,324	22,082	95,883	9,646	368,480	62,040	116,137	36,020	1,455,215	394,255
Arizona, Nevada, and New Mexico	2,663	3,907	2,062								1,129	228	53,586	16,963	59,440	21,098
Colorado and Utah	927,706	48,081	57,011	21,434			38,691	13,029	2,788	684	19 2,108	66,798	230,610	33,247	1,448,914	183,273
Idaho, Montana, and Wyoming											12,047	1,389	7,692	4,007	19,739	5,396
Total, Rocky Mountain	930,369	51,988	59,073	21,434			38,691	13,029	2,788	684	205,284	68,415	291,888	54,217	1,528,093	209,767
California	882,794	126,587	244,889	81,227	131,914	31,937	161,849	98,785	59,649	8,075	355,174	62,069	291,007	109,551	2,127,276	518,231
Oregon	53,790	25,039	59,781	4,530	21,360	6,264			1,950	315	23,875	2,352	29,440	8,757	190,196	47,257
Washington	100,119	34,683	37,439	31,040	1,920	189	25,135	8,101	16,230	1,736	27,766	4,318	50,612	40,465	259,221	120,532
Total, Pacific Coast	1,036,703	186,309	342,109	116,797	155,194	38,390	186,984	106,886	77,829	10,126	406,815	68,739	371,059	158,773	2,576,693	686,020
Total, United States	18,209,178	3,071,854	4,543,463	804,638	4,450,416	916,146	2,996,926	793,179	3,138,896	621,859	8,679,762	1,262,037	14,341,294	2,123,887	56,359,935	9,593,600

TABLE 20.—Stocks of ferrous 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, 1958	8,240,853	459,409	893,338	9,593,600
Dec. 31, 1957	7,619,819	414,136	915,431	8,949,386
	PIG-IRON STOCKS			
Dec. 31, 1958	3,414,782	40,870	508,617	3,964,269
Dec. 31, 1957	3,185,130	56,578	574,991	3,816,699

PRICES [2]

Lessened world demand for ferrous scrap resulted in the lowest prices for open market scrap since 1954.

The price of No. 1 Heavy-Melting scrap at Pittsburgh was at a yearly low of $32.75 per long ton in January—46 percent lower than January 1957. The price for this grade of scrap rose to a high for the year of $45 in October, after which it declined to $42.50 (estimate) in December.

No. 1 Heavy-Melting scrap at Chicago averaged $43.50 (estimate) per long ton for the year. The highest price—$44.90 per ton—for this grade of scrap was in September, and the lowest price of the year—$28.70 was in April,—was the lowest since March 1954.

The average composite price of No. 1 Heavy-Melting iron and steel scrap was $38.08 for the year, $8.67 lower than the 1957 average. The composite price for this grade of scrap fluctuated between a low of $32.73 per long ton in March and a high of $43.10 in September, after which it dropped to an estimated price of $39.92 in December.

TABLE 21.—Average monthly price and composite price per long ton for No. 1 Heavy-Melting scrap in 1958

Month	Chicago	Pittsburgh	Philadelphia	Composite price [1]
January	$31.75	$32.75	$37.13	$33.88
February	37.00	36.50	38.00	37.17
March	35.25	36.50	38.00	36.58
April	28.70	33.10	36.40	32.73
May	31.75	34.75	34.00	33.50
June	35.10	37.50	33.60	35.40
July	39.25	40.75	34.75	38.25
August	44.00	44.50	37.75	42.08
September	44.90	44.50	39.90	43.10
October	42.50	45.00	40.50	42.66
November	42.75	44.75	37.62	41.70
December [2]	38.03	42.50	33.75	39.92
Average: [2] 1958	43.50	39.42	36.78	38.08
1957	44.43	47.53	48.30	46.75

[1] Composite price, Chicago, Pittsburgh, and Philadelphia.
[2] Estimate.

[2] Iron Age, vol. 183, No. 1, Jan. 1, 1959, p. 286.

The average composite price for No. 2 Bundles was quoted at $24.03 per long ton in April, the lowest both for the year and since September 1954. An upward trend followed this low and reached a high for the year of $29.67 in August, but by December the price had dropped to an estimated $28.62 per ton.

The average price of exports, including all grades of scrap, from the United States during 1958 was $36.93 per long ton, $17.62 lower than the 1957 average and the lowest average price since 1954.

FOREIGN TRADE [3]

The export-licensing regulations governing the exportation of iron and steel scrap on an open-end basis after June 18, 1957, were extended through the first quarter of 1958, after which the Bureau of Foreign Commerce announced that these regulations would be in effect through the rest of 1958. Continuation of the open-end exports of scrap was made possible by the reduced domestic and foreign demand for iron and steel scrap.

On June 11, 1958, Public Law 85–453 was approved; it continued, until the close of June 30, 1959, the suspension of duties on certain metal scrap, including iron and steel scrap.

The Bureau of Foreign Commerce lifted export limitations on rerolling rails (regardless of weight, pounds per yard) effective June 12, 1958. This meant exports of rerolling rails were placed on an open-end basis, applications for exporting such rails could be filed at any time, and that the previous quota of 7,000 short tons a quarter was no longer in effect.

Imports.—Iron and steel scrap imports, including tinplate, continued to be small but increased 39 percent in quantity and 9 percent in value over the preceding year. Of the total scrap imported, 95 percent was received from Canada. Of the total imports, 11 percent was tinplate scrap, mostly from Canada, compared with 15 percent during the preceding year.

[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 22.—Ferrous scrap imported for consumption in the United States, by countries, in short tons

[Bureau of the Census]

Country	1957	1958
North America:		
Bahamas	997	951
Barbados	----------	710
Canada	228,402	315,955
Cuba	3,500	2,552
Dominican Republic	420	557
French West Indies	802	428
Leeward and Windward Islands	14	390
Mexico	2,060	----------
Panama	----------	1,062
Trinidad and Tobago	60	376
Other	75	195
Total	236,330	323,176
South America:		
British Guiana	----------	838
Other	16	220
Total	16	1,058
Europe:		
France	30	218
Germany, West	908	139
Europe—Continued		
Netherlands	132	13
Norway	9	45
Sweden	111	32
United Kingdom	142	7,532
Total	1,332	7,979
Asia:		
India	----------	22
Japan	26	276
Total	26	298
Africa:		
Algeria	220	----------
Morocco	223	----------
Union of South Africa	146	----------
Other	317	89
Total	906	89
Oceania	----------	22
Grand total:		
Short tons	238,610	332,622
Value	$10,149,653	$11,069,149

Exports.—The complete withdrawal of the United Kingdom from the export market, the greatly reduced demand of other countries, and the agreement by Japan and the European Coal and Steel Community to limit their imports of United States scrap to 13 percent of the quantity imported in 1956 resulted in the lowest exports of ferrous scrap from this country since 1954. Exports decreased 56.3 percent from the record quantity of 1957 and were 10 percent lower 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 1958 decreased 56.4 percent in quantity and 71 percent in value from 1957.

TABLE 23.—Ferrous scrap exported from the United States, by countries of destination, in short tons

[Bureau of the Census]

Destination	Iron and steel scrap including tinplate and terneplate scrap		Rerolling material	
	1957	1958	1957	1958
North America:				
Canada	[1] 483,269	261,018	2,730	312
Mexico	291,847	288,525	37,377	32,430
Other	55	47	298	----------
Total	[1] 775,171	549,590	40,405	32,742
South America:				
Argentina	44,036	----------	----------	----------
Brazil	11,129	155	----------	----------
Other	380	404	----------	----------
Total	55,545	559	----------	----------
Europe:				
Belgium-Luxembourg	254,768	24,048	----------	----------
France	231,429	142,889	----------	----------
Germany, West	[1] 695,819	138,045	----------	----------
Italy	[1] 1,670,531	1,260,065	----------	----------
Netherlands	18,244	1,148	----------	----------
Spain	[1] 99,987	100,313	----------	----------
United Kingdom	[1] 367,492	----------	----------	----------
Other	90,213	26,683	----------	----------
Total	[1] 3,428,483	1,693,191	----------	----------
Asia:				
Hong Kong	1,387	251	349	----------
India	4,036	1,979	----------	----------
Japan	[1] 2,353,390	630,546	[1] 49,137	10,691
Malaya, Federation of	414	125	----------	----------
Singapore		63		----------
Nansei and Nanpo Islands	----------	----------	224	1,132
Philippines	1,050	1,853	----------	----------
Taiwan	54,231	31,127	----------	----------
Other	1,513	786	----------	----------
Total	[1] 2,416,021	666,730	[1] 49,710	11,823
Africa	657	334	----------	----------
Grand total: Short tons	[1] 6,675,877	2,910,404	[1] 90,115	44,565
Value	$322,600,777	$94,773,303	[1] $6,910,465	$2,673,578

[1] Revised figure.

TABLE 24.—Ferrous scrap imported into and exported from the United States, by classes

[Bureau of the Census]

Classes	1957		1958	
	Short tons	Value	Short tons	Value
Imports:				
Iron and steel scrap	203,407	$9,077,654	295,859	$10,068,777
Tinplate scrap	35,203	1,071,999	36,763	1,000,372
Total	238,610	10,149,653	332,622	11,069,149
Exports:				
No. 1 and No. 2 Heavy-Melting steel scrap	[1] 4,043,509	[1] 201,098,311	1,927,170	64,622,125
No. 1 and No. 2 baled steel scrap	[1] 1,710,466	[1] 76,263,251	616,047	17,387,832
Borings, shovelings, and turnings	[1] 82,636	[1] 3,100,103	52,977	1,009,123
Iron scrap	[1] 753,731	[1] 35,756,456	222,151	7,278,050
Rerolling material	[1] 90,115	[1] 6,910,465	44,565	2,673,578
All other scrap [2]	[1] 85,535	[1] 6,382,656	92,059	4,476,173
Total	[1] 6,765,992	[1] 329,511,242	2,954,969	97,446,881

[1] Revised figure.
[2] Includes terneplated, tinplated, and circles, cobbles, strip and scroll shear butts from tinplated scrap.

WORLD REVIEW

SOUTH AMERICA

Peru.—On April 21, 1958, the Corporacion Peruana del Santa at Chimbote put into operation the first steel plant in Peru. It consists of two electric pig-iron furnaces, each with a daily capacity of 100 tons, and two electric furnaces for steel production, each with a capacity of 25 tons per heat.[4] The plant will use approximately 17,000 short tons of scrap per year if it operates at near capacity.[5]

EUROPE

Belgium.—Scrap consumption in blast furnaces and steel mills showed a decrease of 19 percent from 1957. Scrap consumed in blast furnaces and steel mills totaled 797,000 short tons and 1,283,000 tons, decreases of 26 percent and 15 percent, respectively, from 1957.[6]

Germany, West.—Scrap consumption in the West German steel industry during 1958 declined approximately 12 percent according to preliminary data issued by the Government Statistics Office. Lower scrap consumption per ton of produced steel and a 7 percent decrease in steel production were partial causes for this decline.[7]

United Kingdom.—The iron- and steel-scrap trade in 1958 experienced a transition from a scarce supply on January 1 to an abundant supply on December 31, 1958. This was the first time since World War II that there was a surplus in stocks of iron and steel scrap.[8]

Extreme cuts in the production of steel and iron castings caused scrap requirements to be lessened, but this combined with greatly re-

[4] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, p. 21.
[5] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, pp. 13–14.
[6] U.S. Embassy, Brussels, Belgium, State Department Dispatch 1161: Apr. 22, 1958; Dispatch 92: July 23, 1958; Dispatch 593: Dec. 3, 1958; Dispatch 802: Jan. 21, 1959.
[7] American Metal Market, vol. 66, No. 20, Jan. 29, 1959, p. 12.
[8] Iron and Coal Trades Review, vol. 178, No. 4731, Jan. 23, 1959, pp. 205–214.

duced imports was not enough to halt the accumulation of these stocks. The consuming mills were reluctant to add to their inventories of better than 1 million short tons, and as a result the dealers' storage space and financial obligations were overtaxed. This condition caused the collection, preparation, and distribution of scrap by dealers to be curtailed.

This article discusses in greater detail the industrial setbacks that occurred in the iron- and steel-scrap consuming and supplying industries during the year.

ASIA

Japan.—Import contracts during the 1958 financial year were expected to be concluded for about 65 shiploads averaging 10,000 short tons. This was a sharp drop from the 205 shiploads amounting to about 2.2 million short tons imported during the previous financial year, according to a spokesman for the Japanese Scrap Steel Coordinating Committee, which handles on behalf of Japanese steel mills the imports of scrap steel from the United States.[9]

Lower steel output and a changeover from long-term to spot purchasing were the main reasons for the decline in the imports of U.S. scrap.

TECHNOLOGY

A new pushbutton plant in Houston, Tex., that utilizes a process to convert junked automobiles and other scrap into a material relatively free of impurities and nonferrous metals was constructed and put into operation during May 1958.[10]

The machinery in this plant, in one continuous operation, reduces automobiles and other scrap metals into small and uniform-sized pieces of relatively high density. During this process, paint, enamel, porcelain, and other foreign matter, as well as nonferrous materials, are removed.

The process begins with the loading, by cranes, of unprepared scrap into a conveyor constructed of heavy steel plates. This conveyor moves the material up an incline to an enclosed area where the fragmentation process begins. The resulting material goes through further processing, which includes heat-treating; then the refuse mentioned above is expelled by means of a conveyor belt.

Patents are pending on the plant, its equipment and processes, and the finished product, which has been named Prolerized steel (scrap).

An automatic hydraulic scrap shear that will cut almost any kind of scrap into equal lengths from 6 to 48 inches, do the work of five to 6 conventional shears, and virtually eliminate the need of torch-cutting was demonstrated to representatives of the scrap iron industry.[11]

This article describes the operation of the shear and gives the quantity of scrap sheared per hour.

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[9] American Metal Market, vol. 66, No. 1, Jan. 1, 1959, p. 10.
[10] American Metal Market, vol. 65, No. 93, May 14, 1958, pp. 1, 12.
[11] Waste Trade Journal, vol. 105, No. 4, Apr. 12, 1958, p. 23.

Iron Oxide Pigments

By John W. Hartwell[1] and Betty Ann Brett[2]

DEMAND for finished iron oxide pigments in 1958 declined almost to the low level of 1954, but mine production of crude pigments rose because of increased construction and better general business conditions beginning in the last quarter of 1958.

TABLE 1.—Salient statistics of iron oxide pigment materials in the United States

	1949–53 (average)	1954	1955	1956	1957	1958
Mine production:						
Iron oxide pigment mines:						
Short tons	(1)	23,100	23,600	21,400	20,300	30,100
Iron-ore mines:						
Short tons	(1)	22,600	32,600	32,500	29,000	24,600
Crude pigments sold or used:						
Iron oxide pigment mines:						
Short tons	(1)	18,300	20,300	17,300	18,400	30,700
Value	(1)	$160,500	$175,800	$168,000	$193,400	$234,300
Iron-ore mines:						
Short tons	(1)	22,600	32,600	32,500	29,000	24,600
Value	(1)	$211,000	$243,600	$300,300	$268,900	$210,500
Finished pigments sold or used:						
Short tons	[2] 114,700	98,000	115,300	113,900	[3] 104,900	98,400
Value	[2] $13,567,500	$13,977,500	$17,471,700	$17,103,500	[3] $16,405,300	$15,822,000
Imports:						
Short tons	9,400	10,700	14,000	13,100	13,100	11,700
Value	$678,000	$846,400	$1,195,600	$1,201,700	$1,314,400	$1,159,700
Exports:						
Short tons	4,900	3,600	4,700	5,100	3,700	3,900
Value	$719,800	$682,300	$893,900	$909,200	$1,038,200	$1,064,600

[1] Data not available.
[2] Includes mineral blacks, 1949–51.
[3] Revised figure.

DOMESTIC PRODUCTION

Crude Materials.—The quantity of crude iron oxide pigment materials mined in 1958 increased 11 percent over 1957, mainly because crude sienna production almost tripled. The quantity sold or used increased 17 percent, but because of the low unit value of sienna the average value of crude sales decreased 3 percent. Natural red iron oxide production was 11 percent lower, and the price per ton decreased from $10.29 to $9.41.

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

Finished Pigments.—A 9-percent drop in industrial sales of paint, varnish, and lacquer resulted in a decrease in sales of finished iron oxide pigments in 1958 compared with 1957 of 6 percent in quantity and 4 percent in value, despite a 1-percent increase in retail sales to a new alltime high. Sales continued the decline begun in 1956 and approached the low of 98,000 tons recorded in 1954. The unit value in 1958 was nearly $161 per ton, a new high.

Natural pigments constituted 31 percent of the quantity and 16 percent of the value of total iron oxide pigments sold in 1958. Sales of natural red pigment increased 2 percent. The value of natural red pigments increased $4 per short ton, principally because of increases in the value of natural red iron oxide and burnt sienna. Natural red pigments composed 24 percent of the sales of red iron oxide pigments.

TABLE 2.—Crude iron oxide pigment materials mined and sold or used in the United States, 1958, by States

State	Number of producers	Quantity mined (short tons)	Quantity sold or used (short tons)	Value
Pennsylvania	2	1,154	1,154	$10,300
Colorado, Michigan, Minnesota	4	39,993	39,993	278,500
Georgia, New York, Virginia	3	13,608	14,163	156,000
Total	9	54,755	55,310	444,800

TABLE 3.—Crude iron oxide pigment materials produced and sold or used by processors in the United States, by kinds

Pigments	1957			1958		
	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	5,636	3,009	$58,100	16,167	16,417	$112,800
Umber	551	551	6,300	263	278	3,700
Red iron oxide	31,781	31,781	326,900	28,239	28,239	265,800
Yellow iron oxide:						
Ocher	6,057	6,057	33,900	7,006	7,006	38,300
Natural yellow iron oxide, sulfur mud, and miscellaneous pigments	5,323	5,956	37,100	3,080	3,370	24,200
Total	49,348	47,354	462,300	54,755	55,310	444,800

TABLE 4.—Sales of finished iron oxide pigments in the United States, 1958, by States

State	Number of producers	Quantity sold (short tons)	Value
California	2	6,484	$1,401,700
Georgia, Maryland, Virginia	4	11,789	1,125,600
Illinois, New Jersey, Pennsylvania	8	63,334	9,657,300
Other [1]	3	16,815	3,637,400
Total	17	98,422	15,822,000

[1] Includes New York, Ohio, and a quantity unspecified by States.

Sales of burnt sienna have averaged about 1,000 tons a year since 1949. Many consumers continued to buy burnt sienna because of the depth and richness of its color, which has not been equaled by manufactured pigments.

The average value of finished natural pigments rose from $78.58 per ton to $80.62; average value of manufactured pigments rose from $197 to $200.

TABLE 5.—Finished iron oxide pigments sold by processors in the United States, by kinds

Pigment	1957		1958	
	Short tons	Value	Short tons	Value
Natural:				
Black: Magnetite	229	$19,100	384	$31,100
Brown:				
Iron oxide (metallic)	7,497	739,000	5,997	601,900
Umbers: Burnt	2,321	353,500	2,452	376,100
Raw	580	79,800	559	78,300
Vandyke brown	144	30,800	168	37,600
Red:				
Iron oxide	14,140	696,000	14,063	764,900
Sienna, burnt	1,046	218,100	1,032	219,400
Pyrite cinder	380	34,200	801	44,200
Yellow:				
Iron oxide			131	6,100
Ocher	4,601	172,800	4,278	163,900
Sienna, raw	719	144,400	688	139,800
Total natural	31,657	2,487,700	30,553	2,463,300
Manufactured:				
Black: Magnetic	1,764	514,000	1,801	534,300
Brown: Iron oxide	1,515	421,900	1,436	417,400
Red:				
Pure red iron oxides:				
Calcined copperas	[1] 14,573	[1] 4,257,000	12,062	3,452,400
Other chemical processes	6,647	1,912,500	4,866	1,419,500
Other manufactured red iron oxides	22,169	1,773,800	23,126	2,629,000
Venetian red	3,122	378,200	4,696	642,400
Yellow: Iron oxide	12,355	2,985,800	11,994	2,921,600
Total manufactured	[1] 62,145	[1] 12,243,200	59,981	12,016,600
Mixtures of natural and manufactured red iron oxides	7,575	1,149,800	5,176	861,000
Other and unspecified	3,488	524,600	2,712	481,100
Grand total	[1] 104,865	[1] 16,405,300	98,422	15,822,000

[1] Revised figure.

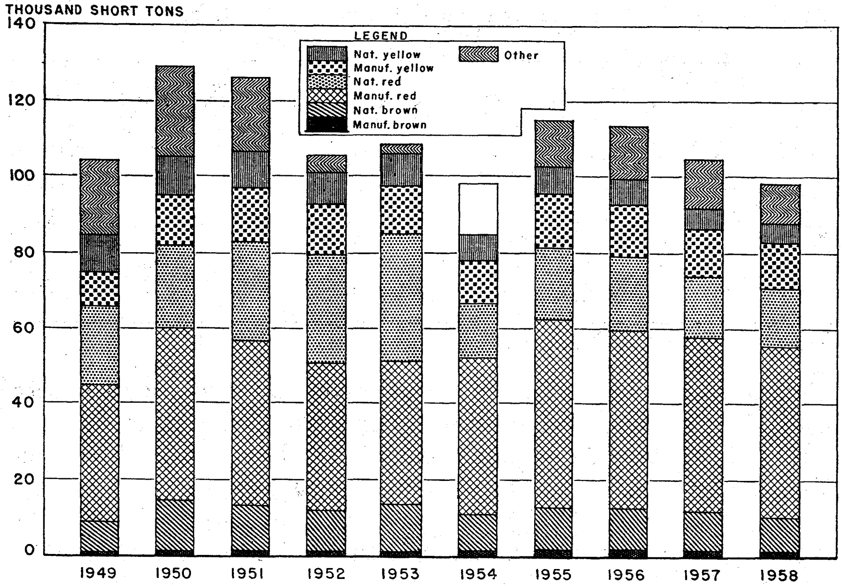

FIGURE 1.—Sales of finished iron oxide pigments by processors in the United States, 1949–58.

PRICES

The high and low annual prices for iron oxide pigments for 1952–58, inclusive, were compiled from weekly quotations.

TABLE 6.—High and low prices quoted on finished iron oxide pigments, per pound, in bags, unless otherwise specified

[Oil, Paint and Drug Reporter]

Iron oxide pigments	1958		Iron oxide pigments	1958	
	High	Low		High	Low
Black:			Red:		
Pure	$0.1475	$0.1325	Domestic (pure)	$0.1425	$0.1275
Synthetic	.1275	.1275	Natural (75–85 percent ferric oxide)	.0675	.0625
Brown:			Persian Gulf	.0875	.0775
Pure	.1425	.1425	Spanish (barrels)	.0575	.0575
Metallic	.0525	.0400	Sienna, burnt	.0650	.0625
Umber, American, burnt	.0750	.0700	Venetian, 40 percent	.0675	.0625
Umber, Turkey, burnt	.0825	.0775	Yellow:		
Umber, American, raw	.0775	.0750	Ocher, Natural, French	.0625	.0600
Umber, Turkey, raw	.0850	.0675	Ocher, Natural, Peruvian	.0230	.0205
Vandyke (barrels)	.0950	.0950	Ocher, hydrated, pure	.1225	.1150
			Sienna, raw	.0675	.0625

FOREIGN TRADE [3]

Imports of natural and manufactured iron oxide pigments were about 11 percent less in quantity and 12 percent less in value in 1958 than in 1957.

Natural pigments supplied 49 percent of the tonnage and 23 percent of the value in 1958 compared with 46 and 20 percent, respectively, in 1957. The average value of natural pigments imported was $47 per ton and of manufactured pigments $150 per ton in 1958 compared with $44 and $149 in 1957.

Iron oxide pigments designated by the U.S. Department of Commerce as "natural iron oxide and iron hydroxide pigments, n.s.p.f." supplied 43 percent of all natural varieties and came principally from Spain (nearly 85 percent) and the United Kingdom (nearly 15 percent).

Imports of manufactured (synthetic) iron oxide pigments came from West Germany (65 percent), Canada (20 percent), the United Kingdom (14 percent), and The Netherlands and France.

All imports of ochre, crude and refined were from the Union of South Africa.

TABLE 7.—Selected iron oxide pigments imported for consumption in the United States

[Bureau of the Census]

Pigments	1957		1958	
	Short tons	Value	Short tons	Value
Natural:				
Ocher, crude and refined	203	$11,979	217	$10,312
Siennas, crude and refined	676	56,340	555	48,867
Umber, crude and refined	1,944	[1] 64,835	2,278	73,256
Vandyke brown	139	9,917	204	14,649
Others [2]	3,079	[1] 125,227	2,485	123,360
Total natural	6,041	268,298	5,739	270,444
Manufactured (synthetic)	7,033	[1] 1,046,139	5,933	889,255
Grand total	13,074	[1] 1,314,437	11,672	1,159,699

[1] Data known to be not comparable with other years.
[2] Classified by the Bureau of the Census as "Natural iron oxide and iron hydroxide pigments, n.s.p.f."

Over 63 percent of the sienna imports was from Italy; the balance was from Malta, Gozo, and Cyprus.

All of the crude umber and 76 percent of the refined umber came from Malta, Gozo, and Cyprus. The balance of the refined material came from the United Kingdom.

Vandyke-brown imports were 75 percent from West Germany and 25 percent from The Netherlands.

Canada received 61 percent of iron oxide pigments exported from the United States and other North American countries received 11 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.

TABLE 8.—Iron oxide pigments exported from the United States, by countries of destination

[Bureau of the Census]

Country	1957		1958	
	Short tons	Value	Short tons	Value
North America:				
Canada	2,212	$380,575	2,389	$419,470
Cuba	195	58,404	184	59,810
Dominican Republic	18	5,350	9	2,297
Guatemala	29	8,267	45	10,815
Haiti	4	1,390	10	7,587
Mexico	120	53,625	93	33,296
Netherlands Antilles	(1)	573	4	1,520
Panama	2	970		
Other	30	9,307	70	6,671
Total	2,610	518,461	2,804	541,466
South America:				
Argentina	(1)	1,871	1	3,550
Bolivia	14	5,190	1	533
Brazil	18	7,891	(1)	664
Chile	25	10,200	18	13,025
Colombia	187	60,360	79	28,695
Ecuador	18	6,032	8	1,000
Peru	31	10,126	14	4,404
Uruguay	19	13,023		
Venezuela	75	56,350	146	25,895
Total	387	171,043	267	77,766
Europe:				
Belgium-Luxembourg	11	13,436	9	4,732
France	53	29,048	40	16,603
Iceland	3	800	6	1,683
Italy	4	3,824	2	3,037
Netherlands	69	5,560	178	33,802
Norway			1	1,067
Portugal	15	4,512	14	4,265
Spain				
Sweden	11	3,290	9	5,915
Switzerland	51	17,506	17	5,841
United Kingdom	3	2,536	12	5,934
Other	4	8,746	2	508
Total	224	89,258	290	83,387
Asia:				
Indonesia	29	39,311	6	3,397
Japan	9	6,855	18	9,464
Korea, Republic of	2	550	130	95,865
Malaya, Federation of	18	23,825		
Philippines	188	92,041	149	73,550
Taiwan	31	6,310		
Turkey	28	9,376		
Other	18	7,018	52	9,277
Total	323	185,286	355	191,553
Africa:				
Union of South Africa	98	36,788	94	31,365
Other	(1)	2,107		
Total	98	38,895	94	31,365
Oceania	33	35,275	104	139,047
Grand total	3,675	1,038,218	3,914	1,064,584

[1] Less than 1 ton.

WORLD REVIEW

Argentina.—Production of ocher in 1957 was 230 short tons valued at US$979.[4]

Government estimates indicated that production of red and yellow iron oxide pigments in 1958 would be 4,400 to 5,000 short tons, filling the domestic requirements.[5]

Canada.—Natural iron oxide production in 1957 was reported to be 7,700 short tons valued at US$182,500, a decrease of less than 1 percent in value but more than 12 percent in quantity from 1956.[6]

In a preliminary report the 1958 iron oxide production was estimated at 2,060 short tons valued at US$162,160.[7]

Cyprus.—Umber production was centered near Larnaca on the south coast. Most umber was exported as crude ore, but some graded material also was sold.

TABLE 9.—Exports of iron oxide pigments from Cyprus[1]

Year	Umber		Ocher	
	Short tons	Value	Short tons	Value
1954	5,599	$102,065	489	$14,871
1955	6,002	156,934	586	23,976
1956	5,318	151,726	454	20,224
1957	4,835	142,286	433	18,732
1958	4,351	131,121	394	17,480

[1] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, September 1958, p. 36; U.S. Consulate, Nicosia, Cyprus, State Department Dispatch 99: Apr. 13, 1959, p. 1.

Ecuador.—The Department of Mining and Petroleum of Ecuador reported production of 700 pounds of ocher in 1958.[8]

Egypt.—Exports of raw coloring earths in 1956 were about 100 tons valued at US$1,269, compared with 20 tons valued at US$244 in 1955. Iron oxide ores and pigments occur in the Aswan and Sinai areas.[9]

India.—Ocher mined in 1957 totaled 17,020 short tons (revised) compared with 14,125 tons in 1956, and 18,166 tons in 1955.[10]

Nepal.—A deposit of ocher was discovered during the mapping of the Pulchoki iron deposit. Trenching proved that the ocher deposit was extensive and of high quality and that it could be mined readily.[11]

Morocco.—The only producer of natural yellow and red iron oxide pigments in Morocco reported production of 1,123 short tons of yellow and 718 tons of red during 1957. Exports in 1957 were 1,075 tons of yellow and 590 tons of red.[12]

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[4] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 1259: Feb. 26, 1959, p. 2.
[5] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 1522: Apr. 10, 1959, pp. 6, 9.
[6] Woodrooffe, H. M., Iron Oxide Pigments in Canada, 1957: Canada Dept. Mines and Tech. Surveys, Ottawa, 1957, p. 2.
[7] Canadian Mining and Metallurgical Bulletin, Canada's Mineral Industry in 1958: Vol. 52, No. 561, January 1959, p. 2.
[8] U.S. Embassy, Quito, Ecuador, State Department Dispatch 468: Apr. 20, 1959, p. 1.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, p. 27.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 26.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, p. 3.
[12] U.S. Consulate, Casablanca, Morocco, State Department Dispatch 18: July 25, 1958, p. 8.

Production of natural iron oxide in 1958 was 2,124 short tons averaging 77 percent iron.[13]

Peru.—Output of ocher totaled 28 short tons in 1957.[14]

Union of South Africa.—Production and exports of ochers, oxides, and umber decreased in 1958 compared with 1957.[15]

TABLE 10.—Production and exports of iron oxide pigments in the Union of South Africa, short tons

	Production		Exports	
	1957	1958	1957	1958
Ochers	6,201	3,841	3,974	2,161
Oxides	2,292	2,032	427	151
Umbers	1,250	406	----------	----------

Uruguay.—The Bureau of Mines of Uruguay quoted production of red ocher during 1958 at nearly 53 short tons.[16]

TECHNOLOGY

Studies on the hiding power of pigments included data on yellow and red iron oxides. The hiding power of the pigments were studied both in dry film and in paint.[17]

Soyabean emulsifier increased the tinting power of iron oxide dispersed with titanium dioxide.[18]

The critical pigment-volume concentration of various pigments was determined by centrifuging. The highest value was obtained with ferrous oxide.[19]

A patent was issued for a process in which iron oxide was produced electrolytically from iron and steel scrap dissolved in an aqueous solution of ammonium carbonate. The oxide produced was low in carbon, silica, and other insoluble impurities.[20] Other patents were issued for a process of manufacturing precipitated red ferric oxide by mixing and reacting a ferrous salt and an alkali in an aqueous solution,[21] and for an apparatus for wetting finely divided pigments.[22]

A process by which magnetic iron oxides are heated in an oxidizing atmosphere to convert them to nonmagnetic red iron oxide was patented in the U.S.S.R.[23]

[13] U.S. Embassy, Rabat, Morocco, State Department Dispatch 372: Mar. 20, 1959, p. 2.
[14] U.S. Embassy, Lima, Peru, State Department Dispatch 235: Sept. 10, 1958, p. 2.
[15] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 233: Feb. 24, 1959, p. 3.
[16] U.S. Embassy, Montevideo, Uruguay, State Department Dispatch 737: Apr. 1, 1959, p. 2.
[17] Saunders, S. L. M., The Hiding Power of Pigments and Mixtures of Pigments: Jour. Oil & Colour Chemists' Assoc. London, No. 40, 1957, pp. 643–660; Chem Abs., vol. 52, No. 9, May 10, 1958, col. 7732i.
[18] Kronstein, Max, and Treade, Morton, Dispersion and Tinting Strength of Iron Oxide: Paint Varnish Prod., vol. 48, No. 2, 1958, pp. 50–51, 82–83; Chem. Abs., vol. 52, No. 19, Oct. 10, 1958, col. 16755i.
[19] Haug, Robert, [Determination and Importance of Pigment-Volume Concentration]: Deut. Farben-Ztg., No. 12, 1958, pp. 139–143; Chem. Abs., vol. 52, No. 15, Aug. 10, 1958, col. 13283f.
[20] Welsh, J. Y. (assigned to Manganese Chemicals Corp.), Electrolytically Dissolving Iron: U.S. Patent 2,834,726, May 13, 1958.
[21] Bennetch, L. M. (assigned to C. K. Williams & Co.), Preparation of Red Oxide of Iron: U.S. Patent 2,866,686, Dec. 30, 1958.
[22] Antonsen, Randolph, and Beattie, R. D. (assigned to Godfrey L. Cabot, Inc.), Apparatus for Wetting Finely Divided Pigments: U.S. Patent 2,834,044, May 13, 1958.
[23] Tsion, A. A., Karagod, I. S., and Brodskii, Yu. A., [Red Ferric Oxide]: Russian Patent 108,220, Oct. 25, 1957; Chem. Abs., vol. 52, No. 9, May 10, 1958, col. 7633a.

Jewel Bearings

By Henry P. Chandler [1] and Betty Ann Brett [2]

DURING 1958 the production and consumption of jewel bearings in the United States declined 8 and 15 percent, respectively, from 1957. Imports also declined 42 percent in quantity and 49 percent in value from the preceding year.

DOMESTIC PRODUCTION

Finished jewel bearings were manufactured in 1958 by firms in Santa Barbara (Calif.), Waltham and West Lynn (Mass.), Newark, Perth Amboy, Trenton, and Hawthorne (N.J.), Rolla (N. Dak), and Morrisville (Pa.).

TABLE 1.—Salient statistics of the jewel-bearings industry in the United States [1]

(Million jewel bearings)

	1949–53 (average)	1954	1955	1956	1957	1958
Finished jewels: [2]						
Production	8.4	10.5	11.8	13.8	13.9	12.8
Consumption [3]	74.5	66.2	74.8	74.6	[4] 67.0	56.7
Sales [3]	22.2	29.4	40.1	42.9	[4] 47.6	37.5
Stocks on hand Dec. 31	101.0	95.4	103.6	96.4	[4] 99.3	82.0

[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.
[2] Includes finished jewels made from glass; includes phonograph needles in 1954–58.
[3] Consumption exceeds shipments owing to direct importations by users.
[4] Revised figure.

CONSUMPTION AND USES

The 15-percent decline in domestic consumption of finished jewel bearings from 1957 was caused almost entirely by decreased demand for watch jewel bearings.

Synthetic sapphire and ruby bearings were 86 percent of the total domestic consumption; the remainder was almost entirely glass bearings. The more widely used types of bearings were illustrated in the Jewel Bearings chapter of Minerals Yearbook, 1955.

The following firms used 70 percent of the synthetic sapphire and ruby jewels consumed in the United States in 1958:

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

George W. Borg Corp., Delevan, Wis.
Bulova Watch Co., Flushing, N.Y.
Elgin National Watch Co., Elgin, Ill.
General Electric Co., Sommersworth, N.H.
Hamilton Watch Co., Lancaster, Pa.
Sangamo Electric Co., Springfield, Ill.
Westclox Div., General Time Corp., La Salle, Ill.
Westinghouse Electric Corp., Raleigh, N.C.

TABLE 2.—Consumption and sales of finished jewels in the United States, 1958, by types

(Million jewel bearings)

Type of jewel	Consumption	Sales
Synthetic sapphire and ruby:		
Watch holes:		
Olive	8.0	(1)
Straight	9.5	1.9
Pallet stones	2.5	(1)
Roller jewels (jewel pins)	1.4	.1
End stones or caps:		
Watch	9.5	1.2
Instrument	1.2	5.5
Vees	2.6	3.0
Instrument rings	.7	7.2
Cups or double cups	5.0	4.2
Synthetic sapphire and ruby—Continued		
Orifice jewel	0.5	0.3
Other [2]	8.1	7.0
Total number of finished synthetic sapphire and ruby jewel bearings	49.0	30.4
Glass and other jewel bearings	7.7	7.1
Total finished jewel bearings	56.7	37.5

[1] Less than 0.1 million.
[2] Includes phonograph needles.

TABLE 3.—Consumption of synthetic sapphire and ruby jewel bearings in 1958, by uses

Use	Jewel bearings (million)
Automobile clocks	6.4
Chart drive mechanisms	.2
Watch movements and repairs	23.6
Clocks, except automobiles; Engine hour meters; Time cycle controllers; Other timing devices	.8
Aircraft instruments and repair	1.0
Electrical measuring and/or controlling instruments, except watt-hour meters	.9
Electronic test equipment; Inspection and quality control; Precision machinists' tools	.7
Laboratory test equipment and apparatus	0.5
Mechanical measuring and/or controlling instruments	.1
Missile instruments	(1)
Watt-hour meters and repair	6.1
Compasses and surveying instruments	.1
Phonograph needles	7.1
Other instruments and mechanisms	1.5
Total number of finished synthetic sapphire and ruby jewel bearings	49.0

[1] Less than 0.1 million.

PRICES

Revised prices for synthetic sapphire and ruby boule and rod used in making jewel bearings and allied products issued by the Linde Co., Division of Union Carbide Corp. September 1, 1958, follow:

	Price per inch
Synthetic sapphire rod:	
Diameter, 0.05 inch; length, 12 inches	$0.37
Diameter, 0.10 inch; length, 18 inches	.30
Diameter, 0.15 inch; length, 14 inches	.95
Diameter, 0.20 inch; length, 10 inches	1.60

Synthetic ruby rod:	*Price per inch*
Diameter, 0.05 inch; length 12 inches	$0.35
Diameter, 0.10 inch; length, 18 inches	.34
Diameter, 0.15 inch; length, 12 inches	1.38

	Less than one box	One box containing about 1,500 grams	One case containing about 15,000 grams		One box containing about 7,500 carats	One case containing about 75,000 carats
White sapphire boule, per gram:				Standard ruby boule, per carat:		
Split	$0.15	$0.055	$0.05	Split	$0.0147	$0.0134
Unsplit	.15	.0525	.0475	Unsplit	.014	.0127

FOREIGN TRADE [3]

Imports of synthetic sapphire and ruby jewel bearings during 1958 were at their lowest point since 1945—a decrease of 42 percent in quantity and 49 percent in value from 1957. Of these imports 76 percent came from Switzerland, 22 percent from Italy, nearly 2 percent from Canada, and negligible quantities from three other countries. The duty on jewel bearings in loose form (not assembled in units) was 10 percent ad valorem; duty on synthetic sapphire boule was 30 percent ad valorem.

Jewel bearings and similar items made of synthetic sapphire or ruby were used where unusual environmental conditions existed, or where their special operational properties were needed. The process of their manufacture and the raw materials needed to obtain the desired products were explained in a trade circular.[4]

TABLE 4.—Jewel bearings imported for consumption in the United States

[Bureau of the Census]

Year	Jewel bearings (million)	Value (thousands)	Year	Jewel bearings (million)	Value (thousands)
1949–53 (average)	101.2	$4,151	1956	54.8	[1] $2,456
1954	49.3	[1] 2,219	1957	70.1	[1] 2,780
1955	66.1	[1] 2,875	1958	40.9	1,418

[1] Owing to changes in tabulating procedures by the Bureau of the Census, data known not to be comparable to 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.

[4] Linde Company, Division of the Union Carbide Corp., Properties and Uses of Linde Sapphire: 1958, 4 pp.

TABLE 5.—Imports [1] of jewel bearings in 1958, by types

Type of jewel	Percent	Type of jewel	Percent
Watch holes:		Vees	7
Olive	10	Instrument rings	12
Straight	14	Cups or double cups	9
Pallet stones	3	Other [2]	18
Roller jewels (jewel pins)	3	Total	100
End stones or caps:			
Watch	12		
Instrument	12		

[1] As reported to the Bureau of Mines.
[2] Includes agate balls, sapphire balls, agate end stones, orifice jewels, insulators, jewel tips, tungsten carbide, clock hole jewels, phonograph points, specialties, and guides.

TECHNOLOGY

From 1948 through 1958 the production of jeweled watches in the United States declined from 3 million units to 2 million units. As a result, some 20 million less jewels were required in the domestic production of watches in 1958. This decline however, was nearly offset by the increased use of jewel bearings in measuring instruments and military items.

An innovation in manufacturing instruments for measuring and controlling electric power was the use of a taut-band suspension ribbon to replace the pivots and jewel bearings formerly used to suspend the pointer. Accurate results under severe operating conditions were reported.[5]

Synthetic sapphire parts and jewels were used for the relief valves on space vehicles where extreme hardness, chemical inertness, high-temperature strength, and dimensional accuracy were needed.[6]

A method of manufacturing sapphire styluses for phonograph needles included vibrating several thousand units in a container with diamond powder and oil for several days to attain the desired finish. These styluses had an operational life of about 100 hours, compared with 1 hour for steel and 2,000 hours for diamond styluses.[7]

A method of polishing crystallizable materials, such as sapphire, was described in a patent issued during the year.[8]

[5] Westinghouse Electric Corp., Meter Dept., Newark, N.J., Taut-Band Suspension Element: Catalog 43–240, June 25, 1958, 8 pp.
[6] Compressed Air Magazine, Sapphire in a Relief Valve: Vol. 63, No. 11, November 1958, p. 32.
[7] Ploegsma, A. W., Fabrication of Sapphire and Diamond Styli for Gramaphone Pick-Ups: Ind. Diamond Rev. (London), vol. 18, No. 216, November 1958, pp. 209–210.
[8] Luedeman, R. T. (assigned to Daystrom, Inc.), Method of Improving the Fire Polishing of Crystallizable Materials, Such as Sapphire, to Prevent Rippling or Other Surface Distortion in the Resulting Jewel Bearings: U.S. Patent 2,854,794, Oct. 7, 1958.

Kyanite and Related Minerals

By Taber de Polo[1] and Gertrude E. Tucker[2]

IMPORTS of kyanite and related minerals in 1958 dropped to one-third the 1957 quantity because of continued competition from domestic kyanite flotation concentrate and the availability of synthetic mullite. Domestic kyanite and mullite production and consumption also declined, as demand lessened for refractories by the metallurgical and glass industries.

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 1958. All kyanite produced was recovered as flotation concentrate. Production decreased about one-third largely owing to a decline in demand by the metallurgical and flat glass industries.

Again in 1958 only two companies were producing 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.

Commercialores, Inc., announced plans to open a new kyanite mine on the southern edge of Crowder Mountain near Gastonia, N.C., where 300 acres had been leased.

Production of synthetic mullite in the United States in 1958 was about 16,000 short tons valued at $1.6 million. There were 6 producing companies.

CONSUMPTION AND USES

Mullite, produced from natural ore or by synthesis, was used almost entirely in manufacturing superduty refractories, as brick and shapes or in cements, mortars, plastics, and ramming mixtures.

For several years about 90 percent of all mullite refractories has been employed to line furnaces operated by the metallurgical and glass industries, using approximately equal quantities in 1958. The remaining 10 percent was consumed in miscellaneous applications, chiefly in the ceramic industry in manufacturing kiln furniture.

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

PRICES

Kyanite prices reported in E&MJ Metal and Mineral Markets remained unchanged during 1958. Quotations 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]

The combined quantity of kyanite (India) and sillimanite (Union of South Africa) imported in 1958 was less than one-third of the 1957 figure and the lowest since statistics became available in 1937.

TABLE 1.—Kyanite and allied minerals imported for consumption into and exported from the United States, 1949–53 (average) and 1954–58

[Bureau of the Census]

Imports

Year and origin	Short tons	Value
1949–53 (average)	12,957	$480,671
1954	4,826	[1] 196,609
1955	7,581	338,993
1956	6,951	306,181
1957		
Europe: Netherlands	5	550
Asia: India	1,630	93,704
Africa: Union of South Africa	4,140	144,487
Oceania: Australia	224	24,634
Total	5,999	263,375
1958		
Europe: United Kingdom	7	502
Asia: India	1,289	74,093
Africa: Union of South Africa	669	20,894
Total	1,965	95,489

Exports

Year and destination	Short tons	Value
1949–53 (average)	1,026	$42,427
1954	1,147	57,952
1955	1,716	87,315
1956	1,331	63,193
1957		
North America:		
Canada	1,147	53,164
Mexico	893	40,252
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
Asia: Indonesia	90	6,666
Total	2,588	129,963
1958		
North America:		
Canada	1,161	58,700
Dominican Republic	12	661
Mexico	736	33,169
Europe:		
France	30	1,634
Germany, West	265	14,313
Italy	121	7,360
Netherlands	73	3,983
United Kingdom	35	2,752
Asia: Japan	60	4,290
Total	2,493	126,862

[1] Data known to be not comparable with other years.

[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

Argentina.—Production of sillimanite in 1958 in Argentina was 66 short tons.[4]

India.—Production of kyanite ore in 1957 totaled 20,294 short tons valued at US$900,000. Exports of kyanite ore during the 11-months' period (January–November 1957) totaled 23,186 tons valued at US$1.4 million. Sillimanite exports during the same period totaled 5,739 short tons valued at US$350,000. A small part of the output was consumed in India for refractories and glass manufacture. During 1957 the Government of India continued its policy of controlling the export of kyanite and sillimanite on a quota basis. Under the Mines and Minerals (Regulation and Development) Act of 1957, the royalty rate on kyanite was increased by the Government from 7.5 percent to 10 percent.[5]

India exported 28,585 short tons of kyanite in 1958 and 12,345 short tons of sillimanite. About half of the kyanite was shipped to the United Kingdom; West Germany and Italy received about half of the sillimanite.[6]

Kenya.—Production of kyanite in Kenya during 1958 was 600 short tons valued at US$42,213.[7]

South-West Africa.—Production of kyanite (probably sillimanite) was 2,985 short tons of which 2,777 tons valued at US$71,453 was exported.[8]

TECHNOLOGY

A report on the occurrence of sillimanite and related minerals in Park and Fremont Counties, Colo., was published. Of the kyanite group of minerals, sillimanite is the only one widely distributed in Colorado. Andalusite is uncommon, kyanite is recorded in only one locality, and topaz occurs in about six pegmatite deposits. Although locally the schists and gneisses may contain more than 50 percent sillimanite, it is not known that such rock occurs in economic quantities.[9]

Kyanite nonmenclature, varieties, crystalllography, composition, physical and optical properties, identification tests, uses, occurrences, and production were presented.[10]

A sillimanite deposit of possible economic value in Hart County, Ga., was described. The area consists of schists, gneisses, and granitic rocks. Petrographic data and chemical analysis were given.[11]

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[4] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 1259: Feb. 26, 1959, p. 1.
[5] U.S. Embassy, New Delhi, India, State Department Dispatch 1612: June 24, 1958, pp. 2, 14–15.
[6] U.S. Embassy, New Delhi, India, State Department Dispatch 893: Feb. 12, 1959, pp. 2–3.
[7] U.S. Embassy, Nairobi, British East Africa, State Department Dispatch 516: Mar. 10, 1959, p. 1.
[8] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 245: Mar. 3, 1959.
[9] Heinrich, E. W., and Bever, J. E., Occurrence of Sillimanite in Park and Fremont Counties, Colo.: Quart. Colorado Sch. Mines, vol. 52, No. 4, 1957, pp. 37–55.
[10] Mine and Quarry Engineering, Mineral Specimens No. 49, Kyanite: Vol. 23, No. 10, November 1957, pp. 428–429.
[11] Grant, W. H., The Geology of Hart County, Ga.: Georgia Dept. Mines, Min. and Geol. Survey Bull. 67, 1958, 75 pp.

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An article described laboratory and pilot plant flotation of kyanite from a schist in the Sudbury area, Ontario, Canada. Flowsheets of the operations were included.[12]

A study was made on the effects of grain size, forming pressure, firing temperature, length of soaking time at the maximum temperature, and small additions of other materials on the densification of domestic kyanite when fired to high temperatures. It was necessary to grind domestic kyanite finer than 325-mesh to obtain dense test pieces at 2,800° F. The degree of densification of kyanite increases with decreasing grain size, increasing forming pressure, increasing firing temperature, and increasing soaking period at maximum temperature.[13]

East African kyanite and sillimanite rock from Arnam were among various refractory material on which flaking tests were made.[14]

The formation of mullite in various materials was investigated by means of X-rays, and results verified with the electron microscope.[15]

Experiments were conducted to determine whether mullite melts congruently or incongruently. A single crystal boule had a melting point 100° C. higher than that of mullite.[16]

The subsolidus relations between mullite and iron oxide were studied to increase the understanding of the properties of fired clay products. It was found that mullite and ferric oxide formed a limited series of solid solutions when fired in air to temperatures between 1,000° to 1,300° C. The solid solutions were characterized by an increase in the lattice dimensions of mullite, by increases in the indices of refraction, and by changes in color.[17]

Samples of zircon-mullite were fired to 1,300°, 1,400°, 1,500°, 1,600°, and 1,700° C. for 4 hours. The porosity, bulk density, and chemical composition at different temperatures were tabulated.[18]

Data on bonded mullite and zircon refractories for use in glass contact areas, superstructure, and feeder forehearths of the glass furnace were presented. Special reference was made to grain structure, mineralogical composition, chemical reaction, and destruction of mullite and zircon refractories in service. Photographs of zircon after service were included to illustrate the application and results obtained.[19]

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[12] Wyman, R. A., Flotation of a Canadian Kyanite: Min. Eng., vol. 10, No. 1, January 1958, pp. 111–112.

[13] Wilson, H. H., and Bole, G. A., Note on the Densification of Domestic Kyanite at High Temperatures: Bull. Am. Ceram. Soc., vol. 37, No. 6, June 1958, pp. 269–271.

[14] Wylde, J. H., Recent Work on the Flaking of Refractories: Gas Council (Gt. Brit.) Research Commun., GC40, 1957, pp. 1–36; Ceram. Abs., vol. 41, No. 3, Mar. 1, 1958, p. 71j.

[15] de Keyser, W. L. [Contribution to the Study of the Formation of Mullite Studied by X-rays and Electron Miscroscopy]: Bull. soc. franc. ceram., No. 35, 1957, pp. 9–19; Ceram. Abs., vol. 41, No. 1, Jan. 1, 1958, p. 30g.

[16] Neuhaus, A., [Growing of Single Crystals of Mullite]: Keram. Zhur., vol. 9, No. 8, 1957, p. 438; Ceram. Abs., vol. 41, No. 4, Apr. 1, 1958, p. 103g.

[17] Brownell, W. E., Subsolidus Relations Between Mullite and Iron Oxide: Jour. Am. Ceram. Soc., vol. 41, No. 6, June 1, 1958, pp. 226–230.

[18] Marants, A. G., and Kamenchik, A. E., [Behavior of Fusion Cast Zircon-Mullite Ware on Heating]: Steklo i Keram., vol. 15, No. 1, 1958, pp. 16–18; Ceram. Abs., vol. 41, No. 5, May 1, 1958, p. 117d.

[19] Knauft, R. W., Smith, K. W., Thomas, E. A., and Pittman, W. C., Bonded Mullite and Zircon Refractories for the Glass Industry: Bull. Am. Ceram. Soc., vol. 36, No. 11, November 1957, pp. 412–415.

Lead

By O. M. Bishop [1] and Edith E. den Hartog [2] [3]

Contents

SUPPLY of lead exceeded demand by a wide margin in 1958, resulting in rapid stock buildups and lower metal prices. Imports, in almost unprecedented quantity, competed successfully with domestic output for an increased share of the diminished United States market. Domestic mine production fell sharply, whereas world production declined only 3 percent. U.S. Government acquisitions of lead, that in previous years had decreased the severity of world surpluses, were greatly reduced.

In the final quarter of the year quotas were effected on lead imports into the United States, there was a moderate upturn in consumption, as well as a rise in the market price of lead, and a small but encouraging increase in domestic mine output. Nevertheless, producers' and consumers' stocks continued to rise.

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[1] Commodity specialist.
[2] Statistical assistant.
[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 1.—Salient statistics of the lead industry, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production:						
Mine production of recoverable lead	392,341	325,419	338,025	352,826	338,216	267,377
Value (thousands)	$119,100	$89,165	$100,731	$110,787	$96,730	$62,566
Primary lead (refined)						
From domestic ores and base bullion	375,455	322,271	321,132	349,188	347,675	269,082
From foreign ores and base bullion	93,363	164,441	158,025	193,120	185,858	201,074
Antimonial lead (primary lead content)	17,345	12,797	14,586	13,657	19,870	16,446
Secondary lead (lead content)	474,120	480,925	502,051	506,755	489,229	401,787
Imports:						
Lead in ores and matte	103,375	161,261	177,479	196,452	198,479	201,628
Lead in base bullion	1,880	41		31	84	460
Lead in pigs, bars, and old	370,692	281,941	284,729	283,392	333,492	375,022
Exports of refined pig lead	1,510	596	403	4,628	4,339	1,359
Stocks (lead content)						
At primary smelters and refineries	107,253	137,039	89,443	97,043	143,916	234,290
At consumer plants	115,200	124,641	117,458	123,995	129,310	122,900
Consumption of metal, primary and secondary	1,142,569	1,094,871	1,212,644	1,209,717	1,138,115	986,387
Price, common lead, New York, average, cents per pound	15.22	14.05	15.14	16.01	14.66	12.11
World:						
Mine production	1,945,000	2,270,000	2,420,000	2,480,000	2,610,000	2,520,000
Smelter production	1,900,000	2,210,000	2,240,000	2,400,000	2,510,000	2,480,000
Price, common lead, London, average, cents per pound	15.76	12.08	13.19	14.52	12.05	9.13

LEGISLATION AND GOVERNMENT PROGRAMS

United Nations Program.—Concerned over the apparently chronic world oversupply of lead, the United Nations, through the U.N. Interim Coordinating Committee on International Commodity Agreements, held talks in London in September designed to explore areas of possible agreement among interested nations to effect stabilization of world lead-zinc supply. Size of the U.S. market and distress of the domestic mine producers qualified the United States as a principal participant. A lead-zinc subcommittee was established that met in Geneva in November. The dimensions of the problem were thoroughly reviewed and a framework for possible multilateral corrective action was discussed.

Import Quotas.—Pursuant to an Escape Clause investigation under authority of the Trade Agreement Extension Act of 1951, as amended, the Tariff Commission, in April, announced its findings that increased imports, in part caused by trade concessions granted under General Agreements on Tariffs and Trade, were causing serious injury to the domestic lead-zinc industry and recommended appropriate remedial measures to the President. Action on the Tariff Commission's recommendations was deferred pending Congressional consideration of the Administration's proposed Minerals Stabilization Plan. The Plan was not enacted, and on September 22, President Eisenhower issued a proclamation imposing import quotas on lead and zinc ores, intermediate smelter products, and refined lead and zinc metal. The quotas, effective October 1, 1958, were established at 80 percent of the United States average annual competitive import rate in the 5-year period, 1953–57. Allocations were on a quarterly basis and major exporting countries received individual quota allowances. For lead, import limits of all categories totaled 354,720 short tons annually. This quantity was approximately one-third less than the lead imports of 1957.

Exploration Program.—Public Law 701 was enacted by the 85th Congress to establish the Office of Minerals Exploration (OME) under the Department of the Interior. The new OME assumed the functions of the Defense Minerals Exploration Administration (DMEA) which legally passed from existance June 30, 1958. Object of the Government program for exploration primarily was to share the financial risk with private industry in exploratory ventures capable of increasing the Nation's mineral resource base. The new law was considerably more restrictive than its predecessor; applicants for loans under OME provisions were required to provide evidence that funds could not be obtained from commercial sources at reasonable interest rates. Government participation in any one contract was limited to a $250,000 maximum.

During 1958, 15 new contracts were made relating to exploration for lead bearing ores. Total authorized expenditure under the contracts was $1,363,651.

Barter Program.—The 85th Congress extended the basic domestic farm surplus disposal law (PB 480) to the end of 1959. Under its authority the U.S. Department of Agriculture, through its agent, the Commodity Credit Corporation (CCC), continued to trade perishable surplus agricultural products for lead and other commodities of foreign origin. In 1958 the CCC contracted for 47,193 tons of lead (55,438 tons in 1957) to be added to the Government supplemental stockpile. Modifications to barter regulations announced during the year liberalized considerably the restrictions relating to country of origin and kinds of materials eligible. Barter contractors were relieved of the burden of proof that the bartered farm products would increase the net exports of the United States. However, the new rules contained adequate measures to protect export markets and prevent substitution of barter for cash sales.

Stockpiling.—Under authority of the Strategic and Critical Materials Stockpile Act of 1946 and supplemental legislation and in accord with directives from the Office of Defense Mobilization, monthly purchases of lead from domestic producers were made during the first half of the year for addition to the strategic stockpile. General Services Administration (GSA) was the procuring and administrating agent. The final authorization for the purchase of lead was issued May 26, 1958 and deliveries were completed by the end of the year, thereby concluding the Government procurement program for lead. Quantities of lead in the strategic stockpile and additions thereto were not published. In accordance with the Agricultural Trade Development and Assistance Act, CCC delivered 41,686 tons of foreign bartered lead to GSA in 1958 for retention in the Government's supplemental stockpile.

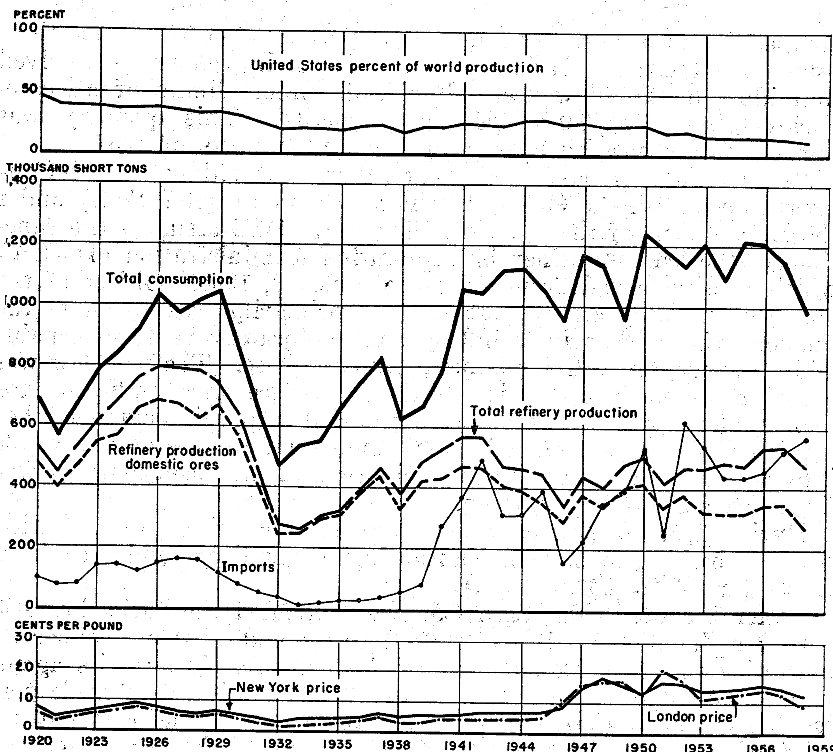

FIGURE 1.—Trends in the lead industry in the United States, 1920–58. Consumption includes primary refined, antimonial, and secondary lead and lead in pigments made directly from ore. Imports are factored to include 95 percent of the lead content of ores, mattes, and concentrates and 100 percent of pigs, bars, base bullion, and scrap.

DOMESTIC PRODUCTION

MINE PRODUCTION

Mines in the United States produced 267,400 tons of recoverable lead, 21 percent less than in 1957 and the lowest annual output since 1899. The sharp decline was attributed to growing industry stocks and lower metal prices resulting from decreased industrial consumption, large imports, and terminations of Government purchases for the national stockpile. Following the downward trend established in the second half of 1957, monthly mine output declined from a high of 26,000 tons in January to a low of 18,400 tons in March. A brief upturn in April was reversed by further production slumps during the summer months. Following Government imposition of import quotas in October, mine production rallied slightly to end the year with an increasing rate of output.

Western States.—Western States contributed 53 percent of mine output of recoverable lead. However, the Western States total of 142,800 tons was 25 percent less than that of 1957. Declines in individual producing States ranged from 550 tons in Arizona to 18,000 tons in Idaho.

TABLE 2.—Ores yielding lead and zinc in the United States in 1958, in short tons [1]

State	Lead ore			Zinc ore			Lead-zinc ores			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
Alaska	5	2											5	2	
Arizona	6,571	1,590	85	14,210		2,636	361,488	10,278	24,706	5,961	3	762	388,230	11,871	28,189
California	1,643	104	39										1,643	104	39
Colorado	16,326	1,126	8	76	3	19	313,418	5,699	26,494	384,959	6,956	10,612	714,779	13,784	37,133
Idaho	87,874	7,270	748	12,424	322	1,108	733,116	41,562	40,439				833,414	49,154	42,295
Illinois				336,281	7	9,836	265,177	963	8,704				601,458	970	18,540
Kansas	2,455	152	27	138,989	311	3,160	85,916	836	1,234				227,360	1,299	4,421
Missouri	[3] 6,194,187	108,296	362							[4] 231,565	4,827		6,425,752	113,123	362
Montana	13,571	2,008	213	648,767	5,633	27,334	666	118	44				663,004	7,759	27,591
Nevada	24,870	3,653	73				162	26	15				25,032	3,679	88
New Mexico	116	22	1	107,477	389	8,321	11,843	545	698				119,436	956	9,020
Oklahoma				31,817	196	963	352,379	3,496	4,304				384,196	3,692	5,267
Tennessee				1,655,588		55,237				1,265,900		3,893	2,921,488		59,130
Utah	13,318	1,316	208	80	3	17	497,652	36,871	37,966				511,050	38,190	38,191
Washington	111	46	1				839,210	8,967	18,795				839,321	9,013	18,796
Wisconsin				99,887	5	2,656	368,935	795	9,484				468,822	800	12,140
New York				302,663		10,495	1,106,791	579	42,519				1,409,454	579	53,014
New Jersey						607									607
Pennsylvania						10,812		2,934	18,149					2,934	10,812
Virginia [2]						323									18,472
Total	6,361,047	125,585	1,765	3,348,259	6,869	133,524	4,936,753	113,669	233,551	1,888,385	11,786	15,267	16,534,444	257,909	384,107

[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 disclosure of individual company operations.
[3] Includes 479,916 tons of tailings containing 245 tons of recoverable zinc and 3,042 tons of recoverable lead.
[4] Includes some copper concentrate yielding 11 tons of lead.

Idaho produced 53,600 tons, ranking it first among the lead-producing Western States and second in the United States. The largest production in the State came from the Bunker Hill mine of the Coeur d'Alene district. Operations at this property, as well as the Page mine of American Smelting and Refining Co. were curtailed during most of 1958 owing to large industry inventories and low metal prices. The improved market situation in the last quarter of the year prompted return to a 5-day week at both the Bunker Hill and Page mines. Development of deeper ore continued uninterrupted in most mines of the Coeur d'Alene district.

Utah was the second largest producer among the Western States with a recorded output of 40,400 tons. The United States and Lark mine continued to be the largest producer in the State. Among other important producers were United Park City, Mayflower-Park Galena and Ophir mines. In June DMEA approved a contract for a half-million dollar exploration project seeking deep ore reserves in the Mayflower mine of the New Park Mining Co. Work at the Ophir mine was suspended by McFarland & Hullinger, contract miners of the Ophir unit since 1944.

Lead output from Arizona mines declined only slightly during the year to total 11,900 tons. The Iron King mine of Shattuck Denn Mining Corp. at Humboldt was again the State's largest producer.

TABLE 3.—Mine production of recoverable lead in the United States, by States, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
Western States and Alaska:						
Alaska	46	------	1	1	9	2
Arizona	20, 658	8, 385	9, 817	11, 999	12, 441	11, 890
California	11, 996	2, 671	8, 265	9, 296	3, 458	140
Colorado	27, 203	17, 823	15, 805	19, 856	21, 003	14, 112
Idaho	80, 873	69, 302	64, 163	64, 321	71, 637	53, 603
Montana	20, 029	14, 820	17, 028	18, 642	13, 300	8, 434
Nevada	7, 669	3, 041	3, 291	6, 384	5, 979	4, 150
New Mexico	4, 922	887	3, 296	6, 042	5, 294	1, 117
Oregon	7	5	3	5	5	1
South Dakota	4	------	------	------	------	------
Texas	72	------	------	------	------	------
Utah	48, 002	44, 972	50, 452	49, 555	44, 471	40, 355
Washington	9, 512	9, 938	10, 340	11, 657	12, 734	9, 020
Wyoming	------	------	------	------	------	------
Total	230, 993	171, 844	182, 461	197, 758	190, 331	142, 824
West Central States:						
Arkansas	9	------	------	------	------	------
Kansas	7, 494	4, 033	5, 498	7, 635	4, 257	1, 299
Missouri	128, 198	125, 250	125, 412	123, 783	126, 345	113, 123
Oklahoma	16, 320	14, 204	14, 126	12, 350	7, 183	3, 692
Total	152, 021	143, 487	145, 036	143, 768	137, 785	118, 114
States east of the Mississippi River:						
Illinois	3, 473	3, 232	4, 544	3, 832	2, 970	1, 610
Kentucky	95	80	------	228	411	516
New York	1, 371	1, 187	1, 037	1, 608	1, 667	579
Tennessee	82	------	------	5	------	------
Virginia [1]	2, 931	4, 324	2, 999	3, 045	3, 152	2, 934
Wisconsin	1, 375	[2] 1, 265	1, 948	2, 582	1, 900	800
Total	9, 327	10, 088	10, 528	11, 300	10, 100	6, 439
Grand total	392, 341	325, 419	338, 025	352, 826	338, 216	267, 377

[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.

McFarland & Hullinger operated the San Xavier during most of the year. Cyprus Mines Corp. closed its Old Dick mine near Bagdad in April. Nash and McFarland leased the Flux mine and purchased the Trench mill near Patagonia.

Washington mine production of lead totaled 9,000 tons, 29 percent less than in 1957. The Grandview mine of American Zinc Lead & Smelting Co. and Pend Oreille mine of Pend Oreille Mines & Metal Co. were the major producers. Curtailed output and economy measures were in force at the two properties but development continued.

Ores rich in gold and silver from the Richmond Eureka mine of the Eureka Corp., Ltd., yielded the major portion of the lead recovered from Nevada mines. A significant quantity of lead was also produced as a by-product of processing manganese ores.

The Idarado Mining Co. mine unit in Ouray County, continued to be Colorado's largest lead producer. New Jersey Zinc Co. operated the Eagle mine at Gilman on a full production basis. The company's mine in Eagle County was the State's second largest lead producer. At mid-year Emperious Mining Co. closed its mines at Creede, the first general shutdown in 25 years. Owing chiefly to cutbacks in late 1957 which continued throughout 1958, lead output fell 33 percent to 14,100 tons.

Lead production in New Mexico fell nearly 80 percent to 1,100 tons. New Jersey Zinc Co. closed its Hanover mine unit May 1.

West Central States.—Output of lead recoverable from ores mined in Kansas, Missouri, and Oklahoma dropped 14 percent to 118,100 tons. As in prior years Missouri was first among the lead-mining States of the Nation. Low metal prices dictated suspension of all mining operations in Kansas and Oklahoma by mid-year.

Despite cutbacks and listless markets, the mines of the Southeast Missouri Lead Belt produced 113,100 tons of lead during the year—42 percent of the National total. Output from the district was 10 percent below the 1957 quantity, however. A 3-week shutdown of St. Joseph Lead Co.'s mine-mill units in March, to effect an inventory reduction, contributed to the decrease. Continued stock accretions prompted National Lead Co. to reduce operations to a 32-hour week in May. In June St. Joseph Lead Co. announced general cutbacks in mine-mill operations, and in July Mine LaMotte Corp. closed its mine and mill unit indefinitely. Although activity continued curtailed in the district throughout the second half of the year, shaft sinking progressed on the new Viburnum orebody of St. Joseph Lead Co. and development was announced at Mine LaMotte.

Lead output of the traditionally productive Tri-State mines in Northeast Oklahoma, Southeast Kansas, and Southwest Missouri was 5,000 tons—less than half the 1957 output. National Lead Co. suspended operations at its Ballard mine near Baxter Springs, Kans. in January. The mines and Central mill of the Eagle-Picher Co. produced at a curtailed rate during the first half of the year but were closed completely in July. Thereafter no production of lead was reported from the Tri-State district mines.

States East of the Mississippi River.—Lead in the Eastern United States was derived almost exclusively from processing zinc ores in which lead occurs in minor quantities. A 36-percent decline in lead output during the year reflected decreases in zinc mining chiefly in Wisconsin, New York, and Virginia.

TABLE 4.—Mine production of lead in the principal districts [1] of the United States, in terms of recoverable lead, in short tons

District or region	State	1957	1958
Southeastern Missouri region	Missouri	126,323	113,123
Coeur d'Alene region	Idaho	67,125	52,488
West Mountain (Bingham)	Utah	29,490	27,446
Park City region	do	9,421	9,105
Metaline	Washington	11,971	8,971
Big Bug	Arizona	6,883	7,728
Summit Valley (Butte)	Montana	9,617	5,492
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	11,462	4,991
Austinville	Virginia	3,143	2,934
Upper Mississippi Valley	Iowa, northern Illinois, Wisconsin	3,691	1,770
Pima (Sierritas, Papago, Twin Buttes)	Arizona	750	1,397
Creede	Colorado	2,231	1,233
Harshaw	Arizona	2,545	1,163
Kentucky-Southern Illinois	Kentucky-southern Illinois	1,590	1,156
Ophir	Utah	1,418	885
Rush Valley & Smelter (Tooele County)	do	1,977	825
St. Lawrence County	New York	1,667	579
Tintic	Utah	1,775	388
Magdalena	New Mexico	1,214	377

[1] Districts producing 1,000 short tons or more in either year.

TABLE 5.—Twenty-five leading lead-producing mines in the United States in 1958, 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	United States & Lark.	West Mountain (Bingham).	Utah	U.S. Smelting, Refining & Mining Co.	Lead-zinc.
3	Bunker Hill	Coeur d'Alene	Idaho	The Bunker Hill Co	Do.
4	Leadwood	Southeastern Missouri.	Missouri	St. Joseph Lead Co	Lead.
5	Indian Creek	do	do	do	Do.
6	Bonne Terre	do	do	do	Do.
7	Iron King	Big Bug	Arizona	Shattuck-Denn Mining Co.	Lead-zinc.
8	Star	Coeur d'Alene	Idaho	The Bunker Hill Co	Do.
9	Treasury Tunnel-Black Bear-Smuggler Union.	Upper San Miguel.	Colorado	Idarado Mining Co	Copper-lead-zinc.
10	Page	Coeur d'Alene	Idaho	American Smelting & Refining Co.	Lead-zinc.
11	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co.	Do.
12	Butte Mines	Summit Valley	Montana	The Anaconda Co	Do.
13	United Park City	Uintah	Utah	United Park City Mines Co.	Do.
14	Desloge	Southeastern Missouri.	Missouri	St. Joseph Lead Co	Lead.
15	Lucky Friday	Coeur d'Alene	Idaho	Lucky Friday Silver-Lead Mines, Inc.	Lead-zinc.
16	Madison	Southeastern Missouri.	Missouri	National Lead Co	Lead-copper.
17	Eagle	Red Cliff (Battle Mountain).	Colorado	The New Jersey Zinc Co.	Copper-lead-zinc.
18	Mine La Motte	Southeastern Missouri.	Missouri	St. Joseph Lead Co	Lead.
19	Mayflower	Blue Ledge	Utah	New Park Mining Co	Lead-zinc.
20	Grandview	Metaline	Washington	American Zinc, Lead & Smelting Co.	Do.
21	Richmond-Eureka	Eureka	Nevada	Eureka Corp., Ltd	Lead.
22	Austinville	Austinville	Virginia	The New Jerzey Zinc Co.	Zinc-lead.
23	Sunshine	Coeur d'Alene	Idaho	Sunshine Mining Co	Silver.
24	Sidney	do	do	Sidney Mining Co	Lead-zinc.
25	San Xavier	Pima	Arizona	McFarland & Hullinger.	Do.

TABLE 6.—Mine production of recoverable lead in the United States, by months, in short tons

Month	1957	1958	Month	1957	1958
January	30, 218	26, 123	August	27, 806	19, 592
February	29, 061	23, 827	September	25, 006	19, 570
March	30, 962	18, 440	October	28, 663	21, 200
April	31, 700	25, 896	November	24, 042	21, 382
May	30, 104	24, 528	December	25, 982	22, 716
June	27, 366	22, 961			
July	27, 306	21, 142	Total	338, 216	267, 377

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 list of primary smelters and refiners presented in the 1957 Lead chapter was unchanged in the first half of the year but the Midvale plant of United States Smelting, Refining & Mining Co. was shut down during the last half. One major secondary smelter was closed early in the year.

Refined Lead—Primary and Secondary.—A total of about 533,400 tons of lead in primary raw materials and 34,400 tons in scrap were consumed by the 13 primary lead smelters and refineries operating in the United States in 1958. From these sources 472,500 tons of refined lead and 47,400 tons of lead in antimonial lead were produced.

Of the 470,200 tons of refined lead produced from primary sources, 57 percent came from domestic ores and 43 percent from foreign ores and bullion (65 percent and 35 percent, respectively, in 1957). Approximately 35 percent of the ore imported came from Peru, 24 percent from Union of South Africa, and 13 percent from Australia.

Primary lead smelters also produced 2,300 tons of refined lead from scrap and secondary lead smelters 113,700 tons from scrap, or a total of 586,200 tons of refined and remelt lead from all sources.

TABLE 7.—Refined lead produced at primary refineries in the United States, by source material, in short tons

Source	1949–53 (average)	1954	1955	1956	1957	1958
Refined lead:						
From domestic ores and base bullion	375, 455	322, 271	321, 132	349, 188	347, 675	269, 082
From foreign ores	91, 688	164, 353	157, 863	193, 084	185, 798	200, 299
From foreign base bullion	1, 675	88	162	36	60	775
Total from primary sources	468, 818	486, 712	479, 157	542, 308	533, 533	470, 156
From scrap	7, 971	5, 066	4, 079	4, 069	3, 263	2, 338
Total refined lead	476, 789	491, 778	483, 236	546, 377	536, 796	472, 494
Average sales price per pound	$0. 152	$0. 137	$0. 149	$0. 157	$0. 143	$0. 117
Total calculated value of primary refined lead (thousands) [1]	$144, 944	$133, 359	$142, 789	$170, 285	$152, 590	$110, 017

[1] Excludes value of refined lead produced from scrap at primary refineries.

Antimonial Lead—Primary and Secondary.—Primary and secondary smelters produced 213,400 tons of antimonial lead in 1958 (199,400 tons lead content)—about 23 percent less than in 1957. Of the primary smelters output of 47,443 tons (lead content), 65 percent came from scrap most of which was battery-lead plates, 18 percent from primary domestic sources and 17 percent from foreign sources. Secondary smelters produced 152,000 tons (lead content) of antimonial lead, 22 percent less than in 1957. Of all lead- and tin-base scrap melted by all plants in 1958, 59 percent was battery lead plates, recovery from most of which was antimonial lead.

TABLE 8.—Antimonial lead produced at primary lead refineries in the United States

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Short tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1949–53 (average)	57,049	4,247	7.5	10,430	6,915	35,457	52,802
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
1958	50,246	2,803	5.6	8,256	8,190	30,997	47,443

TABLE 9.—Stocks and consumption of new and old lead scrap in the United States in 1958, 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	2,863	43,108		43,026	43,026	2,945
Hard lead	1,906	15,523		16,491	16,491	938
Cable lead	3,273	25,765		26,815	26,815	2,223
Battery-lead plates	17,497	320,027		304,850	304,850	32,674
Mixed common babbitt	1,650	5,657		6,148	6,148	1,159
Solder and tinny lead	315	11,336		11,254	11,254	397
Type metals	1,561	24,801		24,857	24,857	1,505
Drosses and residues	22,372	70,090	77,234		77,234	15,228
Total	51,437	516,307	77,234	433,441	510,675	57,069
Foundries and other manufacturers:						
Soft lead	127	356	2	386	388	95
Hard lead	106	363	50	254	304	165
Cable lead	61	294		321	321	34
Battery-lead plates	12	110		10	10	112
Mixed common babbitt	183	8,200		8,088	8,088	295
Solder and tinny lead	55	623	567	91	658	20
Type metals						
Drosses and residues	365	180	238		238	307
Total	909	10,126	857	9,150	10,007	1,028
Grand total:						
Soft lead	2,990	43,464	2	43,412	43,414	3,040
Hard lead	2,012	15,886	50	16,745	16,795	1,103
Cable lead	3,334	26,059		27,136	27,136	2,257
Battery-lead plates	17,509	320,137		304,860	304,860	32,786
Mixed common babbitt	1,833	13,857		14,236	14,236	1,454
Solder and tinny lead	370	11,959	567	11,345	11,912	417
Type metals	1,561	24,801		24,857	24,857	1,505
Drosses and residues	22,737	70,270	77,472		77,472	15,535
Total	52,346	526,433	78,091	442,591	520,682	58,097

[1] Revised figures.

Other Secondary Lead.—In addition to the 116,100 tons recovered from scrap as soft lead, and 183,000 tons reclaimed in antimonial lead, 90,100 tons of lead was recovered in lead-base alloys (solder, type metals, babbitts and cable lead), 13,000 tons in copper-base alloys, and a small quantity in tin-base alloys.

All secondary lead recovered in 1958 by all plants consuming scrap totaled 402,000 tons, a decrease of 18 percent from the quantity reclaimed in 1957, and the lowest recovery since 1946. Secondary lead and copper smelters recovered 90 percent of the total, primary lead smelters 8 percent, and manufacturers and foundries 2 percent.

TABLE 10.—Secondary metal recovered [1] from lead and tin scrap in the United States in 1958, by type of products, gross weight in short tons

Products	Lead	Tin	Antimony	Other	Total
Refined pig lead	93,415				93,415
Remelt lead	22,642				22,642
Lead foil					
Total	116,057				116,057
Refined pig tin		3,470			3,470
Remelt tin		414			414
Total		3,884			3,884
Lead and tin alloys:					
Antimonial lead	182,953	390	11,997	157	195,497
Common babbitt	14,777	944	1,898	141	17,760
Genuine babbitt	45	255	28	8	336
Solder	20,719	5,060	260	33	26,072
Type metals	29,332	2,414	4,878	54	36,678
Cable lead	24,803	11	275		25,089
Miscellaneous alloys	1,472	691	178	38	2,379
Total	274,101	9,765	19,514	431	303,811
Composition foil	37	2	1		40
Tin content of chemical products		665			665
Grand total	390,195	14,316	19,515	431	424,457

[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 11.—Secondary lead recovered in the United States, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
As refined metal:						
At primary plants	7,972	5,066	4,079	4,069	3,263	2,338
At other plants	135,534	114,941	124,241	129,323	123,308	113,719
Total	143,506	120,007	128,320	133,392	126,571	116,057
In antimonial lead:						
At primary plants	35,457	43,555	45,903	49,821	44,852	30,997
At other plants	182,113	195,284	201,800	202,761	195,299	151,956
Total	217,570	238,839	247,703	252,582	240,151	182,953
In other alloys	113,044	122,079	126,028	120,781	122,507	102,777
Grand total:						
Short tons	474,120	480,925	502,051	506,755	489,229	401,787
Value (thousands)	$144,132	$131,773	$149,611	$159,121	$139,919	$94,018

TABLE 12.—Lead recovered from scrap processed in the United States, by kind of scrap and form of recovery, in short tons

Kind of scrap	1957	1958	Form of recovery	1957	1958
New scrap:			As soft lead:		
Lead-base	51,536	53,456	At primary plants	3,263	2,338
Copper-base	5,487	4,779	At other plants	123,308	113,719
Tin-base	323	283			
			Total	126,571	116,057
Total	57,346	58,518			
			In antimonial lead [1]	240,151	182,953
Old scrap:			In other lead alloys	95,132	90,059
Battery-lead plates	255,208	202,007	In copper-base alloys	27,279	12,673
All other lead-base	146,265	123,461	In tin-base alloys	96	45
Copper-base	30,404	17,795			
Tin-base	6	6	Total	362,658	285,730
Total	431,883	343,269	Grand total	489,229	401,787
Grand total	489,229	401,787			

[1] Includes 44,852 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1957 and 30,997 tons in 1958.

CONSUMPTION AND USES

Domestic consumption of lead was 13 percent below the 1957 level, the lowest since 1949, and 20 percent below the peak of 1950. Of all lead consumed, 66 percent was soft lead, primary and secondary; 24 percent was lead content of antimonial lead; 4 percent was lead in alloys; 1.5 percent was lead in copper-base scrap; 4 percent was lead content of scrap which went directly to an end product; and 0.5 percent was lead recovered from ore in the production of leaded zinc oxide and other pigments.

Monthly consumption varied from a low of 72,100 tons in February to a high of 92,600 tons in October but in only 1 month (December) did it surpass or even equal consumption in the comparable months of 1957.

Approximately 71 percent of all lead used went to the manufacture of metal products (including storage batteries), 10 percent was used in pigments, 16 percent in chemicals (including tetraethyl fluid), and 3 percent in miscellaneous and unclassified uses. Storage batteries accounted for 32 percent of all lead consumed, tetraethyl 16 percent, and cable covering 8 percent. These products together required 99,000 tons less than was consumed in 1957.

The Association of American Battery Manufacturers, Inc., reported shipment of 25.2 million units of batteries in 1958 or 3 percent less than the 25.9 million units shipped in 1957.

Nine States accounted for 72 percent of the total lead consumed (excluding scrap) in 1958. New Jersey used 14 percent, Illinois 11 percent, California 10 percent, Indiana 7 percent, New York 6 percent, Missouri and Pennsylvania each 5 percent, and Louisiana and Texas together 14 percent.

TABLE 13.—Consumption of lead in the United States, by products, in short tons

	1957	1958		1957	1958
Metal products:			Pigments:		
Ammunition	42,509	40,215	White lead	15,701	13,589
Bearing metals	26,997	18,980	Red lead and litharge	78,323	64,892
Brass and bronze	24,491	20,379	Pigment colors	12,449	11,853
Cable covering	108,225	74,981	Other [1]	8,888	5,567
Calking lead	65,634	70,807			
Casting metals	12,672	8,674	Total	115,361	95,901
Collapsible tubes	10,316	8,432			
Foil	4,839	4,586	Chemicals:		
Pipes, traps, and bends	24,739	23,044	Tetraethyl lead	177,001	159,412
Sheet lead	27,474	25,104	Miscellaneous chemicals	3,556	3,233
Solder	70,684	59,653			
Terne metal	1,642	1,227	Total	180,557	162,645
Type metal	28,726	26,740			
			Miscellaneous uses:		
Total	448,948	382,822	Annealing	5,317	5,114
			Galvanizing	1,354	1,226
Storage batteries:			Lead plating	670	438
Antimonial lead	185,617	159,795	Weights and ballast	7,526	7,577
Lead oxides	175,398	152,830			
			Total	14,867	14,355
Total	361,015	312,725	Other, unclassified uses	17,367	17,939
			Grand total [2]	1,138,115	986,387

[1] Includes lead content of leaded zinc oxide and other pigments.
[2] Includes lead which went directly from scrap to fabricated products.

TABLE 14.—Consumption of lead in the United States, by months, in short tons

Month	1957	1958	Month	1957	1958
January	102,952	82,385	August	103,442	84,456
February	95,788	72,096	September	95,790	90,222
March	98,822	77,723	October	105,337	92,611
April	96,189	79,969	November	86,385	84,367
May	96,443	76,214	December	79,298	84,578
June	92,100	81,131			
July	85,569	80,635	Total [1]	1,138,115	986,387

[1] Includes lead content of leaded zinc oxide and other pigments and lead which went directly from scrap to fabricated products.

TABLE 15.—Consumption of lead in the United States in 1958, 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	221,128	74,621	36,345	15,489	347,583
Storage batteries	152,930	159,795			312,725
Pigments	90,610	150			90,760
Chemicals	162,635	10			162,645
Miscellaneous	8,784	5,567	4		14,355
Unclassified	15,538	1,401	356		17,295
Total	651,625	241,544	36,705	15,489	[1] 945,363

[1] Excludes 35,883 tons of lead that went directly from scrap to fabricated products and 5,141 tons of lead contained in leaded zinc oxide and other pigments.

TABLE 16.—Lead consumption, by States, in 1958, in short tons [1]

State	Refined soft lead	Lead in antimonial lead	Lead in alloys	Lead in copper-base scrap	Total
California	67,229	22,108	3,217	898	93,452
Colorado	1,300	1,279	121	213	2,913
Connecticut	12,209	9,874	16	1,070	23,169
District of Columbia	109	77			186
Florida	1,993	2,562			4,555
Illinois	68,330	28,252	5,507	2,499	104,588
Indiana	40,647	25,237	2,475	662	69,021
Kansas	4,371	7,497	21	330	12,219
Kentucky	12	2,245	1		2,258
Maryland	8,590	8,415	714	1	17,720
Massachusetts	5,242	3,594	528	371	9,735
Michigan	8,873	8,359	1,155	508	18,895
Missouri	39,372	2,616	174	1,221	43,383
Nebraska	11,257	3,200		38	14,495
New Jersey	101,753	26,674	7,480	574	136,481
New York	44,622	7,989	6,005	922	59,538
Ohio	20,663	13,522	3,180	1,084	38,449
Pennsylvania	29,003	19,081	757	2,045	50,886
Rhode Island	4,434	255	93		4,782
Tennessee	510	5,199	307	318	6,334
Virginia	2,048	958	715	981	4,702
Washington	8,501	3,844	26		12,371
West Virginia	13,329	2,677			16,006
Wisconsin	708	2,833	80	105	3,726
Alabama and Georgia [2]	21,122	8,773	858	621	31,374
Iowa and Minnesota	1,834	5,298	1,049	267	8,448
Montana and Idaho	10,967				10,967
New Hampshire, Maine, and Delaware	3,678	945	959	237	5,819
Arkansas and Oklahoma	1,996	1,515	12		3,523
Hawaii and Oregon	826	2,138		170	3,134
North and South Carolina	67	2,359			2,426
Louisiana and Texas	115,556	11,270	1,255	354	128,435
Utah, Nevada, and Arizona	96	617			713
Undistributed	378	282			660
Total	651,625	241,544	36,705	15,489	945,363

[1] Excludes 35,883 tons of lead which went directly from scrap to fabricated products and 5,141 tons of lead contained in leaded zinc oxides and other pigments.
[2] The following States are grouped to avoid disclosure of individual figures.

LEAD PIGMENTS [4]

A mixed trend was experienced in the major lead-pigment-consuming industries, the overall effect of which was a decline in shipments of the reported pigments; the production of automobiles and trucks and consumption of rubber declined 29 and 7 percent, respectively, but construction and production of paints increased over 1957.

TABLE 17.—Salient statistics of the lead pigments [1] industry of the United States

	1949–53 (average)	1954	1955	1956	1957	1958
Shipments:						
White lead (dry and in oil)....short tons	32,165	25,571	25,575	25,698	23,574	18,360
Red lead....do	31,510	27,163	29,272	27,975	26,998	21,992
Litharge....do	149,756	139,877	148,511	131,525	[2] 106,788	92,165
Black oxide [3]....do	73,892	79,233	113,874	106,956	127,583	120,324
Value of lead pigments	$72,845,600	$61,756,000	$69,133,000	$67,106,000	[1] $54,148,000	$39,442,000
Value per ton received by producers:						
White lead (dry)	377	383	392	413	416	388
Red lead	347	323	342	364	354	289
Litharge	325	303	326	346	321	277
Foreign trade:						
Value of exports	964,600	872,000	976,000	1,106,000	1,404,000	1,094,000
Value of imports	550,200	149,000	195,000	1,465,000	1,896,000	1,759,000
Export balance	414,400	723,000	781,000	−359,000	−492,000	−665,000

[1] Excludes basic lead sulfate; figure withheld to avoid disclosing individual company confidential data.
[2] Revised figure. [3] Production.

[4] Prepared by Arnold M. Lansche, commodity specialist and Esther B. Miller, statistical assistant.

Production and Shipments.—Lead consumed in the manufacture of lead pigments totaled about 235,000 tons compared with 266,000 tons in 1957, a decline of 11 percent.

White lead, red lead, litharge, and black oxide were made from refined lead and constituted 99 percent of all lead used in pigments. The lead content of leaded zinc oxide made up the remaining 1 prcent. Basic lead sulfate is not reported herein, except as it enters leaded zinc oxide; lead silicate, inasmuch as it is derived from litharge, is included with litharge.

A list of lead pigment manufacturer plants and producers follows:

	Location
Manufacturer:	
White lead:	
Euston Lead Co	Scranton, Pa.[5]
W. P. Fuller & Co	South San Francisco, Calif.
John R. MacGregor Lead Co	Chicago, Ill.
National Lead Co	Chicago, Ill.
Do	Oakland, Calif.
Do	Perth Amboy, N.J.
Do	Philadelphia, Pa.
Do	St. Louis, Mo.
Red lead and litharge:	
Bunker Hill Co., The	Seattle, Wash.
Eagle-Picher Co., The	Joplin, Mo.
W. P. Fuller & Co	South San Francisco, Calif.
Hammond Lead Products Co	Hammond, Ind.
Linklater Co	Montebello, Calif.
John R. MacGregor Lead Co	Chicago, Ill.
National Lead Co	Atlanta, Ga.
Do	Brooklyn, N.Y.
Do	Charleston, W. Va.
Do	Chicago, Ill.
Do	Dallas, Tex.
(Morris P. Kirk & Son)	Los Angeles, Calif.
National Lead Co	Oakland, Calif.
Do	Perth Amboy, N.J.
Do	Philadelphia, Pa.
Do	St. Louis, Mo.
Western Lead Products	Los Angeles, Calif.
Black oxide:	
Bunker Hill Co., The	Seattle, Wash.
Eagle-Picher Co	Joplin, Mo.
Electric Auto-Lite Battery Corp	Atlanta, Ga.
Do	Niagara Falls, N.Y.
Do	Oakland, Calif.
Do	Oklahoma City, Okla.
Do	Owosso, Mich.
Do	Vincennes, Ind.
Electric Storage Battery Co., The	Phila., Pa.
General Motors Corp. (Delco-Remy Div.).	Detroit, Mich.
Gould National Batteries	St. Paul, Minn.
Hammond Lead Products, Inc	Hammond, Ind.
Linklater Co	Montebello, Calif.
Price Battery Corp	Hamburg, Pa
Standard Electric Co	San Antonio, Tex.
Western Lead Products Co	Los Angeles, Calif.
Willard Storage Battery Co	Cleveland, Ohio
Do	Dallas, Tex.

[5] Plant closed May 9, 1958.

TABLE 18.—Production and shipments of lead pigments[1] in the United States

Pigment	1957				1958			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value[2]			Short tons	Value[2]	
			Total	Average			Total	Average
White lead:								
Dry	15,280	14,898	$6,193,571	$416	12,760	12,589	$4,883,065	$388
In oil[3]	7,494	8,676	4,072,929	469	5,548	5,771	2,692,295	467
Red lead	27,094	26,998	9,566,096	354	21,934	21,992	6,363,384	289
Litharge	[4] 106,312	[4] 106,788	[4] 34,315,347	321	92,070	92,165	25,503,104	277
Black oxide	127,583				120,324			

[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] Revised figure.

TABLE 19.—Lead pigments[1] shipped by manufacturers in the United States, in short tons

Year	White lead			Red lead	Litharge	Black oxide[2]
	Dry	In oil	Total			
1949–53 (average)	20,029	12,136	32,165	31,510	149,756	73,892
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	[3] 106,788	127,583
1958	12,589	5,771	18,360	21,992	92,165	120,324

[1] Excludes basic lead sulfate and orange mineral; figures withheld to avoid disclosing individual company confidential data.
[2] Production by battery manufacturers.
[3] Revised figure.

TABLE 20.—Lead content of lead and zinc pigments[1] produced by domestic manufacturers, by sources, in short tons

Pigment	1957				1958			
	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			18,219	18,219			14,646	14,646
Red lead			24,561	24,561			19,883	19,883
Litharge			[2] 98,870	[2] 98,870			85,625	85,625
Black oxide			124,109	124,109			115,228	115,228
Leaded zinc oxide	3,231	1,253		4,484	2,675	727		3,402
Total	3,231	1,253	[2] 265,759	[2] 270,243	2,675	727	235,382	238,784

[1] Excludes lead in basic lead sulfate and orange mineral; figures withheld to avoid disclosing individual company confidential data.
[2] Revised figure.

Consumption and Uses—White Lead.—Paintmaking required 83 percent of the white lead shipments in 1958 compared with 82 percent in 1957. Shipments to ceramics makers furnished 1 percent of total distribution in 1958. Other uses for the pigments 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 production of leaded zinc oxide.

Red Lead.—The paint industry received 62 percent of the red lead shipped in 1958 compared with 59 percent in 1957. The "Other" classification consisted of storage batteries, ceramics, rubber, and unspecified uses.

Orange Mineral.—No production of this pigment was reported in 1958.

Litharge.—Battery makers continued to claim most of the litharge shipped to industry; chrome pigments received 4 percent, varnish 4 percent, oil refining 3 percent, rubber 1 percent, and the remaining 88 percent was classified as "Other" which consisted of storage batteries, ceramics, insecticides, floor covering, driers, friction materials, lead chemicals, and unspecified uses.

Battery makers produced 120,000 tons of leaded litharge, commonly termed black or gray suboxide, for making the paste used in filling the interstices of battery plates.

TABLE 21.—Distribution of white lead (dry and in oil) shipments,[1] by industries, in short tons

Industry	1949–53 (average)	1954	1955	1956	1957	1958
Paints	26,835	20,929	19,825	20,288	19,253	15,288
Ceramics	1,224	487	484	633	667	268
Other	4,106	[2] 4,155	[2] 5,266	[3] 4,777	[3] 3,654	[3] 2,804
Total	32,165	25,571	25,575	25,698	23,574	18,360

[1] Excludes basic lead sulfate; figures withheld to avoid disclosing individual company confidential data.
[2] Includes the following tonnages for plasticizers and stabilizers: 1954—1,133; 1955—1,355.
[3] Figures for plasticizers and stabilizers withheld to avoid disclosing individual company confidential data.

TABLE 22.—Distribution of red-lead shipments, by industries, in short tons

Industry	1949–53 (average)	1954	1955	1956	1957	1958
Paints	13,239	12,568	14,308	14,331	15,993	13,726
Storage batteries	14,827	12,062	11,998	9,953	(1)	(1)
Ceramics	799	1,207	667	1,483	(1)	(1)
Other	2,645	1,326	2,299	2,208	11,005	8,266
Total	31,510	27,163	29,272	27,975	26,998	21,992

[1] Included with "Other."

TABLE 23.—Distribution of litharge shipments, by industries, in short tons

Industry	1949–53 (average)	1954	1955	1956	1957	1958
Storage batteries	95,658	94,656	90,200	82,041	(1)	(1)
Ceramics	20,143	17,118	24,173	19,802	18,071	(1)
Chrome pigments	9,377	4,335	6,025	3,558	3,955	3,731
Varnish	4,741	4,162	5,206	3,571	3,227	3,223
Insecticides	5,345	2,501	2,521	(1)	(1)	(1)
Oil refining	5,340	3,775	3,853	3,523	[2] 3,359	2,598
Rubber	2,285	1,768	1,947	2,266	[2] 1,298	1,247
Floor coverings	690	596	803	(1)	(1)	(1)
Other	6,177	10,966	12,783	16,764	76,878	81,366
Total	149,756	139,877	148,511	131,525	[2] 106,788	92,165

[1] Included with "Other."
[2] Revised figure.

Prices.—The quoted price of white lead ranged from 16.50 to 17.75 cents a pound or $330 to $355 a ton; average value of shipments for dry white lead was $388 down $28 from 1957, the in oil variety was off $2 to $467 a ton. The quoted price of red lead ranged from 14.00 to 16.25 cents a pound ($280 to $325 a ton); average value of shipments for red lead was $289 off $65 from 1957. The quoted price of litharge ranged from 13.25 to 15.75 cents a pound ($265 to $315 a ton); average value of shipments for litharge was $277 off $44 from 1957.

Foreign Trade.—Imports of lead pigments and salts declined 7 percent in value and less than 1 percent in quantity, below 1957. Imports of white lead were nearly eight times greater than in 1957 and closely approached the 814-ton average for the period 1949–53. Imports of red lead and litharge declined 75 percent, and 5 percent, respectively, below 1957.

Exports of lead pigments and salts declined in value and quantity 9 and 1 percent, respectively, below 1957. Exports of lead arsenate increased 73 percent above 1957.

TABLE 24.—Value of lead pigments and salts imported into and exported from the United States

[Bureau of the Census]

	Imports for consumption			Exports		
	1956	1957	1958	1956	1957	1958
Lead pigments:						
White lead	$5,980	$25,508	$235,725	$199,528	$273,363	[1] $1,094,569
Red lead	30,706	60,040	13,243	147,617	242,166	
Litharge	[2] 1,388,733	1,794,078	1,509,165	758,978	888,586	
Other lead pigments	39,241	16,961	694	(3)	(3)	(3)
Total	[2] 1,464,660	1,896,587	1,758,827	(3)	(3)	(3)
Lead salts:						
Lead arsenate				575,745	231,495	412,411
Other lead compounds	65,610	15,003	10,770	22,874	18,332	(3)
Total	65,610	15,003	10,770	598,619	249,827	412,411
Grand total	[2] 1,530,270	1,911,590	1,769,597	(3)	(3)	(3)

[1] Beginning Jan. 1, 1958, exports not separately classified.
[2] Data known to be not comparable to other years.
[3] Data not available.

TABLE 25.—Lead pigments and salts imported for consumption in the United States

[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	
1949–53 (average)	814	62	529	37	7	18	46	$575,538
1954		2	596	28			86	[1] 169,477
1955		3	751	34	6		352	266,615
1956	20	113	5,371	78			269	[1] 1,530,270
1957	92	258	8,118	33	1		63	1,911,590
1958	724	64	7,712		2		55	1,769,597

[1] Data known to be not comparable with other years.

TABLE 26.—Lead pigments and salts exported from the United States

[Bureau of the Census]

Year	Short tons					Total value
	White lead	Red lead	Litharge	Lead arsenate	Other lead compounds	
1949-53 (average)	755	606	1,296	309	41	$1,152,930
1954	951	335	1,284	355	31	1,056,754
1955	957	325	1,459	540	33	1,212,731
1956	654	352	2,000	1,282	28	1,704,742
1957	812	622	2,502	608	17	1,653,942
1958		[1] 3,446		1,050	(2)	1,506,980

[1] Beginning Jan. 1, 1958, not separately classified.
[2] Data not available.

STOCKS

Producers' Stocks.—Stocks of lead at primary producing plants, which in 1957 had reached the highest point since the beginning of the survey in 1943, increased by 90,400 tons or 63 percent in 1958. Although small gains occurred in stocks of antimonial lead and lead in bullion and stocks of lead in ore decreased, over 100,000 tons of refined lead was added to inventories during the year. These data represent physical inventories at the plants, irrespective of ownership, and do not include material in process or in transit. The American Bureau of Metal Statistics data show an additional 1,800 tons of bullion in transit to refineries, 19,700 tons of bullion in process at refineries and about 35,000 tons of ore in process at smelters—a total of nearly 300,000 tons of primary raw materials in stock at these plants.

Consumers' Stocks.—Consumers' and secondary smelters' stocks of lead decreased 5 percent with all classes of lead contributing to the decrease.

TABLE 27.—Stocks of lead at primary smelters and refineries in the United States at end of year, in short tons

	1949-53 (average)	1954	1955	1956	1957	1958
Refined pig lead	40,935	78,928	21,871	30,237	74,194	176,098
Lead in antimonial lead	9,221	13,253	9,084	10,740	11,079	11,811
Lead in base bullion	11,859	14,934	15,585	11,141	8,855	9,485
Lead in ore and matte	45,238	29,924	42,903	44,925	49,788	36,896
Total	107,253	137,039	89,443	97,043	143,916	234,290

TABLE 28.—Consumer stocks of lead in the United States at end of year, 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
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
1958	76,924	37,511	----------	7,056	1,409	----------	122,900

[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 was 13 cents a pound on January 1 and also on December 31. However, 11 changes during the year reduced the price to 10.75 cents on August 13 and subsequent raises increased it again to 13 cents on October 14 where it held through the remainder of the year. The average for the year was 12.11 cents.

Quotations on the London Metal Exchange varied from £67⅞ per long ton on August 21 (equivalent to 8.50 cents a pound U.S. currency, computed on the average monthly rate of exchange) to a high of £77¾ (9.76 cents a pound) on June 19. The bid quotation on December 31 was £71¾ a long ton (9.11 cents a pound) and the average for the year £72.80 (9.13 cents a pound).

TABLE 29.—Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, in cents per pound [1]

Month	1957			1958		
	St. Louis	New York	London [2]	St. Louis	New York	London [2]
January	15.80	16.00	14.51	12.80	13.00	9.06
February	15.80	16.00	14.13	12.80	13.00	9.32
March	15.80	16.00	14.10	12.80	13.00	9.40
April	15.80	16.00	13.93	11.80	12.00	9.16
May	15.18	15.38	12.39	11.51	11.71	9.07
June	14.12	14.32	11.42	11.04	11.24	9.20
July	13.80	14.00	11.28	10.80	11.00	8.95
August	13.80	14.00	11.39	10.65	10.85	8.81
September	13.80	14.00	11.17	10.69	10.89	8.83
October	13.49	13.69	10.74	12.47	12.67	9.28
November	13.30	13.50	10.41	12.80	13.00	9.47
December	12.80	13.00	9.17	12.80	13.00	9.04
Average	14.46	14.66	12.05	11.91	12.11	9.13

[1] St. Louis: Metal Statistics, 1959, p. 497. New York: Metal Statistics, 1959, p. 491. 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

Imports.—For the fourth consecutive year, lead imports increased markedly. Lead imported in ore, intermediate smelter products and in pigs, bars, and scrap totaled 577,100 tons—9 percent more than the 1957 quantity. There was a 2-percent increase in imported ores and concentrates, 14 percent increase in pigs and bars and a fivefold rise in lead bullion entries. However, scrap imports dropped 29 percent.

Two-thirds of the total imports was in pigs and bars, 33 percent of which came from Mexico, 22 percent from Australia, 12 percent from Peru, and 11 percent from Canada. Twenty-two percent represented small entries from many countries. Except for relatively minor quantities of lead bullion and scrap, the remaining one-third of United States lead imports was in ore and concentrates. Peru supplied 35 percent, Union of South Africa 24 percent, Australia 13 percent, Canada 11 percent, and many other countries collectively supplied the remaining 17 percent.

Exports.—Exports of lead, as in prior years, were very small.

Tariff.—In September 1957 the Emergency Lead-Zinc Committee, representing domestic mining groups, petitioned the United States Tariff Commission for restrictive regulation of imports, claiming that concessions made by the United States under the GATT agreements had caused an excessive influx of imports that threatened serious injury to the domestic industry. Formal public hearings were held by the Commission in November and investigations continued until April 1958. The Commission unanimously found evidence of injury but members differed 3–3 in recommended remedial measures. Acting on the Tariff Commissions finding, President Eisenhower, on September 22, proclaimed import quotas effective October 1, 1958. The quotas limited competitive imports per quarter to 33,080 tons of lead in ores and 55,600 tons as metal. Tariff duties remained unchanged at $1\frac{1}{16}$ cents a pound for pig lead and $\frac{3}{4}$ cent a pound for lead content of ore and concentrate.

TABLE 30.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, in short tons, in terms of lead content [1]

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
Ore, flue dust and matte:						
North America:						
Canada-Newfoundland and Labrador	15,664	40,593	33,090	30,692	25,193	22,264
Greenland						5,276
Guatemala	3,287	2,686	5,208	6,904	[2] 8,965	5,019
Honduras	588	1,636	2,757	2,969	2,955	3,581
Mexico	3,940	2,167	2,201	3,866	3,835	1,786
Other North America	285	(3)	3	8	113	45
Total	23,764	47,082	43,259	44,439	[2] 41,061	37,971
South America:						
Bolivia	18,176	14,946	13,812	17,177	18,319	14,715
Chile	2,897	173	409	118	35	367
Colombia	72	356	546	1,440	(3)	851
Peru	21,796	38,734	44,223	55,174	[2] 55,756	70,782
Other South America	260	110	82	184	1,079	145
Total	43,201	54,319	59,072	74,093	[2] 75,189	86,860
Europe	104	696		24	264	246
Asia:						
Philippines	1,489	2,160	2,635	2,222	783	1,169
Other Asia	267			422	246	317
Total	1,756	2,160	2,635	2,644	1,029	1,486
Africa:						
Union of South Africa	20,970	35,507	41,575	44,208	43,916	49,215
Other Africa	2,408	19			25	1
Total	23,378	35,526	41,575	44,208	43,941	49,216
Oceania: Australia	11,172	21,478	30,938	31,044	36,995	25,849
Total ore, flue dust and matte	103,375	161,261	177,479	196,452	[2] 198,479	201,628
Base bullion:						
North America	252			31		8
South America	95	41			84	452
Europe	(3)					
Asia	184				(3)	
Oceania	1,349					
Total base bullion	1,880	41		31	84	460

See footnotes at end of table.

TABLE 30.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, in short tons, in terms of lead content [1]—Continued

Country	1949–53 (average)	1954	1955	1956	1957	1958
Pigs and bars:						
North America:						
Canada-Newfoundland and Labrador	74,919	59,887	34,453	16,220	28,607	40,926
Mexico	144,755	68,695	93,369	77,541	102,504	122,864
Other North America	46	20			(3)	
Total	219,720	128,602	127,822	93,761	131,111	163,790
South America:						
Peru	38,505	20,047	24,509	33,540	34,999	42,473
Other South America	173				1,601	146
Total	38,678	20,047	24,509	33,540	36,600	42,619
Europe:						
Belgium-Luxembourg	902	339	231	1,206	1,852	5,872
Germany [4]	5,554	799	496	168	1,550	3,118
Spain	1,190	5,580	10,649	6,700	3,119	14,237
United Kingdom	1,211	2,386	47	115	2,666	8,836
Yugoslavia	41,885	38,465	35,659	38,901	40,262	36,789
Other Europe	2,230	4,058	2,351	2,162	2,584	2,139
Total	52,972	51,627	49,433	49,252	52,033	70,991
Asia	2,079	10	55			
Africa: Morocco	[5,6] 3,732	[5] 17,555	[5] 7,800	[5,7] 5,428	9,018	10,537
Oceania: Australia	41,189	58,445	54,530	80,673	95,517	80,515
Total pigs and bars	358,370	276,286	264,149	262,654	324,279	368,452
Reclaimed, scrap, etc.:						
North America:						
Canada-Newfoundland and Labrador	2,264	3,023	7,598	5,898	[2] 2,558	1,908
Mexico	968	1,298	6,120	9,701	2,583	1,939
Other North America	1,147	832	1,378	1,549	652	420
Total	4,379	5,153	15,096	17,148	[2] 5,793	4,267
South America:						
Peru	103	173	166	299	[2] 4	48
Venezuela	196		1,653	230		
Other South America	44				53	
Total	343	173	1,819	529	[2] 57	48
Europe:						
Belgium-Luxembourg	109		576	117		7
Denmark	12		282	1,000	84	
Germany [4]	191	56	3	348	168	
Netherlands	315		112	157		
Other Europe	528	213	567	179	32	
Total	1,155	269	1,540	1,801	284	7
Asia:						
Japan (including Nansei and Nanpo Islands)	3,674	[illegible]	2	4		19
Other Asia	607	47	24	1		
Total	4,281	60	26	5		19
Africa	99					
Oceania:						
Australia	1,959		2,099	1,255	3,079	2,229
Other Oceania	106					
Total	2,065		2,099	1,255	3,079	2,229
Total reclaimed, scrap, etc	12,322	5,655	20,580	20,738	[2] 9,213	6,570
Grand total	475,947	443,243	462,208	479,875	[2] 532,055	577,110

[1] Data are "general imports", that is, include lead imported for immediate consumption plus material entering the country under bond.
[2] Revised figure. [3] Less than 1 ton.
[4] West Germany, effective Jan. 1, 1952. [5] French Morocco.
[6] Includes 90 tons from Northern Rhodesia.
[7] Includes material classified by Bureau of the Census as being from Algeria but believed by Bureau of Mines to be from French Morocco.

TABLE 31.—Total lead imported for consumption in the United States in ore, matte, base bullion, pigs, bars, reclaimed and sheets, pipe, and shot, by countries, in short tons, in terms of lead content

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
Ore, flue dust and matte:						
North America:						
Canada-Newfoundland and Labrador	10,165	58,867	41,164	26,733	30,302	31,394
Greenland	----------	----------	----------	----------	----------	5,276
Guatemala	3,038	2,765	2,916	5,613	12,129	4,944
Honduras	277	1,330	699	3,018	6,108	3,811
Mexico	3,568	3,237	1,592	2,829	6,602	3,167
Other North America	285	----------	1	1	16	12
Total	17,333	66,199	46,372	38,194	55,157	48,604
South America:						
Bolivia	15,775	16,955	9,131	19,771	14,874	22,501
Chile	4,860	3,235	5,654	2,957	1,758	88
Colombia	13	207	409	852	1,000	850
Peru	18,070	33,348	42,280	58,363	50,506	92,072
Other South America	323	944	121	152	676	465
Total	39,041	54,689	57,595	82,095	68,814	115,976
Europe	88	696	----------	24	----------	21
Asia:						
Philippines	1,489	2,160	2,635	2,227	816	1,169
Other Asia	276	61	----------	187	308	311
Total	1,765	2,221	2,635	2,414	1,124	1,480
Africa:						
Union of South Africa	14,744	48,796	28,008	35,417	65,289	41,386
Other Africa	2,455	9	7	----------	25	1
Total	17,199	48,805	28,015	35,417	65,314	41,387
Oceania:						
Australia	9,141	23,444	21,816	32,999	44,207	33,829
Other Oceania	21	----------	----------	159	----------	----------
Total	9,162	23,444	21,816	33,158	44,207	33,829
Total ore, flue dust, and matte	84,588	196,054	156,433	191,302	234,616	241,297
Base bullion:						
North America	220	----------	----------	31	----------	8
South America	30	41	----------	----------	25	408
Europe	(1)	----------	----------	----------	----------	----------
Asia	184	----------	----------	----------	----------	----------
Oceania	761	----------	----------	----------	----------	----------
Total base bullion	1,195	41	----------	31	25	416
Pigs and bars:						
North America						
Canada-Newfoundland and Labrador	74,919	59,887	34,453	16,220	28,607	40,926
Mexico	141,509	66,695	93,313	76,242	99,208	117,938
Other North America	93	20	----------	----------	----------	----------
Total	216,521	126,602	127,766	92,462	127,815	158,864
South America:						
Peru	38,461	20,047	24,393	33,540	34,999	42,533
Other South America	173	----------	----------	----------	1,601	146
Total	38,634	20,047	24,393	33,540	36,600	42,679
Europe:						
Belgium-Luxembourg	902	339	231	1,206	1,852	4,604
Denmark	----------	3,902	2,296	1,389	1,916	1,452
Germany [2]	5,554	799	496	168	1,550	3,008
Spain	1,190	5,580	10,649	6,700	3,119	9,505
United Kingdom	1,211	2,386	47	115	2,666	8,556
Yugoslavia	41,885	38,465	35,659	38,901	40,262	36,789
Other Europe	2,226	156	55	773	667	507
Total	52,968	51,627	49,433	49,252	52,032	64,421
Asia	2,023	10	55	----------	----------	----------

See footnotes at end of table.

TABLE 31.—Total lead imported for consumption in the United States in ore, matte, base bullion, pigs, bars, reclaimed and sheets, pipe, and shot, by countries, in short tons, in terms of lead content—Continued

Country	1949–53 (average)	1954	1955	1956	1957	1958
Pigs and bars—Continued						
Africa:						
Morocco	[3] 3,642	[3] 17,555	[3] 7,800	[3][4] 5,428	9,018	9,760
Other Africa	164	---	---	849	726	---
Total	3,806	17,555	7,800	6,277	9,744	9,760
Oceania: Australia	41,189	58,445	54,530	80,673	95,517	76,035
Total pigs and bars	355,141	274,286	263,977	262,204	321,708	351,759
Reclaimed, scrap, etc.:						
North America:						
Canada-Newfoundland and Labrador	2,295	3,023	7,598	5,881	2,558	1,787
Mexico	968	1,298	6,120	10,109	4,000	2,433
Other North America	1,129	938	1,412	1,542	645	228
Total	4,392	5,259	15,130	17,532	7,203	4,448
South America:						
Peru	122	173	166	299	4	274
Venezuela	196	---	1,653	230	---	---
Other South America	147	---	---	---	53	34
Total	465	173	1,819	529	57	308
Europe:						
Belgium-Luxembourg	109	---	576	117	---	7
Denmark	12	---	282	1,000	84	---
Germany [2]	191	56	3	348	168	278
Netherlands	315	---	112	157	---	---
Other Europe	528	213	567	179	32	172
Total	1,155	269	1,540	1,801	284	457
Asia	4,422	60	26	4	---	19
Africa	99	---	---	---	---	---
Oceania:						
Australia	1,301	1,456	375	598	32	3,387
Other Oceania	94	---	54	---	---	---
Total	1,395	1,456	429	598	32	3,387
Total reclaimed, scrap, etc.	11,928	7,217	18,944	20,464	7,576	8,619
heets, pipe, and shot:						
North America:						
Canada	59	241	321	136	101	252
Canal Zone	---	---	---	---	19	---
Mexico	---	63	1,295	6,830	4,770	559
Total	59	304	1,616	6,966	4,890	811
South America	14	---	---	---	---	---
Europe	89	93	432	688	1,027	1,813
Asia	4	---	---	---	---	1
Total sheets, pipe, and shot	166	397	2,048	7,654	5,917	2,625
Grand total	453,018	477,995	441,402	481,655	569,842	604,716

[1] Less than 1 ton. [2] West Germany, effective Jan. 1, 1952.
[3] French Morocco.
[4] Includes material classified by the Bureau of the Census as being from Algeria but believed by the Bureau of Mines to be from French Morocco.

TABLE 32.—Lead imported for consumption in the United States, by classes [1]

[Bureau of the Census]

Year	Lead in ores, flue dust or fume, and mattes, n.s.p.f.		Lead and base bullion		Pigs and bars		Sheets, pipe, and shot		Not otherwise specified value (thousand)	Total value (thousand)
	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)		
1949–53 (average)	84,588	$22,358	1,195	$400	355,141	$101,695	166	$74	$149	$127,494
1954	196,054	[2] 47,967	41	10	274,286	[2] 68,420	397	[2] 129	[2] 149	[2] 118,125
1955	156,433	[2] 38,143	------	------	263,977	73,032	2,048	535	[2] 164	[2] 115,805
1956	191,302	50,621	31	11	262,204	[2] 77,719	7,654	2,017	[2] 184	[2] 135,820
1957	[3] 234,616	[3] 62,284	25	8	[3] 321,708	[3] 85,146	5,917	1,377	[2] 360	[2] [3] 150,816
1958	241,297	51,707	416	136	351,759	71,404	2,625	596	446	125,730

[1] In addition to quantities shown (value included in total value), "reclaimed, scrap, etc.," imported as follows—1949–53 (average); 11.928 tons, $2,817,611; 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: [3] 7,576 tons,[2] [3] $1,640,902; 1958: 8,619 tons, $1,440,639.
[2] Data known to be not comparable with other years.
[3] Revised figure.

TABLE 33.—Miscellaneous products containing lead, imported for consumption in the United States

[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 (thousand)	Gross weight (short tons)	Lead content (short tons)	Value (thousand)
1949–53 (average)	2,015	1,241	$1,593	8,956	7,777	$3,122
1954	2,309	1,572	[1] 1,946	4,138	3,367	1,251
1955	2,286	1,283	[1] 1,911	14,579	13,213	4,379
1956	4,106	2,526	[1] 3,381	9,544	8,500	2,763
1957	3,502	2,100	[1] 3,049	5,275	4,858	1,527
1958	4,244	2,049	4,677	5,170	4,525	1,190

[1] Data known to be not comparable with other years.

TABLE 34.—Total lead exported from the United States in ore, matte, base bullion, pigs, bars, anodes and scrap, by destination, in short tons [1]

[Bureau of the Census]

Destination	1949–53 (average)	1954	1955	1956	1957	1958
Ore, matte, base bullion (lead content):						
North America:						
Canada	836	18	12	6	54	
Mexico			1,322	1,049	851	912
Total	836	18	1,334	1,055	905	912
Europe	(2)					30
Asia		84			1	70
Total ore, matte, base bullion	836	102	1,334	1,055	906	1,012
Pigs, bars, anodes:						
North America:						
Canada	106	18	13	38	266	19
Cuba	51	23	36	44	62	33
Mexico	5	34	16	2	18	4
Other North America	113	89	25	53	136	79
Total	275	164	90	137	482	135
South America	696	202	167	306	194	96
Europe	70	2	13	2,128	560	3
Asia:						
Japan	7			1,176	2,305	
Nansei and Nanpo			5	5	16	7
Philippines	172	192	96	180	451	427
Other Asia	283	34	32	690	330	691
Total	462	226	133	2,051	3,102	1,125
Africa	7	2		6	1	
Oceania	(2)					(2)
Total pigs, bars, anodes	1,510	596	403	4,628	4,339	1,359
Scrap:						
North America	77	370	1	11		5
South America		(2)				
Europe:						
Belgium-Luxembourg	79	103	754	20		
Germany	90	[3] 29	[3] 495	[3] 563	[3] 264	[3] 292
Netherlands			148	788	304	157
United Kingdom	725	1,060	880	554	125	382
Other Europe		318	219	14	55	178
Total	894	1,510	2,496	1,939	748	1,009
Asia:						
Japan	167	2,014	486	186	137	
Other Asia	2					1
Total	169	2,014	486	186	137	1
Total scrap	1,140	3,894	2,983	2,136	885	1,015
Grand total	3,486	4,592	4,720	7,819	6,130	3,386

[1] In addition foreign lead was reexported as follows: ore, matte, base bullion 1949–53 (average): 1 ton 1954: none; 1955: 3 tons; 1956: 6 tons; 1957: 4 tons; 1958: none. Pigs, bars, anodes, 1949–53 (average): 188 tons: 1954–55 none; 1956: 50 tons; 1957: 300 tons; 1958: 25 tons. Scrap: 1949–53 (average) 1 ton; 1954: 121 tons; 1955–58: none.
[2] Less than 1 ton.
[3] West Germany.

WORLD REVIEW [6]

NORTH AMERICA

Canada.—Although mine output of lead in 1958 rose slightly to total 185,800 tons, refinery production dropped from 144,000 to 135,000 tons. Exports of lead in ores and concentrates totaled 54,100 tons;

[6] When zinc or copper were coproducts with lead, additional information on mines and countries may be found in the Zinc and Copper chapters of the Minerals Yearbook 1958.

exports of pig lead, 92,400 tons. Though the volume of exports rose 11 percent, lower market prices caused a 12 percent drop in value.

The Consolidated Mining & Smelting Co. of Canada, Ltd., as in previous years, was the largest Canadian producer of lead. Ores from the British Columbia company-owned Sullivan, H. B., and Bluebell mines, together with a quantity of purchased concentrates yielded 134,827 tons of lead.[7] Other lead producers in British Columbia included Reeves-McDonald Mines, Ltd., at Remac and Sheep Creek Mines, Ltd., at Nelson. Yale Lead & Zinc Mines, Ltd., at Ainsworth closed late in the year but continued exploration below the mine's lowest level.

Buchans Mining Co., Ltd., continued to operate its mine near Red Indian Lake, Newfoundland. The mill treated approximately 380,000 tons of lead-zinc-copper ore. Sinking the new concrete-lined McLean shaft continued throughout the year.

United Keno Hill Mines, Ltd., operated the Hector and Calumet mines in the Mayo district of Yukon Territory. In addition to high silver and zinc values, the ore assayed approximately 6 percent lead.[8]

The copper-lead-zinc mine of Heath Steele Mines, Ltd., near Newcastle, New Brunswick was put on a stand-by basis in May after only 15 months of operation owing to low demand for metal. The 7 million-ton deposit averages 2.4 percent lead, 5.9 percent zinc, 1.2 percent copper and several ounces of silver per ton.[9]

The Brunswick Mining & Smelting Corp., Ltd., which holds extensive deposits of lead-zinc-copper-silver ore in northern New Brunswick, discontinued metallurgical research and shaft sinking April 1, 1958.[10]

Mexico.—American Smelting and Refining Co. operated its Mexican mines throughout 1958. Lead concentrates were smelted at com-

TABLE 35.—World mine production of lead (content of ore), by countries, in short tons [1 2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada [3]	169,250	218,495	202,762	188,854	181,484	185,770
Cuba	13		88	120	90	[4] 70
Greenland				5,000	8,000	[4] 9,400
Guatemala	4,568	2,607	5,084	8,967	12,535	8,788
Honduras	549	1,286	1,961	2,315	[5] 2,955	3,380
Mexico	253,947	238,788	232,383	220,029	236,860	222,582
United States [3]	392,341	325,419	338,025	352,826	338,216	267,377
Total	820,668	786,595	780,303	778,111	780,140	697,367
South America:						
Argentina	20,534	22,300	26,500	31,250	34,200	33,000
Bolivia (exports) [3]	31,271	20,092	21,070	22,687	28,948	25,149
Brazil [6]	2,924	3,026	4,028	4,896	7,330	[4] 6,600
Chile	5,144	3,300	3,300	3,190	3,237	2,848
Ecuador	191	121	929			
Peru	92,634	121,327	130,900	142,281	151,184	133,877
Total	152,698	170,166	186,727	204,304	224,899	201,474

See footnotes at end of table.

[7] Consolidated Mining and Smelting Co. of Canada, Ltd., 53rd Annual Report, 1958, pp. 3–4.
[8] Mining Magazine (London), vol. 100, No. 3, March 1959, p. 163.
[9] American Metal Climax, Inc., 1958, Annual Report, p. 18.
[10] St. Joseph Lead Co., 1958, Annual Report, p. 11.

TABLE 35.—World mine production of lead (content of ore), by countries, in short tons [1] [2]—Continued

Country	1949–53 (average)	1954	1955	1956	1957	1958
Europe:						
Austria	5,211	5,432	5,286	5,281	5,969	6,012
Bulgaria	33,050	53,800	53,250	63,600	69,600	[4] 77,900
Czechoslovakia [4]	1,200	3,300	5,500	6,600	6,600	6,600
Finland	203	291	853	1,554	2,623	2,432
France	12,835	12,346	10,063	9,780	11,758	13,600
Germany:						
East [4]	2,900	5,500	6,600	6,600	6,600	6,600
West	55,538	74,171	74,334	72,181	78,392	67,146
Greece [7]	4,960	5,900	9,500	11,400	16,200	15,500
Ireland	960	1,511	2,931	2,560	2,240	412
Italy	42,968	47,400	56,100	53,200	59,300	61,700
Norway	416	778	783	887	990	2,351
Poland [6]	27,000	35,200	37,700	38,800	39,400	39,400
Portugal	1,609	1,931	1,614	1,365	1,518	[4] 1,650
Rumania [4] [6]	9,502	11,600	12,200	13,200	13,200	13,200
Spain	45,411	61,002	68,994	66,765	70,360	74,245
Sweden	24,779	32,731	35,459	36,097	40,200	46,594
U.S.S.R. [4]	[6] 147,140	[6] 228,500	[6] 255,000	[6] 290,000	310,000	330,000
United Kingdom	5,438	9,736	8,336	8,139	9,069	[3] 4,505
Yugoslavia	88,417	92,735	99,297	96,257	99,304	99,034
Total [4]	509,500	683,900	743,800	784,300	843,300	868,900
Asia:						
Burma	[4] 3,150	15,680	18,879	17,456	16,366	20,620
China [4]	2,580	11,000	19,800	23,100	27,600	[8] 27,600
Hong Kong	172	220	220	110	80	20
India	1,502	2,391	2,948	3,183	3,666	4,356
Iran [4] [9]	[10] 12,070	13,300	19,900	18,700	18,700	18,700
Japan	15,218	25,176	28,852	32,545	39,533	40,248
Korea:						
North [4]	2,400	3,300	8,800	16,000	18,700	18,700
Republic of	96	91	753	1,600	1,016	1,343
Philippines	1,485	2,014	2,555	2,360	897	1,415
Thailand	1,509	5,463	5,862	4,419	3,346	1,032
Turkey	[4] 770	2,200	3,000	5,042	4,465	3,250
Total [4]	41,000	80,800	111,600	124,500	134,400	137,300
Africa:						
Algeria	4,012	11,564	11,645	11,281	11,497	10,717
Belgian Congo	54	184	91	[4] 110	[4] 220	
Egypt	143	143	143	132	280	[4] 220
French Equatorial Africa	2,872	3,833	3,673	3,316	2,034	3,611
Morocco:						
Northern Zone	465	515	900	670	897	} 102,410
Southern Zone	70,106	90,813	98,000	95,502	101,288	
Nigeria	23	10	18	49	504	546
Rhodesia and Nyasaland, Federation of: Northern Rhodesia [6]	14,719	16,800	17,975	17,024	16,800	14,196
South-West Africa [11]	49,247	[3] 77,146	100,707	[3] 89,100	[3] 88,763	[3] 83,796
Tanganyika (exports)	1,636	2,372	4,033	5,730	5,433	6,350
Tunisia	23,193	28,976	29,306	25,848	26,347	24,814
Uganda (exports)	25	61	90	128	17	90
Union of South Africa	604	181	564	911	1,223	36
Total	167,099	232,598	267,145	249,801	255,303	246,786
Oceania: Australia	254,144	319,046	331,458	335,423	373,256	366,252
World total (estimate)	1,945,000	2,270,000	2,420,000	2,480,000	2,610,000	2,520,000

[1] Data derived in part from United Nations Statistical Yearbook, Yearbook of the American Bureau of Metal Statistics, and annual issues of the Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London), and Metal Statistics (Metallgesellschaft) Germany.
[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] Recoverable.
[4] Estimate.
[5] U.S. imports.
[6] Smelter production.
[7] Includes lead content of zinc-lead concentrates.
[8] Data represents estimate of 1957 production; however, 1958 production was probably much greater.
[9] Year ended March 21 of year following that stated.
[10] Average for 1950–53.
[11] Includes lead content of lead-vanadium concentrates.

TABLE 36.—World smelter production of lead, by countries where smelted, in short tons [1] [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	165,799	166,379	149,795	149,262	144,017	134,827
Gutaemala	303	[3] 110		147		
Mexico	245,673	230,567	224,474	213,947	231,745	218,290
United States (refined)[4]	467,143	486,624	478,995	542,272	533,473	469,381
Total	878,918	883,680	853,264	905,628	909,235	822,498
South America:						
Argentina	20,619	28,700	19,800	26,800	28,600	35,300
Brazil	2,924	3,026	4,028	4,896	7,330	[3] 6,600
Chile		49	554			321
Peru	48,410	63,648	66,533	65,892	75,897	70,637
Total	71,953	95,423	90,915	97,588	111,827	112,858
Europe:						
Austria [5]	11,944	13,294	12,673	12,293	13,156	13,756
Belgium [5]	81,587	79,258	91,242	112,715	109,423	105,685
Bulgaria	2,900	5,034	5,612	6,600	21,300	28,700
Czechoslovakia [3]	5,950	8,800	8,800	9,900	9,900	9,900
France	60,387	68,877	76,465	73,179	81,345	77,871
Germany:						
East [3] [5]	112,700	33,000	33,000	33,000	33,000	33,000
West		121,504	118,593	128,417	151,945	147,985
Greece	2,924	3,042	2,776	3,814	3,987	3,638
Italy	38,050	40,758	46,845	43,118	43,703	52,912
Netherlands [3]	3,064	4,000				
Poland	27,000	35,200	37,700	38,800	39,300	[3] 39,300
Portugal	786	1,109	2,167	938	829	[3] 1,000
Rumania [3]	9,500	11,600	12,200	13,200	13,200	13,200
Spain	47,640	64,617	68,132	72,491	64,981	75,372
Sweden	14,174	22,147	23,397	25,553	27,421	36,539
U.S.S.R. [3]	147,140	228,500	255,000	290,000	320,000	340,000
United Kingdom [3]	4,608	7,600	6,800	7,200	7,800	4,400
Yugoslavia	68,795	73,556	83,348	83,509	86,536	92,904
Total [3]	639,100	821,900	884,800	954,700	1,027,800	1,076,200
Asia:						
Burma	3,666	12,258	21,378	21,889	21,816	19,611
China [3] [5]	5,700	16,500	14,300	14,300	17,600	[6] 17,600
India	1,099	2,005	2,502	2,797	3,556	3,735
Iran [7]	[8] 527	1,000	1,366	1,580	[3] 770	1,047
Japan	13,519	28,916	31,918	41,151	50,214	42,412
Korea:						
North [3]	1,400	3,300	8,800	16,000	18,700	18,700
Republic of	[3] 190	91				
Turkey [3]	265	1,650	1,750	2,000	2,000	1,650
Total [3]	26,400	65,700	82,000	99,700	114,700	104,800
Africa:						
Morocco: Southern Zone	21,829	29,418	29,421	30,991	34,441	36,513
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	14,719	16,800	17,975	17,024	16,800	14,196
Tunisia	26,174	29,972	30,123	27,357	29,669	31,548
Total	62,722	76,190	77,519	75,372	80,910	82,257
Oceania:						
Australia:						
Refined lead	180,421	224,459	209,591	218,500	215,516	214,451
Pb content of lead bullion	38,813	42,723	41,879	46,657	52,518	64,032
Total	219,234	267,182	251,470	265,157	268,034	278,483
World total (estimate)	1,900,000	2,210,000	2,240,000	2,400,000	2,510,000	2,480,000

[1] Data derived in part from United Nations Statistical Yearbook, Yearbook of the American Bureau of Metal Statistics, and annual issues of Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London), and Metal Statistics (Metallgesellschaft) Germany.

[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] Data represents estimate of 1957 production; however, 1958 production was probably much greater.

[7] Year ended March 21 of year following that stated.

Average for 1952–53.

pany plants at San Luis Potosi and Chihuahua, and lead bullion was refined at Monterrey.

Combined lead smelting and refining operations of Cia. Metalurgica Penoles, S.A. (a subsidiary of American Metal Climax, Inc.) at Torreon and Monterrey produced 82,000 tons of refined and antimonial lead—80 percent of production capacity.

In addition to zinc concentrate, Cia. Minera de Penoles, S.A., recovered 30,000 tons of lead concentrate from milling 338,000 tons of ore during the year. In July the company announced its intention to close the Ocampo mine owing to depletion of the ore.[11]

The Fresnillo Co. commenced sinking its new circular Fortuna shaft in June at Fresnillo, Zacatecas. The Mexican Government granted substantial tax aid applying to equipment and construction cost of the project. The shaft is to be bottomed at a depth of 3,000 feet and will develop an extensive area northwest of the present mine. In fiscal year ended June 30, 1958 the Fresnillo mine produced 520,000 tons of ore.[12]

San Francisco Mines of Mexico, Ltd., at San Francisco del Oro, Chihuahua during the year ended September 30, 1958, milled 857,500 tons of lead-zinc-copper-silver ore that yielded 57,100 tons of lead concentrate containing 38,000 tons of lead. The concentrate was smelted by Cia. Metalurgica Penoles, S.A. A breakdown in the North Shaft prevented hoisting at the Frisco mine for a 15-day period. Installation of the new and larger hoist was completed at the yearend. Ore reserves were increased by 0.5 million tons to total over 6 million tons.

Other significant lead producers in Mexico were El Potosi Mining Co. (subsidiary of Howe Sound Co.) which operated its El Potosi and El Carmen mines in Chihuahua and Minas de Iquala, S.A. (subsidiary of Eagle-Picher Co.) at Parral, Chihuahua.

SOUTH AMERICA

Argentina.—In addition to lead mined by Cia. Minera Aguilar S.A., Cia. Minera Castano Viejo, S.A., produced 96,500 tons of crude ore that yielded 7,700 tons of lead concentrate containing 6,100 tons of lead. Concentrate from the Castano Viejo mine was reduced at the National Lead Co. smelter at Puerto Villelas. In 1958 total output of the Puerto Villelas plant was 18,900 tons of pig lead, 40 tons of chemical grade lead, and 210 tons of antimonial lead—all derived from Argentine ores and all consumed by Argentine industry. Cia. Minera Los Marayes was reported producing zinc and lead concentrates from sulfide veins in La Blanca and El Azufre.

Bolivia.—COMIBOL, the State controlled mining organization, continued construction of a new sink-float plant in the vicinity of the San Jose mine. Mines having large production of lead were Tatasi, Animas, Telemayo, and San Jose.

Brazil.—Two lead smelters, one at Santa Amaro, the other at Nova Iguacu, State of Rio de Janeiro, were completed in 1958. The combined annual production capacity of 20,400 tons will supply nearly all Brazil's lead needs.[13]

Peru.—Although the volume of lead exports from Peru increased

[11] Work cited in footnote 9.
[12] The Fresnillo Co., Annual Report for the year ended June 30, 1958, p. 2.
[13] Mining World, Annual Survey and Directory, April 1959.

more than 12 percent, the value declined 15 percent owing to lower metal prices. Cerro de Pasco Corp. produced 70,636 tons of lead at its Oroya refinery.[14] Though this quantity was somewhat less than the 1957 output, the portion derived from company ores was considerably greater than in previous years. Increased output from Cerro de Pasco mines failed, however, to offset the decrease in custom ore shipments caused by shutdown of many uneconomic small mines. Mining and milling operations were begun at the Santander mine of Cia. Minerales Santander, Inc. The mill capacity was 500 tons a day and the ore reserve more than 4 million tons averaging 12 percent zinc, 2.5 percent lead, 0.5 percent copper, and 3 ounces of silver. Other significant lead producers in Peru were Cia. Minera Atacocha, S.A., Northern Peru Mining Corp., Chilete mine at Chilete, Hochschild and Cia. Esquilache mine, Compagnie des Mines de Huaron mine in Department of Pasco, Cia. Mineral Milpo and Volcan.

EUROPE

Austria.—The lead-zinc mines of Austria produced 207,200 tons of crude ore. Bleiberg-Bergwerks Union, Austria's dominant producer, treated lead concentrate derived from company ore together with quantities of domestic scrap lead to produce 12,100 tons of pig lead.

Bulgaria.—Output of refined lead was expected to rise to 33,000 tons by 1962, according to details of the third Five Year Plan (1958–62) published in Sofia. Bulk of the increase was planned to come from the newly developed ore bodies in the Rhodope mountains near the Greek border. Bulgarian reserves were estimated to be 50 million tons of ore.[15]

France.—Societe Miniere et Metalurgique de Penarroya announced plans for erection of a blast furnace similar to the type installed at Avonmouth, England, to treat mixed lead-zinc ores. Anticipated yearly output of lead bullion was 11,000 tons. The new smelter will be constructed at Noyelles-Godault and will be in addition to the company's existing two lead blast furnaces and horizontal retort zinc plant.[16] Development of deposits was started at Saint Sebastion d'Agrefeuille, which contain proved reserves of 3 million tons of ore.

Germany, West.—A decision was made to close Gewerkschaft Mechernick Werke lead mines near the German-Belgian border. An economic survey proved production cost to be higher than value of the lead produced.

United Kingdom.—In June the British Board of Trade announced suspension of sales of lead from its stockpile. Between January and June, 7,500 short tons were sold.[17]

Yugoslavia.—There was 1,980,000 tons of lead-zinc ore mined.[18] Refined lead production at the Zvecan smelter, produced from company-purchased ores, was 77,908 tons. The Mezica lead smelter in Slovenia had an output of 15,000 tons. The new Kisnica mine, south

[14] Cerro de Pasco Corp., Annual Report, 1958.
[15] Mining Journal (London), vol. 251, No. 6421, Sept. 12, 1958, p. 282.
[16] Mining World, vol. 20, No. 12, November 1958, p. 33.
[17] Metal Bulletin (London), No. 4304, June 20, 1958.
[18] Mining World, Annual Survey and Review, 1958, p. 142.

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of Trepca started production late in 1958. The ore averaged 6 percent lead and was milled at Trepca.

ASIA

Burma.—The Burma Corp., Ltd., continued to operate the Bawdwin lead-zinc-silver mine in northern Burma. For the year ended June 30, 1958, the company's refinery at Namtu, 13 miles from the mine, produced 15,200 tons of refined lead, 265 tons of antimonial lead, and 1,206,300 ounces of silver.

India.—Output of lead-zinc ores at the Zawar mine totaled 133,900 tons that yielded 5,775 tons of lead concentrate. Ore reserves are estimated to be 4.5 million tons averaging 2 percent lead and 5.7 percent zinc.

Iran.—Development and modernization of mines and milling methods was in progress in the Golpayeyan area southwest of Tehran. The previously hand-sorted lead and zinc ore has been sold to the U.S.S.R. Iranian, French, and German organizations were interested in the properties.

Japan.—Mitsui Mining & Smelting Co., Ltd., operated its Kamioka mine throughout the year, producing approximately 850,000 tons of lead-zinc ore. The mills produced a 69-percent lead concentrate that was smelted at Kamioka in a blast furnace to produce impure lead anodes that in turn were electrolyzed by the Betts method. The 58.4-percent zinc concentrate was refined at Kamioka, Miike and Hikoshima plants.[19]

AFRICA

Algeria.—Algeria exported 14,850 tons of lead concentrate containing 8,910 tons of lead. Of the total exports France received 72 percent, Tunisia 18 percent, and West Germany 10 percent.

Morocco.—Production of lead concentrate was 151,000 tons having a 70-percent average metal content.

Rhodesia and Nyasaland, Federation of.—The Rhodesia Broken Hill Development Co., Ltd.[20] mined 164,000 tons of crude lead-zinc ore that yielded 20,095 tons of concentrate containing 15,550 tons of lead. Output of refined lead at the company smelter was 14,200 tons. Production of retort bullion amounted to 56,600 pounds containing 154,500 troy ounces of silver. Early in the year the company closed its new lead smelter and reopened the old one in an effort to cut cost and improve efficiency at a reduced level of output.

South-West Africa.—The Tsumeb Corp., Ltd., mined and milled 660,000 tons of ore averaging 25.7 percent combined copper, lead, and zinc during the year ended June 30, 1958. The reserve above the 30th level was estimated at 8,850,000 tons averaging 5.41 percent copper, 13.97 percent lead, and 4.33 percent zinc. Drilling at the nearby Asis claim indicated additional lead reserves. Tsumeb sold 72,540 tons of lead during the year.[21]

Tunisia.—Approximately 39,200 tons of lead concentrates containing 24,800 tons of lead was produced. Production of base bullion at the country's two lead smelters totaled 31,550 tons.

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[19] Mitsubishi Metal Mining Co., Ltd., Outline of the Company, pp. 2–12.
[20] The Rhodesia Broken Hill Development Co., Ltd., 49th Annual Report, 1958.
[21] American Metal Climax, Inc., 1958, Annual Report, p. 30.

OCEANIA

Australia.—For the second consecutive year Australia was the leading lead-producing country in the world. Mine production totaled 366,300 tons of which 214,000 tons was refined at local smelters. Approximately 65,000 tons of lead in base bullion was exported to the United Kingdom. Sales of Australian lead to local consumers totaled 44,000 tons. Approximately 178,000 ton of refined lead was exported, chiefly to the United States and the United Kingdom.

The Broken Hill district in New South Wales continued to be the leading Australian lead-producing district. Combined output of the four companies operating in the district—New Broken Hill Consolidated, Ltd.; Zinc Corp., Ltd.; Broken Hill South, Ltd.; and North Broken Hill, Ltd.—totaled 2,050,000 tons of crude ore that yielded lead concentrates containing 250,000 short tons of lead.

In the fiscal year ended June 30, 1958, Mount Isa Mines, Ltd., produced 1,854,000 tons of crude ore from its Cloncurry district mines in Queensland. The ore yielded 57,075 tons of lead bullion that contained 4,256,000 ounces of silver. Copper and zinc concentrates were also produced from treatment of Mount Isa ore.[22]

The Lake George Mines, Pty., Ltd., produced 18,298 tons of lead concentrate from ores of the Captain's Flat district of New South Wales.[23] The mill processed 235,600 tons of crude ore during the fiscal year ended June 30, 1958 and, in addition to lead, recovered zinc and copper concentrates.

Electrolytic Zinc Co. of Australasia, Ltd., continued to operate its mines in the Read-Roseberry district on the west coast of Tasmania.[24] For the fiscal year ended June 30, 1958, the mines produced 235,000 short tons of ore that yielded 89,765 tons of lead, zinc, and copper concentrates.

TECHNOLOGY

Lead producers in the United States, Canada, Mexico, Great Britain, Australia, and South America cooperated financially in an accelerated research program on lead metal and lead compounds to find new uses for these materials. Projects begun included research on the use of lead in ceramics, lead cable sheathing, heat emissive properties of the metal, lead alloys, the semiconductor properties of lead compounds and also lead as a shielding material for nuclear reactors.

Knapp Mills[25] of New York, N.Y., developed an automatic lead cladding device for applying lead metal to a steel surface. Essentially the process consists of laying strips of lead metal on the steel to be coated then traversing the length of the strip with an automatically traveling nozzle (1 foot per minute) ejecting flame which melts the lead. The molten lead forms a metallurgical bond with the steel. Lead so bonded to steel is said to have no creep problem, and is able to withstand temperatures up to 500° F. Consolidated Mining & Smelting Co. of Canada, Ltd., which solved one of its plant problems with this technique, reported that the process is lower in cost ($3.50 to $5 a square foot) than other methods and that relatively

[22] American Smelting and Refining Co., Annual Report, 1958, 14 pp.
[23] Lake George Mining Corp., Ltd., Annual Report, 1958, 13 pp.
[24] Industrial and Mining Standard, vol. 113, No. 2870, Dec. 4, 1958, pp. 22–23.
[25] Chemical Engineering, Automatic Lead Cladding Slashes Costs: Vol. 65, No. 13, June 30, 1958, pp. 122, 124, 126.

unskilled labor can do a lead cladding job about eight times faster than by the hand cladding process.

A new method and plant for pelletizing and sintering lead concentrate of 70 to 80 percent lead content was reported.[26] The method, in operation at the lead plant of the Rönnskär Works, Skelleftehamm, Sweden, consists of applying on cores of return sinter concentric layers of concentrate and other charge ingredients, then roasting with one-pass-sintering to a sulfur content suitable for electrothermic roast-reactor-smelting.

The Bureau of Mines Laboratory[27] at Reno, Nev. worked out a method for obtaining high recovery of lead, gold, and silver from a lead ore found to contain magnesia and arsenic and unamenable to conventional methods of concentrating and extracting. In this method a mixture of the ore and calcium chloride dihydrate is roasted for 1 hour at 1,000° C. Ninety-nine percent of the lead, 98 percent of the gold, 96 percent of the silver, but only 6 percent of the arsenic were volatilized.

Lead zirconate-titanate,[28] a polycrystalline piezoelectric material comprises the heart of a new stereophonic record playing cartridge expected to revolutionize the record playing industry. Properties which make it desirable for stereophonic use are principally its better electrical output, greater compliance, and greater mechanical damping ability.

Patents were issued on processes for making hydrocarbon lead compounds by reacting a lead chalkogen [29] or a lead halide [30] from the group consisting of oxygen and sulfur with a stable hydrocarbon-metal compound having up to 10 carbon atoms inclusive in each hydrocarbon radical.

After 9 years of testing, a basic lead silicochromate pigment[31] was introduced to the paint industry by the National Lead Co. The pigment consists essentially of a fusion of basic lead chromate and silica on a silica core. The pigment is said to be readily susceptible to tinting and is resistant to chalking.

A fixed-resistance method of high discharge was reported[32] to provide an adequate field test of lead-acid storage batteries.

A quarternary alloy of lead-antimony-tin-silver for use in lead-acid batteries was reported[33] as providing the best compromise between alloy grids with good growth characteristics and those with good corrosion characteristics.

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[26] Wallden, S. J., Lindvall, N. B., and Gorling, K. G., Sinter Roasting of Lead-Rich Galena Concentrates at the Electrothermic Lead Plant of the Rönnskär Works, Sweden: Transactions of the Metallurgical Society of AIME, vol. 212, No. 2, April 1958, pp. 146–153.

[27] Engel, A. L., and Heinen, H. J., Chloride Volatilization of Oxidized Lead Ore from Eureka, Nev.: Bureau of Mines Rept. of Investigations 5409, 1958, 7 pp. Engineering and Mining Journal, Chloride Volatilization for Lead Ores Developed: Vol. 159, No. 9, September 1958, p. 133.

[28] American Metal Market, Lead is Heart of Stereophonic Hi-Fi; vol. 65, No. 170, Sept. 3, 1958, p. 6.

[29] Blitzer, Sidney M., and Pearson, Tillmon H. (assigned to Ethyl Corp., New York, N.Y.) Manufacture of Organolead Compounds: U.S. Patent 2,859,225, Nov. 4, 1958.

[30] Blitzer, Sidney M., and Pearson, Tillmon H. (assigned to Ethyl Corp., New York, N.Y.) Manufacture of Organolead Compounds: U.S. Patent 2,859,226, Nov. 4, 1958.

[31] Oil, Paint and Drug Reporter, Chrome Pigment has New Twist: Apr. 7, 1958, p. 4; American Metal Market, Eagle-Picher Co. Has a New Pigment in Chemical Line: Vol. 65, No. 113, June 12, 1958, p. 6.

[32] Derricotte, C. B., High Rate Discharge Characteristics of Lead-Acid Storage Batteries: Detroit Arsenal, October 1956, 27 pp. (Order PB 131498 from OTS, United States Department of Commerce, Washington 25, D.C., $0.75).

[33] Lander, J. J., Simon, A. C., and Jones, E. L., The Effect of Corrosion and Growth on the Life of Cycling Lead-Acid Cells: Naval Research Laboratory, March 1958, 18 pp. (Order PB 131588 from OTS, United States Department of Commerce, Washington 25, D.C., $0.50).

Lime

By C. Meade Patterson[1] and James M. Foley[2]

DURING 1958, 10 percent less lime was produced than in 1957, and 13 percent less than in the record year 1956. An outstanding development was the substantial growth in use of hydrated lime for stabilizing soil in highway and other construction.

TABLE 1.—Salient statistics of lime sold or used in the United States [1]

	1949–53 (average)	1954	1955	1956	1957	1958
Active plants	164	154	150	153	146	146
Sold or used by producers:						
By types:						
Quicklime ------ thousand short tons	4,222	5,128	6,113	5,967	5,942	5,538
Hydrated lime ------ do	1,885	1,980	2,238	2,186	2,081	2,014
Dead-burned dolomite ------ do	1,853	1,521	2,129	2,424	2,251	1,659
Total lime:						
Thousand short tons	7,960	8,629	10,480	10,577	10,274	9,211
Value [2] (thousands)	$91,378	$101,723	$127,144	$135,727	$135,323	$118,298
Average per ton	$11.48	$11.79	$12.13	$12.83	$13.17	$12.84
Total open-market lime thousand short tons	7,282	7,180	8,930	9,004	8,516	7,388
Total captive tonnage lime ------ do	[3] 678	1,449	1,550	1,573	1,758	1,823
Imports for consumption ------ do	33	36	40	42	50	26
Exports ------ do	64	73	82	83	65	46

[1] Includes Puerto Rico and Hawaii.
[2] Selling value, f.o.b. plant, excluding cost of containers.
[3] Incomplete figures; before 1954 the coverage of captive plants was only partial.

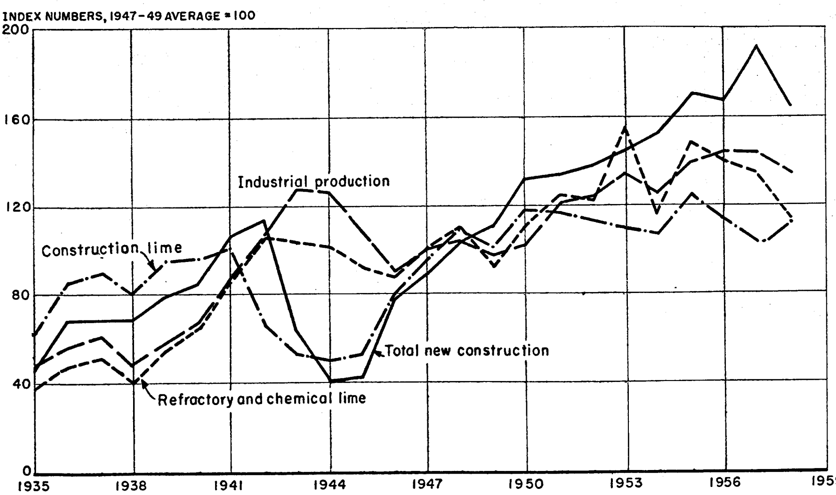

FIGURE 1.—Production of construction lime compared with physical volume of total new construction, and output of refractory and chemical lime compared with industrial production, 1935–58. Units are reduced to percentages of the 1947–49 average. Statistics on new construction from U.S. Department of Commerce and on industrial production from Federal Reserve Board.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

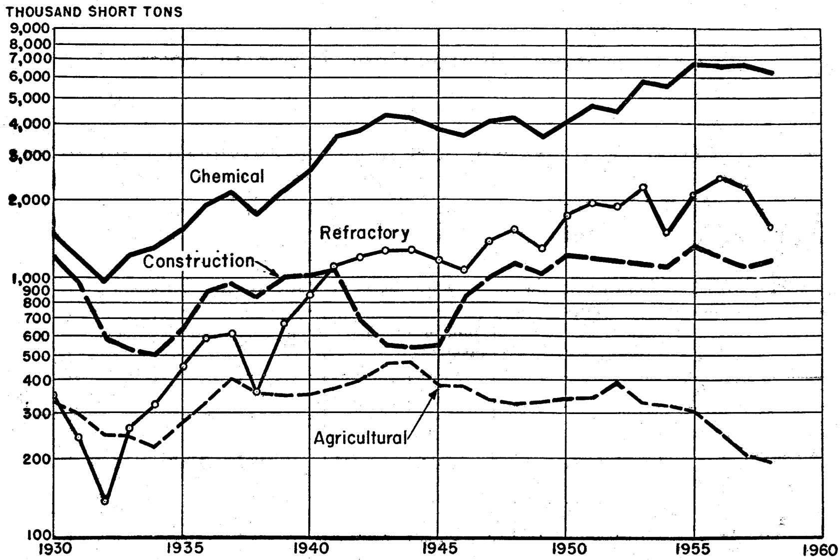

FIGURE 2.—Trends in major uses of lime, 1930–58.

DOMESTIC PRODUCTION

Lime production declined 10 percent from 1957 to 9.2 million short tons. Although open-market lime decreased 13 percent captive lime rose 4 percent. Twenty percent of the total lime production was captive, compared with 17 percent in 1957. All major use categories, except construction which increased 8 percent, showed slight to moderate declines.

Lime was produced in 34 States and in Puerto Rico. Ohio, Missouri, and Pennsylvania, in descending order, continued to be the three ranking lime-producing States, supplying 50 percent of the national total. The next five States, in descending order of production, were Texas, Illinois, Alabama, Virginia, and Michigan.

Colorado Lime Co., at Pikeview, Colo., 4 miles north of Colorado Springs, began producing quicklime in vertical kilns and hydrating some of it in January 1958. High-purity limestone was mined by room-and-pillar methods.

Round Rock White Lime Co., Round Rock, Tex., was engaged in a $750,000 expansion program to be completed early in 1959. Two new rotary kilns, preheaters, and coolers were expected to triple production to satisfy increased demand for lime in soil stabilization, water purification, and chemical industries.[3]

Lime was a byproduct of carbon dioxide manufacture at the West End Chemical Co.'s automatic, natural-gas-fired, rotary limekiln, Westend, Calif. The carbon dioxide was used to convert Searles Lake sodium sulfate to insoluble sodium bicarbonate.[4]

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[3] Rock Products, Lime Producer Triples Output: Vol. 61, No. 9, September 1958, p. 68.
[4] Chilton, C. H., Practice—Process Flowsheet, Crystallization—Key Step in Sodium Sulfate Process: Chem. Eng., vol. 65, No. 16, Aug. 11, 1958, pp. 116–119.

The Flintkote Co. of New York, one of the largest building materials companies in 1958, acquired Utah Lime & Stone Co., producer of chemical and industrial lime near Tooele, Utah, in a $1-million transaction.[5]

United States Lime Products Corp., Los Angeles, Calif., a subsidiary of The Flintkote Co., which had 55 plants, opened its new $2-million lime plant at Arrolime, near Las Vegas, Nev., May 23. Two 10- by 150-foot, completely instrumented, natural-gas-fired rotary kilns were expected to produce 400 tons of quicklime daily. Limestone was quarried from an adjacent high-calcium formation. This plant was needed to meet the rising demand for quicklime by metallurgical, paper, chemical, water-treatment, and construction industries throughout the Western States.[6]

TABLE 2.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States

State or commonwealth	1957			1958		
	Active plants	Short tons	Value	Active plants	Short tons	Value
Alabama	9	553, 552	$6, 271, 495	8	520, 170	$4, 660, 364
Arizona	5	138, 221	2, 126, 708	5	125, 851	1, 816, 678
Arkansas	2	(1)	(1)	2	(1)	(1)
California	5	325, 309	5, 407, 588	5	261, 807	4, 469, 723
Colorado	1	2, 500	45, 500	2	(1)	(1)
Connecticut	1	30, 341	503, 295	1	28, 996	464, 180
Florida	2	(1)	(1)	2	(1)	(1)
Hawaii	1	8, 469	270, 686	1	8, 106	260, 050
Illinois	6	(1)	(1)	5	(1)	(1)
Iowa	1	(1)	(1)	1	(1)	(1)
Louisiana	1	(1)	(1)	1	(1)	(1)
Maine	1	(1)	(1)	1	(1)	(1)
Maryland	3	(1)	(1)	3	(1)	(1)
Massachusetts	3	137, 284	2, 232, 731	3	139, 062	2, 120, 677
Michigan	3	(1)	(1)	4	(1)	(1)
Minnesota	1	(1)	(1)	1	(1)	(1)
Missouri	6	1, 392, 780	16, 475, 404	6	1, 172, 862	14, 136, 475
Montana	2	(1)	(1)	2	(1)	(1)
Nevada	3	(1)	(1)	4	(1)	(1)
New Jersey	1	(1)	(1)	2	(1)	(1)
New Mexico	1	23, 986	290, 231	1	21, 454	259, 593
New York	2	(1)	(1)	3	(1)	(1)
Ohio	18	2, 763, 128	38, 383, 106	18	2, 410, 504	32, 470, 838
Oklahoma	1	(1)	(1)	1	(1)	(1)
Oregon	1	(1)	(1)	1	(1)	(1)
Pennsylvania	23	1, 298, 401	18, 405, 823	22	1, 003, 058	12, 456, 548
Puerto Rico	2	(1)	(1)	2	(1)	(1)
South Dakota	1	(1)	(1)	1	(1)	(1)
Tennessee	3	93, 650	1, 134, 221	2	(1)	(1)
Texas	10	796, 394	7, 488, 795	9	690, 661	7, 146, 240
Utah	3	53. 360	821, 293	4	79. 640	1, 512, 565
Vermont	2	(1)	(1)	3	(1)	(1)
Virginia	10	510, 216	6, 029, 142	9	471, 313	5, 532, 833
West Virginia	5	(1)	(1)	4	(1)	(1)
Wisconsin	7	(1)	(1)	7	141, 287	2, 192, 649
Undistributed [1]		2, 146, 915	29, 436, 817		2, 136, 201	28, 798. 338
Total	146	10, 274, 506	135, 322, 835	146	9, 210, 972	118, 297, 751

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.

[5] Chemical and Engineering News, vol. 36, No. 27, 1958, p. 28.
Mining Congress Journal, vol. 44, No. 8, August 1958, p. 108.
Western Mining and Industrial News, vol. 26, No. 7, July 1958, p. 1.

[6] Engineering and Mining Journal, vol. 159, No. 8, August 1958, p. 190.
Mining Congress Journal, vol. 44, No. 8, August 1958, p. 107.
Mining World, vol. 20, No. 9, August 1958, p. 68.
Pit and Quarry, U.S. Lime Products Corp. Opens $2,000,000 Plant: Vol. 51, No. 1, July 1958, p. 23.
Rock Products, Flintkote Opens New Lime Plant in Nevada: Vol. 61, No. 8, August 1958, p. 50.
Rock Products, Preheater and Cooler Boost Lime Plant Efficiency: Vol. 61, No. 11, November 1958, pp. 90–92.
Intermountain Industry and Mining Review, U.S. Lime Products Corp.: Vol. 60, No. 9, September 1958, p. 47.

Basic, Inc., Cleveland, Ohio, closed its Clay Center (Ohio) rotary-kiln plant and moved the manufatcure of lime products to Gibsonburg, Ohio. Clay Center rotary kilns were maintained for dead-burning dolomite beyond the capacity of Basic's 11 other Ohio kilns.[7]

Since 1922, Ohio has been the Nation's leading lime producer. High-calcium lime came from the Silurian Brassfield formation of southwestern Ohio, the Devonian Columbus limestone of central Ohio, and the subsurface Mississippian Maxville limestone of southeastern Ohio. Dolomitic lime was produced from the Silurian Cedarville and Springfield and from the Devonian Monroe formations. Ohio premium lime was high-calcium chemical lime. Dolomitic lime was used in mortar, plaster, concrete, stucco, sand-lime brick, and dead-burned dolomite.[8]

Olin Mathieson Chemical Corp., Saltville, Va., recovered CO_2 and byproduct lime from limekilns. Total 1958 production of CO_2 was estimated at 887,500 short tons, of which 537,500 tons was solid and 350,000 tons liquid and gas. Annual capacity of all CO_2 plants was about 3 million tons, half solid and half liquid and gas.[9]

An estimated 82 vertical-kiln lime plants, 58 rotary-kiln lime plants, and 10 lime plants with both vertical and rotary kilns operated in the United States.[10]

TABLE 3.—Lime sold or used by producers in the United States,[1] by types and major uses, in short tons

	1957			1958		
	Sold	Used	Total	Sold	Used	Total
By type:						
Quicklime	6,650,584	1,543,204	8,193,788	5,545,874	1,651,021	7,196,895
Hydrated lime	1,865,548	215,170	2,080,718	1,842,357	171,720	2,014,077
Total lime	8,516,132	1,758,374	10,274,506	7,388,231	1,822,741	9,210,972
By use:						
Agricultural:						
Quicklime	69,382		69,382	76,150		76,150
Hydrated lime	139,218		139,218	119,975		119,975
Total	208,600		208,600	196,125		196,125
Construction:						
Quicklime	98,529	43,545	142,074	103,210	48,358	151,568
Hydrated lime	939,160	20,076	959,236	1,025,665	15,654	1,041,319
Total	1,037,689	63,621	1,101,310	1,128,875	64,012	1,192,887
Chemical and other industrial:						
Quicklime	4,250,964	1,479,940	5,730,904	3,725,442	1,584,551	5,309,993
Hydrated lime	787,170	195,094	982,264	696,717	156,066	852,783
Total	5,038,134	1,675,034	6,713,168	4,422,159	1,740,617	6,162,776
Refractory (dead-burned dolomite)	2,231,709	19,719	2,251,428	1,641,072	18,112	1,659,184

[1] Includes Hawaii and Puerto Rico.

[7] Pit and Quarry, Basic, Inc., Lime Operation Moved to Gibsonburg, Ohio: Vol. 51, No. 1, July 1958, p. 23.

[8] Ohio Division of Geological Survey, The Story of Ohio's Mineral Resources: Inf. Circ. 9, 1958, p. 7.

[9] Leonard, Jackson D., CO_2 A Steadily Growing Giant: Chem. Eng. News, vol. 36, No. 40, Oct. 6, 1958, pp. 114–118, 121.

[10] Rock Products, Electric Motors in the Rock Products Industry: Research Report R188–H508, August 1958, pp. 14–16.

CONSUMPTION AND USES

Sixty-seven percent of all lime produced in 1958 was used by chemical and industrial plants, 18 percent as refractory material, 13 percent in construction, and 2 percent in agriculture.

Quicklime and hydrated lime (excluding refractory lime or dead-burned dolomite) were used in three major fields—chemical and industrial processing, construction, and agriculture. Chemical and industrial uses consumed 81 percent of the total sold or used by producers, construction 16 percent, and agriculture 3 percent.

TABLE 4.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, by uses, in short tons

Use	1957			1958		
	Open-market	Captive	Total	Open-market	Captive	Total
Agriculture	208, 600	----------	208, 600	196, 125	----------	196, 125
Construction:						
Finishing lime	503, 108	4, 400	507, 508	525, 977	3, 533	529, 510
Mason's lime	437, 824	6, 529	444, 353	366, 881	20, 960	387, 841
Soil stabilization	(1)	(1)	(1)	130, 621	----------	130, 621
Other (including masonry mortars)	96, 757	52, 692	149, 449	105, 396	39, 519	144, 915
Total	1, 037, 689	63, 621	1, 101, 310	1, 128, 875	64, 012	1, 192, 887
Chemical and other industrial:						
Alkalies (ammonium, potassium and sodium compounds)	13, 490	843, 932	857, 422	6, 562	735, 632	742, 194
Asphalts and other bitumens	(2)	----------	(2)	(2)	----------	(2)
Brick, sand-lime and slag	14, 525	----------	14, 525	5, 724	----------	5, 724
Brick, silica (refractory)	25, 158	50	25, 208	20, 794	----------	20, 794
Calcium carbide and cyanamide	739, 877	----------	739, 877	607, 540	328, 000	935, 540
Calcium carbonate (precipitated)	36, 738	----------	36, 738	24, 181	----------	24, 181
Coke and gas (gas purification and plant byproducts)	18, 922	----------	18, 922	18, 903	----------	18, 903
Explosives	4, 563	----------	4, 563	3, 287	----------	3, 287
Food and food byproducts	5, 230	----------	5, 230	17, 438	----------	17, 438
Glassworks	259, 300	----------	259, 300	230, 212	----------	230, 212
Glue	3, 668	----------	3, 668	4, 384	----------	4, 384
Grease, lubricating	13, 222	----------	13, 222	11, 359	----------	11, 359
Insecticides, fungiticides, and disinfectants	62, 998	----------	62, 998	49, 858	----------	49, 858
Medicines and drugs	(2)	----------	(2)	(2)	----------	(2)
Metallurgy:						
Steel (open-hearth and electric furnace flux)	1, 319, 166	143, 451	1, 462, 617	1, 218, 547	96, 910	1, 315, 457
Ore concentration [3]	202, 491	366, 890	569, 381	168, 334	222, 560	390, 894
Wire drawing	12, 818	----------	12, 818	9, 818	----------	9, 395
Other [4]	125, 202	----------	125, 202	75, 045	----------	75, 045
Oil drilling	16, 317	----------	16, 317	1, 364	----------	1, 364
Paints	(2)	(2)	15, 249	(2)	(2)	23, 805
Paper mills	(2)	(2)	817, 466	(2)	(2)	661, 185
Petrochemicals (glycol)	(2)	----------	(2)	(2)	----------	(2)
Petroleum refining	35, 834	----------	35, 834	40, 432	----------	40, 432
Rubber manufacture	2, 799	----------	2, 799	2, 533	----------	2, 533
Salt refining	(2)	----------	(2)	(2)	----------	(2)
Sewage and trade-wastes treatment	123, 048	55	123, 103	(2)	(2)	107, 521
Soap and fat	(2)	----------	(2)	----------	----------	----------
Sugar and refining	30, 033	7, 067	37, 100	(2)	(2)	37, 628
Tanneries	70, 397	----------	70, 397	64, 032	----------	64, 032
Water purification	640, 504	23, 850	664, 354	614, 884	24, 656	639, 540
Wood distillation	----------	(2)	(2)	----------	----------	----------
Undistributed [5]	1, 261, 834	289, 739	718, 858	1, 227, 351	332, 859	730, 071
Total	5, 038, 134	1, 675, 034	6, 713, 168	4, 422, 159	1, 740, 617	6, 162, 776
Refractory lime (dead-burned dolomite)	2, 231, 709	19, 719	2, 251, 428	1, 641, 072	18, 112	1, 659, 184
Grand total	8, 516, 132	1, 758, 374	10, 274, 506	7, 388, 231	1, 822, 741	9, 210, 972

[1] Complete data not available.
[2] Included with "Undistributed" and "Total" columns to avoid disclosing individual company confidential data.
[3] Includes flotation, cyanidation, bauxite purification, and magnesium manufacture.
[4] Includes various metallurgical uses.
[5] Includes alcohol, asphalt, medicine and drugs, magnesium products, paints, paper mills, polishing compounds, salt, soap and fat, sugar, sulfur, petrochemicals, miscellaneous uses, and unspecified uses.

Gains were made in the quantities of lime used in soil stabilization, calcium carbide and cyanamide manufacture, food and food byproducts, glue, paints, and petroleum refining. Losses were recorded in the amount of lime used in masonry; alkali manufacture; sand-lime, slag, and refractory brick manufacture; precipitated calcium carbonate; explosives; glass; lubricating grease; insecticides, fungicides, and disinfectants; steel manufacture; ore concentration; wire drawing; oil drilling; paper; sewage and trade-wastes treatment; tanning; wood distillation; and refractory material. Lime consumed in some chemical and industrial uses, such as gas purification, coke byproducts, sugar refining, and rubber manufacture, remained virtually the same as in 1957.

In connection with the 50th Anniversary of the Bureau of Mines (1910–60), special, historical table 6, showing the combined quick and hydrated lime sold or used in the United States, has been compiled from all available sources—Bureau of the Census, Federal Geological Survey, and Federal Bureau of Mines.

Intermittent statistics of the total value of lime began in 1880, total lime tonnage has been reported every year since 1904, and a breakdown of lime consumption by three major use categories (construction, agricultural, and chemical and industrial) has been made since 1906. A fourth category was introduced with the first domestic production and reporting of refractory lime or dead-burned dolomite in 1914, when European sources of magnesian refractories were cut off by World War I.

All lime sold in the United States before 1905 was quicklime, its hydration being left to the consumer. That year lime plants began to offer for sale lime already hydrated, and hydrated lime became a recognized commodity that has assumed steadily increasing importance ever since. Producers reported only sales of lime to the Bureau of Mines through 1952. Subsequently, captive or used lime within chemical, industrial, and lime plants has been reported in increasing amounts.

TABLE 5.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States,[1] by major uses

Use	1957			1958		
	Short tons	Value[2]		Short tons	Value[2]	
		Total	Average		Total	Average
Agricultural	208,600	$2,857,726	$13.70	196,125	$2,580,906	$13.16
Construction:						
Finishing lime	507,508	9,152,826	18.03	529,510	8,698,248	16.43
Mason's lime	444,353	6,976,493	15.70	387,841	6,005,218	15.48
Soil Stabilization	(3)	(3)	(3)	130,621	1,639,712	12.55
Other (including masonry mortars)	149,449	1,919,158	12.84	144,915	1,803 940	12.45
Total construction	1,101,310	18,048,477	16.39	1,192,887	18,147,118	15.21
Chemical and industrial uses	6,713,168	78,545,398	11.70	6,162,776	70,191,964	11.39
Refractory (dead-burned dolomite)	2,251,428	35,871,234	15.93	1,659,184	27,377,763	16.50
Grand total lime	10,274,506	135,322,835	13.17	9,210,972	118,297,751	12.84

[1] Includes Hawaii and Puerto Rico.
[2] Selling value, f.o.b. plant, excluding cost of container.
[3] Complete data not available.

TABLE 6.—Lime sold or used in the United States, 1880, 1889, and 1894–1958

Year	Construction [1]		Agricultural [1]		Refractory		Chemical		Total	
	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)
1880	----	----	----	----	----	----	----	----	----	$4,639
1889	----	----	----	----	----	----	----	----	----	8,217
1894	----	----	----	----	----	----	----	----	----	8,288
1895	----	----	----	----	----	----	----	----	----	6,589
1896	----	----	----	----	----	----	----	----	----	6,328
1897	----	----	----	----	----	----	----	----	----	6,390
1898	----	----	----	----	----	----	----	----	----	6,887
1899	----	----	----	----	----	----	----	----	----	6,983
1900	----	----	----	----	----	----	----	----	----	6,797
1901	----	----	----	----	----	----	----	----	----	8,204
1902	----	----	----	----	----	----	----	----	----	9,336
1903	----	----	----	----	----	----	----	----	----	9,256
1904	----	----	----	----	----	----	----	----	2,708	9,951
1905	----	----	----	----	----	----	----	----	2,984	10,942
1906	2,506	$10,248	300	$713	----	----	271	$1,041	[2] 3,198	[2] 12,481
1907	2,068	8,908	367	1,100	----	----	516	1,992	[2] 3,093	[2] 12,657
1908	1,811	7,825	416	1,204	----	----	404	1,514	[2] 2,767	[2] 11,091
1909	2,147	9,458	690	2,027	----	----	648	2,361	3,485	13,846
1910	2,119	9,122	710	2,265	----	----	677	2,701	3,506	14,088
1911	1,887	8,413	729	2,259	----	----	777	3,017	3,393	13,689
1912	1,976	8,421	745	2,471	----	----	808	3,078	3,529	13,970
1913	1,877	8,379	763	2,584	----	----	955	3,685	3,595	14,648
1914	1,648	7,163	846	2,836	4	$23	883	3,247	3,381	13,269
1915	1,596	6,781	822	2,789	40	281	1,165	4,573	3,623	14,424
1916	1,789	9,244	707	2,686	167	967	1,410	5,612	4,073	18,509
1917	1,459	9,648	537	2,787	223	2,327	1,567	9,046	3,786	23,808
1918	998	8,502	419	2,939	319	4,098	1,470	11,270	3,206	26,809
1919	1,259	12,201	461	3,583	222	2,229	1,388	11,436	3,330	29,449
1920	1,359	15,867	370	3,296	316	3,732	1,525	14,649	3,570	37,544
1921	1,275	13,689	297	2,381	108	1,113	852	7,712	2,532	24,895
1922	1,886	18,896	287	2,149	349	2,814	1,118	9,396	3,640	33,255
1923	2,131	22,522	240	1,826	358	3,599	1,347	12,047	4,076	39,994
1924	2,170	23,012	248	1,864	329	3,209	1,325	11,511	4,072	39,596
1925	2,387	24,115	299	2,129	392	3,731	1,503	12,634	4,581	42,609
1926	2,320	23,227	297	2,153	387	3,594	1,556	12,592	4,560	41,566
1927	2,149	20,962	323	2,238	374	3,460	1,569	11,978	4,415	38,638
1928	1,986	17,706	334	2,288	449	4,283	1,689	12,173	4,458	36,450
1929	1,641	14,304	338	2,388	488	4,262	1,803	12,525	4,270	33,479
1930	1,205	10,050	343	2,373	352	3,045	1,488	10,148	3,388	25,616
1931	947	6,940	297	1,924	244	1,867	1,220	7,944	2,708	18,675
1932	597	3,851	244	1,367	136	1,055	983	6,029	1,960	12,302
1933	533	3,829	246	1,318	262	2,065	1,228	7,042	2,269	14,254
1934	511	4,261	222	1,478	325	2,698	1,339	8,727	2,397	17,164
1935	657	5,717	283	1,902	455	3,786	1,592	10,344	2,987	21,749
1936	891	7,590	337	2,109	597	4,887	1,924	12,348	3,749	26,934
1937	949	8,213	406	2,738	618	5,218	2,151	13,922	4,124	30,091
1938	854	7,163	364	2,376	367	3,096	1,762	11,503	3,347	24,138
1939	1,000	8,564	362	2,215	672	5,447	2,220	13,823	4,254	30,049
1940	1,010	8,542	365	2,085	868	6,925	2,644	16,404	4,887	33,956
1941	1,065	9,259	383	2,387	1,070	9,111	3,561	22,184	6,079	42,941
1942	698	6,173	401	2,519	1,229	10,817	3,776	24,858	6,104	44,367
1943	558	4,854	454	3,135	1,277	11,243	4,308	29,832	6,597	49,064
1944	520	4,487	467	3,477	1,291	11,441	4,196	29,293	6,474	48,698
1945	550	4,909	374	2,907	1,187	10,614	3,810	27,488	5,921	45,918
1946	846	8,627	385	3,152	1,078	10,102	3,684	29,152	5,993	51,033
1947	1,008	11,553	341	3,158	1,395	14,295	4,035	34,820	6,779	63,826
1948	1,141	14,004	323	3,296	1,545	17,847	4,255	40,016	7,264	75,163
1949	1,052	13,644	328	3,544	1,319	15,930	3,619	36,201	6,318	69,319
1950	1,249	16,882	333	3,604	1,759	21,726	4,137	41,036	7,478	83,248
1951	1,234	16,431	344	3,713	1,967	26,375	4,711	50,416	8,256	96,935
1952	1,191	16,232	392	3,817	1,928	26,098	4,562	49,084	8,073	95,231
1953	1,166	16,513	329	3,426	2,295	31,455	5,884	60,764	9,674	112,158
1954	1,130	16,695	323	3,714	1,521	21,961	5,655	59,353	8,629	101,723
1955	1,310	19,559	305	3,437	2,129	31,425	6,736	72,723	10,480	127,144
1956	1,203	18,957	252	3,082	2,424	37,745	6,698	75,943	10,577	135,727
1957	1,101	18,049	209	2,858	2,252	35,871	6,713	78,545	10,275	135,323
1958	1,193	18,147	196	2,581	1,659	27,378	6,163	70,192	9,211	118,298

[1] From 1907 through 1922, a significant quantity of lime was not reported by use but only as sold through dealers. Distribution of this lime to construction and agricultural uses was estimated.

[2] Includes following data for hydrated lime not distributed by use: 1906, 120,357 short tons, $479,079; 1907, 140,135 tons, $657,636; 1908, 136,441 tons, $548,262.

TABLE 7.—Apparent consumption of lime sold and used in United States, in short tons

State	1957			1958		
	Apparent consumption		Total	Apparent consumption		Total
	Quicklime	Hydrated lime		Quicklime	Hydrated lime	
Alabama	291,147	29,214	320,361	237.897	30,369	268,266
Arizona	120,030	10,693	130,723	119,327	13,686	133,013
Arkansas	76,621	6,879	83,500	32,799	9,200	41,999
California	335,002	90,807	425,809	256,569	90,588	347,157
Colorado	28,818	14,057	42,875	16,004	7,737	23,741
Connecticut	9,226	21,819	31,045	24,725	27,970	52,695
Delaware	50,597	7,328	57,925	38,165	7,620	45,785
District of Columbia	200	6,246	6,446	50	6,945	6,995
Florida	114,417	78,940	193,357	105,343	72,004	177,347
Georgia	84,750	28,493	113,243	68,899	26,366	95,265
Idaho	9,224	1,755	10,979	3,906	1,545	5,451
Illinois	426,965	160,133	587,098	341,454	133,195	474,649
Indiana	481,926	39,942	521,868	440,651	36,715	477,366
Iowa	82,388	18,408	100,796	80,160	18,447	98,607
Kansas	32,970	20,062	53,032	33,335	21,797	55,132
Kentucky	541,921	22,301	564,222	437,662	21,444	459,106
Louisiana	325,723	66,381	392,104	305,679	62,302	367,981
Maine	92,216	13,419	105,635	35,660	10,478	46,138
Maryland	121,508	23,399	144,907	141,112	27,164	168,276
Massachusetts	46,995	50,836	97,831	70,973	44,505	115,478
Michigan	312,741	64,642	377,383	390,680	55,521	446,201
Minnesota	85,833	23,613	109,446	74,424	21,941	96,365
Mississippi	42,049	6,855	48,904	42,910	11,050	53,960
Missouri	183,824	53,573	237,397	116,067	56,476	172,543
Montana	61,338	3,961	65,299	86,661	3,726	90,387
Nebraska	3,632	7,499	11,131	4,202	8,038	12,240
Nevada	113	32,941	33,054	24,338	1,617	25,955
New Hampshire	5,669	7,311	12,980	2,748	7,211	9,959
New Jersey	42,380	101,649	144,029	29,384	98,175	127,559
New Mexico	29,561	28,696	58,257	1,804	27,671	29,475
New York	199,422	130,929	330,351	291,652	110,844	402,496
North Carolina	58,036	34,209	92,245	62,124	30,840	92,964
North Dakota	5,577	2,211	7,788	6,184	2,701	8,885
Ohio	1,344,631	145,174	1,489,805	1,205,681	123,935	1,329,616
Oklahoma	59,130	11,781	70,911	79,104	14,530	93,634
Oregon	38,669	10,134	48,803	40,679	12,007	52,686
Pennsylvania	1,293,059	219,927	1,512,986	932,986	189,191	1,122,177
Rhode Island	9,555	8,962	18,517	4,536	5,156	9,692
South Carolina	5,827	6,642	12,469	5,836	5,304	11,140
South Dakota	9,929	1,437	11,366	10,045	2,280	12,325
Tennessee	49,793	25,142	74,935	120,133	22,182	142,315
Texas	662,412	85,777	748,189	344,262	229,788	574,050
Utah	59,364	25,984	85,348	72,725	27,322	100,047
Vermont	7	1,645	1,652	247	1,401	1,648
Virginia	87,998	44,837	132,835	69,288	37,225	106,513
Washington	23,840	8,943	32,783	22,244	9,943	32,187
West Virginia	205,385	28,438	233,823	212,969	20,327	233,296
Wisconsin	96,369	49,261	145,630	75,930	43,792	119,722
Wyoming	163	2,848	3,011	148	3,567	3,715
Total	8,248,950	1,886,133	10,135,083	7,120,361	1,853,838	8,974,199

PRICES

The average price for quicklime and hydrated lime, f.o.b. plant, excluding cost of container, was $12.84 in 1958, compared with $13.17 in 1957. Oil, Paint and Drug Reporter [11] quoted the following prices, which included $6.29 freight charge for New York City delivery: [12]

[11] Oil, Paint and Drug Reporter, vol. 173, Nos. 1–27; vol. 174, Nos. 1–27; Jan. 6–Dec. 29, 1958.

[12] All Oil, Paint and Drug Reporter lime prices were quoted for bulk, carlots, 50,000 tons, Metropolitan New York destination, freight equalized with nearest producing point.

Type:	Price, Jan. 1, 1958	Price, Dec. 31 1958
Quicklime (chemical lime).	$22.13 per ton, becoming $21.20 Feb. 24, 1958, to Apr. 21, 1958, afterwards.	$20.54
Hydrated lime	$23.63 per ton, becoming $24.45 Feb. 24, 1958, to Apr. 21, 1958, afterwards.	23.54
Spray lime	$27.63 per ton (bags) to Apr. 21, 1958, afterwards.	24.54

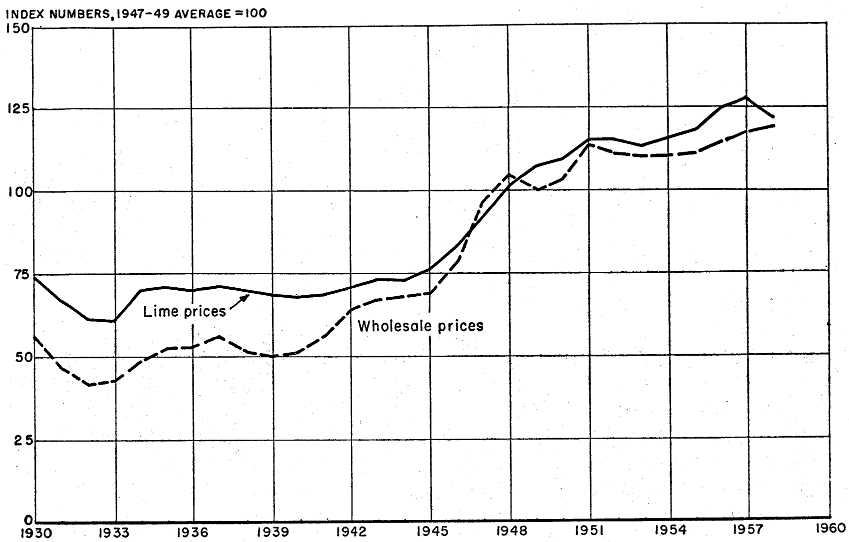

FIGURE 3.—Average price of lime per ton compared with wholesale prices of all commodities, 1930–58. Units are reduced to percentages of the 1947–49 average. Wholesale prices from U.S. Department of Labor.

Lime sales were 20 percent less during the first half of 1958, than the first half of 1957,[13] resulting in a highly competitive lime market.[14] Production was more than ample, and sellers met competitors' prices where shading was required.

Delivered 1958 prices per ton, in paper, carlots, for hydrated finishing lime, hydrated lime, and pulverized or lump quicklime throughout the United States were as follows: [15]

Destination	Hydrated finishing lime	Common hydrated lime	Pulverized or lump quicklime	Destination	Hydrated finishing lime	Common hydrated lime	Pulverized or lump quicklime
Atlanta, Ga	$23.50	$24.50	--------	Kansas City, Mo	$36.26	$34.26	$29.76
Baltimore, Md	35.60	23.20	--------	Los Angeles, Calif	38.00	38.00	39.00
Birmingham, Ala	35.02	22.30	[1] $26.33	Minneapolis, Minn.[4]	47.00	37.00	49.00
Boston, Mass	39.20	31.20	--------	New Orleans, La	44.00	32.00	32.00
Chicago, Ill	38.00	[2] 35.20	--------	New York, N.Y	40.00	37.00	--------
Cincinnati, Ohio	30.04	26.04	30.04	Philadelphia, Pa	27.60	25.60	--------
Cleveland, Ohio	31.00	25.00	--------	Pittsburgh, Pa	36.00	31.00	--------
Dallas, Tex	41.80	24.58	28.50	San Francisco, Calif	29.24	29.24	31.74
Denver, Colo.[3]	46.00	42.00	46.00	Seattle, Wash.[4]	52.00	38.00	--------
Detroit, Mich	38.00	34.00	--------				

[1] Lump quicklime was $26.72.
[2] Mason's double-hydrated or pressure-hydrated lime.
[3] Prices for trucklots.
[4] Prices for less than carlots.

[13] Oil, Paint and Drug Reporter, vol. 174, No. 9, Sept. 1, 1958, pp. 33–34.
[14] Oil, Paint and Drug Reporter, Chem. Outlook Quart., sec. 2, Dec. 1, 1958, p. 7.
[15] Engineering News-Record, vol. 161, No. 9, Aug. 28, 1958, p. 64.

FOREIGN TRADE[16]

Imports.—Lime imports came from Canada into border States from New England to Washington, but primarily into Washington.

Exports.—Lime exports went to 24 countries. In descending order by magnitude of receipts, six countries—Canada, Chile, Mexico, Peru, Colombia, and Honduras—received 90 percent of the lime exported by the United States.

WORLD REVIEW

NORTH AMERICA

British West Indies.—Bahama Islands produced 3,120 short tons of lime valued at $35,015 in 1957.[17]

Canada.—Lime shipped or used in Canada in 1957 (excluding reused lime) totaled 1,378,617 short tons valued at Can$16,678,614, an all-time record. Production of quicklime was 1,074,338 short tons valued at Can$13,048,505 (Can$12.15 per ton average) and of hydrated lime, 304,279 short tons valued at Can$3,630,109 (Can$11.93 per ton average). Output of quicklime increased over 13 percent in quantity above 1956 and 10 percent in value. Hydrated lime decreased 11 percent in quantity and 5 percent in value. Thirty-nine lime plants with 122 vertical and 21 rotary kilns were active in Canada in 1957.[18] An estimated 2,562,740 tons of limestone was burned to produce Canada's

TABLE 8.—Lime imported for consumption in the United States

[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
1949–53 (average)	1,269	$23,125	28,853	$501,783	2,648	$134,067	32,770	$658,975
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
1958	1,000	20,646	18,822	318,495	5,686	322,386	25,508	661,527

[1] "Dead-burned basic refractory material consisting chiefly of magnesia and lime."
[2] Includes weight of immediate container.

TABLE 9.—Lime exported from the United States

[Bureau of the Census]

Year	Short tons	Value	Year	Short tons	Value
1949–53 (average)	63,720	$1,100,050	1956	82,737	$1,546,127
1954	73,246	1,299,681	1957	65,195	1,328,575
1955	82,461	1,464,036	1958	45,844	1,047,310

[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] U.S. Consulate, Nassau, British West Indies, State Department Dispatch 110, May 1, 1958.
[18] Dominion Bureau of Statistics (Industry and Merchandising Division, Mineral Statistics Section, Ottawa), The Lime Industry, 1957: 1958, 9 pp.

total output which amounted to 54 percent by weight of the limestone after hydration. Of the 29 million short tons of Canadian limestone produced in 1957,[19] nearly 9 percent was calcined to lime. Some pulp, paper, and chemical plants produced lime from sludge by recirculating the sludge through the kiln. Ninety-four percent (1,010,841 tons) of the 1957 Canadian production of quicklime was shipped to chemical and industrial plants and 6 percent (63,497 tons) was used for building and nonindustrial purposes. Only 178,806 tons (59 percent) of the hydrated lime was for chemical and other industrial uses; 125,473 tons (41 percent) went to building, agricultural, and other uses. Five lime plants were active in Alberta in 1957, 3 in British Columbia, 6 in Manitoba, 2 in New Brunswick, 14 in Ontario, and 9 in Quebec.

Expanding uranium production increased demand for quicklime in the Blind River and Bancroft areas of northeastern Ontario. Cobo Minerals, Ltd.'s 100-ton-a-day, coal-fired, automatic rotary kiln, near Coboconk, Ontario, began producing quicklime in August 1957. The feed was Black River limestone, 98 to 99 percent $CaCO_3$ and 90 to 95 percent CaO when burned at 1,800° to 1,900° F. Pebble quicklime was used by uranium, paper, and steel industries, ground quicklime by uranium and gold industries, and bagged quicklime for building. A continuous hydrator was planned to produce hydrated lime for soil stabilization.[20]

Delivered prices per ton, in paper, carlots, of hydrated finishing lime, hydrated lime, and pulverized or lump quicklime were, respectively, $39, $22, and $13.25 in Montreal, Quebec, and $36, $33.50, and $31.50 in Toronto, Ontario, in August 1958.[21]

Dominican Republic.—Production of lime was 3,907 short tons in 1956, 4,079 tons in 1955, and 3,748 tons in 1954. Lime production in 1957 was valued at $66,000.[22]

SOUTH AMERICA

Argentina.—Limestone deposits in Aquada Cecilio were estimated at 21 million short tons. They averaged 80 percent or more calcium carbonate, and some high-purity formations were suitable for calcining.[23]

Paraguay.—The 1957 lime production was 10,322 short tons valued at $307,617.[24]

Peru.—Lime production was 54,784 short tons in 1957: Agricultural, 7,165 short tons, chemical and industrial, 11,574 short tons; construction, 19,290 short tons; and mineral concentration, 16,755 short tons.[25]

Venezuela.—All high-quality chemical lime for the glass industry was imported in 1957.[26]

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[19] Ross, J. S., Limestone (General), 1957: Canada Dept. of Mines and Tech. Surveys, Ind. Min. Div., Ottawa, Review 45, June 1958, 4 pp.
[20] Trauffer, Walter E., Uranium Boom Reason for Building of New Lime Plant: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 191–193.
[21] Work cited in footnote 15.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 27.
U.S. Embassy, Ciudad Trujillo, Dominican Republic, State Department Dispatch 590, June 6, 1958.
[23] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 1592, Apr. 16, 1958, p. 1.
[24] U.S. Embassy, Asuncion, Paraguay, State Department Dispatch 402, May 13, 1958.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 4, October 1958, p. 46.
[26] U.S. Embassy, Caracas, Venezuela, State Department Dispatch 469, Encl. 1, Jan. 7, 1958, p. 35.

EUROPE

Denmark.—Quicklime production in 1957 was 115,433 short tons valued at $1,812,645.[27]

Finland.—Quicklime production in 1953 was 218,158 short tons; in 1954, 246,435 short tons; in 1955, 259,041 short tons; in 1956, 236,994 short tons; and in 1957, 241,404 short tons valued at $3,795,250.[28]

United Kingdom.—Government contributions to improve soil fertility under the Agricultural Lime Schemes of 1947–55 were made at rates of 60 to 70 percent of the purchasing, transporting, and spreading costs. They amounted to $26 million in 1956–57. Agricultural lime was 6.2 million tons in 1956.[29] Much agricultural lime on order was not spread in time to collect the 70-percent subsidy that ended September 6, 1958. Consequently, most farmers discontinued liming until after harvest.[30]

Yugoslavia.—During the first 4 months of 1958, lime production amounted to only 184,000 short tons of the 649,000 tons planned, and the price rose 7 percent because of the reduced supply.[31]

ASIA

India.—Pallithura Brick and Tiles, Ltd., built a plant to manufacture daily 40,000 bricks and tile from lime and sand in Shertalli, Kerala.[32] There was enough domestic lime and limestone to supply the bichromates industry.[33]

Kankars are recent, impure, cryptocrystalline limestone nodules, extensively deposited in Indian soils by ground water saturated with dissolved carbonates. They contain 35 to 53 percent calcium oxide and are calcined into lime in country kilns. Lime from kankars has hydraulic properties because of its argillaceous content.[34]

Lebanon.—Estimated lime production in 1957 was 7,716 short tons valued at $99,056.[35]

Pakistan.—Coquina limestone and coral on St. Martin's Island in the Bay of Bengal, 14 miles south of Cox's Bazaar, were found to be suitable for lime. Preliminary analyses indicated 90 percent calcium carbonate. Lime plant could be built at Chittagong port, 110 miles to the north, but water transportation would be hazardous during the monsoon months of April through October.[36]

Philippines.—Production in 1957 included hydrated lime (11,806 short tons valued at $286,978), agricultural lime (7,781 short tons, $25,161), industrial lime (28,267 short tons, $327,937), lime for other

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[27] U.S. Embassy, Copenhagen, Denmark, State Department Dispatch 455, Dec. 4, 1958, p. 1.

[28] U.S. Embassy, Helsinki, Finland, State Department Dispatch 626, Apr. 30, 1958, p. 2. Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, p. 36.

[29] Chemistry and Industry (London), No. 39, Sept. 27, 1958, pp. 1257–1258.

[30] Fertiliser and Feeding Stuffs Journal (London), vol. 49, No. 7, Sept. 24, 1958, p. 291.

[31] U.S. Embassy, Belgrade, Yugoslavia, State Department Dispatch 73, Aug. 22, 1958, pp. 4–5.

[32] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 33.

[33] U.S. Consulate, Bombay, India, State Department Dispatch 563, Feb. 25, 1958.

[34] Strikantia, S. V., Kankars: Indian Min. Jour. (Calcutta), vol. 6, No. 7, July 1958, pp. 19–20, 25.

[35] U.S. Embassy, Beirut, Lebanon, State Department Dispatch 473, Feb. 27, 1958.

[36] U.S. Consulate, Dacca, Pakistan, State Department Dispatch 182, Mar. 4, 1958, pp. 1–2.

U.S. Embassy, Karachi, Pakistan, State Department Dispatch 800, Mar. 12, 1958, pp. 6–7.

uses (8,253 short tons, $86,267), and shell-derived lime (10,258 short tons, $55,577).[37]

AFRICA

Belgian Congo.—In 1957, 110,737 short tons of lime valued at $199,000 was produced.[38]

Libya.—Output of construction lime totaled 11,000 short tons in 1957.[39]

Rhodesia and Nyasaland, Federation of.—Rhodesia Cement Co.'s new $280,000 lime plant, which was opened at Shamva, August 23, 1957, quarried limestone from two deposits—one for general-purpose lime and the other for high-quality lime. Most of the 25,000 tons of hydrated lime imported in 1956 and valued at $243,600 came from the Union of South Africa.[40]

Tanganyika.—Lime exports and local sales were 5,828 short tons valued at $55,852 in 1956. Total 1957 lime exports and local sales were 4,579 short tons valued at $54,211.[41]

Uganda.—Lime production in 1957 totaled 9,620 short tons, compared with 9,247 short tons in 1956.[42]

Union of South Africa.—Three so-called "high-calcium" lime plants burned limestone containing 8 percent or more magnesia. Fifteen other plants produced 350 tons of dolomitic lime daily. Mixed-feed, dolomitic limekilns (bottle-shaped, 30-foot shafts having a maximum diameter of 12 feet) were charged with two parts of limestone and one part of coal. All dolomitic quicklime was slaked in open pits for building and plastering and, when hydrated and bagged, sold for about $10 a ton. Dolomitic lime production was advanced by the introduction of a rotary kiln. One "high-calcium" plant had coal-fired, mixed-feed, 11- by 56-foot vertical kilns that produced only 30 tons a day. A pressure hydrator for dolomitic lime was designed by the National Laboratories Building Research Institute, at Pretoria.[43]

OCEANIA

Australia.—Australian lime plants were reported to be old-fashioned, inefficient, low in capacity, and high in production costs. Lime was high-priced. Hydrated lime sold for $40 a ton and inferior lump quicklime for $25 a ton.[44]

New Zealand.—Lime & Marble, Ltd., produced high-grade lime at Port Mapua, Nelson, for fungicides and insecticides.[45]

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[37] U.S. Embassy, Manila, Philippines, State Department Dispatch 852, Encl. 1, Apr. 17, 1958, p. 2.
[38] U.S. Consulate, Elisabethville, Belgian Congo, State Department Dispatch 1, Encl. 1, July 7, 1957.
[39] U.S. Embassy, Tripoli, Libya, State Department Dispatch 352: Mar. 31, 1958, p. 1.
[40] U.S. Consulate, Salisbury, Federation of Rhodesia and Nyasaland, State Department Dispatch 157: Oct. 24, 1958.
[41] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 33.
U.S. Consulate, Dar es Salaam, Tanganyika, State Department Dispatch 131, Jan. 17, 1958, p. 1.
U.S. Consulate, Dar es Salaam, Tanganyika, State Department Dispatch 222, May 23, 1958.
[42] Bureau of Mines Trade Notes: Vol. 47, No. 5, November 1958, p. 33.
U.S. Consulate, Kampala, Uganda, British East Africa, State Department Dispatch 111, Apr. 28, 1958.
[43] Azbe, Victor J., Lime Production Primitive in Africa: Rock Products, vol. 61, No. 9, September 1958, pp. 134, 136, 138, 140, 143, 155.
[44] Azbe, Victor J., Lime Around The World, pt. 2, Research is Imperative in Australia: Rock Products, vol. 61, No. 7, July 1958, pp. 94, 96, 98, 100, 102, 128, 136.
[45] U.S. Embassy, Wellington, New Zealand, State Department Dispatch 121, Aug. 27, 1958, p. 3.

TECHNOLOGY

PROCESSING

Calcination.—A shaft kiln[46] and an improved method for firing rotary kilns, using natural gas with a new burner, were patented.[47] A new rotary kiln increased lime production several times, improved calcining efficiency and lime quality, and reduced cost.[48] Its calcining zone was tripled in length by a burner consisting of multiple concentric jets having different velocities, combined with recirculated inert gases from the dust chamber and highly preheated (900° to 1,100° F.) air and fuel. To improve heat efficiency, coke was mixed with limestone in gas- and oil-fired vertical kilns in quantities necessary to supply 20 to 30 percent of the total heat required.[49]

A patented apparatus gradually preheated limestone feed to form nodules low in moisture content.[50] To preheat limestone feed, another patent was issued for a countercurrent heat exchanger. Feed was entrained in a gas stream that was partly recirculated between individual sections against the main gas flow.[51] Greater heat efficiency and maximum recovery of fines were claimed for a heat-exchange apparatus that used rotary-kiln gases to preheat lime-kiln feed.[52]

After being partly air-cooled on a traveling grate, the lime was fractionated. The coarse fractions were crushed and recombined with the fines for further cooling in an airstream.[53] Lime was dropped from the calcining zone of a rotary kiln into a soaking zone, where it remained until the incompletely calcined particles were completely calcined.[54] A vertical apparatus was patented for cooling lime from a rotary kiln.[55]

Heat consumption is affected by the temperature differential between gas and calcining material at the boundary between the preheating and burning zones. Reducing the temperature differential to 30° C. increased thermal efficiency to 90 percent.[56] Temperature distribution in the different kiln zones, heat exchange between gas

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[46] Suter, H. R. (assigned to L. von Roll, A. G., Zurich, Switzerland), Shaft Kiln for the Burning of Cement, Lime, Dolomite, and Similar Substances, and Method of Operating Said Kiln: U.S. Patent 2,861,788, Nov. 25, 1958.

[47] Niemitz, G. (assigned to Kennedy Van Saun Manufacturing & Engineering Corp., New York, N. Y.), Method of Firing Rotary Kilns and Gas Burner Therefor: U.S. Patent 2,857,148, Oct. 21, 1958.

[48] Pit and Quarry, Unusual Features Patented in Rotary Kiln Design: Vol. 50, No. 11, May 1958, pp. 120, 140, 148.

Tayler, T. C., Lime Burning Apparatus and Method: U.S. Patent 2,624,562, Jan. 6, 1953.

[49] Solvay et Cie (Solvay and Co.), Brussels, Belgium, Burning of Limestone: British Patent 796,722, June 18, 1958.

[50] Sylvest, K. J. (assigned to F. L. Smidth & Co., New York, N.Y.), Preheating of Finely Divided Material: Canadian Patent 565,037, Oct. 21, 1958.

[51] Rosa, J., and Petr, V., Counter-Current Recirculating Device for the Exchange of Heat Between a Gas and a Finely Granulated Material: U.S. Patent 2,819,890, Jan. 14, 1958.

[52] Beal, R. V., and Bishop, L. H. (assigned to The Associated Portland Cement Manufacturers, Ltd., London, England), Manufacture of Portland Cement, Lime, and the Like: U.S. Patent 2,863,654, Dec. 9, 1958.

[53] Petersen, L. (assigned to F. L. Smidth & Co., New York, N.Y.), Cooling Apparatus for Use with Rotary Kilns: U.S. Patent 2,859,955, Nov. 11, 1958.

[54] Niems, L. H. (assigned to Marblehead Lime Co., Chicago, Ill.), Apparatus for Cooling and Calcining: U.S. Patent 2,858,123, Oct. 28, 1958.

[55] Lellep, O. G. (assigned to Allis-Chalmers Manufacturing Co., Milwaukee, Wis.), Apparatus for Cooling Granular Materials: U.S. Patents 2,861,353 and 2,861,356, Nov. 25, 1958.

[56] Eigen, H., Technische Grenzwerte des Wärmeverbrauchs des Koksbeheitzen Kalkschachtofens (Technical Limits of Heat Consumption of Coke-Fired Shaft Lime Kilns): Zement-Kalk-Gips, (Wiesbaden, West Germany), vol. 11, No. 6, June 1958, pp. 258–262.

and product, and heat storage and transmission by lining of the kiln were discussed.[57]

A research program for Australia included building a pilot lime plant and studying the reaction of limestone to heat, effects of silica in limestone, nature and reactivity of insolubles in lime, effects of time and temperature on calcination, causes and elimination of lime discoloration, effects of sulfur in limestone and fuel, and relative value of lime for chemical and construction uses.[58]

Hydration.—Quicklime was hydrated by limewater and fractionated. The coarse fraction, which contained the impurities and the unhydrated lime particles, was agitated. Instead of using clear water, the lime suspension, from which the coarse fraction had been removed by settling, was recycled to hydrate fresh quicklime. Agitation broke down the large lime particles and facilitated their hydration when they were circulated through the hydrator again.[59] A patent was issued for a hydrator and a method of hydrating dolomitic quicklimes at atmospheric pressures.[60] Quicklime lumps were treated superficially with mist or steam so that only their contaminated surfaces were hydrated, then loosened and removed from their quicklime cores by vibrating or screening.[61]

X-ray diffraction study of a $Ca(OH)_2$ crystal showed that the oxygen-hydrogen bond paralleled the c-axis.[62]

Dust Control.—For three rotary limekilns, Union Carbide Corp.'s Electro Metallurgical Co. (now Union Carbide Metals Co.) plant at Niagara Falls, N.Y., installed three cyclonic scrubbers that operated at 95 to 98 percent efficiency. Dust emission was reduced to 0.06 pound per 1,000 pounds of gases—well below the limit of 0.85 pound per 1,000 pounds imposed by the local dust code.[63]

Reuse.—At Dayton, Ohio, lime has been produced at the municipal water-softening plant since December 1957 by recalcining all calcium carbonate sludge formerly pumped as waste into large lagoons. The carbonate came from lime used in water treatment and from precipitated hardness of the treated water. Where annual lime requirements had been 18,000 tons, the new $1.5-million lime-recovery plant had an annual capacity of 30,000 to 40,000 tons. Excess lime was sold to the Springfield (Ohio) water-softening plant at $10.50 a ton. Its 9.5- by 265-foot rotary kiln was fired with natural gas. A washmill, a thickener, centrifuges, and pumps were installed to process both fresh sludge and the old sludge from the lagoons.[64] A similar lime-

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[57] Helmbold, P. A., Chim. et Ind. (Chemistry and Industry), (Paris), vol. 70, No. 4, 1953, pp. 672–676.
Ceramic Abstracts, vol. 41, No. 10, October 1958, p. 287.

[58] Work cited in footnote 44.

[59] Knibbs, N. V. S., and Thyer, E. G. S. (assigned to Fawham Developments, Ltd., London, England), Hydration of Lime and Allied Substances: U.S. Patent 2,833,626, May 6, 1958.

[60] Allen, A. A. (assigned to Kennedy Van Saun Manufacturing & Engineering Corp., New York, N.Y.), Improvements in Method and Apparatus for Hydrating Dolomitic Quicklimes: British Patent 797,328, July 2, 1958.

[61] Wuhrer, J. (assigned to Rheinische Kalksteinwerke, Wülfrath, Germany), Verfahren zur Herstellung eines weitgehend von Verunreiningungen befreiten stückigen Kalkes (Method for Manufacturing Lump Lime Largely Free of Impurities): German Patent 1,005,431, Mar. 28, 1957.

[62] Petch, H. W., A Determination of the Hydrogen Positions in Calcium Hydroxide by X-ray Diffraction: Canadian Jour. of Physics, vol. 35, No. 8, 1957, pp. 983–985.

[63] Blackmore, S. S., Dust Emission Control Program at Electromet: Industrial Wastes, vol. 3, No. 3, May–June 1958, pp. 73–78.

[64] Chemical Week. The City of Dayton, O., A Producer of Lime Since Last Fall: Vol. 83, No. 7, Aug. 16, 1958, p. 65.
Herod, Buren C., Lime Produced, Recovered in City of Dayton's New Calcining Plant: Pit and Quarry, vol. 50, No. 11, May 1958, pp. 128–132, 170.

recovery plant has been operated by the city of Miami, Fla., since 1948.[65] Municipal water-softening plants also recovered lime in 1958 at Lansing, Mich.,[66] Marshalltown, Iowa, and Salina, Kans.

Recarbonation.—Bagged, high-quality, hydrated lime, which analyzed 94.5 percent $Ca(OH)_2$ and less than 1 percent $CaCO_3$, fell below standard after 5 months' storage. Standard-quality hydrated lime, which analyzed 91.3 percent $Ca(OH)_2$ and 3.5 percent $CaCO_3$, fell below standard after 3 months' storage, although carbon dioxide absorption was somewhat slower.[67] Laminated paper-asphalt bags virtually eliminated carbonation. Plastering lime was stored in these bags as long as 3 years without apparent deterioration.[68]

Quicklime was converted to calcium carbonate when heated in CO_2 at 500° to 700° C. CO_2 absorption was greater with smaller lime crystals obtained by lower temperature calcination but was less when limestone was calcined with 1 percent sodium chloride. Activity of quicklime was estimated by hydration velocity and CO_2 absorption velocity.[69]

USES

Building.—A patent was issued for a wall plaster of lime, calcined gypsum, boric acid, and rice flour that could be applied as a single coat or in more than one coat without waiting for the undercoat to dry.[70] An aqueous lime and keratin slurry, hydrolyzed under pressure at 220° to 300° F., was patented as a high-strength retarder for gypsum plaster.[71] To stabilize the set of gypsum plaster, the dried reaction product of lime, alum, and water was added with a filler and a retarder to calcined gypsum.[72] Hydrated lime, calcium chloride, aluminum sulfate, and copper sulfate were added to a slurry for making lightweight building material from portland cement and expanded perlite.[73] A lightweight, nailable concrete contained shredded sugarcane bagasse, hydrated lime, portland cement, cement activator, pozzolan, and water.[74] Although of low durability, a whitewash of 90 percent quicklime and 10 percent tallow was more effective than aluminum paint or foil in reducing temperatures of bituminous roofs at least 15° F. more than 10 percent of the time.[75]

Soil Stabilization.—Lime contracts for soil stabilization climbed to a record 240,000 tons in 1958, according to the National Lime Associa-

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[65] Cliffe, W. R., and Atherton, C. R., Limelight on Water Treatment: Pit and Quarry, vol. 41, No. 11, May 1949, pp. 106–112, 114–119.

[66] Herod, Buren C., Lime Reclaiming Plant Utilizes Fluidizing Techniques: Pit and Quarry, vol. 51, No. 4, October 1958, pp. 120–125.

[67] Therond, L., Essais Expérimentaux sur la Carbonatation des Chaux pour Sulfatage (Experiments on the Carbonation of Lime for Sulfating): Annales des Falsifications et des Fraudes (Paris), vol. 50, No. 581–582, May–June 1957, pp. 212–219.

[68] National Lime Association, Limeographs: Vol. 25, October 1958, p. 30.

[69] Ohno, Yoshio, Carbon Dioxide Absorption by Calcined Limestone: Sekko to Sekkai (Tokyo), vol. 1, 1957, pp. 1366–1370.

Chem. Abs., vol. 51, No. 18, 1957, p. 14,161.

[70] Busatti, V. G., Plaster: U.S. Patent 2,833,660, May 6, 1958.

[71] Teale, R. R. (assigned to National Gypsum Co., Buffalo, N.Y.), Plaster Retarder and Method of Making Same: U.S. Patent 2,865,905, Dec. 23, 1958.

[72] Schneiter, H. J., and Oshida, O. A. (assigned to National Gypsum Co., Buffalo, N.Y.), Gypsum Plaster Set Stabilization: U.S. Patent 2,820,714, Jan. 21, 1958.

[73] Rodsky, B. (partly assigned to J. C. and W. E. Boyd), Building Material: U.S. Patent 2,858,227, Oct. 28, 1958.

[74] Miller, A. C., and Fishman, N. (assigned to Hawaiian Development Co., Ltd., Honolulu, Hawaii), Bagasse Concrete: U.S. Patent 2,837,435, June 3, 1958.

[75] Ballantyne, E. R., and Spencer, J. W., Division of Building Research, Commonwealth Scientific Industrial Research Organization, Melbourne, Australia, Temperatures of Bituminous Roof-Surfaces: ASTM Bull. 223, July 1957, pp. 69–73.

tion.[76] Bureau of Public Roads observed that recognition of the value of lime in stabilization was just beginning, and the American Road Builders Association pointed out that the greatest future use of lime was in secondary roads.[77] Lime has been used in stabilization since 1945 and on a large scale since 1955, but calcium chloride has been used since 1915. Fifteen to 22 pounds of lime and only 2 pounds of calcium chloride were used per square yard.[78]

Delaware's first lime-asphalt stabilization project, in June 1958, consolidated nonplastic sandy silt in Kent County with 3 percent hydrated lime, followed by liquid asphalt. Lime added structural strength, facilitated mixing, reduced water absorption, and inhibited bleeding of the asphalt.[79]

Hydrated lime was used to convert marginal river-gravel base material into a dependable base course at a cost of $1.25 a cubic yard, when a Tarrant County (Tex.) road was built in 1954. The base course remained intact when Trinity River floodwaters submerged a mile of this road for 1- and 3-week periods in May and June 1957.[80] In constructing Bergstrom Air Force Base, Austin, Tex., 13,000 tons of hydrated lime was used to stabilize the subgrade.[81]

Louisiana State Highway Department first used lime stabilization in 1955. Rain did not affect stabilized road bases, and projects were completed in less time.[82] Hydrated lime stabilized a motor-pool stand at Fort Polk, Leesville, La. Three percent hydrated lime was incorporated in a clay-gravel base, asphalt surfacing followed, and 140,000 square yards supported 45-ton tank traffic in wet weather. Lime combined with the alumina and silica of the clay to form calcium-aluminum silicates.[83]

Over 3,300 short tons of pulverized quicklime was applied to the clay subgrade on part of the Autobahn in northern Germany. Quicklime stabilized the clay and reduced construction time one-third during a rainy period.[84]

In September 1958, the National Lime Association began a 3-year research fellowship at the University of Illinois, Urbana, Ill., to determine how hydrated lime affects clay soils and pure clays. As clay minerals are primary constituents of clay soils and clay formations, understanding their reactions with hydrated lime is necessary to understand what occurs when hydrated lime is added to subbases in highway and other construction stabilization.[85]

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[76] Rock Products, Production Estimates, 1958–59, Lime-Chemical Uses Lead, 1958, p. 10.
[77] Rock Products, Highways—Markets for Lime: Vol. 61, No. 8, August 1958, p. 28.
Trauffer, Walter E., N. L. A. Convention Stresses Lime-Soil: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 90–91.
[78] National Lime Association, Limeographs: Vol. 25, December 1958, p. 53.
National Lime Association, Lime Stabilization Gains Rapidly: Press Release, Apr. 1, 1959, 2 pp.
[79] Haber, R. A., Lime-Asphalt Soil Stabilization: Rural Roads, vol. 8, No. 5, September–October 1958, pp. 32, 43.
[80] Bingham, J. M., Results of Lime Stabilization: Texas Highways, vol. 5, No. 5, May 1958, pp. 6–7.
[81] National Lime Association, Limeographs: Vol. 25, December 1958, p. 51.
[82] Trauffer, Walter E., N.L.A. Convention Stresses Lime Soil: Pit and Quarry, vol. 51, No. 1, July 1958, p. 89.
[83] Van Dine, Charles G., Low Cost Roads and Hardstands, Lime Stabilization Methods and Experience at Fort Polk, Louisiana: Roads and Streets, vol. 101, No. 9, September 1958, pp. 54–56, 58.
[84] National Lime Association, Limeographs: Vol. 25, September 1958, p. 21.
[85] Rock Products, N.L.A. Establishes Fellowship on Lime in Clay Mineralogy: Vol. 61, No. 10, October 1958, p. 49.

Lime stabilization was tested in the soil laboratory at Royal Melbourne Technical College, Sunshine, Victoria, Australia, and Melbourne University planned a stabilization research program of several years' duration. Stabilization was expected to reduce road-construction costs 20 percent, according to tests by the soil laboratory at Royal Melbourne Technical College, Sunshine, Victoria. Their machine dug up 3 inches of soil, mixed it with lime, and relaid the mixture.[86]

Agriculture.—Virginia and North Carolina soils required, respectively, 3 and 4 million tons of liming material to reach proper lime levels and 1 million tons added annually in each State to maintain them.[87] Soil liming requires more than a pH test. Determination of the amounts of exchangeable calcium and magnesium and the total base-exchange capacity of the soil were also recommended.[88]

University of Missouri South Farms, near Columbia, demonstrated that corn on limed soil grows faster and has better color than corn on adjoining, unlimed soil. Lime supplied calcium, provided nitrogen by breaking down organic matter, and increased availability of phosphates.[89]

Calcium and magnesium are essential nutrients for plant growth and must be maintained in a highly available state in a soil of correct pH. Liming soil to the proper pH level was regarded as the first step toward increasing crop yields,[90] but correction of soil acidity by lime was considered a long-time investment.[91] A water-insoluble, inorganic plant nutrient was made by reacting quicklime with zinc sulfate.[92]

Chemical and Industrial.—Vienna lime, stearic acid, acidless tallow, and an antislaking additive constituted patented buffing compositions.[93] Hydrated lime was used in substantially stable, anhydrous calcium hydroxystearate greases.[94] Porous material for humidifier plates and filters was made by diepressing a mixture of rice-hull ash particles, ball clay, lime, and water and firing the shapes to 1,800° to 2,350° F.[95]

Lime increased the viscosity of tall-oil and petroleum-oil gels.[96] Lime desulfurized carbon monoxide produced from sulfur-containing solid fuels.[97] Caustic soda was prepared by decomposing aqueous sodium sulfate solutions with lime.[98] Porous, lump quicklime, which

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[86] National Lime Association, Limeographs: Vol. 25, October 1958, p. 26.
[87] Lewis, W. W., Lack of Lime Serious Farm Problem: Southern Planter, vol. 119, No. 8, August 1958, p. 18.
[88] Journal of Agricultural and Food Chemistry, Intelligent Liming: Vol. 6, No. 8, August 1958, pp. 572–573.
[89] Preston, Alva, Lime Is Better to Corn: Better Crops with Plant Food, vol. 42, No. 7, August-September 1958, p. 7.
[90] Musgrave, O. L., Making Soil Test Recommendations in Ohio: Better Crops with Plant Food, vol. 42, No. 7, August–September 1958, pp. 32–37.
[91] Doll, E. C., Balanced Fertilization, First Step to Efficient Production: Better Crops with Plant Food, vol. 42, No. 6, June–July 1958, pp. 26–30.
[92] Allison, J. R. (assigned to Leffingwell Chemical Co., Whittier, Calif.), Inorganic Micro-Nutrient Complexes: U.S. Patent 2,823,107, Feb. 11, 1958.
[93] Marsh, B. E., and Betcher, R. L. (assigned to Armour & Co., Chicago, Ill.), Anti-Slaking Buffing Compositions: U.S. Patent 2,847,290, Aug. 12, 1958.
Riegler, W. L. and Dybalski, J. N. (assigned to Armour & Co., Chicago, Ill.), Anti-Slaking Buffing Compositions: U.S. Patent 2,850,369, Sept. 2, 1958.
[94] Swenson, R. A., and Zajac, S. J. (assigned to Standard Oil Co., Chicago, Ill.), Process for Preparing Anhydrous Lime Grease: U.S. Patent 2,841,556, July 1, 1958.
[95] Jones, J. D., Porous Media: U.S. Patent 2,826,505, Mar. 11, 1958.
[96] Maddox, J. R. (assigned to Armstrong Cork Co., Lancaster, Pa.), Viscosity Controlling Method: U.S. Patent 2,845,361, July 29, 1958.
[97] Eastman, D. B. (assigned to The Texas Co., New York, N.Y.), Gasification of Sulfur-Bearing Carbonaceous Fuels: U.S. Patent 2,830,883, Apr. 15, 1958.
[98] Lauer, K. H. (assigned to Columbia-Southern Chemical Corp., Pittsburgh, Pa.), Method of Preparing Caustic Soda: U.S. Patent 2,862,793, Dec. 2, 1958.

preferably still showed original limestone texture, was used in a process for reducing volatility and reactivity of sodium and magnesium for use in treating ferrous melts.[99] Aluminum sulfate was produced from bauxite and high-alumina clay by using lime and iron-contaminated, waste sulfuric acid.[1]

Federal Bureau of Fisheries' chemical method of destroying starfish was to release quicklime granules into salt water over oysterbeds. Quicklime either was sifted down onto the starfish or deposited directly on them by an underwater spout. Slaking quicklime particles that settled on starfish caused death.[2] Calcium silicate made from hydrated lime, diatomite, and colloidal silica had a greater sorptive power for insecticides than fuller's earth. Calcium silicate was used as a carrier for wettable 75-percent DDT, a highly concentrated insecticide for long-distance domestic shipment and export.[3] Roles of lime and magnesia in open-hearth steelmaking were discussed and phase relations in various lime, magnesia, silica, iron oxide, and alumina systems presented.[4] An aqueous drilling fluid, resistant to thickening under high-temperature borehole conditions, consisted of bentonite, a dispersing agent, lime or barium hydroxide, magnesium hydroxide, and a lignosulfonate.[5]

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[99] Deyrup, A. J., and Ferron, J. R., (assigned to E. I. du Pont de Nemours & Co., Wilmington, Del.), Agent for Treating Molten Metals: U.S. Patent 2,823,989, Feb. 18, 1958.

[1] Schurr, C., Production of Aluminum Sulfate From Waste Materials: U.S. Patent 2,844,439, July 22, 1958.

[2] U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Fisheries, Information Service Release, June 20, 1958, p. 3.

Chemical and Engineering News, vol. 36, No. 26, June 30, 1958, p. 114.

[3] Mulryan, Henry T., Minerals for Insecticide Formulations: Min. Eng., vol. 10, No. 12, December 1958, pp. 1259–1260.

[4] Kramer, H. M., Reactions in the Open Hearth Affecting Refractory Life: Bull. Am. Ceram. Soc., vol. 37, No. 7, July 15, 1958, pp. 312–316.

[5] Thompson, W. E. (assigned to Sun Oil Co., Philadelphia, Pa.), Aqueous Drilling Fluid: U.S. Patent 2,828,258, Mar. 25, 1958.

Lithium

By Albert E. Schreck [1]

THE LITHIUM industry in 1958 reflected no major changes from 1957. No new firms entered the industry and there was no significant expansion of existing facilities. The greatest emphasis was placed on developing commercial markets.

DOMESTIC PRODUCTION

The number of domestic producers of lithium minerals declined in 1958, as many small producers in the Black Hills, S. Dak., lacked markets for their output. Maywood Chemical Co. and the Black Hills-Keystone Corp., both in Pennington County, were the only active producers. The former recovered spodumene from the Etta mine and the latter a small tonnage of amblygonite from the Ingersoll mine. Foote Mineral Co. continued to produce spodumene from its Kings Mountain, N.C., quarry, and in California, American Potash & Chemical Corp. recovered dilithium-sodium phosphate from Searles Lake brines.

Lithium chemicals were produced by the Foote Mineral Co. at Sunbright, Va., from North Carolina spodumene ore; American Potash & Chemical Corp. converted dilithium-sodium phosphate to lithium carbonate; Maywood produced a variety of lithium compounds from both domestic and imported ore; Lithium Corp. of America at its Bessemer City, N.C., plant produced lithium chemicals from Canadian spodumene concentrates; and American Lithium Chemicals, Inc., converted Rhodesia lepidolite to lithium chemicals at its San Antonio, Tex., plant.

The American Lithium Institute, founded in late 1956, was disbanded in June 1958.

Metal Hydrides, Inc., doubled the capacity of its lithium-aluminum hydride plant at Beverly, Mass.[2]

Industry interest in lithium perchlorate was apparent as the three major producers, American Potash, Foote, and LCA, operated pilot plants for its manufacture.[3]

Lithium Corp. also entered into an agreement with Brooks and Perkins, Inc., of Detroit, Mich., for research and development of lithium alloys.

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[1] Commodity specialist.
[2] Chemical Engineering, Expansion Mirrors Rising Use of Metal Hydrides: Vol. 65, No. 25, Dec. 15, 1958, p. 200.
[3] Chemical and Engineering News, Perchlorates Go Big League: Vol. 36, No. 51, Dec. 22, 1958, pp. 11, 12.

CONSUMPTION AND USES

Lithium minerals and compounds were used in a variety of industries, including grease, ceramics, metallurgy, air conditioning, and pharmaceuticals. The major commercial consumers were, however, the grease and ceramics industries. Lithium stearate or other soap is used in all-purpose or multipurpose greases, which retain their lubricating properties through extremes of temperature and also have good water-resistance properties.

A survey sponsored by the American Lithium Institute revealed that 72 percent of the grease manufacturers responding produced lithium-base greases. The same survey estimated that by 1965 almost 42 percent of the domestic automotive grease output will be lithium-base grease, representing about 250 million pounds per year.[4]

Lithium and its compounds were used in glasses, glazes, and enamels when high gloss and superior scratch and chemical resistance were desired. The addition of lithium to porcelain enamels for aluminum and steel coatings reduces the maturing temperature and increases the fluidity of the coating, permitting it to be fired at lower temperatures.

Lithium chloride and fluoride were used in welding and brazing compounds, and the bromide and chloride were used in industrial air-conditioning systems. Lithium hydroxide continued to be used as an additive in alkaline storage-battery electrolytes to increase output and lengthen cell life.

Lithium metal was used as a scavenger in metal manufacture and in organic synthesis.

The Atomic Energy Commission continued to receive shipments of lithium hydroxide from producers under contract for its lithium-6 isotope extraction processes.

Late in the year Foote Mineral Co. announced a new series of lithium dispersions that contain almost no oxygen.[5] The dispersions, containing less than 0.1 percent of oxygen-containing compounds and ranging in particle size from 15 to 50 microns, are chemically more reactive than conventional lithium metal dispersions. Use in the catalytic and organic reaction field was anticipated.

PRICES

The prices of most lithium compounds remained stable throughout 1958. The price of lithium hydroxide advanced 17 cents a pound in August 1958, regaining most of the 20-cent-a-pound cut of December 1957.

The price of lithium metal was reduced in late January. During the first 2 weeks of the year E&MJ Metal and Mineral Markets quoted the metal (98 percent) at $11–$14 per pound. In the latter half of the month and for the remainder of the year the metal (99.5 percent) was quoted at $9–$11 per pound.

[4] Chemical Week, Grease Speeds Lithium's Production Growth: Vol. 82, No. 15, Apr. 12, 1958, pp. 37–38, 40.

[5] Chemical and Engineering News, Coming: More Reactive Lithium: Vol. 36, No. 44, Nov. 3, 1958, pp. 40–41.

Lithium mineral prices are usually determined by direct negotiation between buyer and seller and were not quoted in trade journals in 1958.

TABLE 1.—Range of prices on selected lithium compounds, in 1958 in pounds
[Oil, Paint and Drug Reporter]

Compound	January 1958	December 1958
Lithium benzoate, drums	$1.65-$1.67	$1.65-$1.67
Lithium bromide, NF, gran. works, freight equalized	2.60	2.60
Lithium carbonate, technical, drums, carlots, tonlots, freight allowed	.67	.67
Drums, tonlots, same basis	.73	.73
Drums, smaller lots, same basis	.79	.79
Lithium chloride, technical, anhydrous, drums, carlots, tonlots, delivered or works, freight allowed	.87	.87
Less than carlots, same basis	.88- .92	.88- .92
Lithium hydride, powder, drums, 500-pound lots, works	9.50	9.50
Lithium hydroxide monohydrate, drums, carlots, tonlots, freight allowed	.55	[1].72
Less than carlots, same basis	.56	[1].73
Lithium nitrate, technical, drums, 100-pound lots	1.15- 1.25	1.15- 1.25
Lithium stearate, drums, carlots, works	.47½	.47½
Tonlots, works	.48½	.48½
Less than tonlots, works	.53½	.53½

[1] Price change published Aug. 11, 1958.

FOREIGN TRADE

United States imports of lithium minerals were supplied principally by Canada and the Federation of Rhodesia and Nyasaland.

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.

No imports of lithium metal were reported in 1958.

WORLD REVIEW

In a little more than a quarter of a century lithium-mineral production rose from 4,000 to over 122,000 short tons and the number of producing countries from 5 to about 12. The increase in both production and number of producing countries can be traced in table 2, which gives historical statistics on lithium-mineral output from 1925 to 1958.

NORTH AMERICA

Canada.—Quebec Lithium Corp. remained the sole producer of lithium ore. The firm constructed a pilot plant to determine the most suitable process for manufacturing lithium chemical.[6] The indicated reserve at the mine was increased to more than 20 million tons containing 1.15 percent Li_2O.[7] The company produced 11 days out of every 2 weeks; 49 men were employed underground, totaling 156 persons at the operation.

SOUTH AMERICA

Brazil.—The only lithium-chemical producer, Orquima, S.A. of Sao Paulo, reported output of about 300 tons of lithium compounds per

[6] Northern Miner, vol. 44, No. 44, Jan. 22, 1959, p. 19.
[7] Northern Miner, Quebec Lithium Has Fine Year; Ore Reserves Up: Vol. 44, No. 5, Apr. 24, 1958, p. 3.

TABLE 2.—World production of lithium minerals, by countries, 1925–58, in short tons

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

Country	Mineral produced	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
North America:																		
Canada	Spodumene			[1] 24	[1] 18	[1] 71	[1] 65							[1] 32				
United States	Lithium minerals	3,140	3,700	4,173	4,600	(3)	1,797	(3)	(3)	504	719	1,154	1,241	1,357	892	1,990	2,011	3,832
South America:																		
Argentina	Lithium minerals (1925–58).												66	203	186			55
Brazil	Spodumene (exports)																	
	Amblygonite (exports).																	
Europe:																		
Czechoslovakia	Lithium minerals	36	27	52			34							7				
France	Lepidolite	(3)	280	336	1,120	1,680	(3)							491				
Germany	Lithium minerals	552	732	668	297	870	866											
Portugal	Amblygonite	101	46	105	170	9	6			52								22
	Lepidolite	239	206	424	376	829	296	637	649	257	330		9	121				
	Lithiophylite																	
Spain	Amblygonite																	116
Sweden	Petalite														(3)	(3)	242	465
	Spodumene														(3)	(3)	211	125
Asia: Korea	Lithium minerals																	
Africa:																		
Belgian Congo [5]	Amblygonite																	
	Spodumene (exports)																	
Mozambique	Lepidolite																	
	Amblygonite																	
Rhodesia and Nyasaland, Federation of: Southern Rhodesia.	Eucryptite																	
	Amblygonite																	
	Lepidolite			21														
	Petalite																	
	Spodumene																	
South-West Africa.	Amblygonite													247	836	898	282	228
	Lepidolite						280	112	112		259	548	954	1,154	856	482	997	
	Petalite																45	11
	Spodumene																	
Uganda	Amblygonite																	
Union of South Africa.	Amblygonite																	
Oceania: Australia	Lithium minerals	44									17							
Total		4,112	4,991	5,803	6,581	3,459	3,344	749	761	813	1,325	1,702	2,270	3,612	2,770	3,370	3,788	4,854

TABLE 2.—World production of lithium minerals, by countries, 1925–58, in short tons—Continued

Country	Mineral produced	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
North America:																		
Canada	Spodumene	-	-	-	-	-	-	-	-	-	-	-	-	[2] 9	[2] 57	[2] 2,395	[2] 2,570	[2] 1,969
United States	Lithium minerals	6,405	8,155	13,319	2,446	3,065	2,441	3,881	4,838	9,306	12,897	15,611	27,240	37,830	(3)	(3)	(3)	(3)
South America:																		
Argentina	Lithium minerals (1925–45).	-	83	-	-	2	-	-	-	(3)	1	-	-	42	110	165	22	(3)
Brazil	Spodumene (exports)	-	[4] 276	-	-	-	2	-	-	-	-	-	-	1,560	1,047	-	-	468
	Amblygonite (exports).	-	-	661	-	-	-	45	-	-	-	-	-	1,300	789	-	552	-
Europe:																		
Czechoslovakia	Lithium minerals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	Lepidolite	336	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Germany	Lithium minerals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Portugal	Amblygonite	(3)	100	110	2	-	-	-	20	11	19	11	18	10	4	-	-	(3)
	Lepidolite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Lithiophylite	-	-	-	-	-	-	-	-	7	55	-	-	-	-	-	-	(3)
Spain	Amblygonite	198	250	111	-	-	-	-	-	-	-	11	35	148	125	57	7	(3)
Sweden	Petalite	244	344	162	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Spodumene	38	93	122	22	54	-	-	-	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Asia: Korea	Lithium minerals	-	-	842	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Africa:																		
Belgian Congo [5]	Amblygonite	-	-	-	-	-	-	-	-	-	-	-	-	409	1,491	1,996	2,317	(3)
	Spodumene (exports)	-	-	-	-	-	-	-	-	-	6	-	-	36	28	72	-	(3)
Mozambique	Lepidolite	-	-	-	-	-	-	-	661	244	308	1,213	6,297	-	-	1,105	379	96
	Amblygonite	-	-	-	-	-	-	-	-	1	-	-	-	-	-	39	-	(3)
Rhodesia and Nyasaland, Federation of: Southern Rhodesia.	Eucryptite	-	-	-	-	-	-	-	-	-		-	-	-	12	-	56	398
	Amblygonite	-	-	-	-	-	-	-	-	200		90	336	433	180	646	122	1,835
	Lepidolite	-	-	-	-	-	-	360	-	-	2,645	1,233	7,682	26,909	57,714	84,599	93,545	64,699
	Petalite	-	-	-	-	-	-	-	-	-		112	11,580	26,708	24,210	13,524	9,934	13,166
	Spodumene	-	-	-	-	-	-	-	-	-		45	45	-	50	4,445	5,599	5,238
South-West Africa.	Amblygonite	25	-	-	-	-	34	176	130	292	578	714	338	1,172	1,414	831	535	534
	Lepidolite	442	806	1,842	644	1,882	3,304	1,361	895	9,318	11,090	7,914	8,443	4,178	1,832	1,139	882	1,043
	Petalite	17	-	-	-	-	112	179	134	180	174	1,174	1,598	1,936	5,278	3,675	5,325	7,404
	Spodumene	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-
Uganda	Amblygonite	-	-	-	-	-	-	-	224	297	21	-	18	8	-	-	6	(3)
Union of South Africa.	Amblygonite	-	-	-	-	-	-	-	-	15	-	-	60	57	426	713	30	-
Oceania: Australia	Lithium minerals	-	9	-	-	-	-	-	6	-	-	-	-	17	4	-	-	(3)
Total		7,705	10,116	17,169	3,114	5,003	5,893	6,002	6,908	19,871	27,794	28,128	63,691	102,763	94,771	115,401	121,881	96,850

[1] Sales, includes some amblygonite and lepidolite as well as spodumene.
[2] Tons of lithia in spodumene concentrates.
[3] Data not available and no estimates are included in the total.
[4] U.S. imports.
[5] Includes Ruanda-Urundi.

year.[8] Most production was exported, but domestic sales were expected to increase.

EUROPE

United Kingdom.—Controlling interest of Kemball, Bishop and Co. Ltd., one of two producers of lithium chemicals in England, was acquired by Pfizer Ltd.[9] The latter firm purchased nearly all shares of Kemball, Bishop, except about 17 percent held by Charles Pfizer and Co., Inc., New York. Kemball, Bishop and Co., Ltd., will retain its name and operate as a separate unit, handling the Pfizer bulk chemicals.

The manufacture of lithium carbonate from petalite at the Bootle Works of Associated Lead Manufacturers, Ltd., was described in a publication and its accompanying flow-sheet.[10]

AFRICA

Rhodesia and Nyasaland, Federation of.—Bikita Minerals, Ltd., and George Nolan, Ltd., produced lithium minerals in Southern Rhodesia. Because chemical plants processing lepidolite had proved more efficient than anticipated and less ore was required by the glass industry, a reduction in output rate was reported by Bikita early in 1958. Rand Mines took an option on the lithium deposits of George Nolan and began exploratory diamond drilling.[11]

TABLE 3.—Exports of lithium ores from the Federation of Rhodesia and Nyasaland in 1957

Country of destination	Short tons	Value	Country of destination	Short tons	Value
France	5,980	$83,720	United Kingdom	1,306	$19,432
Germany, West	607	10,018	United States	29,187	403,897
Japan	20	448			
Netherlands	994	28,700	Total	38,094	546,215

TECHNOLOGY

Arfwedson's experiments in analyzing petalite, leading ultimately to the discovery of lithium, were described.[12]

Several patents on recovering lithium carbonate from spodumene were issued.[13] In the first process, beta spodumene is sulfated, and the resulting lithium sulfate is leached out and treated with ammonium fluoride to precipitate lithium fluoride. The fluoride is heated with ammonium sulfate and the resulting lithium sulfate then mixed with water and treated with CO_2 and ammonia-forming lithium carbonate. The carbonate is recovered, and the ammonium is recycled to an earlier step.

[8] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, p. 40.
[9] Chemical Trade Journal and Chemical Engineering (London), vol. 143, No. 3724, Oct. 17, 1958, p. 903.
[10] Laidler, D. S., Lithium and Its Compounds: Royal Institute of Chemistry, Lectures, Monographs, and Reports, No. 6, 1957, 33 pp.
[11] Mining Journal (London), vol. 250, No. 6392, Feb. 21, 1958, p. 214.
[12] Gentieu, Norman P., The Problem of the Elusive Element: Chemistry, vol. 31, No. 6, February 1958, pp. 22–30.
[13] Dwyer, T. E. (assigned to Tholand, Inc., New York, N.Y.), Method of Producing Lithium: U.S. Patent 2,840,453, June 24, 1958; Production of Lithium Carbonate: U.S. Patent 2,840,455, June 24, 1958.

In the second process the ore is sulfated, and the resulting lithium sulfate is treated in the molten state with a gaseous reducing agent to form lithium sulfide. The sulfide is dissolved in water, carbonated to form lithium carbonate, and the carbonate recovered.

A process for obtaining lithium nitride from lithium metal was patented.[14] A homogeneous mixture of finely divided solid lithium metal and finely divided solid lithium nitride is heated to about 400° C, in a nitrogen atmosphere to convert the metal to the nitride. The mixture is then cooled and the nitride recovered.

In research using lithium minerals in ceramics, a laboratory shape and test method was developed, which reproduced dunting (a type of failure caused by internal stresses during cooling or reheating of fired ceramic ware), often found in commercial operations. The results of these tests indicated that 10 percent petalite added to commercial compositions produced better resistance to dunting, improved strength, and somewhat lowered the coefficients of expansion.[15]

Lithium borohydride can be prepared by reacting anhydrous sodium borohydride with anhydrous lithium chloride in anhydrous N N-dimethylformamide.[16] The precipitated sodium chloride is removed, and the solvent is evaporated to recover the solid lithium borohydride.

[14] Lam, Hung Kei Henry, and Schafer, Glen H. (assigned to American Potash & Chemical Corp.), Preparation of Lithium Nitride: U.S. Patent 2,866,685, Dec. 30, 1958.

[15] Commons, C. H., Jr., and Romano, P. J., Laboratory Development of Dunt Resisting Bodies Containing 10 Percent Petalite: Am. Ceram. Soc. Bull., vol. 37, No. 8, August 1958, pp. 353–356.

[16] Cunningham, G. L., Bryant, J. M., and Gause, E. M. (assigned to Callery Chemical Co., Pittsburgh, Pa.), Preparation of Lithium Borohydride: U.S. Patent 2,829,946, Apr. 8, 1958.

Magnesium

By H. B. Comstock[1] and Jeannette I. Baker[2]

WORLD production of primary magnesium in 1958 fell 34 percent below 1957. This decrease resulted mostly from curtailed production in the United States, where accumulated stocks had increased beyond average annual consumption. During 1958 domestic consumption of the metal was 17 percent above production. New magnesium alloys were developed for use in aircraft and missiles in areas subjected to high heat and vibrational stresses.

New structural applications of the metal reflected improvements in fabrication, heat treatment, and protective coatings.

TABLE 1.—Salient statistics of magnesium, 1949–53 (average) and 1954–58

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Domestic production:						
Primary magnesium..........short tons..	53,420	69,729	61,135	68,346	81,263	30,096
Secondary magnesium..........do....	10,154	8,250	10,246	10,529	10,658	8,812
Imports [1]..........do....	1,994	733	1,844	630	982	537
Exports..........do....	1,076	3,096	8,230	3,388	[2] 1,219	[3] 207
Consumption..........do....	30,597	39,218	46,463	53,610	44,442	35,352
Price per pound [4]..........cents..	23.6	27.0	29.5	33.9	35.25	35.25
World: Primary production.....short tons..	100,000	[2] 131,000	[2] 133,000	[2] 142,000	[2] 155,000	101,000

[1] Metallic and scrap.
[2] Revised figure.
[3] Effective Jan. 1, 1958, some material formerly included with metals and alloys in crude form, and scrap included with semifabricated forms, not elsewhere specified.
[4] Magnesium ingots (99.8 percent) in carlots, f.o.b. Freeport, Tex.

DOMESTIC PRODUCTION

Primary.—During the first quarter of 1958, producers of primary magnesium began to cut back output, The Dow Chemical Co. closed its Valasco, Tex., plant on March 1, 1958. Dow's 30,000-ton electrolytic plant at Freeport, Tex., produced magnesium throughout the year; and the Government-owned silicothermic plant at Canaan, Conn., was operated by Nelco Metals, Inc., at 5,000-ton capacity to produce magnesium and calcium.

Titanium Metals Corporation of America recycled magnesium throughout the year as an integrated operation of its production of titanium at Henderson, Nev.

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

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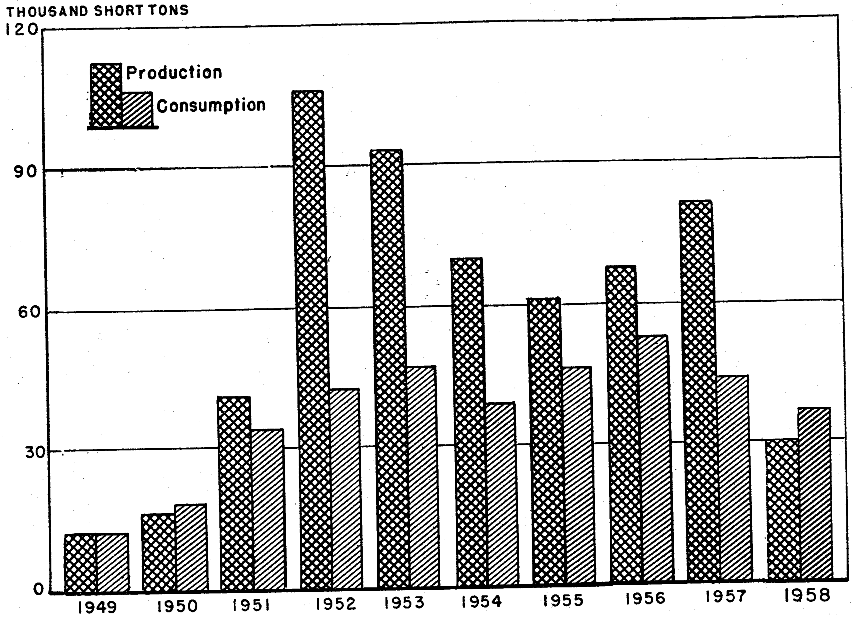

FIGURE 1.—Trends in domestic production and consumption of primary magnesium, 1949–58.

In November 1958 Alabama Metallurgical Corporation began constructing a plant at Selma, Ala., to produce magnesium from dolomite, utilizing ferrosilicon as the reducing agent. Initial annual production capacity of 7,000 tons was planned. Production of metal was expected to begin in August 1959. This was the first undertaking to build a silicothermic magnesium plant in the United States with private funds. Domestic production of the metal previously had been more economical in electrolytic plants.

Secondary.—Recovery of magnesium from scrap in 1958 was 17 percent below 1957. This percentage of decrease was about the same

TABLE 2.—Production of primary magnesium in the United States, 1949–53 (average) and 1954–58, by month, in short tons

Month	1949–53 (average)	1954	1955	1956	1957	1958
January	4, 240	6, 447	5, 090	6, 337	7, 391	5, 272
February	4, 076	5, 856	4, 647	5, 908	6, 617	3, 526
March	4, 613	6, 545	4, 942	6, 347	7, 383	3, 235
April	4, 502	6, 204	1, 859	6, 081	7, 222	2, 772
May	4, 472	6, 460	4, 277	6, 359	7, 227	2, 469
June	4, 119	6, 191	4, 757	6, 098	6, 718	1, 784
July	4, 210	6, 049	5, 112	1, 136	6, 777	1, 799
August	4, 365	5, 772	5, 881	3, 314	7, 152	1, 845
September	4, 255	5, 325	5, 923	6, 128	6, 486	1, 791
October	4, 622	5; 149	6, 287	6, 735	6, 468	1, 927
November	4, 818	4, 942	6, 130	6, 818	5, 995	1, 814
December	5, 130	4, 789	6, 230	7, 085	5, 827	1, 862
Total	53, 420	69, 729	61, 135	68, 346	81, 263	30, 096

in recovering magnesium from magnesium scrap as from aluminum scrap.

Of the total 7,935 tons of magnesium scrap consumed, 93 was used in magnesium castings, 4 in wrought products, 524 in aluminum alloys, 108 in other alloys and chemicals, 3,711 in magnesium alloy ingot, and 3,495 in anodes for cathodic protection.

TABLE 3.—Magnesium recovered from scrap processed in the United States 1957–58, in short tons [1]

Kind of scrap	1957	1958	Form of recovery	1957	1958
New scrap:			Magnesium-alloy ingot [1]	4,200	3,099
Magnesium-base	3,360	2,280	Magnesium-alloy castings (gross weight)	75	78
Aluminum-base	2,237	1,803	Magnesium-alloy shapes		4
Total	5,597	4,083	Aluminum alloys	3,383	2,679
Old scrap:			Zinc and other alloys	22	35
Magnesium-base	4,350	4,156	Chemical and other dissipative uses	29	45
Aluminum-base	711	573	Cathodic protection	2,949	2,872
Total	5,061	4,729	Grand total	10,658	8,812
Grand total	10,658	8,812			

[1] Figures include secondary magnesium content of both secondary and primary magnesium alloy ingot.

TABLE 4.—Stocks and consumption of new and old magnesium scrap in the United States in 1958, gross weight in short tons

Scrap item	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Cast scrap	[1] 1,049	5,334	370	5,076	5,446	937
Solid wrought scrap	179	1,241	1,277		1,277	143
Borings, turnings, drosses, etc	205	1,056	1,212		1,212	49
Total	[1] 1,433	7,631	2,859	5,076	7,935	1,129

[1] Revised figure.

CONSUMPTION AND USES

Consumption of magnesium was 20 percent below that in 1957. However, shipments from producers to consumers began to increase in September and continued to rise during the fourth quarter. Consumption of the primary metal was 17 percent above production. Its use for structural products was 26 percent below the quantity consumed for distributive or sacrificial purposes.

Technological improvements begun in 1956 and 1957 which included installing hot chamber die-casting machines, resulted in markedly increased use of magnesium die castings in some areas in 1958.

TABLE 5.—Domestic consumption of primary magnesium (ingot equivalent and magnesium content of magnesium-base alloys) by uses, 1949–53 (average) and 1954–58, in short tons

Product	1949–53 (average)	1954	1955	1956	1957	1958
For structural products:						
Castings:						
Sand	9,035	9,545	6,872	6,478	6,076	5,698
Die	1,308	1,743	2,619	1,875	1,649	1,553
Permanent mold	697	785	876	1,034	571	889
Wrought products:						
Sheet and plate	4,218	3,033	6,424	5,496	4,916	4,061
Extrusions (structural shapes, tubing)	3,657	2,461	4,106	6,223	5,081	2,624
Forgings	215	110	307	473	7	141
Total for structural products	19,130	17,677	21,204	21,579	18,300	14,966
For distributive or sacrificial purposes:						
Powder	662	582	681	918	386	352
Aluminum alloys	6,084	8,061	11,104	13,323	11,236	10,746
Other alloys	415	103	364	98	587	446
Scavenger and deoxidizer	772	80	654	865	867	708
Chemical	395	63	124	63	325	148
Cathodic protection (anodes)	1,835	5,479	3,941	3,036	2,997	2,028
Reducing agent for titanium, zirconium, hafnium, uranium, and beryllium	(1)	6,386	8,056	13,303	9,695	5,953
Other [2]	1,304	787	335	425	49	5
Total for distributive or sacrificial purposes	11,467	21,541	25,259	32,031	26,142	20,386
Grand total	30,597	39,218	46,463	53,610	44,442	35,352

[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, and producing nodular iron and secondary magnesium alloys.

The new magnesium alloys containing thorium in the form of sheet, plate castings, extrusions, and forgings were used in constructing jet planes and missiles.[3] These lightweight alloys met the requirements for components subjected to severe thermal shock and vibrational stresses. New magnesium alloys containing beryllium were extruded for use in gas-cooled atomic reactors.[4]

Increase in the volume of magnesium consumed for forgings was caused principally by use of forged wheels for aircraft and automotive equipment.[5] Magnesium alloys were also forged to produce aircraft-brake housings and fuel-meter bodies.[6]

Consumption of magnesium in extrusions sharply dropped, but the use of magnesium extrusions for airfield landing mats increased in 1958.[7]

STOCKS

Producers' and consumers' stocks at the close of 1958 were 52,000 tons of primary magnesium and 6,000 tons of primary magnesium alloy ingot—this was a decrease of 7,000 tons of primary magnesium

[3] Materials in Design Engineering, Magnesium Reduces Weight, Increases Power of Jet: Vol. 49, No. 1, January 1959, pp. 12, 162.
Steel, Magnesium: Vol. 142, No. 15, Apr. 14, 1958, p. 97.
Materials in Design Engineering, Three Magnesium Parts Reduce Weight of ICBM: Vol. 48, No. 7, December 1958, p. 10.
[4] American Metal Market, Mg-Be Tubing: Vol. 65, No. 66, Apr. 4, 1958, p. 8.
[5] Main, John A., Magnesium Wheels: Light Metal Age, vol. 16, Nos. 11 and 12, December 1958, pp. 18–19.
[6] Wilensky, Lester E., Magnesium Forgings Save Weight: Materials in Design Engineering, vol. 49, No. 1, January 1959, pp. 92–94.
[7] Modern Metals, Magnesium Extrusions Make Ideal Airfield Landing Mats: Vol. 14, No. 10, November 1958, pp. 31–32.

and 5,000 tons of primary magnesium alloy ingot below stocks at the close of 1957. Government agencies continued to retain quantities of primary magnesium, as provided by the Strategic and Critical Materials Stockpiling Act.

PRICES

The base price of primary magnesium ingot in standard 42-pound pig form remained throughout 1958 at 35.25 cents per pound, f.o.b., Velasco, Tex.[8]

FOREIGN TRADE [9]

Imports.—Imports of magnesium in 1958 decreased 463 tons below 1957. About 70 percent of the total 562 tons was scrap metal. On June 30, 1958, duty on magnesium changed from 14.3 cents per pound to 50 percent ad valorem; and for magnesium powder, sheets, tubing, manufactures, and so forth, the duty dropped from 18 cents per pound plus 9.5 percent ad valorem, to 17 cents per pound plus 8.5 percent ad valorem. Suspension of duty on magnesium scrap was extended to June 30, 1959. The metal came from six countries in 1958. Of the total 562 tons imported, less than 1 ton came from Bermuda; 158 tons from Canada; 2 tons from the Dominican Republic; 360 tons from Japan; 27 tons from Taiwan; and 15 tons from the United Kingdom.

Exports.—Magnesium exports decreased 544 tons below 1957 and were the lowest since 1952. The countries that received the metal are shown in table 7.

WORLD REVIEW

World production of magnesium was the lowest since 1951. In most areas consumption of the metal was slightly higher than in 1957. Reports from several countries indicated progress in basic research as well as in fabrication and use techniques.

Canada.—Production of primary magnesium in Canada was little more than two-thirds the quantity produced in 1957. Improved use techniques indicated new uses. Development of welding techniques,[10] and new methods for forming and bonding magnesium for structural parts in aircraft were described.[11] Late in 1958 Dominion Magnesium, Ltd., had orders to deliver 11,000 tons of primary magnesium to Germany in 1959 for producing components of Volkswagen automotive equipment.[12]

France.—Studies demonstrating the feasibility of using magnesium for containers of uranium in reactors that were cooled with carbon dioxide were reported.[13]

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[8] American Metal Market, Magnesium: Vol. 66, No. 1, Jan. 1, 1959, p. 6.

[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.

[10] McClelland, J. B., Production Welding of Magnesium: Canadian Metalworking, vol. 21, No. 2, February 1958, pp. 46, 48, and 50.

[11] Light Metals Age, Magnesium—New Auto Claving Method Used to Form Canadian "Arrow" Fighter Skin: Vol. 16, Nos. 9 and 10, October 1958, p. 16.

[12] Northern Miner (Toronto, Canada), Dominion Magnesium Finds Competition Getting Tougher: Vol. 44, No. 33, Nov. 6, 1958, p. 4.

[13] Salesse, Marc, Safety of Magnesium Canning for CO_2-Cooled Reactors: Nucleonics, vol. 16, No. 2, February 1958, pp. 123–124.

TABLE 6.—Magnesium imported for consumption and exported from the United States, 1949–53 (average) and 1954–58 [1]

[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		Semi-fabricated forms, n.e.c.		Powder	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1949–53 (average)	1,994	$542,444	5	$10,428	33	$67,268	1,076	$615,070	[2] 222	[2] $334,609	(3)	(3)
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	[4] 24,526	8,230	4,556,229	[2] 236	[2] 514,986	14	33,911
1956	630	303,586	24	202,675	2	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	[5] 1,219	[5] 1,122,164	[2] 355	[2] 767,656	22	39,469
1958	537	280,316	9	38,096	16	97,194	[6] 207	[6] 225,522	[6] 834	[6] 1,053,844	11	16,147

[1] Revisions in Minerals Yearbook 1957, p. 777; 1948–52 average value of alloys should read $7,332.
[2] Owing to changes in items included in each classification 1953–57, data are not strictly comparable with earlier years.
[3] Not separately classified before 1952; 1952—43 tons ($59,843); 1953—21 tons ($41,591).
[4] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.
[5] Revised figure.
[6] Effective Jan. 1, 1958, some material formerly included with metals and alloys in crude form, and scrap included with semifabricated forms, not elsewhere classified.

TABLE 7.—Magnesium exported from the United States, 1957–58, by classes and countries, in short tons

[Bureau of the Census]

Country	1957			1958		
	Primary metal, alloys, and scrap	Semifabricated forms, n.e.c.	Powder	Primary metal, alloys, and scrap[1]	Semifabricated forms, n.e.c.[1]	Powder
North America:						
Canada	94	165	14	26	225	7
Mexico	100	2	-----	1	47	-----
Netherlands Antilles	7	24	-----	-----	7	-----
Trinidad and Tobago	76	-----	-----	34	63	-----
Other North America	12	-----	(2)	2	4	-----
Total	289	191	14	63	346	7
South America:						
Colombia	6	16	-----	-----	79	-----
Venezuela	89	19	-----	14	70	-----
Other South America	6	3	-----	1	13	1
Total	101	38	-----	15	162	1
Europe:						
Belgium-Luxembourg	[3] 38	4	5	17	13	1
Denmark	44	2	-----	-----	(2)	-----
France	102	19	-----	1	4	-----
Germany, West	52	6	-----	20	12	-----
Italy	90	2	(2)	9	15	-----
Netherlands	10	5	-----	34	3	-----
Norway	71	-----	3	-----	-----	2
Sweden	95	15	-----	48	6	-----
Switzerland	(2)	17	-----	-----	9	-----
United Kingdom	23	2	-----	(2)	15	-----
Other Europe	-----	(2)	-----	-----	1	-----
Total	[3] 525	72	8	129	78	3
Asia:						
Indonesia	3	-----	-----	-----	92	-----
Israel	21	5	-----	-----	7	-----
Japan	249	28	-----	-----	67	-----
Kuwait	7	-----	-----	-----	27	-----
Taiwan	(2)	-----	-----	-----	38	-----
Other Asia	23	13	-----	-----	6	-----
Total	303	46	-----	-----	237	-----
Oceania	-----	3	-----	-----	1	-----
Africa	1	5	-----	-----	10	-----
Grand total	[3] 1,219	355	22	207	834	11

[1] Some material formerly included with metals and alloys in crude form, and scrap included with semifabricated forms, not elsewhere classified.
[2] Less than 1 ton.
[3] Revised figure.

Germany, West.—The Knapsack-Griesham, A.G., silicothermic plant produced primary magnesium in 1958. At this plant a process was studied to obtain magnesium from spent potassium liquors.[14]

Italy.—Primary magnesium was produced at the silicothermic plant at Bolzano. Magnesio S.A. of Genoa successfully operated a pilot plant to produce magnesium from sea water.[15]

Japan.—Production of primary magnesium came from the Furukawa Magnesium Co. plant near Oyama; dolomite was used as the

[14] Chemical and Engineering News, Magnesium in Germany: Vol. 36, No. 17, Apr. 28, 1958, p. 100.
[15] Metal Bulletin (London), New Plant for Italy: No. 4287, Apr. 18, 1958, p. 20.

TABLE 8.—World production of magnesium metal, by countries,[1] 1949–53 (average) and 1954–58, in short tons [2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
Canada	3,704	[3] 6,600	[3] 7,700	9,606	8,385	5,810
France	844	1,268	1,670	1,676	1,750	1,913
Germany, West [4]		154	144	194	260	209
Italy	589	1,836	3,161	4,097	4,162	[3] 4,200
Japan		23	[5] 148	[5] 86	[5] 472	[3] 450
Norway	[6] 1,510	5,183	7,433	8,185	9,504	10,226
Poland	[6] 50	95	103	158	150	[3] 165
Switzerland	231					
U.S.S.R.[3]	35,000	40,000	45,000	45,000	45,000	45,000
United Kingdom [4]	4,538	5,577	6,054	4,064	3,831	[3] 2,600
United States	53,420	69,729	61,135	68,346	81,263	30,096
World total (estimate)[1] [2]	100,000	131,000	133,000	142,000	155,000	101,000

[1] In addition to countries listed, China (Manchuria) produced magnesium metal, but data on output are not available; estimates by author of chapter are included in the total.
[2] This table incorporates revisions of data published in previous Magnesium chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Primary metal and remelt alloys.
[5] In addition, the following quantities of remelted magnesium were produced: 1955—401 short tons; 1956—897 short tons; and 1957—1,906 short tons.
[6] Average for 1951–53.

source of the metal. Diminishing requirements for magnesium during 1958 resulted in increased producers' stocks by December.[16]

Norway.—Norsk Hydro, producer of primary magnesium, continued to make magnesium anodes for cathodic protection.

U.S.S.R.—The U.S.S.R. announced plans to increase production of magnesium.[17]

United Kingdom.—Special studies of methods to protect magnesium alloys from corrosion were published.[18] New magnesium alloys containing silver, rare earth metals, and zirconium were developed.[19] Magnesium was used as a reducing agent to produce uranium for fuel in nuclear reactors.[20]

TECHNOLOGY

Increased interest was noted in 1958 in basic research to produce pure primary magnesium and to develop magnesium-base alloys with improved properties. New equipment and techniques were used to reduce major impurities in primary electrolytic magnesium.[21] Either alone or in combination four methods were employed to reduce the maximum total of all impurities to less than 0.2 percent: (1) Chemical treatment of magnesium chloride while preparing it for cell feed, to remove certain impurities; (2) chemical treatment of the molten metal to remove iron absorbed from the steel cathodes during electrolysis; (3) change in materials used to construct production equip-

[16] Mining World, vol. 20, No. 1, January 1958, p. 96.
[17] Northern Miner (Toronto), New Russian 5-Year Plan to Enlarge Metal Industry: Vol. 43, No. 46, Feb. 6, 1958, p. 28.
[18] Higgins, W. F., Chemistry and Industry, No. 49, Dec. 6, 1958, pp. 1604–1612.
[19] Metal Industry (London), Magnesium Alloys: Vol. 93, No. 8, Aug. 22, 1958, p. 154.
[20] Chemical and Engineering News, Britain Fuels up for Atom Power: Vol. 37, No. 6, Feb. 9, 1959, pp. 78–82, 111.
[21] Krenzke, F. J., and Others, High Purity Electrolytic Magnesium: Jour. Metals, vol. 10, No. 1, January 1958, pp. 28–30.

ment; (4) batch selection of the primary metal with impurity levels acceptable for given uses.

Basic research during 1958 was concerned largely with development of improved magnesium alloys that would withstand the vibrational stresses and changes in temperature encountered by aircraft and missiles. The Bureau of Mines conducted studies at the Missouri Valley Experiment Station, Rolla, Mo., on commercial and experimental magnesium-base alloys, cast and wrought, to determine their vibration damping capacity. This work was described in a paper delivered at the annual convention of the Magnesium Association.[22]

A new magnesium-base alloy containing about 0.65 percent zirconium was developed by The Dow Chemical Co. for use in sand castings for component parts in missiles.[23]

This alloy (ASTM designation K1A) was accepted for application in housings and support brackets to protect electronic components of aircraft and missiles from damaging vibration.[24]

The development of improved melting and sand-casting techniques [25] included more attention to the accuracy of pattern equipment, more careful preparation and placing of gates and risers in the molding sand, and new methods for control of composition of the sand.

New techniques for melting and casting high-temperature magnesium-thorium alloys were developed; new methods of grinding, blasting, and pickling processes insured smooth, clean finishes.[26] As a safety measure, melting furnaces were equipped with necessary accessories to provide for disposal of radioactive fumes from the thorium. In preparing sand molds for these alloys, special provision was required for more shrinkage of the metal than in casting other magnesium-base alloys. Techniques were developed for artificial aging, and solution heat treatments of these magnesium-thorium alloy castings increased their tensile and yield strengths.

The first permanent mold castings were made from the relatively new magnesium alloys containing zirconium and thorium.[27] The techniques of melting these alloys prevented loss of the alloying ingredients during melting. To avoid turbulence during pouring, very small ladles were used and the permanent molds were so designed as to assume a smooth flow of the molten metal.

One of the new and improved processes for fabricating and working magnesium was chemical milling.[28] Complex patterns of various depths were etched on flat or curved surfaces, with no accumulation of dusts. Standard methods acceptable in the general handling of

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[22] Walsh, D. F., and Others, Vibration Damping Capacity of Magnesium Alloys: Proceedings of Fourteenth Annual Convention, The Magnesium Association, 1958, pp. 50–63.

[23] ASTM Bulletin, Alloy Described for Missile Applications: No. 231, July 1958, p. 15.

[24] Modern Metals, Dow Announces New Magnesium Missile Alloy: Vol. 14, No. 5, June 1958, p. 82.

[25] McCreery, L. H., Precision Pays Off: Modern Metals, vol. 14, No. 3, April 1958, pp. 66, 68, 70.

[26] Dickinson, Thomas A., Casting Magnesium-Thorium Alloys: Foundry, vol. 86, No. 2, February 1958, pp. 156, 158.

[27] Gaines, Frank, Permanent Mold Castings of Zirconium-Thorium Alloys: Foundry, vol. 86, No. 9, September 1958, pp. 136, 138.

[28] Clark, Ken, How to do Chemical Milling: American Machinist, vol. 102, No. 6, Mar. 24, 1958, pp. 125–127.

chemical solutions were used in disposing of any wastes.[29] Additional experimental data on cold-working and heat treatment of the newer magnesium-base alloys containing rare earths and zirconium were presented.[30] Solution heat treatment and aging of certain magnesium-base forgings was said to result in gains up to 40 percent in tensile yield strength, with negligible distortion during treatment.[31]

Improvements in welding techniques encouraged wider use of magnesium-base alloys in elevated temperature areas.[32] The process of dip brazing was employed to join complex magnesium components in airborne radar equipment.[33] By this method, the parts to be joined were immersed in a molten flux bath that was held at a temperature below the melting point of the parts but above the melting point of the brazing alloy. X-ray examinations showed that the joints were nearly always free from cracks, with little or no porosity. Tests indicated sheer strengths of 12,000 to 26,000 pounds per square inch for lap joints.

New and improved protective coatings and plating for magnesium and its alloys were reported.[34] Magnesium alloys immersed in a solution containing nickel and phosphorus were both age hardened and plated. This process was said to be much simpler and less expensive than electroplating.

New methods were developed to fabricate armorplate from magnesium-lithium alloys for tanks and other military vehicles.[35] When reinforced internally with steel fibers, this lightweight armorplate has high strength and deflection properties.[36]

Reports of chemical tests on cast magnesium alloy anodes [37] covered more than 7 years' service performance of these anodes for protecting steel hulls of ships from corrosion in sea water. New techniques of fabrication insured maximum cathodic protection, requiring little or no servicing of the anodes for 2 years or more.

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[29] Modern Metals, Chemical Milling Broadens Magnesium-Thorium Alloy Use in Missiles: Vol. 14, No. 7, August 1958, pp. 62, 64.
Iron Age, Chemical Milling Is New Foundry Tool: Vol. 182, No. 20, Nov. 13, 1958, p. 164.

[30] McDonald, J. C., Anomalous Behavior During Cold Working and Subsequent Heating of Certain Magnesium-Base Alloys: Trans. AIME, vol. 212, No. 1, February 1958, pp. 45–46.

[31] Modern Metals, T–6 Aging Strengthens Magnesium Forgings: Vol. 14, No. 1, February 1958, p. 76.

[32] Korbin, C. L., and Dodd, R. A., The Relationship Between Weld Cracking and Alloy Constitution in Some Binary and Ternary Magnesium Alloys: Am. Soc. Metals, Prepr. 101, 1958, 7 pp.
Breen, J. E., and Dwyer, Arthur S., The Fatigue Strength of Magnesium Alloy HK31 as Modified by a Weld Joint: ASTM Bull., No. 234, December 1958, pp. 60–63.
Steel, Magnesium Alloy Welded Without Stress Relief: Vol. 144, No. 4, Jan. 26, 1959, p. 77.

[33] Light Metals (London), Dip Brazing of Magnesium: Vol. 21, No. 246, September 1958, p. 267.

[34] Light Metals (London), Clear Anodize for Magnesium: Vol. 22, No. 250, January 1959, p. 5.
Metal Industry (London), Dip Brazing Magnesium: Vol. 93, No. 25, Dec. 19, 1958, pp. 513–514.
Huppert, Paul A., Ceramic Coating of Magnesium: Light Metal Age, vol. 16. Nos. 3, 4, April 1958, pp. 8–10.
Materials in Design Engineering, Electroless Nickel Gives Hard Surface to Magnesium: Vol. 48, No. 2, August 1958, p. 126.

[35] Steel, Light Armor: Vol. 144, No. 3, Jan. 19, 1959, p. 61.

[36] Iron Age, Metal That Almost Floats: Vol. 182, No. 10, Sept. 4, 1958, p. 37.

[37] Christie, G. L., Service Performance of Cast Magnesium Alloy Anodes: Corrosion, vol. 14, No. 7, July 1958, pp. 337t–340t.

Magnesium Compounds

By H. B. Comstock [1] and Jeannette I. Baker [2]

PRODUCTION of magnesium oxide from sea water and other magnesium-rich brines in the United States, which in 1956 increased above that obtained from ores, rose in 1958 to 59 percent of the total output of the oxide. Expansion of production facilities was reported in several countries. World production of crude magnesite was 5 percent above 1957, continuing the small but steady increase in output of the ore, as demands rose for refractories in steel furnaces. Value of exports of magnesium compounds increased 30 percent over 1957.

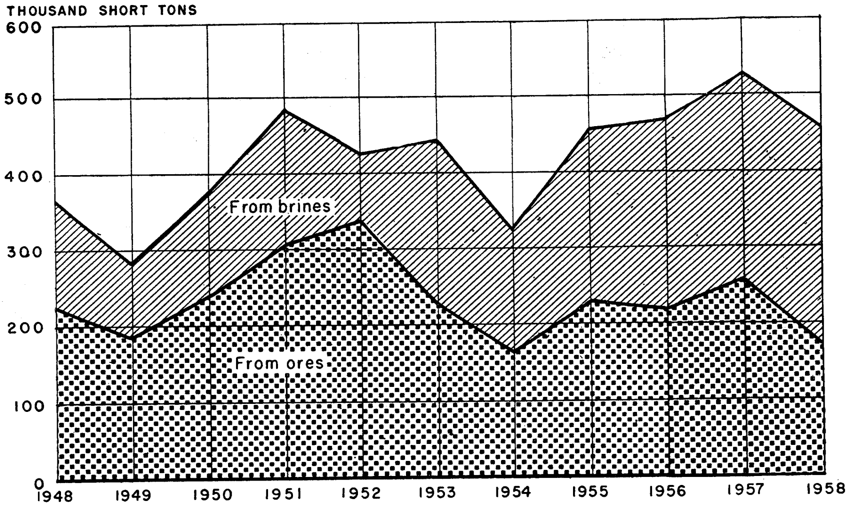

FIGURE 1.—Domestic production of magnesia from ores and brines, 1948–58.

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

TABLE 1.—Salient statistics of magnesite, magnesia, and dead-burned dolomite in the United States

	1949–53 (average)	1954	1955	1956	1957	1958
Crude magnesite produced:						
Short tons	[1] 490, 154	[1] 284, 015	[1] 486, 088	[2] 686, 569	[2] 678, 489	[2] 492, 982
Value [3]	$3, 129, 000	$1, 391, 000	$2, 713, 000	$2, 502, 000	$3, 258, 000	$2, 409, 000
Average per ton	$6. 38	$4. 90	$5. 58	$3. 64	$4. 80	$4. 89
Caustic-calcined magnesia sold or used by producers:						
Short tons	41, 002	32, 254	35, 751	35, 508	60, 815	44, 621
Value [4]	$3, 963, 000	$2, 155, 000	$2, 241, 000	$2, 426, 000	$3, 161, 000	$2, 648, 000
Average per ton [5]	$96. 67	$66. 80	$62. 67	$68. 33	$51. 97	$59. 35
Refractory magnesia sold or used by producers:						
Short tons	360, 806	288, 270	418, 761	430, 619	467, 723	414, 874
Value	$16, 022, 000	$19, 851, 000	$20, 305, 000	$22, 663, 000	$26, 319, 000	$23, 375, 000
Average per ton	$44. 41	$48. 05	$48. 49	$52. 63	$56. 27	$56. 34
Dead-burned dolomite sold or used by producers:						
Short tons	1, 853, 490	1, 520, 854	2, 128, 960	[6] 2, 423, 909	[6] 2, 251, 428	1, 659, 184
Value	$24, 317, 000	$21, 961, 000	$31, 425, 000	[6] $37, 745, 000	[6] $35, 871, 000	$27, 378, 000
Average per ton	$13. 12	$14. 44	$14. 76	[6] $15. 57	[6] $15. 93	$16. 50

[1] Includes crude ore, heavy-medium concentrates, and flotation concentrate.
[2] All run-of-mine material.
[3] Partly estimated; most of the crude is processed by mining companies, and very little enters the open market.
[4] Includes specialty magnesias of high unit value.
[5] Average receipts f.o.b. mine shipping point.
[6] Revised figure.

DOMESTIC PRODUCTION

Table 2 shows the location of mines and plants producing magnesium ores and compounds in 1958. Although mining operations were curtailed owing to decreased demands for basic refractories, Basic, Inc., began a $2-million improvement program at its ore-dressing facilities in Gabbs, Nev.[3]

Magnesia.—The expansion program in the magnesia and basic-refractories industries continued through 1958. Late in the year Michigan Chemical Corp. began constructing a new plant to produce magnesia from sea water at Port St. Joe, Fla.[4]

The new plant of Harbison-Walker Refractories Co. at Hammond, Ind., began producing several types of basic refractories early in the year.[5] The principal raw materials were magnesium oxide produced from brines in Ludington, Mich., and chromite from Cuba, the Philippines, and South Africa.

H. K. Porter Co. Inc., completed construction of a new chemicals and refractories plant at Pascagoula, Miss., and began producing basic refractories in November. Magnesia was obtained from sea water and dolomite, and chromite was imported.[6]

[3] Mining World, Nevada: Vol. 20, No. 7, June 1958, p. 81.
[4] American Metal Market, Consultant Employed: Vol. 65, No. 224, Nov. 21, 1958, p. 9.
[5] Blast Furnace and Steel Plant, Basic Refractories Plant Placed in Production: Vol. 46, No. 6, June 1958, pp. 615–617.
[6] Fortune, H. K. Porter Builds Plant to Make Basic Refractories and Magnesia from Sea Water: Vol. 59, No. 2, February 1959, pp. 42–43.
Re: Porter, Chemical Plant in Operation: December 1958, p. 12.

TABLE 2.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1958

Company	Location of mine or plant	Products	Raw materials
ALABAMA			
Norton Co	Huntsville	Heavy magnesium oxide.	Magnesite.
Tennessee Coal & Iron Division.	Fairfield	Dead-burned dolomite	Raw dolomite.
CALIFORNIA			
Fibreboard Paper Products Co.	Emeryville	Precipitated magnesium carbonate.	Sea water, dolomite.
James McPeters	Western Mine (near Livermore).	Magnesite	
Kaiser Aluminum & Chemical Corp.	Moss Landing	Caustic-calcined magnesia; refractory magnesia; magnesium hydroxide; magnesium oxide, extra-light, light, and heavy.	Sea water, dead-burned dolomite.
	Natividad	Dead-burned dolomite	Raw dolomite.
Marine Magnesium Division, Merck & Co., Inc.	South San Francisco	Magnesium oxides, extra-light, light, and heavy; magnesium hydroxide; precipitated magnesium carbonate.	Sea water, sea-water bitterns, dead-burned dolomite.
Philadelphia Quartz Co. of California.	Alameda County	Epsom salt	Magnesite, brucite, calcined magnesia.
Westvaco Chemical Division, Food Machinery & Chemical Corp.	Newark	Caustic-calcined magnesia; refractory magnesia; magnesium chloride crystals; magnesium hydroxide.	Sea-water bitterns, dead-burned dolomite, magnesite.
DELAWARE			
E. I. du Pont de Nemours & Co.	New Castle	Magnesium chloride	Byproduct from reducing titanium tetrachloride with magnesium.
ILLINOIS			
Johns-Manville Products Corp.	Waukegan	Precipitated magnesium carbonate.	Dolomite.
Marblehead Lime Co	Thornton	Dead-burned dolomite	Raw dolomite.
Standard Lime & Cement Co.	LaGrange	Do.	Do.
MICHIGAN			
Dow Chemical Co	Ludington	Magnesium chloride crystals; magnesium chloride fluxes; magnesium hydroxide.	Well brines.
	Midland	Epsom salt	Do.
Harbison Walker Refractories Co.	Ludington	Refractory magnesia	Magnesium hydrate.
Michigan Chemical Corp.	St. Louis	Precipitated magnesium carbonate; magnesium hydroxide; magnesium oxide, extra-light, light, and heavy.	Well brines, dead-burned dolomite.
Morton Chemical Co	Manistee	Precipitated magnesium carbonate; magnesium oxide, extra-light and light.	Well brines.
Standard Lime & Cement Co.	do	Refractory magnesia	Do.

TABLE 2.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1958—Continued

Company	Location of mine or plant	Products	Raw materials
MISSISSIPPI			
H. K. Porter Co	Pascagoula	Refractory magnesia	Raw dolomite, sea water.
MISSOURI			
Valley Dolomite Corp	Bonne Terre	Dead-burned dolomite	Raw dolomite.
NEVADA			
Basic, Inc	Gabbs	Brucite, magnesite, refractory magnesia, caustic-calcined magnesia.	Magnesite and brucite.
Standard Slag Co	do	Magnesite, refractory magnesia, caustic-calcined magnesia.	Magnesite
NEW JERSEY			
J. T. Baker Chemical Co	Phillipsburg	Magnesium chloride crystals; epsom salt; other high purity magnesium chemicals.	Magnesium carbonate
Northwest Magnesite Co	Cape May	Refractory magnesia	Sea water, calcined dolomite.
NEW MEXICO			
International Minerals & Chemical Corp.	Carlsbad	Magnesium oxide, heavy.	Potash-reject brines.
NEW YORK			
Carborundum Metals Co	Erie	Magnesium chloride	Byproduct from producing zirconium.
NORTH CAROLINA			
Balsam Gap Co	Balsam Gap Mine (near Sylva).	Olivine	
Harbison-Walker Refractories Co.	Addie Mine (near Sylva).	do	
C. R. Wiseman	Wray Mine (near Burnsville).	do	
OHIO			
J. E. Baker Co	Millersville	Dead-burned dolomite	Raw dolomite.
Basic, Inc	Maple Grove	do	Do.
Dolite Co	Gibsonburg	do	Do.
Moores Lime Co	Springfield	do	Do.
Ohio Lime Co	Woodville	do	Do.
Standard Lime & Cement Co.	do	do	Do.

TABLE 2.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1958—Continued

PENNSYLVANIA

Company	Location of mine or plant	Products	Raw materials
J. E. Baker Co.	York	Dead-burned dolomite	Raw dolomite.
Philip Carey Mfg. Co.	Plymouth Meeting	Precipitated magnesium carbonate; magnesium oxide, extra-light and light.	Dolomite.
G. & W. H. Corson	do	Dead-burned dolomite	Raw dolomite.
Keasbey & Mattison Co.	Ambler	Precipitated magnesium carbonate; magnesium oxide, extra-light and light.	Dolomite.

TEXAS

Company	Location of mine or plant	Products	Raw materials
Dow Chemical Co.	Freeport	Magnesium chloride, cell-feed; caustic-calcined magnesia.	Sea water.

UTAH

Company	Location of mine or plant	Products	Raw materials
Marblehead Lime Co.	Delle	Dead-burned dolomite	Raw dolomite.

WASHINGTON

Company	Location of mine or plant	Products	Raw materials
Agro Minerals, Inc.	Tonasket	Epsom salt	Lake brine.
Northwest Magnesite Co.	Chewelah	Magnesite, caustic-calcined magnesia, refractory magnesia.	Magnesite.
Northwest Olivine Co.	Twin Sisters Quarry (near Clear Lake).	Olivine	

WEST VIRGINIA

Company	Location of mine or plant	Products	Raw materials
Jones & Laughlin Steel Corp.	Millville	Dead-burned dolomite	Raw dolomite.
Standard Lime & Cement Co.	do	Refractory magnesia, dead-burned dolomite.	Dolomite.

TABLE 3.—Magnesia sold or used by producers in the United States, 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 (thousands)	Short tons	Value (thousands)	Short tons	Value (thousands)
1957						
Caustic-calcined	28,688	$828	32,127	$2,332	60,815	$3,161
Refractory	228,384	10,624	239,339	15,695	467,723	26,319
Total	257,072	11,452	271,466	18,027	528,538	29,480
1958						
Caustic-calcined	12,836	277	31,785	2,371	44,621	2,648
Refractory	161,767	7,420	253,107	15,955	414,874	23,375
Total	174,603	7,697	284,892	18,326	459,495	26,023

[1] Magnesia made from a combination of dolomite and sea water is included with that from sea water.

Dolomite.—Production of dead-burned dolomite decreased 26 percent in quantity and 24 percent in value below 1957.

TABLE 4.—Dead-burned dolomite sold in and imported into the United States

Year	Sales of domestic product		Imports [1]	
	Short tons	Value (thousands)	Short tons [2]	Value (thousands)
1949–53 (average)	1,853,490	$24,317	2,583	$134
1954	1,520,854	21,961	4,426	345
1955	2,128,960	31,425	7,993	558
1956	[3] 2,423,909	[3] 37,745	9,031	587
1957	[3] 2,251,428	[3] 35,871	10,419	640
1958	1,659,184	27,378	5,686	322

[1] Dead-burned basic refractory material comprising chiefly magnesium and lime.
[2] Includes weight of immediate container.
[3] Revised figure.

In June Marblehead Lime Co. began operating its new plant in Tooele County, Utah, to produce dead-burned dolomite for steel mills.[7] Dolomite came from deposits on the western shore of Great Salt Lake.

Brucite.—Mine output of brucite decreased to approximately one-fourth of the quantity and value of 1957 production. Basic, Inc., Gabbs, Nev., remained the only producer.

Olivine.—Production of olivine was about one-half the 1957 output.

Other Magnesium Compounds.—Total production of specified magnesias, U.S.P. and technical grades, both light and heavy increased 6 percent over 1957. A decrease in total output of magnesium chloride to approximately one-third the 1957 production was due largely to curtailment in requirements for magnesium metal when the Velasco (Tex.) magnesium plant was closed in March. Magnesium trisilicate was produced at two plants in 1958. Output rose 53 percent above that in 1957.

CONSUMPTION AND USES

Consumption of magnesium ores and compounds, except specified magnesias, magnesium hydroxide, and magnesium trisilicate, decreased. Although steel production dropped 24 percent below the 1957 level, the consumption of refractory magnesia decreased only 11 percent owing to the widening acceptance of the all-basic open hearth and especially to the increase in all-basic roof construction.[8]

[7] Pit and Quarry, Marblehead's New Utah Plant Producing Dead-Burned Dolomite for Western Steel Markets: Vol. 51, No. 5, November 1958, pp. 122–125.
[8] Heuer, R. P., All-Basic Open Hearths to Sweep Steelmaking: Steel, vol. 144, No. 1, Jan. 5, 1959, pp. 212, 214.
Metal Progress, The All-Basic Open Hearth: Vol. 73, No. 6, June 1958, pp. 85–87.

TABLE 5.—Specified magnesium compounds produced, sold, and used by producers in the United States

Products [1]	Plants	Produced (short tons)	Sold		Used (short tons)
			Short tons	Value (thousands)	
1957					
Specified magnesias (basis, 100 percent MgO), U.S.P. and technical:					
Extra-light and light	5	2,130	2,219	$1,197	------
Heavy	3	18,689	17,654	2,133	204
Total	[2] 6	20,819	19,873	3,330	204
Precipitated magnesium carbonate	7	30,231	7,566	1,768	22,111
Magnesium hydroxide, U.S.P. and technical (basis, 100 percent Mg $(OH)_2$)	4	156,610	7,526	551	148,931
Magnesium chloride	5	360,348	16,217	770	[3] 333,000
1958					
Specified magnesias, (basis, 100 percent MgO), U.S.P. and technical:					
Extra-light and light	6	1,833	1,954	1,043	------
Heavy	4	20,133	18,359	2,178	1,799
Total	[2] 8	21,966	20,313	3,221	1,799
Precipitated magnesium carbonate	7	25,696	7,224	1,342	18,687
Magnesium hydroxide, U.S.P. and technical (basis, 100 percent Mg $(OH)_2$)	5	213,115	65,062	1,915	129,641
Magnesium chloride	5	130,176	13,493	744	[3] 120,000

[1] In addition, magnesium phosphate, nitrate, sulfate, and trisilicate were produced.
[2] A plant producing more than 1 grade is counted but once in arriving at total.
[3] Greater part used for magnesium metal.

TABLE 6.—Domestic consumption of caustic-calcined magnesia (percent) by uses

Use	1954	1955	1956	1957	1958
Oxychloride and oxysulfate cement	33	34	32	30	50
Rayon	3	4	3	1	2
Fertilizer	2	1	2	(1)	(1)
85 percent MgO insulation	14	11	10	6	10
Rubber	1	3	8	2	4
Fluxes	1	(1)	(1)	(1)	(1)
Refractories	------	4	------	29	(1)
Chemical processing	------	------	------	------	[2] 2
Uranium processing	------	------	------	------	[2] 6
Miscellaneous (including chemicals and paper industry)	46	43	45	32	26
Total	100	100	100	100	100

[1] Less than 1 percent.
[2] Previously included in miscellaneous.

TABLE 7.—Domestic consumption of U.S.P. and technical-grade magnesias (percent) by uses

Use	1954	1955	1956	1957	1958
Rayon	24	16	8	17	18
Rubber (filler and catalyst)	47	27	9	18	12
Refractories	10	15	42	11	11
Medicinal	3	7	1	3	(1)
Uranium processing	------	2	3	4	5
Fertilizer	------	------	------	(1)	1
Electrical	------	------	------	------	[2] 21
Neoprene compounds	------	------	------	------	[2] 2
Miscellaneous	16	33	37	47	30
Total	100	100	100	100	100

[1] Less than 1 percent.
[2] Previously included in miscellaneous.

PRICES

Few changes were noted in prices and net-sales values of magnesium compounds from 1957. The average net-sales value of caustic-calcined, oxychloride-cement-grade magnesia increased $7.21 per ton, and dead-burned-dolomite price ranges narrowed from $15 to $17 per ton at the close of 1957 to $15.60 to $17 per ton at the close of 1958.

TABLE 8.—Prices quoted on selected magnesium compounds, carlots

Commodity	Container	F.o.b.	Source	December 1957	December 1958
Magnesite:					
Caustic-calcined, oxychloride-cement-grade, powdered short tons..	Bags	Newark, Calif.	(1)	[2] $82.79	$90.00.[2]
Dead-burned, grain.......do....	Bulk	Chewelah, Wash.	(3)	46.00	Unchanged.
Do.......do....	Bags	do	(3)	52.00-54.00	Do.
Periclase: Kiln-run, 90-percent short tons..	Bulk	Newark, Calif.	(1)	60.00	Do.
Dead-burned dolomite, domestic short tons..	do	Works	(4)	15-17	15.60-17.[5]
Epsom salt: Technical-grade 100 pounds..	Bags	do	(6)	2.15	Unchanged.
Magnesia, calcined:					
Technical-grade.......pound..	Cartons	do	(6)	.2575-.265	Do.
Synthetic-rubber-grade....do....	do	do	(6)	.2975-.305	Do.
U.S.P.:					
Light.......do....	do	do	(6)	.365-.375	Do.
Heavy.......do....	Barrels	do	(6)	.45-.52	Do.
Magnesium carbonate:					
Technical-grade.......do....	Bags	(7)	(6)	.105	Do.
U.S.P.-grade.......do....	do	(7)	(6)	.13	Do.
Magnesium chloride (hydrous), powdered or flaked..short tons..	Barrels	Works	(6)	55.00	Do.
Magnesium hydroxide: Medicinal-grade.......pound..	Drums		(6)	.245-.255	Do.

[1] General average from producing industry.
[2] Average net-sales value.
[3] E&MJ Metal and Mineral Markets.
[4] Steel.
[5] Effective July 28.
[6] Oil, Paint and Drug Reporter.
[7] Magnesium carbonate prices are quoted f.o.b. works, freight equalized with Metropolitan New York and competitive producing points.

FOREIGN TRADE [9]

The duty on crude magnesite in 1958, based on the Geneva Agreement of 1947, was at $^{15}/_{64}$ cent per pound, with an ad valorem of 15.2 percent. The duty on dead-burned and grain magnesite and periclase was $^{23}/_{60}$ cent per pound, with an ad valorem of 12 percent; on caustic-calcined magnesia, $^{15}/_{32}$ cent per pound, with an ad valorem of 19.6 percent, and on magnesium oxide, $2\frac{1}{2}$ cents per pound, with an ad valorem of 14.9 percent. The duty on dead-burned dolomite was 15 percent ad valorem.

Exports.—Magnesite, magnesia, and manufactures (except refractories) exported in 1958 were valued at $3,721,000—a 30 percent increase above the 1957 figure of $2,863,000.

[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 9.—Crude and processed magnesite imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957		1958	
	Short tons	Value	Short tons	Value
CRUDE MAGNESITE				
Asia: India	------	------	11	$340
LUMP OR GROUND CAUSTIC-CALCINED MAGNESIA				
Europe:				
Austria	110	$4,300	66	$2,623
Netherlands	534	30,205	529	29,814
United Kingdon	45	9,371	24	5,596
Yugoslavia	1,885	69,997	882	33,659
Total	2,574	113,873	1,501	71,692
Asia: India	3,060	150,955	895	43,103
Grand total	5,634	264,828	2,396	114,795
DEAD-BURNED AND GRAIN MAGNESIA AND PERICLASE				
North America: Canada	343	$64,153	814	$197,020
Europe:				
Austria	25,872	1,701,936	41,251	2,743,458
Germany, West	------	------	2,756	158,675
Sweden	11	2,064	------	------
Switzerland	------	------	8,642	604,969
Trieste	19,998	978,131	5,557	372,531
Yugoslavia	28,780	1,286,967	16,203	720,405
Total	74,661	3,969,098	74,409	4,600,038
Grand total	75,004	4,033,251	75,223	4,797,058

TABLE 10.—Magnesium compounds imported for consumption in the United States

[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
1949–53 (average)	1	$100	211	$59,723	67	$2,406	3,251	$79,106	305	$65,947	23	$7,066
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
1958	355	119,012	326	66,174	685	28,038	9,908	238,236	1,202	52,814	1	660

[1] Includes magnesium silicofluoride or fluosilicate and calcined magnesia.
[2] Data known to be not comparable to other years.

TABLE 11.—Magnesite and magnesia exported from the United States, by countries

[Bureau of the Census]

Country	Magnesite and magnesia, dead-burned				Magnesite and magnesia (except dead-burned), and manufactures, n.e.c.[2]	
	1957		1958[1]		1957	1958[1]
	Short tons	Value	Short tons	Value	Value	Value
North America:						
Canada	697	$111,764	1,615	$230,213	$546,950	$236,144
Cuba	----	----	----	----	80,525	80,499
El Salvador	----	----	5	604	2,974	2,482
Honduras	----	----	----	----	8,280	21,987
Mexico	4,065	240,075	8,185	531,962	193,534	24,934
Other North America	----	----	----	----	24,557	27,780
Total	4,762	351,839	9,805	762,779	856,820	393,826
South America:						
Argentina	3	1,890	3	1,996	7,656	32.435
Brazil	----	----	----	----	33,193	105,035
Chile	117	8,846	80	7,589	14,281	25,797
Colombia	----	----	20	2,160	18,905	8,327
Venezuela	----	----	10	1,910	104,577	46,143
Other South America	----	----	----	----	16,573	17,877
Total	120	10.736	113	13,655	195,185	235,614
Europe:						
Denmark	16	11,749	22	14,591	----	----
France	----	----	5	961	36,128	22,498
Germany, West	----	----	247	38,065	9,707	1,463
Italy	----	----	4	2,712	9,156	----
Norway	1	842	6	4,977	----	12,096
Sweden	----	----	7	4,537	4,588	15,078
Switzerland	1	702	3	2,233	2,836	2,029
Spain	----	----	57	41,164	----	14,306
United Kingdom	1	681	32	20,209	13,144	----
Other Europe	(3)	506	----	----	13,619	4,166
Total	19	14,480	383	129,449	89,178	71,636
Asia:						
Japan	21,176	983.831	42,736	1,891,344	73,232	50,062
Korea, Republic of	331	15,684	----	----	50,144	27,155
Philippines	----	----	----	----	28,201	31,750
Taiwan	105	6,935	50	3,125	46,577	----
Other Asia	635	43,434	----	----	31,331	12,411
Total	22,247	1,049,884	42,786	1,894,469	229,485	121,378
Africa:						
Belgian Congo	----	----	----	----	36,116	57,912
Union of South Africa	----	----	7	4,719	525	3,312
Other Africa	----	----	----	----	722	----
Total	----	----	7	4,719	37,363	61,224
Oceania: Australia	12	8,681	47	32,621	19,330	----
Grand total	27,160	1,435,620	53,141	2,837,692	1,427,361	883,678

[1] Owing to changes in classifications by the Bureau of the Census, data not strictly comparable with 1957; combined values are comparable.
[2] Not elsewhere classified.
[3] Less than 1 ton.

WORLD REVIEW

World production of crude magnesite increased 5 percent above 1957. Austria continued to lead.

EUROPE

Austria.—Veitscher Magnesitwerke, Austria's largest producer of magnesite, founded a magnesite research center at Goess in the Province of Styria.[10]

Greece.—The Anglo-Greek Magnesite Co., Ltd., reported difficulty in marketing magnesite for flooring, owing to competition from tile manufacturers.[11]

TABLE 12.—World production of magnesite, by countries,[1] in short tons[2]

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

Country[1]	1949–53 (average)	1954	1955	1956	1957	1958
North America: United States	490,154	284,015	486,088	686,569	678,489	492,982
Total[1 3]	750,000	760,000	720,000	990,000	970,000	740,000
South America:						
Brazil[3]	9,920	11,000	11,000	11,000	11,000	3,000
Venezuela	1,100					
Total[3]	11,020	11,000	11,000	11,000	11,000	3,000
Europe:						
Austria	723,928	925,007	1,093,173	1,194,502	1,292,567	1,346,133
Bulgaria	50,883	92,704	124,561	155,536	[3] 154,300	[3] 165,350
Czechoslovakia	[3] 203,900	(4)	(4)	(4)	(4)	(4)
Germany, West	2,772					
Greece	64,056	114,410	66,980	68,350	52,392	77,162
Italy	1,130	3,348	4,527	5,448	8,512	6,500
Norway	1,709	915	874	1,124	[3] 880	[3] 880
Poland	[3] 17,000	35,825	21,639	18,673	18,850	[3] 18,750
Spain	12,300	32,399	29,973	26,891	40,455	62,828
Yugoslavia	94,229	153,572	129,114	214,260	233,983	246,032
Total[1 3]	2,700,000	3,200,000	3,300,000	3,600,000	3,700,000	3,800,000
Asia:						
Cyprus (exports)	22					
India	99,161	78,968	64,410	102,717	99,552	110,880
Korea, Republic of	73					
Turkey	1,888	1,174		937	1,439	717
Total[1 3]	275,000	420,000	530,000	730,000	780,000	1,240,000
Africa:						
Egypt	255					
Kenya	42				117	551
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	11,429	7,792	11,610	8,611	2,910	
Tanganyika (exports)	629	87	367	272	284	337
Union of South Africa	19,476	26,874	19,753	33,485	35,414	80,200
Total	31,831	34,753	31,730	42,368	38,725	81,088
Oceania:						
Australia	44,049	48,331	64,595	72,447	93,490	75,706
New Zealand	577	807	434	818	675	[3] 660
Total	44,626	49,138	65,029	73,265	94,165	76,366
World total (estimate)[1 2]	3,800,000	4,500,000	4,700,000	5,450,000	5,600,000	5,900,000

[1] Quantities in this table represent crude magnesite mined. In addition to countries listed, magnesite is also produced in Canada, China, Mexico, North Korea, 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 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.

[10] Mining World, Austria: Vol. 21, No. 1, January 1959, p. 77.
[11] Mining World and Engineering Record (London), Anglo-Greek Magnesite: Vol. 174, No. 4519, October 1958, p. 369.

TABLE 13.—Exports of magnesia and magnesite brick from Austria, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	Magnesia				Magnesite brick	
	Caustic-calcined		Refractory			
	1957	1958	1957	1958	1957	1958
North America: United States	139	98	19,426	31,207	16	154
South America:						
Argentina	204	70	1,601	2,329	3,836	9,624
Brazil	16	9	--	--	156	212
Chile	83	--	119	193	595	836
Colombia	--	--	40	--	554	--
Mexico	--	--	6	6	379	477
Peru	--	--	--	134	3	374
Europe:						
Belgium-Luxembourg	99	131	569	701	9,693	8,940
Bulgaria	--	--	116	40	1,234	774
Czechoslovakia	4,868	5,176	472	169	551	296
Denmark	82	109	1,084	471	4,980	4,589
Finland	--	--	474	336	3,075	2,946
France	3,347	3,979	9,927	12,351	38,325	43,704
Germany: West	72,923	73,018	58,140	53,462	63,651	46,813
Greece	--	--	191	272	1,120	1,903
Hungary	1,027	1,391	7,417	5,800	247	--
Italy	3,214	3,331	10,672	9,655	34,304	17,854
Netherlands	15	21	186	98	6,811	5,072
Norway	--	--	284	333	1,835	2,294
Poland	2,918	--	6,381	1,422	4,990	4,518
Rumania	--	--	--	--	2,144	1,531
Saar	--	--	349	402	2,429	6,096
Spain	--	--	55	103	1,289	2,008
Sweden	88	83	1,122	741	11,732	10,736
Switzerland	2,433	2,301	1,009	728	1,130	1,542
United Kingdom	150	--	32,661	13,221	3,293	5,005
Asia:						
India	--	--	1,195	442	2,950	6,581
Japan	22	--	10,836	9,190	238	282
Korea, Republic of	--	--	655	470	294	--
Turkey	--	22	266	162	5,074	2,585
Africa:						
Belgian-Congo	--	8	70	43	142	651
Egypt	28	11	54	58	1,779	1,051
Oceania: Australia	10	--	1,540	220	6,657	6,880
Other countries	443	312	1,545	1,685	9,948	10,700
Total	92,059	90,070	168,462	146,444	225,454	207,028

[1] Compiled from customs returns of Austria.

TABLE 14.—Exports of magnesite and calcined magnesia from Greece, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	Crude magnesite		Calcined magnesia	
	1957	1958	1957	1958
Austria	5,508	7,743	--	--
France	3,412	6,100	--	--
Germany:				
East	4,488	5,192	--	--
West	--	--	12,063	10,096
Italy	2,028	2,083	--	--
Netherlands	829	1,682	15,782	15,370
United Kingdom	--	--	3,412	3,491
Other countries	2,159	2,276	1,802	2,199
Total	18,424	25,076	33,059	31,156

[1] Compiled from customs returns of Greece.
[2] This table incorporates a number of revisions of data published in previous Magnesium Compounds chapters.

TABLE 15.—Exports of refractory magnesia from Netherlands, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1954	1955	1956	1957	1958
Belgium-Luxembourg	503	386	602	595	596
Denmark	825	695	670	588	665
Finland	540	784	787	547	320
France	190	131	119	248	259
Germany, West	9,197	10,546	8,926	7,980	5,675
Norway	470	333	331	280	199
Portugal	99	84	112	138	150
Saar	202	142	229	126	152
Sweden	975	960	826	774	888
Union of South Africa	127	177	69	106	99
United Kingdom	3,746	3,727	3,788	3,285	2,997
United States	----------	----------	290	505	629
Other countries	140	233	346	373	334
Total	17,014	18,198	17,095	15,545	12,963

[1] Compiled from customs returns of the Netherlands.

United Kingdom.—A new plant of The Steetley Co., Ltd., Hartlepool, County Durham, for producing refractory magnesia from dead-burned dolomite and sea water was reported to be the largest producer of refractories in Europe.[12]

ASIA

India.—Output of magnesite in India increased 11 percent over 1957. Dalmia Magnesite Corp. began producing dead-burned magnesite at its new plant at Chettichavadi Jagir, near Salem, in December. Plant capacity was reported to be 100 tons a day.[13]

TECHNOLOGY

Progress in research on magnesium ores and compounds reflected the increasing demands by metal industries for basic refractories with improved properties.

Basic research was reported on magnesium oxide crystals. Analyses of optical and X-irradiation showed results of the growth and thermal decay of the optical absorption.[14] MgO crucibles were used for melting uranium. The use of fused magnesia crucibles for melting nickel and cobalt was described. Contamination of the melt was held to a minimum.[15]

Harbison-Walker Refractories Co. increased its programs of fundamental and applied research and in December moved all research work to a newly completed research center near Pittsburgh, Pa.[16]

[12] Metallurgia (London), Magnesia from Sea Water: Vol. 58, No. 349, November 1958, pp. 225–227.
Chemical Age (London), Steetley's Sea Water Magnesia Plant Now Meets All U.K. Requirements: Vol. 80, No. 2047, Oct. 4, 1958, pp. 558–559.
[13] Da Silva, A. L. (drafting officer), Package Report on New Installations and Expansions: State Dept. Dispatch 333, Madras, India, Jan. 22, 1959, p. 2.
[14] Shatas, R. A., and others, Post-Bombardment Conductivity in MgO Crystals: Phys. Rev., vol. 109, No. 6, Mar. 15, 1958, pp. 1953–1958.
[15] Advanced Materials Technology, Crystals That Bend: Vol. 1, No. 5, December 1958, pp. 2–3.
[16] Brick and Clay Record, Harbison-Walker Refractories: Vol. 134, No. 1, January 1959, p. 77.

Kaiser Aluminum & Chemical Corp. consolidated and expanded the magnesia and basic refractory research programs at its Milpitas (Calif.) laboratories.[17]

Improvements in process and equipment for producing magnesia from sea water were described.[18] A report gave results of tests by producers and consumers of basic refractories to determine the extent of hydration in the materials.[19] Periclase brick was developed and substituted for chrome brick in subhearths of open-hearth and electric furnaces. Successful operating service was reported after 4 years of testing a basic refractory material to protect floor surfaces of marine and stationary boilers. The material was produced from periclase fired at 3,250° F.[20] Results were given of tests on basic refractories containing additions of various metal oxides.[21]

Physical and thermal properties of 85-percent-magnesia insulation material were compared with those of calcium silicate and silica insulation materials.[22]

Preparation of magnesia to form standard shapes for insulating industrial furnaces was described, with test results of its strength in different temperature ranges.[23] Compressed, granular magnesium oxide (periclase) was applied to enclosed, coiled heating elements.[24]

An improved process was adopted for preparing wood pulp to make paper.[25] Using magnesium hydroxide instead of calcium in the sulfur dioxide solution improved the quality of the pulp, enabled recycling of the chemicals with considerable saving of chemicals and fuel, and prevented pollution of streams and rivers near the plants.[26]

Hercules Powder Co. reported improvements in equipment and processes for producing nitric acid in its plant at Parlin, N.J.[27] Substituting magnesium carbonate for sulfuric acid in dehydrating the acid decreased the cost of operation and reduced corrosion.

Magnesium carbonate was used with asbestos fibers to produce insulation material for industrial applications. Preparation and application of the material were described.[28]

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[17] The Glass Industry, Kaiser Chemicals Expands Refractory Research: Vol. 39, No. 5, May 1958, p. 294.

[18] Forbath, T. Peter, Magnesia from Sea Via Streamlined Process: Chem. Eng., vol. 65, No. 6, pp. 112–115.

[19] Eusner, G. R., and Bachman, J. R., Hydration of Basic Refractories: Bull. Am. Ceram. Soc., vol. 37, No. 5, May 1958, pp. 213–219.

[20] American Metal Market, Refractory Material Designed to Reduce Slag Break-Cost: Vol. 65, No. 101, May 24, 1958, p. 5.

[21] Nelson, James W., and Cutler, Ivan, Effect of Oxide Additions on Sintering of Magnesia: Jour. Am. Ceram. Soc., vol. 41, No. 10, October 1958, pp. 406–409.

[22] Materials in Design Engineering, New Property Data for Thermal Insulations: Vol. 48, No. 7, December 1958, pp. 150–152.

[23] Industrial Heating, Casting Magnesium Oxide: Vol. 25, No. 4, April 1958, pp. 800–802.

[24] Karpinski, J. M., and others, Thermal Conductivity and Dielectric Strength of Periclase Insulation: Bull. Am. Ceram. Soc., vol. 37, No. 7, July 1958, pp. 329–333.

[25] Chilton, C. H., Magnesia Buttons Up Sulfite Pulping: Chem. Eng., vol. 67, No. 18, pp. 114–117.

[26] Chemical Week, New Incentive for Pulping Switch: Vol. 83, No. 15, Oct. 11, 1958, pp. 79–80.

[27] Chemical and Engineering News, "Maggie" Concentrates Nitric: Vol. 36, No. 23, June 9, 1958, pp. 40–41.
Chemical Engineering, New Process Chops Cost of Concentrating Nitric: Vol. 65, No. 15, July 28, 1958, p. 68.

[28] Materials in Design Engineering, 85% Magnesia: Vol. 47, No. 3, March 1958, pp. 125–127.

The properties of olivine were discussed and results of studies of its use in steel and nonferrous foundries were given.[29] When used as molding sand, olivine withstood thermal shock without cracking or shattering. Comparison of molding sands showed that using olivine sand for steel castings containing manganese reduced cleaning costs, because the olivine did not adhere to the steel as much as silica sand did. Some nonferrous foundries shifted from synthetic silica sand to synthetic olivine sand containing no organic material. Grain size of aluminum castings formed in olivine sand was finer.

[29] Schaller, Gilbert S., and Snyder, W. A., Industrial Applications of Olivine Aggregate: Modern Castings, vol. 33, No. 6, June 1958, pp. 295–300.

Manganese

By Gilbert L. DeHuff [1] and Teresa Fratta [2]

GOVERNMENT purchases of manganese ore continued to result in relatively high domestic production (ore, concentrate, and nodules), amounting to 323,000 short tons in 1958. Domestic-ore consumption of 1.5 million short tons and ore imports of 2.5 million short tons were lower than in 1957.

LEGISLATION AND GOVERNMENT PROGRAMS

Financial participation in the exploration of domestic manganese deposits was continued by the Defense Minerals Exploration Administration (DMEA) at 75 percent of approved exploration costs until termination of the program June 30. Uncompleted manganese projects, five in number, were then continued in effect under administration of the newly created Office of Minerals Exploration (OME). Regulations published in September set Government participation with respect to new applications at 50 percent of the total allowable costs for all eligible minerals, including manganese.

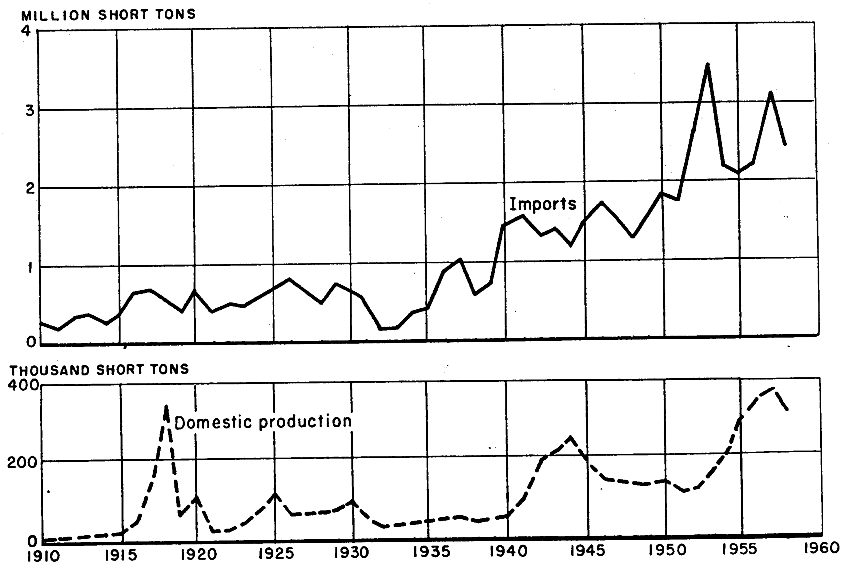

FIGURE 1.—General imports and domestic production (shipments) of manganese ore, 1910–58.

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

TABLE 1.—Salient statistics of manganese in the United States, gross weight in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
Manganese ore (35 percent or more Mn):						
Production (shipments):						
Metallurgical ore	114,017	191,376	275,544	341,291	364,227	323,108
Battery ore	13,640	14,694	11,711	3,444	2,107	(1)
Miscellaneous ore	45	58				
Total shipments [2]	127,702	206,128	287,255	344,735	366,334	323,108
Value (thousands)	$7,637	$15,176	$21,651	$26,990	$29,363	$23,300
General imports	2,263,371	2,165,694	2,078,205	2,238,568	3,105,172	2,452,578
Consumption	1,781,602	1,740,648	2,109,623	2,264,159	2,361,460	1,497,574
Manganiferous ore (5 to 35 percent Mn):						
Production (shipments)	1,117,278	558,332	911,636	680,651	865,127	520,601
Value (thousands)	$5,190	$3,079	$5,128	$3,984	$5,413	$3,532
Ferromanganese:						
Domestic production	750,908	718,721	869,977	923,012	963,814	636,736
Imports for consumption	97,068	56,772	65,121	160,203	[3] 338,079	63,932
Exports	2,081	1,732	1,789	2,248	7,395	1,406
Consumption	800,913	716,910	934,451	945,210	935,725	674,495

[1] Battery ore included in metallurgical.
[2] Shipments are used as the measure of manganese production for compiling U.S. mineral-production value. They are taken at the point that the material is considered to be in marketable form from the consumer's standpoint.
[3] Revised figure.

The terminal date for registration to participate in the Government's "carlot" domestic-manganese purchase program was extended from June 30 to December 31, 1958. As of the latter date, 22,133,000 long-ton units of contained manganese had been acquired of the 28 million authorized. Low-grade manganese ores and concentrates, and a small quantity of high-grade, continued to be received under the Butte-Philipsburg program until its termination in May with fulfillment of its quota of 6 million long-ton units of recoverable manganese. On December 31, the General Services Administration (GSA) announced the sale to Electro Metallurgical Co. of approximately 297,000 long tons of low-grade Mexican ore that had been purchased in 1953 and 1954 under Defense Materials Procurement Agency (DMPA) contracts and which was stockpiled at El Paso, Tex. The sale price was based at $0.17 per long-ton unit of contained manganese for ore of 30 percent manganese content.

DOMESTIC PRODUCTION

Government purchases of domestic Metallurgical-grade material on the carlot program and under special contracts for Nevada nodules absorbed more than three-fourths of the 1958 production of manganese ore containing 35 percent or more manganese. Shipments under the carlot program from Western States in 1958 decreased 6 percent to 108,000 short tons; shipments also were made under the program from Arkansas, Georgia, Missouri, Tennessee, and Virginia.

Manganese, Inc., was again responsible for Nevada's leading position among the manganese-ore-producing States. It produced metallurgical nodules containing 45 percent manganese from Three Kids oxide ore. Arizona, with more than 90 mines shipping to the carlot program, was in second place among the States. Metallurgical nodules containing approximately 57 percent manganese, produced by The Anaconda Co. from Butte carbonate ore, provided the bulk of Montana manganese-ore shipments. The greater part of these nodules continued to be used by The Anaconda Co. to make standard ferromanganese, containing 80 percent manganese, in electric furnaces in Montana. The Nation's only production of natural Battery-grade ore or concentrate was from the Philipsburg district of Montana, and Trout Mining Division, American Machine and Metals, Inc., was the principal producer. Manganese Chemicals Corp., Riverton, Minn., continued to use the ammonium carbamate leach process to produce synthetic battery ore and synthetic miscellaneous ore from low-grade Cuyuna range material.

Commercial shipments of low-grade manganese ores containing 10 to 35 percent manganese were made from Arizona, Georgia, Minnesota, Montana, New Mexico, and Virginia. 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 shown in tables 1, 2, 3, and 10, the Government received low-grade ores and concentrates, together with a small quantity of higher grade, under its Butte-Philipsburg purchase program until close of the depot in May. Almost all of the low-grade receipts came from Montana; only small quantities came from Nevada and Utah. Deliveries of higher grade ore or concentrate were made from Montana, Utah, and Washington. None of the depot shipments are included in the tables, nor will they appear in them until shipment is made from the depots as usable ore or concentrate.

TABLE 2.—Metallurgical manganese ore,[1] ferruginous managanese ore,[2] and manganiferous iron ore,[3] shipped in the United States, by States, in short tons

State	1957			1958		
	Metallurgical manganese ore	Ferruginous manganese ore	Manganiferous iron ore	Metallurgical manganese ore	Ferruginous manganese ore	Manganiferous iron ore
Arizona	79,505			62,279	1,455	
Arkansas	23,261			22,221		
California	9,009			17,644		
Colorado	175			210		
Michigan			123,547			112,536
Minnesota	(4)	200,817	491,478		50,289	320,314
Montana	66,191	4,547		[5] 53,123	(4)	
Nevada	129,046			127,322		
New Mexico	25,459	42,535		24,665	(4)	
Tennessee	12,938			5,935		
Utah	142			1,043		
Virginia	12,655			8,128	56	
Undistributed [6]	5,846			538	35,951	
Total	364,227	247,899	615,025	323,108	87,751	432,850

1 Containing 35 percent or more manganese (natural).
2 Containing 10 to 35 percent manganese (natural).
3 Containing 5 to 10 percent manganese (natural).
4 Included with "Undistributed."
5 Includes battery ore.
6 Includes shipments of metallurgical manganese ore from Georgia, Missouri, Oklahoma, and West Virginia in 1957; from Georgia and Missouri in 1958; and shipments of ferruginous manganese ore from Georgia in 1958.

TABLE 3.—Manganese and manganiferous ores shipped [1] in the United States in 1958, by States

	Short tons [1]		Value (thousands)
	Gross weight	Manganese content	
Manganese ore: [2]			
Arizona	62,279	26,099	$5,220
Arkansas	22,221	9,440	1,737
California	17,644	7,857	1,516
Colorado	210	85	17
Montana	53,123	29,790	4,036
Nevada	127,322	57,400	7,566
New Mexico	24,665	9,984	1,996
Tennessee	5,935	2,331	452
Utah	1,043	424	84
Virginia	8,128	3,440	647
Georgia and Missouri	538	204	29
Total	323,108	147,054	$23,300
Manganiferous ore:			
Ferruginous manganese ore: [3]			
Arizona	1,455	356	32
Minnesota	50,289	6,608	(4)
Virginia	56	17	1
Georgia, Montana and New Mexico	35,951	4,094	570
Total	87,751	11,075	(4)
Manganiferous iron ore: [5]			
Michigan	112,536	6,077	(4)
Minnesota	320,314	19,916	(4)
Total	432,850	25,993	(4)
Total manganiferous ore	520,601	37,068	$3,532

[1] Shipments are used as the measure of manganese production for compiling U.S. 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 concentrate and nodules made from domestic ores.
[2] Containing 35 percent or more manganese (natural). All metallurgical ore except Montana, which includes battery ore as well. Does not include Minnesota's production of synthetic battery ore and synthetic miscellaneous ore. Instead, the low-grade Minnesota ore used to make these items is included under ferruginous manganese ore and manganiferous iron ore.
[3] Containing 10 to 35 percent manganese (natural).
[4] Included in total.
[5] Containing 5 to 10 percent manganese (natural).

CONSUMPTION, USES, AND STOCKS

U.S. consumption of manganese ore decreased 37 percent compared with 1957. Domestic sources supplied 3 percent of the total manganese ore consumed, compared with 2 percent in 1957 and 3 percent in 1956. Industrial stocks of ore at year's end were more than 2 million short tons.

The consumption of manganese as ferroalloys and direct-charged ore per short ton of open-hearth, bessemer, and electric steel produced was 12.8 pounds compared with 13.3 pounds in 1957. Of the 12.8 pounds, 11.5 pounds was in the form of ferromanganese, 1.0 pound silicomanganese, 0.1 pound spiegeleisen, and 0.2 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. The ore figure does not include ore used in making pig iron.

TABLE 4.—Consumption and stocks of manganese ore [1] and manganese alloys in the United States, gross weight in short tons

Category of use and form in which consumed	Quantity consumed 1957	Quantity consumed 1958	Stocks Dec. 31, 1958 [2] (including bonded warehouses)
Manganese alloys and manganese metal:			
Manganese ore:			
Domestic	41,315	41,986	311
Foreign	2,232,463	1,372,627	1,997,807
Total manganese ore	2,273,778	1,414,613	1,998,118
Ferromanganese, silicomanganese and manganese metal	--	--	183,559
Spiegeleisen	--	--	14,287
Steel ingots and steel castings: [3]			
Manganese ore:			
Domestic	--	6	--
Foreign	234	585	340
Total manganese ore	234	591	340
Ferromanganese:			
High-carbon	816,179	587,187	106,014
Medium-carbon Low-carbon	58,940	45,139	8,558
Total ferromanganese	875,119	632,326	114,572
Spiegeleisen	36,574	25,020	11,255
Silicomanganese	90,558	64,032	11,658
Manganese briquets	--	--	--
Manganese metal	6,787	7,007	749
Steel castings: [4]			
Manganese ore:			
Domestic	--	--	--
Foreign	276	82	59
Total manganese ore	276	82	59
Ferromanganese:			
High-carbon	24,004	16,030	3,718
Medium-carbon Low-carbon	3,188	1,781	783
Total ferromanganese	27,192	17,811	4,501
Spiegeleisen	3,424	1,678	592
Silicomanganese	11,248	6,921	1,563
Manganese briquets	631	383	118
Manganese metal	639	800	289
Pig iron:			
Manganese ore:			
Domestic	4,819	951	--
Foreign	6,695	4,090	6,793
Total manganese ore	11,514	5,041	6,793
Dry cells:			
Manganese ore:			
Domestic	1,400	2,157	771
Foreign	28,702	24,447	23,366
Total manganese ore	30,102	26,604	24,137
Chemicals and miscellaneous industries:			
Manganese ore:			
Domestic	1,014	164	62
Foreign	44,542	50,479	11,886
Total manganese ore	45,556	50,643	11,948

See footnotes at end of table.

TABLE 4.—Consumption and stocks of manganese ore[1] and manganese alloys in the United States, gross weight in short tons—Continued

Category of use and form in which consumed	Quantity consumed 1957	Quantity consumed 1958	Stocks Dec. 31, 1958[2] (including bonded warehouses)
Miscellaneous small consumers:			
Ferromanganese:			
High-carbon	27,366	19,172	3,509
Medium-carbon / Low-carbon	6,048	5,186	1,094
Total ferromanganese	33,414	24,358	4,603
Spiegeleisen	13,617	10,331	2,433
Silicomanganese	11,893	15,933	2,094
Manganese briquets	10,531	10,206	2,102
Manganese metal	[5] 1,828	1,436	275
Grand total:			
Manganese ore:			
Domestic	48,548	45,264	1,144
Foreign	2,312,912	1,452,310	2,040,251
Total manganese ore	[6] 2,361,460	[6] 1,497,574	[7] 2,041,395
Ferromanganese:			
High-carbon	867,549	622,389	113,241
Medium-carbon / Low-carbon	68,176	52,106	10,435
Total ferromanganese	935,725	674,495	[8] 123,676
Spiegeleisen	53,615	37,029	28,567
Silicomanganese	113,699	86,886	[8] 15,315
Manganese briquets	11,162	10,589	[8] 2,220
Manganese metal	[5] 9,254	9,243	[8] 1,313
Producers stocks ferromanganese, silicomanganese and manganese metal			183,559

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.—As in 1957, most manganese metal consumed was electrolytic manganese. However, some metal of lesser purity was consumed which was produced by electric-furnace or thermic processes. Two companies produced electrolytic manganese, and one company produced manganese metal by a thermic process.

Ferromanganese.—Production of ferromanganese in the United States was 637,000 short tons, compared with 964,000 short tons in 1957; the quantity made in blast furnaces was twice that made in electric furnaces. Ferromanganese shipped from furnaces in the United States in 1958 amounted to 608,000 short tons valued at $146 million, compared with 882,000 short tons valued at $210 million in 1957, a decrease of 31 percent in both quantity and value. Of the 1,271,000 short tons of manganese ore consumed in producing ferromanganese in 1958, 3 percent was of domestic origin.

During the course of the year the Charleston, W. Va., and Niagara Falls, N.Y., plants of the Pittsburgh Metallurgical Co. became ferromanganese producers. Electro Metallurgical Co. formally changed its name to Union Carbide Metals Co.

TABLE 5.—Ferromanganese imported into, and made from domestic and imported ores in the United States

	1957		1958	
	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]	22,484	18,074	25,855	20,893
From imported ore[2]	941,330	725,560	610,881	473,868
Total domestic production	963,814	743,634	636,736	494,761
Imported	[3] 338,079	257,821	63,932	49,521
Total ferromanganese	1,301,893	1,001,455	700,668	544,282
Open-hearth, bessemer, and electric-furnace[4] steel produced	112,714,996		85,254,885	

[1] Number of domestic plants making ferromanganese: 1957, 16; 1958, 17.
[2] Estimated.
[3] Revised figure.
[4] Includes crucible.

TABLE 6.—Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture[1]

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		
1949–53 (average)	750,908	76.92	577,602	1,395,336	98,024	12,799	1.99
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
1958	636,736	77.70	494,761	1,228,769	42,061	1,091	2.00

[1] For 1955, includes ore used in manufacture of silicomanganese and manganese briquets.

TABLE 7.—Manganese ore used in manufacture of ferromanganese in the United States, by source of ore

	1957		1958	
	Gross weight (short tons)	Mn content, natural (percent)	Gross weight (short tons)	Mn content, natural (percent)
Domestic	36,692	56.32	42,061	56.78
Foreign:				
Africa	673,260	44.99	384,879	46.31
Brazil	411,615	44.01	247,154	45.40
Chile	16,072	46.12	12,295	45.42
Cuba	185,746	37.51	38,415	38.16
India	598,511	44.47	431,681	43.95
Indonesia	900	38.22		
Mexico	143,731	44.27	97,897	45.28
Philippines	2,645	47.15	897	48.38
Turkey	6,434	39.00	2,647	42.50
Other	27,779	42.62	12,904	42.79
Grand total	2,103,385	44.10	1,270,830	45.30

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Silicomanganese.—Production of silicomanganese in the United States was 81,000 short tons in 1958, compared with 115,000 tons in 1957. Shipments from furnaces totaled 82,000 short tons ($20,638,-000) and 108,000 tons ($27,853,000), respectively, for the two years. Fourteen plants of 7 companies produced silicomanganese, compared with 10 plants of 5 companies in 1957. Consumption of silicomanganese was 12.9 percent that of ferromanganese, compared with 12.2 percent in 1957, 13.3 percent in 1956, and 12.0 percent in 1955.

Producing plants that made silicomanganese in 1958 but not in 1957 were Pittsburgh Metallurgical Co., Charleston, W. Va.; Tennessee Products & Chemical Corp., Rockwood, Tenn.; Tenn-Tex Alloy & Chemical Corp., Houston, Tex.; and Vanadium Corp. of America, Graham, W. Va.

Spiegeleisen.—There were two producers of spiegeleisen, one of which, Pittsburgh Coke & Chemical Co., Neville Island (Pittsburgh), Pa., was a new producer.

Manganiferous Pig Iron.—Pig-iron furnaces used 1,556,000 short tons of manganese-bearing ores containing (natural) over 5 percent manganese. Of this, 588,000 tons was of domestic origin and 968,000 tons foreign. Of the domestic ore, 537,000 tons contained (natural) 5 to 10 percent managanese, 50,000 tons contained 10 to 35 percent manganese, and 1,000 tons contained over 35 percent manganese. Of the foreign ore, 927,000 tons contained (natural) 5 to 10 per cent manganese, 37,000 tons contained (natural) 10 to 35 percent manganese, and 4,000 tons contained 35 percent or more manganese. All of the foreign manganiferous iron ore came from Canada; the foreign ferruginous manganese ore was from Egypt.

Battery and Miscellaneous Industries.—Manufacturers of dry-cell batteries during 1958 used 27,000 short tons of manganese ore containing more than 35 percent manganese (natural); 2,200 tons was of domestic origin. Chemical plants and miscellaneous industries used 51,000 short tons of manganese ore containing 35 percent or more manganese, almost all of which was from foreign sources. All the chemical grade manganese dioxide ore used, 30,000 tons, was imported.

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 spot purchases of Indian manganese ore of 46- to 48-percent manganese content, as quoted by E&MJ Metal and Mineral Markets, opened the year at $1.36 to $1.39, nominal, per long-ton unit of manganese, c.i.f. U.S. ports, import duty extra, including Indian export duty. These prices gradually decreased, reaching $1.05 to $1.10, nominal at the end of July, and then remained constant till November when India eliminated export duties on manganese ore. The quotation of $0.915 to $0.965 nominal at the end of the year reflected removal of this export duty, which amounted to $0.135. Throughout 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 the 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 1958 was $239.51 per short ton, compared with $238.08 in 1957. The price of standard ferromanganese, 74 to 76 percent manganese, at eastern furnaces, carlots, was 12.25 cents per pound of alloy, unchanged throughout the year. A quoted price of $102.50 per long ton prevailed throughout the year for spiegeleisen of 19- to 21-percent manganese content.

Manganese Metal.—The price of electrolytic manganese metal continued to be quoted by E&MJ Metal and Mineral Markets the entire year at 34 cents per pound for carlots and 36 cents per pound for ton lots. A premium of 0.75 cent per pound for hydrogen-removed metal continued unchanged throughout the year.

FOREIGN TRADE [3]

The average grade of imported manganese ore, 46.9 percent manganese, was the highest grade recorded for general imports since 1947. It compared with 46.1 percent in 1957 and 45.4 percent in 1956. Brazil supplied 27 percent of the total ore received in 1958; India, 26 percent; Ghana, 13 percent; the Union of South Africa, 11 percent; Mexico, 7 percent; and the Belgian Congo, 6 percent. General imports of ore containing more than 10 and less than 35 percent manganese totaled 5,036 short tons, of which 4,659 tons came from Mexico, 366 tons from British West Pacific Islands, and 11 tons from Norway. In 1957, ore receipts of this grade were 5,865 short tons, all from Mexico. In both years, imports for consumption were identical with general imports.

Imports for consumption of ferromanganese decreased 81 percent below those of 1957. In 1958, imports for consumption classified as "manganese silicon (includes silicon manganese)" were 8,908 short tons (manganese content), coming from Japan (8,561), Norway (293), and Canada (54); in 1957, they totaled 5,109 short tons (manganese content) coming from Japan (3,861), Chile (618), Yugoslavia (556), and Norway (74). There were no imports for consumption of manganese metal, nor of spiegeleisen, in either year.

Exports of ferromanganese in 1958 were 1,406 short tons valued at $464,000, compared with 7,395 tons, valued at $1,866,000 in 1957; exports classified as "manganese metal and alloys in crude form and scrap" totaled 586 short tons ($300,103) in 1958 and 733 tons ($401,857) in 1957. Spiegeleisen exports in 1958 were 834 short tons valued at $79,243. The quantity of manganese ore and concentrate (10 percent or more manganese) exported in 1958 totaled 4,883 short tons valued at $700,268.

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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.

TABLE 8.—Manganese ore (35 percent or more Mn) imported into the United States, 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			
	1957	1958	1957	1958	1957	1958	1957	1958	1957	1958
North America:										
Canada	50		22		183		81		$5,405	
Costa Rica	49		18		49		18		1,767	
Cuba	156,651	71,895	64,086	30,224	159,393	71,895	65,402	30,224	[3] 5,670,489	$2,356,637
Mexico	218,229	181,832	98,173	83,915	217,648	155,828	97,950	72,031	8,055,126	6,805,355
Panama		2,001		900		2,001		900		119,741
Total	374,979	255,728	162,299	115,039	377,273	229,724	163,451	103,155	[3] 13,732,787	9,281,733
South America:										
Argentina	546		240		546		240		22,135	
Brazil	926,498	661,134	438,769	315,798	600,408	426,051	281,495	201,717	25,776,697	20,588,179
British Guiana	332		133		332		133		3,563	
Chile	33,586	17,941	14,859	8,137	28,093	18,584	12,342	8,360	1,295,363	845,109
Peru	15,074	5,312	6,574	2,191	15,074	5,312	6,574	2,191	551,874	192,426
Venezuela	6,884		2,917		3,756		1,728		105,000	
Total	982,920	684,387	463,492	326,126	648,209	449,947	302,512	212,268	27,754,632	21,625,714
Europe:										
Greece	6,684	17,932	3,174	8,607	5,565	5,715	2,670	2,757	253,292	267,716
Portugal	1,598		789		1,598		789		86,954	
Total	8,282	17,932	3,963	8,607	7,163	5,715	3,459	2,757	340,246	267,716

Asia:										
India	794,583	638,374	[3] 359,682	291,863	678,470	513,565	[3] 307,633	234,410	[3] 21,407,120	18,254,964
Indonesia	5,130	3,345	2,185	1,503	5,130	3,345	2,185	1,503	141,764	74,400
Philippines	9,835	11,236	[3] 4,586	5,417	7,584	9,611	[3] 3,558	4,667	[3] 340,342	434,049
Portuguese Asia, n.e.c.	18,979	----	8,278	----	18,979	----	8,278	----	664,346	----
Thailand	----	220	----	116	----	220	----	116	----	18,024
Turkey	13,209	6,057	5,196	2,549	13,209	6,057	5,196	2,549	364,078	173,379
Total	841,736	659,232	[3] 379,927	301,448	723,372	532,798	[3] 326,850	243,245	[3] 22,917,650	18,954,816
Africa:										
Angola	[3 4] 45,688	27,038	[3 4] 22,302	13,602	[4] 32,661	43,779	[4] 15,674	21,775	[4] 1,539,733	1,689,613
Belgian Congo	[3 4] 165,777	150,316	[3 4] 82,634	74,875	[4] 139,225	69,723	[4] 69,607	34,910	[4] 6,126,762	3,449,023
Ghana	313,270	310,839	151,195	154,594	[3] 249,044	192,935	122,113	94,569	[3] 11,076,652	10,701,203
Morocco	50,882	38,088	24,246	19,211	70,015	23,977	34,552	11,483	3,687,437	1,384,670
Mozambique	----	1,098	----	494	----	1,098	----	494	----	40,127
Rhodesia and Nyasaland, Federation of	25,359	10,022	12,015	4,720	25,359	10,022	12,015	4,720	1,052,264	380,974
Sudan	1,958	----	822	----	----	----	----	----	----	----
Union of South Africa	243,722	266,158	105,317	117,079	224,988	207,611	97,028	93,272	6,351,047	7,038,130
United Arab Republic (Egypt Region)[5]	1,640	6,947	754	3,255	1,640	4,778	754	2,214	87,909	174,560
Total	848,296	810,506	399,285	387,830	[3] 742,932	553,923	351,743	263,437	[3] 29,921,804	24,858,300
Oceania:										
Australia	18,213	9,131	8,378	4,200	18,213	9,131	8,378	4,200	1,043,426	470,387
British Western Pacific Islands	30,746	15,662	14,634	7,192	22,011	17,384	10,839	8,038	959,409	797,805
Total	48,959	24,793	23,012	11,392	40,224	26,515	19,217	12,238	2,002,835	1,268,192
Grand total [6]	3,105,172	2,452,578	[3] 1,431,978	1,150,442	[3] 2,539,173	1,798,622	[3] 1,167,232	837,100	[3] 96,669,954	76,256,471

[1] Comprises ore received in the United States; part went into consumption during the year, and remainder entered bonded warehouses.

[2] Comprises ore received during the year for immediate consumption plus material withdrawn from bonded warehouses; excludes imports for manufacture in bond and export.

[3] Revised figure.

[4] General imports for the 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 coming from Angola in 1957 is believed to have originated in the Belgian Congo.

[5] Effective July 1, 1958.

[6] In 1958, general imports of ore classified as Battery and Chemical grades totaled 60,469 short tons averaging 54 percent manganese. Of this quantity 41,068 short tons came from Ghana, 9,881 short tons from Morocco, 7,321 short tons from Cuba, 1,264 short tons from the Belgian Congo, 535 short tons from the Philippines, 220 short tons from Thailand, 128 short tons from Peru and 52 short tons from Mexico. In addition it is believed that virtually all of the ore from Greece was Battery and Chemical grade. Imports for consumption of Battery and Chemical grades in 1958 totaled 49,599 short tons valued at $4,121,867 or $83.10 per short ton f.o.b. foreign ports. Of this total Ghana supplied 30,198 short tons ($2,951,229), Morocco 9,881 short tons ($709,750), Cuba 7,321 short tons ($352,498), the Belgian Congo 1,264 short tons ($64,455), Philippines 535 short tons ($18,750), Thailand 220 short tons ($18,024), Peru 128 short tons ($5,774), and Mexico 52 short tons ($1,387). Changes in Minerals Yearbook, 1957, p. 808, are as follows: receipts of Battery and Chemical grades totaled 141,925 short tons averaging 54.3 percent manganese. Of this quantity 6,148 short tons came from Greece. Imports for consumption of Battery and Chemical grades in 1957 totaled 95,905 short tons valued at $6,113,008 or $63.74 per short ton f.o.b. foreign ports. Of this total Greece supplied 3,054 short tons ($143,835).

TABLE 9.—Ferromanganese imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957			1958		
	Gross weight (short tons)	Mn content (short tons)	Value	Gross weight (short tons)	Mn content (short tons)	Value
North America:						
Canada	124,473	94,872	$22,544,924	198	153	$46,281
Mexico	2,154	1,629	366,793	813	624	147,688
Total	126,627	96,501	22,911,717	1,011	777	193,969
South America: Chile	1,306	1,022	230,183	1,913	1,513	276,500
Europe:						
Belgium-Luxembourg	4,698	3,571	[1] 956,290	4,163	3,182	519,715
France	[1] 89,954	[1] 67,722	[1] 15,529,446	16,237	12,394	3,135,993
Germany, West	[1] 43,248	[1] 32,900	[1] 7,478,187			
Norway	11,405	9,465	2,529,040	55	43	9,850
Yugoslavia	4,507	3,465	866,307	4,403	3,525	738,044
Total	[1] 153,812	117,123	[1] 27,359,270	24,858	19,144	4,403,602
Asia:						
India				648	483	114,796
Japan	55,783	42,734	9,638,636	35,502	27,604	6,056,925
Total	55,783	42,734	9,638,636	36,150	28,087	6,171,721
Africa: Belgian Congo	551	441	95,875			
Grand total	[1] 338,079	257,821	60,235,681	63,932	49,521	11,045,792

[1] Revised figure.

Barter of surplus U.S. agricultural products for various manganese items by the Commodity Credit Corporation, U.S. Department of Agriculture, continued to be a factor in trade between the United States and other nations.

WORLD REVIEW

NORTH AMERICA

Cuba.—Preliminary export figures for 1958 follow: 67,000 short tons of metallurgical ore averaging 39 percent manganese, 8,200 tons of metallurgical ore averaging 44 percent manganese, and 8,300 tons of chemical ore averaging approximately 83 percent manganese dioxide. Lack of shipments of the last two grades in the second quarter was attributed to unfavorable market conditions as well as interruptions in mining operations because of political disturbances. All shipments went to the United States.[4] At the end of 1958, Holston Trading Corp. reported its stocks to be 3,300 short tons of Metallurgical grade (44 percent manganese, valued at $39 per long ton f.o.b. Santiago de Cuba), and 56 short tons of Chemical grade (84 percent manganese dioxide, valued at $73 per long ton). Although figures regarding stocks held by others were not obtainable, it is known that shipments

[4] U.S. Embassy, Habana, Cuba, State Department Dispatches 1057, 278, 672, and 1257: June 18, Sept. 17 and Dec. 30, 1958, and May 6, 1959.

were made whenever cargo lots were accumulated.[5] A comprehensive description of the geology of Cuban manganese deposits was published. Although manganese-ore deposits have been reported from all six Cuban provinces, only the deposits of Oriente have produced any appreciable quantity of ore, and the Charco Redondo, Ponupo, and Quinto mines have been the largest producers. In Oriente, the principal deposits occur as manganese oxides in or near the Charco Redondo limestone.[6] Total Cuban production from the start of mining about 1888 through 1958 is estimated to have been about 5 million short tons.

TABLE 10.—World production of manganese ore, by countries,[1] in short tons [2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	Percent Mn [3]	1949–53 (average)	1954	1955	1956	1957	1958
North America:							
Cuba	36–50+	198,570	296,801	346,680	[4] 257,996	[4] 148,276	[4] 75,739
Mexico	30+	122,572	277,996	97,326	[3] 171,000	[3] 220,000	[3] 187,400
Panama [5]	44+	----------	----------	----------	----------	----------	2,001
United States (shipments)	35+	127,702	206,128	287,255	344,735	366,334	323,108
Total	----------	448,844	780,925	731,261	773,731	734,610	588,248
South America							
Argentina	30–40	2,963	11,389	14,145	9,682	10,779	[3] 11,000
Brazil	38–50	244,951	179,157	234,249	342,645	1,011,939	[4] 766,153
Chile	40–50	46,750	58,422	[3] 58,400	51,878	59,724	42,061
Peru	40+	1,053	4,960	6,008	11,826	16,917	3,229
Venezuela	38+	----------	----------	----------	10,318	32,939	9,039
Total	----------	295,717	253,928	312,802	426,349	1,132,298	831,482
Europe:							
Bulgaria	30+	[6] 18,739	36,376	69,005	84,657	89,600	[3] 88,200
Greece	35+	11,119	18,697	27,148	8,695	17,545	22,046
Hungary	30+	100,353	120,412	105,208	[3] 94,000	[3] 132,000	[3] 132,000
Italy	30	33,848	54,902	62,684	50,627	51,286	47,810
Portugal	35+	29,015	10,627	4,388	3,508	6,036	[3] 5,500
Rumania	35	95,083	191,112	429,814	259,054	292,402	[3] 220,500
Spain	30+	26,375	39,511	48,375	36,100	45,622	41,784
U.S.S.R.[7]	----------	4,285,000	5,058,500	5,228,300	5,443,200	5,674,700	5,915,000
Yugoslavia	30+	8,879	4,960	4,850	[3] 6,000	[3] 4,400	[3] 4,400
Total [1]	----------	4,608,411	5,535,097	5,979,772	5,985,841	6,313,591	[3] 6,477,000
Asia:							
Burma	35+	3,818	4,160	342	1,287	506	1,405
China [3]	----------	88,000	190,000	305,000	580,000	600,000	[8] 600,000
India	40+	1,385,584	1,582,639	1,773,566	1,889,005	1,852,484	1,377,602
Indonesia	35–49	9,549	22,309	38,810	90,568	59,257	48,340
Iran [9]	36–46	5,464	8,799	5,484	6,614	2,205	2,205
Japan	32–40	183,387	180,155	222,350	314,175	318,497	304,510
Korea, Republic of	30–48	2,848	1,744	3,838	2,158	3,533	287
Philippines	35–51	26,595	10,354	13,131	4,866	33,324	24,590
Portuguese India	32–50+	86,709	116,756	149,523	215,836	257,904	[4] 138,446
Thailand	40+	----------	----------	----------	450	381	1,102
Turkey	30–50	60,765	54,925	55,228	65,962	62,522	33,242
Total [3]	----------	1,853,000	2,172,000	2,567,000	3,171,000	3,191,000	2,532,000

See footnotes at end of table.

[5] U.S. Embassy, Habana, Cuba, State Department Dispatch 1299: May 15, 1959.
[6] Simons, Frank S., and Straczek, John A., Geology of the Manganese Deposits of Cuba: Geol. Survey Bull. 1057, 1958, 289 pp.

TABLE 10.—World production of manganese ore, by countries,[1] in short tons [2]—Continued

Country [1]	Percent Mn [3]	1949-53 (average)	1954	1955	1956	1957	1958
Africa:							
Angola	38-48	43,003	34,865	34,853	29,647	23,518	38,499
Bechuanaland	50+					243	5,893
Belgian Congo	50	98,067	424,320	508,972	363,250	404,572	365,015
Egypt [10]	57	2,025	6,991	7,994	21,195	10,315	[3] 5,500
Ghana (exports)[11]	48	850,909	515,475	604,330	712,154	718,306	574,124
Morocco:							
Northern zone	50	1,436	856	1,262	1,795	732	
Southern zone	35-50	385,622	441,203	453,013	464,523	541,772	452,041
Rhodesia and Nyasaland, Federation of:							
Northern Rhodesia	30+	[12] 4,598	17,562	19,717	40,760	41,294	49,946
Southern Rhodesia	48+	353	18	1,330	816	1,785	2,512
South-West Africa	45+	[13] 19,549	34,066	41,880	57,262	89,661	103,049
Sudan [3]	36-44				7,700	8,800	6,600
Union of South Africa	40+	861,406	772,862	649,471	768,395	787,878	934,097
Total		2,266,968	2,248,218	2,322,822	2,467,497	2,628,876	2,537,276
Oceania:							
Australia	45-48	17,011	31,587	53,039	66,510	86,251	62,317
Fiji (exports)	40+	1,157	10,773	19,803	25,067	38,858	20,850
New Caledonia	45+	11,086					
New Zealand	48+	374	268	179	175	41	116
Papua		60		22	14		
Total		29,688	42,628	73,043	91,766	125,150	83,283
World total (estimate)[1]		9,503,000	11,033,000	11,987,000	12,916,000	14,126,000	13,049,000

[1] In addition to the countries listed, Czechoslovakia and Sweden report production of manganese ore (approximately 15 to 17 percent manganese content), but since the manganese content averages less than 30 percent, the output is not included in this table. Czechoslovakia averages annually 220,000 short tons and Sweden approximately 16,500 tons.
[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] Estimate.
[4] Exports.
[5] United States Imports (believed to be produced in 1957).
[6] Average for 1952-53.
[7] Grade unstated. Source: The Industry of the U.S.S.R., Central Statistical Administration, 1957 (Moscow).
[8] Data represents 1957 production; however 1958 production was probably much greater.
[9] Year ending March 20 of year following that stated.
[10] In addition to high-grade ore shown in the table, Egypt produced the following tonnages of less than 30 percent manganese content: 1949-53 (average), 201,066; 1954, 188,703; 1955, 227,042; 1956, 200,075; 1957, 83,957; and 1958, not available.
[11] Dry weight.
[12] Average for 1951-53.
[13] Average for 1950-53.

Mexico.—During June, July, and August, Cia. Minera Autlan, S.A., cut production in half and temporarily suspended exports, because of lack of U.S. demand for the Company's manganese ore. In earlier months, and again in September, shipments to the United States were at the rate of 27,000 short tons per month.[7]

Panama.—Exploraciones Rosario, S.A., subsidiary of New York and Honduras Rosario Mining Co., shipped 2,000 short tons of manganese ore to the steel mills of the Birmingham, Ala., district. The ore came from an open-pit mine at Nombre de Dios, Province of Colon, held on concession from Hyatt-Panama Mining Co.[8]

[7] U.S. Consulate, Guadalajara, Mexico, State Department Dispatch 17: Sept. 30, 1958.
[8] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, p. 14.

SOUTH AMERICA

Brazil.—A large deposit of manganese ore, having a manganese content of 68 percent, was reported to have been found at Alto Jari, Para. Near Corumba, Mato Grosso, the Urucum deposit continued under development by Sociedade Brasileira de Mineracao Ltda (SOBRAMIL).[9] In September, the newly completed Urucum ore transshipment station of Navios Corp., a wholly owned U.S. Steel Corp. subsidiary, was inaugurated at Nueva Palmira, Uruguay. It is believed that this station will be capable of transferring approximately 5,000 tons of ore a day from river barge to ocean vessel.[10] Although shipments of Urucum development ore totaling 600 tons were made by ordinary Paraguay River boats in December 1957 and February 1958, regular barge shipments to the new station were not expected to start until January 1959. Brazilian consumption of manganese ore is estimated at 30,000 tons per year.

British Guiana.—Construction proceeded on the 33-mile railroad from the manganese-ore deposits at Matthews Ridge, in northwestern British Guiana, to a shipping point on the Kaituma River. Financed by Union Carbide Corp., the operation is under the control of African Manganese Co. Ltd. (Mines Management).[11]

Chile.—Exports of manganese ore totaled 22,000 short tons, compared with 38,000 in 1957. In both years, the United States received 95 percent of the total and West Germany the remainder. In 1957, manganese ore production and exports each averaged 44.3 percent manganese, and two-thirds of the production was by Cia. Manganeso de Atacama. Stocks held by that company at the end of 1957 totaled 12,000 tons. In 1957, the same company produced 5,200 tons of ferromanganese from its plant at Guayacan, near La Serena. The 1957 production of Chile's only other manganese ferroalloy producer, Fabrica Nacional de Carburo y Metalurgia, with its plant at Huachipato (Concepcion), was 8,960 tons of ferromanganese (8,800 high carbon; 130 medium carbon; 24 low carbon), 1,700 tons of silicomanganese, and 200 tons of spiegeleisen.[12] Exports of ferromanganese in 1958 totaled 4,600 tons, compared with 5,400 in 1957. The countries of destination for 1958 were: the United States, 3,000; Colombia, 760; Peru, 450; the Netherlands, 220; Switzerland, 110; New Zealand and Panama, the remainder. In 1957, the United Kingdom took 62 percent; Colombia, 20 percent; the United States, 7 percent; and Germany, Uruguay, Peru, and the Netherlands, the remainder in that order. Silicomanganese exports in 1958 totaled 970 tons compared to 1,700 in 1957. Of these, distribution was as follows (1957 percentages in parentheses): West Germany, 53 percent (47); Venezuela, 29 percent; the United Kingdom, 18 percent (17); the United States (33); Argentina (2); and Mexico (less than 1).[13]

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9 Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 3, March 1959, p. 19.
10 U.S. Embassy, Montevideo, Uruguay, State Department Dispatch 263: Oct. 2, 1958.
11 Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 5, May 1959, p. 16.
12 U.S. Embassy, Santiago, Chile, State Department Dispatches 235 and 693: Sept. 8, 1958, and Jan. 15, 1959.
13 U.S. Embassy, Santiago, Chile, State Department Dispatches 123 and 900: Aug. 6, 1958, and Mar. 11, 1959.

French Guiana.—Union Carbide Corp. held approximately 55 percent and Bureau Minier Guyanais the remainder of the shares of Société du Manganese de Guyane (SOMAG), newly formed company exploring for manganese ore in the interior.[14]

Peru.—Minas Gran Bretana, near Azulcocha on the Pachacayo-Mauricocha road about 30 miles south of Oroya, continued to account for most of Peru's manganese ore production in 1957. The ore occurred in sediments and was upgraded in jigs before shipment. According to Banco Minero del Peru, exports for that year totaled 4,600 short tons of contained manganese,[15] all of which went to the United States. The zinc refineries of Cerro de Pasco Corp. used about 2,000 tons in Peru.

EUROPE

Czechoslovakia.—Production of electrolytic manganese, apparently in a pilot plant, was reported to have started in September, culminating a 10-year development period. It was expected that industrial-scale operation would begin sometime in 1959 in a converted copper mill at Banska-Bystrica in Central Slovakia. A two-phase lye-treatment process was being developed in an effort to obtain higher manganese recoveries from ore mined at Kiskovice-Svabovce.[16]

France.—Of the 901,000 short tons of manganese ore imported in 1957, India supplied 355,000, Morocco 309,000, the Union of South Africa 65,000, and the U.S.S.R. 60,000.[17]

Greece.—Exports of manganese ore in 1957 totaled 19,000 short tons, of which 9,500 went to the United States, 3,500 to West Germany, 1,900 to France, 1,800 to the United Kingdom, and 1,700 to Italy.[18] Much of the ore exported in 1957 and 1958 was a Battery grade from the Scalistiri group of mines near the Bulgarian border north of Drama: the Granitis, Cynthia, and Tartana. At the Granitis mine, where the ore occurs in combination with marble and silicates, operations were both open pit and underground, a jig plant being located at the mine. At Tartana the ore was in clay; it was mined by open pit, and the mine output was run through a small washing plant. At the Cynthia the ore occurs as narrow lenses in marble, and the mine was being developed as an underground operation. Monthly average production of the group was reported in 1958 to exceed 1,200 tons of ore containing 50 percent manganese. This was trucked 35 miles or more to the port of Kavalla for shipment to the United States, the United Kingdom, and Europe.

Italy.—Italy's small production of manganese metal (96–97 percent manganese) was discontinued in 1956. Production of manganese ferroalloys for the period 1955–57 follows (short tons):

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[14] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 18.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 15.
[16] E&MJ Metal and Mineral Markets, Vol. 30, No. 5, Jan. 29, 1959, p. 8.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 4, October 1958, p. 28.
[18] U.S. Embassy, Athens, Greece, State Department Dispatch 420: Nov. 26, 1958.

Year	Refined ferro-manganese	Carbide ferro-manganese	Silico-manganese	Spiegel-eisen	Silico-spiegel-eisen
1955	1,700	42,000	13,000	15,000	2,500
1956	2,100	46,000	12,000	21,000	2,100
1957	1,400	55,000	11,000	18,000	4,400

Production of carbide ferromanganese (over 50 percent manganese) in the first 6 months of 1958 was one-third less than that of the same 1957 period. This item was made in electric furnaces, but electric power costs were too high to allow favorable competition with imported ferromanganese from the Union of South Africa and the U.S.S.R., in spite of a protective tariff. Italian imports for the 1955–57 period were (short tons):

Year	Manganese metal (over 90 percent Mn)	Spiegel-eisen (over 15 percent up to 25 percent Mn)	Ferromanganese (over 25 percent up to 90 percent Mn)	Ferro-silicon manganese	Manganese ore and ferruginous manganese ore
1955	64	2,700	4,300	600	92,000
1956	59	2,400	9,200	1,300	136,000
1957	61	190	10,200	3,200	147,000

In 1957, India supplied 50 percent of the ores; Portuguese India, 11.2 percent; Iran, 10 percent; and the Union of South Africa, 6.7 percent. Exports of manganese items were negligible except for 800 short tons of ferromanganese in 1957.[19]

Spain.—Production of ferromanganese was 26,000 short tons in 1957 and 24,000 in 1956 and in 1955. Of the 1956 production, 65 percent was stated to be of low manganese content, as against 51 percent in 1955. Three plants, at Boo (Santander), Cee (Coruna), and Claveaga (Bilbao), accounted for the total production of these 2 years. Imports were 1,900 short tons in 1955, 180 in 1956, and 380 in 1957.[20]

Sweden.—Manganese ore imports totaled 43,000 short tons in 1957. The Soviet Union and the Union of South Africa each supplied 12,000 short tons, while 9,000 came from Turkey and 5,200 from Morocco. Exports of manganese ore in 1957 amounted to 490 short tons, most of which went to Czechoslovakia.[21]

U.S.S.R.—Oxygen enrichment of the blast was reported to be used in producing ferromanganese.[22] Soviet metallurgists foresaw a nickel shortage for their future production of stainless steel and were investigating the use of manganese as a substitute for nickel. An electrolytic manganese plant has been constructed in Agledzia, Georgia S.S.R.[23] From the official Soviet document, Statistical Review of the U.S.S.R. Foreign Trade in 1957, and other sources, exports of manganese ore for that year totaled 878,000 short tons, distributed as follows: Poland and the United Kingdom, 197,000 each; East

[19] U.S. Embassy, Rome, Italy, State Department Dispatches 658 and 1028: Nov. 26, 1958 and Feb. 25, 1959.
[20] U.S. Embassy, Madrid, Spain, State Department Dispatch 942: June 30, 1958.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 20.
[22] Steel, vol. 143, No. 10, Sept. 8, 1958, p. 89.
[23] Journal of Metals, vol. 10, No. 3, March 1958, p. 161.

Germany, 191,000; Czechoslovakia, 107,000; France, 63,000; West Germany, 43,000; Norway, 37,000; Sweden, 18,000; Yugoslavia, 14,000; Italy, 6,000; and Austria, 5,000. Exports of peroxide manganese ore, presumably of Battery grade, totaled 12,000 short tons with the following distribution (1956 exports, in parentheses, totaled 14,000 short tons): Netherlands, 4,600 (1,100); East Germany, 4,000 (5,600); Czechoslovakia, 2,000 (5,500); Poland, 900 (1,300); and Finland 400 (400).[24] The Zaphorozhe ferroalloy plant produced manganese metal containing 97 percent manganese, using four 3,000-kw. open-arc electric furnaces, 3.5 meters in diameter, with graphite electrodes. The metal and a high manganese slag were obtained by reducing manganese ore with silicomanganese. The slag was then smelted to standard ferromanganese using a submerged arc. Power consumption was 13,000 kw.-hr. per metric ton.[25] The second part of a large central beneficiation plant to treat Chiatura manganese ores was being completed. Together with the first part, which was placed in operation in 1947, the plant was expected to have a capacity of 440 short tons of crude ore per hour.[26]

United Kingdom.—Provisional data show that a total of 532,000 short tons of manganese ore was imported in 1957. Of this quantity, 173,000 tons came from the U.S.S.R., 148,000 from India, 121,000 from Ghana, 56,000 from South Africa and 22,000 from Morocco. Manganiferous ore imports totaled 5,200 short tons. The following average manganese and iron percentage contents respectively were reported: the U.S.S.R., 50 and 2; India, 46 and 8; West Africa, 49 and 5; South Africa, 38 and 17; Rhodesia, 51 and 1; and Indonesia, 47 and 3. Manufacture of iron and steel consumed 200,000 short tons of ordinary ferromanganese (76 to 80 percent manganese), 9,000 tons of refined ferromanganese (up to 3 percent carbon), 35,000 tons of spiegeleisen, 600 tons of silicospiegel, and 15,000 tons of silicomangenese. Exports of spiegeleisen and ferromanganese totaled 700 short tons.[27]

Yugoslavia.—Total exports of ferromanganese and silicomanganese, with percentages going to the United States (parentheses), in 1957 were 4,300 (83) and 880 (75) short tons; in 1956, 3,200 (87) and 550 (100); and in 1955, 4,500 (81) and 880 (63).[28]

ASIA

China.—Construction was begun in November of a plant in the eastern suburbs of Canton for production of ferromanganese and ferrosilicon.[29]

India.—Consumption of manganese ore by the Indian glass and dry-cell industries was placed at approximately 4,000 tons per year, with India exporting dry cells to neighboring countries.[30] From pro-

[24] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1 and vol. 47, No. 3, January 1959 and September 1958. (Special Supplements 55 and 56.)
[25] Swan, David, Alloyed Steel in the Ukraine: Jour. Metals, vol. 10, No. 3, March 1958, p. 186.
[26] Gorny Zhurnal (Mining Journal) (Moscow), Chiatura Manganese: No. 11, November 1957, p. 17.
[27] Iron and Steel Board and the British Iron and Steel Federation, Annual Statistics—1957: London, 1958, pp. 6, 11, 91, 124.
[28] U.S. Embassy, Belgrade, Yugoslavia, State Department Dispatch 233: Nov. 28, 1958.
[29] U.S. Consulate General, Hong Kong, State Department Dispatch 577: Jan. 23, 1959.
[30] Indian Mining Journal (Calcutta), India's Industrial Minerals: Vol. 6, No. 6, June 1958, pp. 7–8.

visional figures, exports of manganese ore in 1958 were 1,066,000 short tons, of which the United States took 464,000 tons; Japan, 137,000; France, 116,000; the Netherlands, 103,000; the United Kingdom, 75,000; Belgium, 60,000; Poland, 22,000; Sweden, 15,000; Spain, 13,000; Italy, 12,000; Rumania, 12,000; Yugoslavia, 12,000; West Germany, 8,200; Norway, 7,800; Canada, 7,000; Denmark, 1,700; and Formosa, 300. More than 40 percent of the ore was shipped from the port of Visakhapatnam, approximately one-third from Bombay, approximately 15 percent from Calcutta, and the remainder from Madras. The State Trading Corp. exported 28 percent of the total. Also from provisional figures, exports of ferromanganese were 3,600 short tons, approximately two-thirds of which went to the United States and the remainder to Belgium; manganese dioxide exports totaled 2,200 tons of which 1,500 tons went to United Kingdom, 400 tons to West Germany, 200 tons to Sweden, and 100 tons to the Netherlands; and manganese peroxide exports were 160 tons, all to the United Kingdom.[31] The decrease in manganese ore exports of approximately 700,000 tons from those of 1957 was believed to be in part a result of the following Indian Government regulations: The export duty on ore containing more than 44 percent manganese, in effect until November 24, 1958, which was the equivalent of $6.30 per long ton; effective June 1, 1958, royalty rates on manganese ore containing 45 percent manganese or more were increased from 7½ to 12½ percent of pit-mouth value, raising the ore cost roughly $1.25 per long ton; and, effective October 1, 1958, rail-freight rates were increased up to 40 percent, increasing costs for high-grade metallurgical ore approximately $2.50 per long ton.[32] Exports of manganese ore continued to be licensed on a quota basis.[33] In April the Government removed the requirement that 40 percent of a shipper's export quota had to be of a grade containing less than 42 percent manganese.[34] In February, the export duty was removed on ore containing less than 42 percent manganese; in November, all remaining export duties on manganese ore were removed.

Central Provinces Manganese Ore Co., Ltd., reported that diamond-drilling indicated considerable tonnages of good ore at the Kandri and Ukwa mines, and that the Balaghat mine had been connected to the Government's electrical power system.[35]

Kalinga Industries Ltd. was understood to have received a license to erect a low shaft furnace at Barabil, Orissa, for producing pig iron and ferromanganese.[36] The new electric-furnace ferromanganese plant of Tata Iron and Steel Co. at Joda, Orissa, was formally opened April 20, 1958. Initial capacity of the plant was 34,000 short tons a year.[37] Ferromanganese production from the new plant replaced that of the company's blast furnaces at Jamshedpur and was expected to supply all of the company's future ferromanganese re-

[31] U.S. Embassy, New Delhi, India, State Department Dispatches 210 and 893: Aug. 11, 1958, and Feb. 12, 1959.
[32] U.S. Embassy, New Delhi, India, State Department Dispatches 488 and 874: Oct. 27, 1958, and Feb. 6, 1959, U.S. Consulate, Bombay, India, State Department Dispatch 247: Oct. 22, 1958.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, pp. 19–20.
[34] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 4, October 1958, p. 28.
[35] Mining Journal (London), vol. 250, No. 6409, June 20, 1958, pp. 737–738.
[36] The Tata Iron and Steel Co., Ltd. (Calcutta), A Valley Called Joda: April 1958.
[37] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, p. 24.

quirements in addition to providing ferromanganese for export. Other new electric-furnace ferromanganese plants starting production in 1958 were those of Ferro Alloys Corp. at Garivadi, Andhra, with annual capacity of 34,000 tons, and Jeypore Mining Syndicate at Rayagada, Orissa, with 13,000 tons annual capacity. Construction proceeded on the 34,000-ton-capacity ferromanganese electric-furnace plant of Cambatta Ferro Manganese at Tumsar, Bombay State, and on the same capacity electric-furnace plant of Khandelwhal Ferro Alloys at Kanhan, Bombay State, both located near the Nagpur manganese ore district.

Japan.—Production of electrolytic manganese, of which there were two producers, totaled 1,950 short tons in 1957. In addition, a third company produced 13 tons of manganese metal by the silico-thermic process. The electrolytic metal had a guaranteed minimum manganese content of 99.9 percent, the silico-thermic metal 97 percent. Approximately two-thirds of the manganese-metal production was exported in approximately equal portions to the United States, the United Kingdom and West Germany; the remainder was consumed in Japan.[38] In 1956, production of manganese dioxide was 13,000 short tons, having an average grade of 68.3 percent manganese dioxide; production of metallurgical manganese ore totaled 301,000 tons with an average grade of 35.3 percent manganese. For the first half of 1957, production of metallurgical ore was at the same rate and grade as 1956; manganese dioxide production was 7,400 tons averaging 65.6 percent manganese dioxide. According to a survey of the Japan Ferroalloy Association, as of March 1957 there were 65 furnaces for production of high-carbon ferromanganese, 22 for medium- and low-carbon ferromanganese, and 36 for silicomanganese, with annual capacities of 187,000, 51,000, and 117,000 tons, respectively.[39]

Korea.—As of January 1957, reserves of manganese ore containing 40 percent manganese were estimated to be 550,000 short tons for South Korea and 220,000 for North Korea. The Changgun mine, Kyongsang Pukdo, and the Dongnam mine, Kangwon Do, were the principal mines in South Korea.[40]

Philippines.—From quarterly reports, exports of manganese ore in 1958 totaled 22,000 short tons, slightly more than one-third of which went to the United States, the remainder going to Japan.[41] Reports for 1957 showed the four major producers to be: Zambales Base Metals, with deposits on Siquijor Island (just south of Cebu), having reserves of 33,000 short tons, and two washing-jigging plants; General Base Metals, Inc., with reserves at Guindulman, Bohol Island, amounting to 77,000 tons positive of 38 to 48 percent manganese direct-shipping ores and 1.7 million tons of earthy ores containing 10 percent manganese, engaged in diamond-drilling through a limestone cap and erecting a logwasher; Jecel Mining Corp., with reserves of 55,000 tons of direct shipping ore near Coron on Busuanga Island in the Calamanian group off the north coast of Palawan; and Pala-

[38] U.S. Embassy, Tokyo, Japan, State Department Dispatch 493: Oct. 30, 1958.
[39] U.S. Embassy, Tokyo, Japan, State Department Dispatch 1268: Apr. 23, 1958.
[40] U.S. Embassy, Seoul, Republic of Korea, State Department Dispatch 70: Aug. 9, 1958.
[41] U.S. Embassy, Manila, P.I., State Department Dispatches 1016, 162, 427, 631: June 10, Sept. 4 and Dec. 16, 1956, and Mar. 11, 1959.

wan Manganese Mines, Inc., with reserves estimated at 55,000 tons containing 48 to 50 percent manganese, also near Coron, Busuanga Island. Northern Luzon Mining Co., with estimated reserves of 33,000 tons averaging 54 percent manganese, produced 300 tons and shipped to Japan 200 tons of ore having 85 percent manganese dioxide content, for which $90 per ton c.i.f. Kobe was obtained. Other producers were: Philippine Base Metals with an estimated reserve of 28,000 tons of direct shipping ore (48 percent manganese or better) in Capas, Tarlac Province, Luzon; Consolidated Philippine Ores, which estimated reserves of 55,000 tons containing 40 to 50 percent manganese in Maasin Manticao, Misamis Oriental, Mindanao; and Laur Manganese Mines, at Laur, Nueva Ecija Province, Luzon, having an estimated reserve of 28,000 tons of direct shipping ore plus 55,000 tons probable.[42]

Portuguese India.—Manganese-ore exports from Goa totaled 139,000 short tons in 1958. This is believed to include some ferruginous manganese ore. West Germany received 70,000 tons; the United States, 15,000; France, 14,000; Belgium, 13,000; the Netherlands, 12,000; Switzerland, 5,700; Czechoslovakia, 5,600; and Italy, 3,700.[43]

Thailand.—High-grade manganese ore from deposits near the Mekong River in Northern Thailand was exported to the United States, the United Kingdom, Japan, and the Netherlands. Some also was reported used in Thailand to make dry cells.

Turkey.—In 1957 the Karabuk steel plant consumed 12,000 short tons of domestic manganese ore in the production of pig iron and in producing 1,800 tons of ferromanganese. Exports of manganese ore for that year were 35,000 tons. The United States received 14,000; France, 6,800; the United Kingdom, 4,400; Spain, 3,300; Sweden, Switzerland, West Germany, Italy, and Czechoslovakia, the remainder. Thirteen operators reported manganese ore production in 1957.[44]

AFRICA

Angola.—Production of ferruginous manganese ore (20 percent manganese, 35 percent iron) was 32,000 short tons in 1957 compared with 29,000 in 1956 and 15,000 reported in 1958 as manganiferous ore. Exports of this grade in 1957 were 44,000 tons. Average manganese content of manganese ore (containing 35 percent or more manganese) produced in 1958 was 43 percent; in 1957 and 1954, 48 percent; 1956, 35 percent; and 1955, 38 percent.[45]

Egypt.—In 1957, only 23,000 short tons of manganese and/or manganiferous ores were exported. The Netherlands received 13,000 tons; West Germany, 8,600; Czechoslovakia, 1,100; and Saudi Arabia, 200. Manganese was obtained from the Um Bogma and Bir Nassib mines in Sinai. Consideration was given to exploitation of deposits discovered in the Sharm el-Sheikh zone in Sinai, and the Elba zone in the Eastern Desert. Contracts were signed with the U.S.S.R. for research in mineral dressing of low-grade manganese ores, for production from

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[42] U.S. Embassy, Manila, P.I., State Department Dispatch 1042: June 17, 1958.
[43] U.S. Consulate, Bombay, India, State Department Dispatch 649: Apr. 30, 1959.
[44] U.S. Embassy, Ankara, Turkey, State Department Dispatch 121: Aug. 18, 1958.
[45] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 5, May 1958, p. 15. U.S. Consulate, Luanda, Angola, State Department Dispatches 123 and 146: Dec. 29, 1958 and Mar. 20, 1959.

the Elba deposit, and for equipment and materials to assist the Sinai operations.[46] Ten grades of high-grade ore were available for market, ranging from Alpha with 90 percent guaranteed minimum manganese dioxide, 0.50 percent guaranteed maximum iron, 0.60 percent guaranteed silica, to Omicron with 60 percent minimum manganese dioxide, 6.00 maximum iron, and 4.00 percent maximum silica.[47]

Ghana.—Manganese ore exports in 1958 totaled 570,000 short tons, of which 80,000 tons was Battery grade, 490,000 tons Metallurgical grade, and 500 tons contained less than 30 percent manganese.[48]

Morocco.—Production of Chemical-grade manganese ore in 1958 was 62,000 short tons, compared with 85,000 tons in 1957; Metallurgical-grade was 390,000 tons in 1958 and 457,000 tons in 1957. All of the chemical ore in 1957 came from the Imini mine of Société Anonyme Chérifienne d'Études Minières, except for 725 tons from the Arbalou site of Société Minarba, and 150 tons from the Hamarouet mine of Société des Mines de Bou Arfa. The Arbalou ore averaged 82 percent manganese dioxide; the remainder averaged 85 percent.[49] In addition to the 1957 production recorded above, which was from the Southern Zone, 730 tons of manganese ore containing 40 percent manganese was produced from the Northern Zone.[50] Also in 1957, the sinter plant at Sidi Marouf (Casablanca) produced 164,000 tons of sinter (56 percent manganese) from 198,000 tons of ore or concentrate; the Bou Arfa (Hamarouet) sinter plant produced 8,000 tons (35 percent manganese) of sinter from 13,000 tons.[51] In 1958, 72 percent of manganese exports went to French Zone markets.[52]

Rhodesia and Nyasaland, Federation of.—Five mines contributed to the 1957 Northern Rhodesian manganese ore production of 41,000 short tons; Kampumba (34 percent), Bahati (30 percent), Chiwefwe (26 percent), Luano, and Musofu.[53]

South-West Africa.—Except for development ore, South African Minerals Corp., Ltd. suspended manganese ore production at the end of August [54] from its mines, 110 miles from the railway at Okahandja, because of increased production costs and low prices.[55] Transportation and inadequate port facilities were problems.[56]

Union of South Africa.—In 1957 manganese ore production and local sales respectively were: 40 percent manganese and less, 484,000 and 269,000 short tons; 40 to 45 percent, 217,000 and 99,000 tons; 45 to 48 percent, 64,000 and 210 tons; over 48 percent, 23,000 and none.[57] Construction of the new ferroalloy plant of Ferroalloys Ltd. (Associated Manganese Mines of South Africa) started early in 1958 at Cato Ridge, Natal, 35 miles from Durban. Initial capacity will be

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[46] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 4, April 1959, pp. 17–18.
[47] U.S. Embassy, Cairo, Egypt, State Department Dispatch 469: Jan. 5, 1959.
[48] U.S. Embassy, Accra, Ghana, State Department Dispatch 649: Apr. 21, 1959.
[49] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 18–19. U.S. Embassy, Rabat, Morocco, State Department Dispatch 372: Mar. 20, 1959.
[50] U.S. Consulate General, Casablanca, Morocco, State Department Dispatch 47: Sept. 29, 1958.
[51] U.S. Consulate General, Casablanca, Morocco, State Department Dispatch 19: July 25, 1958.
[52] U.S. Embassy, Rabat, Morocco, State Department Dispatch 269: Jan. 21, 1959.
[53] U.S. Consulate General, Johannesburg, Union of South Africa, State Department Dispatch 128: Oct. 28, 1958.
[54] Mining World, vol. 20, No. 13, December 1958, p. 71.
[55] Iron and Coal Trades Review (London), vol. 178, No. 4728, Jan. 2, 1959, p. 50.
[56] U.S. Consulate General, Johannesburg, Union of South Africa, State Department Dispatch 284: May 20, 1958.
[57] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, pp. 17–18.

120 tons of high-carbon ferromanganese per day using two electric furnaces.[58] The manganese deposits of the Krugersdorp, Ventersdorp, Randfontein, and Marico districts of the Transvaal continued to supply low-grade manganese ore to uranium-leaching plants in 1958, although a possible trend away from this use was noted.[59]

OCEANIA

Australia.—New deposits of manganese ore, including some of high grade, were discovered at the eastern end of the Pilbara field.[60] Union Carbide Corp., through an Australian subsidiary, Union Carbide Exploration Corp., obtained options in Western Australia and began exploration looking toward a large manganese-mining operation.[61]

TECHNOLOGY

A comparative study by the Federal Bureau of Mines of four different methods for estimating tonnage and average grade of a large ore deposit was reported, using exploration data from the Maggie Canyon manganese deposit, Artillery Mountains region of Arizona. The report included a section on the fundamentals of statistical analysis applicable to such a study, and demonstrated that statistical analysis could be used to determine the minimum proper number of samples required—a matter left to the judgment of the engineer in the case of other methods. The report presents the results of the first of a series of investigations of the application of statistical analysis to sampling of ore deposits.[62]

The manganiferous deposits of the Cuyuna iron range of Minnesota were described, together with research for their beneficiation, and research investigations of the high-temperature differential sulfatization process developed by the Bureau's North Central Experiment Station for utilizing their manganese content. Not including merchantable manganiferous iron ore, the manganese resource was estimated to amount to 485 million short tons of material averaging 5 percent manganese and 30 percent iron.[63]

Further investigation by the Bureau of Mines of the Batesville district of Arkansas increased the estimate of inferred potential manganese resources of the district to 166 million long dry tons having an average manganese content of 5 to 6 percent. Manganiferous limestone, estimated to have an average manganese content of approximately 5 percent, accounted for better than 140 million tons of this resoure; manganiferous clay constituted most of the remainder.[64]

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[58] U.S. Consulate General, Johannesburg, Union of South Africa, State Department Dispatch 83: Sept. 23, 1958. U.S. Consulate, Durban, Union of South Africa, State Department Dispatch 27: Mar. 24, 1959.

[59] U.S. Consulate General, Johannesburg, Union of South Africa, State Department Dispatch 157: Nov. 26, 1958.

[60] Dunn, J. A., Advance Review of the Australian Mineral Industry in 1958: Chemical Engineering and Mining Review (Melbourne), vol. 51, No. 3, Dec. 15, 1958, p. 46.

[61] U.S. Consulate, Perth, Australia, State Department Dispatch 45: June 25, 1958.

[62] Hazen, Scott W., A Comparative Study of Statistical Analysis and Other Methods of Computing Ore Reserves, Utilizing Analytical Data From Maggie Canyon Manganese Deposit, Artillery Mountains Region, Mohave County, Ariz.: Bureau of Mines Rept. of Investigations 5375, 1958, 188 pp.

[63] Lewis, Walter E., Heising, L. F., Pennington, James W., and Prasky, Charles, Investigation of Cuyuna Iron-Range Manganese Deposits, Crow Wing County, Minn., Progress Report I: Bureau of Mines Rept. of Investigations 5400, 1958, 49 pp.

[64] Kline, H. D., and Brown, W. F., Manganese Resources of the Batesville District, Ark.: Bureau of Mines Rept. of Investigations 5411, 1958, p. 36.

Federal Bureau of Mines examination of 39 manganese deposits in southwestern Oregon distinguished three types of deposits: manganese silicate, manganese oxide, and manganiferous iron. The silicate and oxide deposits were reported to be small and irregular; the manganiferous iron deposits were low grade, although larger and more regular.[65]

The Bureau examined 115 manganese deposits in western Arizona, an area which supplied much of the manganese ore and concentrate delivered to the Wenden purchase depot of GSA during its operating period from July 1952 to May 1955. A significant custom-milling operation, from the standpoint of versatility of processes and continuity of production, was that of Mohave Mining and Milling Co., operating a 600-ton-per-day gravity plant in Mohave County and a 1,000-ton-per-day combination heavy-media and flotation plant and a sinter plant in Yavapai County. During the period of operation of the Wenden and Deming purchase depots, approximately eight other mills in western Arizona concentrated low-grade manganese ores. The eight mills included two heavy-media plants, which had capacities of 1,000 and 250 tons per day, respectively. Minimum acceptable manganese content for the depot purchases was 15 percent.[66]

Deposits of manganese-iron-bearing slates, manganese content of which varied from 9 to 13 percent, were drilled by the Bureau in the southern district of Aroostook County, Maine. An ammonia-ammonium carbonate leach, after reduction in hydrogen atmosphere, recovered 85 percent of the manganese with only 14 percent of the iron. Leaching with sulfuric acid obtained higher manganese extractions, but iron extractions doubled.[67]

Studies at the Bureau's Electrometallurgical Experiment Station, Boulder City, Nev., isolated four different cultures of micro-organisms which leached manganese from low-grade Boulder City (Nev.) and Cuyuna range (Minn.) manganiferous materials. With pH controlled at 5 to 6 at room temperatures, manganese extractions of four different samples averaged 97.5 percent in 60 days. Raising the pH over 7.0 precipitated the manganese and iron from the solutions. A beef and peptone extract was used as nutrient for the bacteria.[68]

Heats of combustion and formation for the nitrides, Mn_5N_2 and Mn_4N, were obtained at the Bureau's Minerals Thermodynamics Experiment Station, Berkeley, Calif., using electrolytic manganese analyzing 99.92 percent manganese.[69]

Work of the National Research Corp., Cambridge, Mass., sponsored by the Navy's Bureau of Aeronautics, has developed a new group of light-weight iron-aluminum-manganese alloys having excellent cold workability properties, together with high strength and oxidation resistance at temperatures above 1,200° F. The composition of

[65] Appling, Richard N., Manganese Deposits of Southwestern Oregon: Bureau of Mines Rept. of Investigations 5369, 1958, 56 pp.

[66] Farnham, L. L., and Stewart, L. A., Manganese Deposits of Western Arizona: Bureau of Mines Inf. Circ. 7843, 1958, 87 pp.

[67] Eilertsen, N. A., Investigation of Manganese Areas, Hammond Plantation and Hodgdon Townships Southern District, Aroostook County, Maine: Bureau of Mines Rept. of Investigations 5392, 1958, 38 pp.

[68] Perkins, E. C., and Novielli, F., Bacterial Leaching of Manganese Ores: Min. Cong. Jour., vol. 44, No. 8, August 1958, pp. 72–73.

[69] Mah, Alla D., The Heats of Combustion and Formation of Two Manganese Nitrides, Mn_5N_2 and Mn_4N: Jour. Am. Chem. Soc., vol. 80, June 20, 1958, pp. 2954–2955.

one alloy singled from the group was 34.4 percent manganese, 10 percent aluminum, 0.75 percent carbon, and the remainder iron.[70]

Westinghouse Research Laboratories reported discovery of new ceramic thermoelectric materials composed of nickel oxide, manganese oxide, and lithium-cobalt oxides for converting heat directly to electricity.[71]

Electro Metallurgical Co., a division of Union Carbide Corp., used the slags from its electric ferromanganese furnaces as raw material for its production of electrolytic manganese at Marietta, Ohio. The ferromanganese furnaces were operated so as to produce a slag containing approximately 20 percent manganese. After grinding to a 200-mesh powder, this slag was leached with recycled anolyte and make-up sufuric acid; the anolyte consisted principally of ammonium sulfate solution, and pH of the leach bath was adjusted to 6 by introducing ammonia gas. Electrolysis was accomplished in 3 banks of 42 cells each, power requirements for each bank being 10,000 amp. at 250 v. with temperature maintained at 100° F. The cathodes were stainless steel; the anodes were an alloy consisting of 99 percent lead and 1 percent silver. Potassium sulfate and boric acid were added to the cell feed in order that the manganese deposited on the cathode would have good thickness and density. Addition of sulfur dioxide stablized the electrolyte and improved current efficiency. The manganese metal was manually stripped from the cathodes on a 72-hour cycle, after which traces of hydrogen and other gaseous impurities were removed by heating in an oven.[72]

Production of type 201–202 manganese-bearing stainless steels was 30,000 short tons in 1958 (a year of reduced industrial activity), compared with 26,000 tons in 1957, 19,000 in 1956, and 1,900 in 1955.[73] Cost savings in the production of stainless steels of both the 200 and 300 series were claimed for the use of ferromanganese-silicon, a new low-carbon grade of silicomanganese having a maximum carbon content of 0.10 percent, 63 to 66 percent manganese, 28 to 32 percent silicon, 0.05 percent maximum phosphorous, and 0.03 percent maximum sulfur. The alloy served as a low-priced source for low-carbon manganese additions, while providing silicon for slag reduction.

The Geological Survey of the Maine Department of Economic Development announced that an aeromagnetic survey of southeastern Penobscot County, near Greenfield, had disclosed extensive manganese-iron deposits similar to those of Aroostook County.[74]

The University of California at La Jolla (Scripps Institute of Oceanography) studied the possibility of deep-sea deposits of manganese nodules as a manganese resource.[75] The deposits, which also contain nickel, copper, cobalt, and iron, have been known for many years.[76] They occur at depths of 3,000 to 4,000 feet or more, reportedly

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[70] American Metal Market, vol. 65, No. 245, Dec. 23, 1958, p. 11.

[71] Iron Age, New Ceramics Convert Heat to Electricity: Vol. 182, No. 11, Sept. 11, 1958, p. 125.

[72] Chemical Engineering, High Purity Manganese via Electrolysis: Vol. 65, No. 10, May 19, 1958, pp. 136–139.

[73] American Iron and Steel Institute, Annual Statistics Report—1958, p. 62.

[74] American Metal Market, vol. 65, No. 73, Apr. 16, 1958, p. 11.

[75] Mero, John L., A Preliminary Report on the Economics of Mining and Processing Deep-Sea Manganese Nodules: Institute of Marine Resources, Division of Mineral Technology, University of California, Jan. 1, 1959, 96 pp.

[76] Dietz, Robert S., Manganese Deposits on the Northeast Pacific Sea Floor: Calif. Jour. of Mines and Geology, vol. 51, No. 3, July 1955, pp. 209–220.

over large areas, but are only a few inches thick. They are described mineralogically as manganese oxides comparable to wad or bog manganese and have been found in both the Atlantic and Pacific oceans. A 4-month expedition of two Scripps ships (terminating at the end of February 1958) participated in the oceanographic program of the International Geophysical Year and was responsible for the renewed interest in deep-sea manganese.

Higher residual manganese in the steel bath at the end of the heat was claimed for the L–D (oxygen converter) process of steelmaking as compared to the conventional procedure of making steel in the open-hearth furnace. Besides appreciable manganese savings, the higher residual manganese allowed reduction or elimination of aluminum additions to the ladle when producing rimmed steel.[77]

A patent was issued for a process to recover manganese from spessartite garnet by grinding to less than 30-mesh and roasting in air with an alkali metal compound in an amount sufficient to provide two atoms of the selected alkali metal for each atom of manganese in the ore. The roasting was accomplished in a temperature range of about 500° to 900° C.[78]

[77] Blast Furnace and Steel Plants, vol. 46, No. 12, December 1958, p. 1308.
[78] Trost, Walter R., Process for Treating Manganese Garnet Ore: U.S. Patent 2,850,370, Sept. 2, 1958.

Mercury

By J. W. Pennington [1] and Gertrude N. Greenspoon [2]

OUTPUT of mercury at domestic mines in 1958 rose 10 percent above 1957 to 38,000 flasks—the highest peacetime annual production since 1883. Continued high domestic consumption of 53,000 flasks (virtually unchanged from 1957), a 28-percent drop in U.S. imports to 30,000 flasks, and Government purchase of 17,000 flasks of domestic mercury helped support prices, which averaged $229 a flask in 1958.

In addition to the guaranteed-price purchase program, which expired December 31, other Government actions in 1958 included continuation of exploration assistance and the authorization of mercury for barter transactions. Under the latter program, 10,000 flasks of mercury was obtained from Spain.

World output of mercury in 1958 rose for the 10th consecutive year and totaled 248,000 flasks. A 7-percent drop in output in Italy, stemming from work stoppages at the large mercury-producing mines, was more than offset by increased output in Mexico, Peru, and the United States.

TABLE 1.—Salient mercury statistics in 76-pound flasks

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production	9,728	18,543	18,955	24,177	[1] 34,625	38,067
Value (thousands)	$1,591	$4,903	$5,504	$6,284	$8,552	$8,720
Number of producing mines	35	71	98	147	[1] 120	101
Imports:						
For consumption	72,466	64,957	20,354	47,316	42,005	30,158
General	71,376	65,317	20,948	52,009	45,449	30,935
Exports	442	890	451	1,080	1,919	320
Reexports	713	1,436	267	2,025	3,275	934
Stocks at end of year	29,630	22,486	10,028	22,310	[1] 25,388	11,274
Producers	2,190	186	928	1,210	[1] 3,588	674
Consumers and dealers	27,440	22,300	9,100	21,100	[1] 21,800	10,600
Consumption	48,147	42,796	57,185	54,143	52,889	52,617
Average price per flask: New York	$152.60	$264.39	$290.35	$259.92	$246.98	$229.06
World: Production	144,200	180,000	185,000	[1] 220,000	[1] 245,000	248,000

[1] Revised figure.

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TABLE 2.—Salient statistics of the mercury industry, 1910–58, in 76-pound flasks

Year	Production			Imports for consumption	Exports	Apparent consumption	Price	
	World	United States	United States (percent of world total)				Average per flask at New York	Adjusted by wholesale index [1]
1910	107,053	20,330	19	9	1,898	18,441	[2] $47.69	$104
1911	120,423	20,976	17	6,209	287	26,898	[2] 47.16	112
1912	120,650	24,734	21	1,088	306	25,516	[2] 43.03	96
1913	117,465	19,947	17	2,259	1,125	21,081	[2] 40.07	88
1914	108,601	16,330	15	8,090	1,427	22,993	[2] 48.95	110
1915	112,871	20,756	18	5,551	3,328	22,979	[2] 88.17	195
1916	101,544	29,538	29	5,585	8,763	26,360	[2] 127.16	229
1917	115,087	35,683	31	5,138	10,636	30,185	[2] 107.72	141
1918	99,256	32,450	33	6,631	3,057	36,024	[2] 125.12	147
1919	89,940	21,133	23	10,495	8,987	22,641	[2] 93.38	104
1920	84,470	13,216	16	13,982	1,533	25,665	[2] 82.20	82
1921	61,916	6,256	10	10,462	388	16,330	[2] 46.07	73
1922	91,819	6,291	7	16,697	287	22,701	[2] 59.74	95
1923	93,040	7,833	8	17,836	314	25,355	[2] 67.39	103
1924	89,138	9,952	11	12,996	205	22,743	[2] 70.69	111
1925	103,344	9,053	9	20,580	201	29,432	[2] 84.24	125
1926	115,969	7,541	7	25,634	114	33,061	[2] 93.13	143
1927	149,905	11,128	7	19,941	(3)	[4] 30,900	118.16	191
1928	149,083	17,870	12	14,562	(3)	[4] 32,300	123.51	196
1929	162,699	23,682	15	14,917	(3)	[4] 38,500	122.15	197
1930	108,985	21,553	20	3,725	(3)	[4] 25,200	115.01	205
1931	99,069	24,947	25	549	[5] 4,984	20,512	87.35	184
1932	82,644	12,622	15	3,886	[5] 214	16,294	57.93	138
1933	59,828	9,669	16	20,315	(3)	[4] 29,700	59.23	138
1934	76,939	15,445	20	10,192	(3)	[4] 25,400	73.87	152
1935	100,261	17,518	17	7,815	(3)	[4] 25,200	71.99	138
1936	123,878	16,569	13	18,088	263	34,400	79.92	152
1937	133,136	16,508	12	18,917	454	35,000	90.18	161
1938	150,000	17,991	12	2,362	713	19,600	75.47	148
1939	145,000	18,633	13	3,499	1,208	20,900	103.94	207
1940	215,000	37,777	18	171	9,617	[6] 26,800	176.87	346
1941	275,000	44,921	16	7,740	2,590	[6] 44,800	185.02	326
1942	265,000	50,846	19	[7] 38,941	[7] 345	[6] 49,700	196.35	306
1943	236,000	51,929	22	[7] 47,805	[7] 385	[6] 54,500	195.21	291
1944	163,000	37,688	23	19,553	750	[6] 42,900	118.36	175
1945	131,000	30,763	23	68,617	1,038	[6] 62,429	134.89	196
1946	154,000	25,348	16	13,894	907	[6] 31,552	98.24	125
1947	168,000	23,244	14	13,008	884	[6] 35,581	83.74	87
1948	107,000	14,388	13	31,951	526	[6] 46,253	76.49	73
1949	121,000	9,930	8	103,141	577	[6] 39,857	79.46	80
1950	143,000	4,535	3	56,080	447	[6] 49,215	81.26	79
1951	147,000	7,293	5	47,860	241	[6] 56,848	210.13	183
1952	151,000	12,547	8	71,855	400	[6] 42,556	199.10	178
1953	160,000	14,337	9	83,393	546	[6] 52,259	193.03	175
1954	180,000	18,543	10	64,957	890	[6] 42,796	264.39	240
1955	185,000	18,955	10	20,354	451	[6] 57,185	290.35	262
1956	220,000	24,177	11	47,316	1,080	[6] 54,143	259.92	227
1957	245,000	34,625	14	42,005	1,919	[6] 52,889	246.98	210
1958	248,000	38,067	15	30,158	320	[6] 52,617	229.06	192

[1] Quoted price divided by Bureau of Labor Statistics wholesale price index (1947–49=100).
[2] Quoted price for 75-pound flask calculated to equivalents for 76-pound flasks.
[3] Not separately classified for 1927–30 and 1933–35.
[4] Estimated by Bureau of Mines.
[5] From a special compilation, Bureau of Foreign and Domestic Commerce.
[6] Actual consumption.
[7] Large quantities re-exported in 1942 and 1943 are included in imports but not exports.

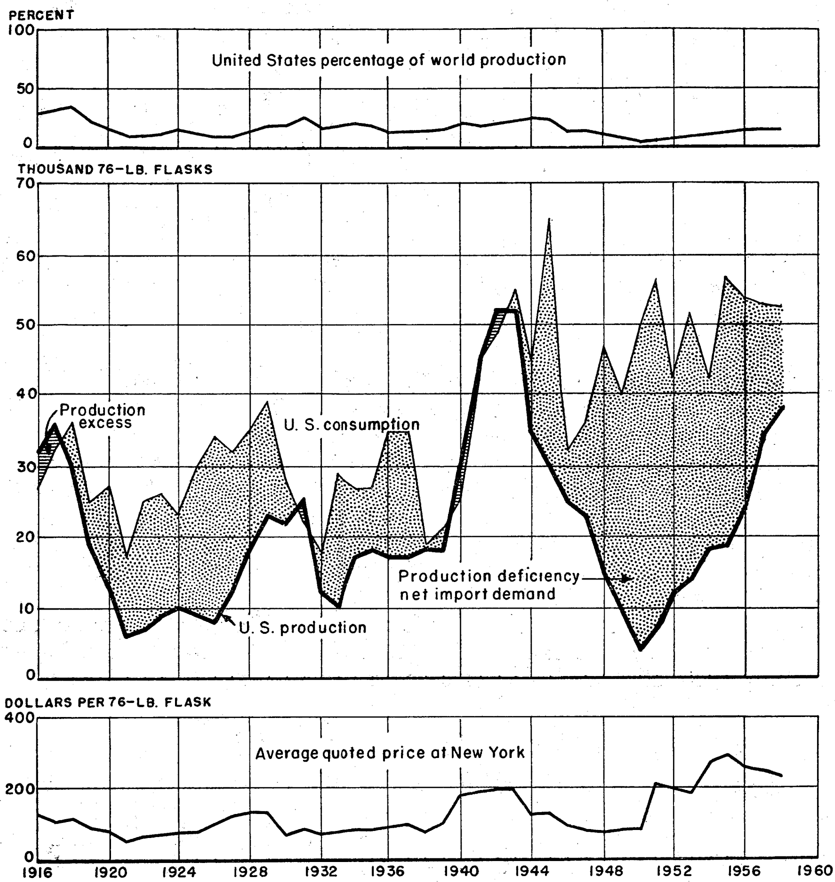

FIGURE 1.—Trends in production, consumption, and price of mercury, 1916–58.

LEGISLATION AND GOVERNMENT PROGRAMS

The Defense Minerals Exploration Administration (DMEA) entered into contracts for exploring mercury deposits through June 30, 1958, when DMEA became Office of Minerals Exploration (OME). Under OME mercury continued to be eligible for exploration assistance with 50-percent Government participation, but no contracts were executed.

The Government guaranteed-purchase-price program, initiated by General Services Administration (GSA) in July 1954, was continued in 1958. Revisions 2 to Regulations 11 and 12 were issued March 28, modifying the packaging requirements and making miscellaneous changes in Revisions 1 to the regulations. On December 2 GSA announced that the program would end December 31, 1958, and all deliveries must be made by that date. Purchases under the program totaled 26,891 flasks of domestic and 3,274 flasks of Mexican mercury. Of these totals, 9,428 flasks of domestic and 766 flasks of Mexican

TABLE 3.—DMEA contracts involving mercury executed during 1958, by States

State and contractor	Property	County	Contract	
			Date	Total amount[1]
California:				
H. L. M. Mining Co	Aetna Springs Resort	Napa	Nov. 19, 1957	$16, 520
Trans-Pacific Metals, Inc	Reed	Yolo	June 16, 1958	102, 316
Idaho:				
Mac D Mining Corp	Lucky Boy No. 1	Owyhee	June 6, 1958	6, 748
T. R. Baugh	Fern Cinnabar Group	Valley	June 23, 1958	21, 720
Oregon:				
Moneta Porcupine Mines, Ltd	Elkhead	Douglas	June 20, 1958	5, 199

[1] Government participation in exploration projects was 50 percent.

mercury were purchased under the original program, which expired December 31, 1957, and 17,463 domestic and 2,508 Mexican under the extended program, ending December 31, 1958.

On March 19 the U.S. Tariff Commission instituted an investigation of the mercury industry under section 332 of the Tariff Act of 1930. A public hearing was held on August 5, and members of the mining, selling, and consuming industries were present. Results of the Commission's investigation were published in "Report on Investigation No. 32, November 1958."

On November 14 the U.S. Department of Agriculture announced that mercury was on the list of materials eligible for acquisition for the supplemental stockpile through barter or exchange transactions.

DOMESTIC PRODUCTION

Mercury production at mines in the United States rose for the 8th consecutive year; output was 10 percent greater than in 1957 and, except for 1941–43, was the largest since 1883. Production increased in California, Idaho, and Nevada; output in Alaska and Oregon declined. The number of producing properties dropped from 120 (revised) in 1957 to 101 in 1958, but the quantity of ore treated rose 6 percent, and the average grade of the ore treated was 0.2 pound per ton higher than 1957. Output of secondary mercury decreased 7 percent.

California remained the leading mercury-producing State and supplied 59 percent of the U.S. total. Output rose 35 percent—the largest since 1944. The Abbott, New Idria, Buena Vista, and Mount Jackson (including Great Eastern) properties supplied 86 percent of the State total and furnished most of the increase.

Nevada remained in second place, contributing 19 percent of the domestic output. Production was 16 percent greater than in 1957, and established a new production peak. The Cordero mine in Humboldt County, the leading producer in the State, ranked second in the United States. Its output was 24 percent greater than in 1957.

Although production dropped 38 percent in Alaska, the State continued to rank third in output of mercury, supplying 9 percent of the total. The Red Devil mine, Kuskokwim River region, which furnished virtually the entire output, operated at a reduced rate during 1958.

A 16-percent increase in production enabled Idaho to rise to fourth place in output, and to account for 7 percent of total production. The Hermes (Cinnabar) mine in Valley County, which was closed in August 1956 because the plant had been destroyed by fire, resumed operations in 1958. The new plant used flotation, leaching, and electrolytic processes for recovering the mercury. Output of the other large producer in the State, Idaho-Almaden mine in Washington County, was slightly below that in 1957.

Oregon dropped to fifth place among mercury-producing States, as the State's contribution to the total U.S. production fell from 12 percent in 1957 to 6 percent in 1958. The 43-percent decrease in output was due chiefly to a substantial drop in production at the Bonanza mine in Douglas County, the State's leading producer in 1957; the closure in mid-1958 of the Horse Heaven mine, Jefferson County, and continued suspension of operations at the Black Butte mine, Lane County, which shut down for an indefinite period in August 1957. At the Bretz mine in Malheur County a 10-ton Herreshoff furnace, installed in 1957, and a flotation plant operated during the year; output, however, was 11 percent below that in 1957.

The remainder of the 1958 output (less than 1 percent) was produced in Arizona, Texas, and Washington.

TABLE 4.—Mercury produced in the United States, by States

Year and State	Producing mines	76-pound flasks	Value [1]
1955:			
Alaska and Texas	4	690	$200, 342
Arizona	4	477	138, 497
California	48	9, 875	2, 867, 206
Idaho	2	1, 107	321, 417
Nevada	33	5, 750	1, 669, 512
Oregon	7	1, 056	306, 610
Total	98	18, 955	5, 503, 584
1956:			
Alaska	2	3, 280	852, 538
Arizona and Texas	8	734	190, 781
California	71	9, 017	2, 343, 699
Idaho	2	3, 394	882, 168
Nevada	51	5, 859	1, 522, 871
Oregon	13	1, 893	492, 029
Total	147	24, 177	6, 284, 086
1957:			
Alaska	2	5, 461	$1, 348, 758
Arizona	5	28	6, 915
California	[2] 57	[2]16, 511	[2]4, 077, 887
Idaho	2	2, 260	558, 174
Nevada	[2] 44	6, 313	1, 559, 185
Oregon	8	3, 993	986, 191
Texas and Washington	2	59	14, 572
Total	[2] 120	[2]34, 625	[2]8, 551, 682
1958:			
Alaska	2	3, 380	774, 223
Arizona	4	53	12, 140
California	48	22, 365	5, 122, 927
Idaho	3	2, 625	601, 282
Nevada	35	7, 336	1, 680, 384
Oregon	7	2, 276	521, 341
Texas and Washington	2	32	7, 330
Total	101	38, 067	8, 719, 627

[1] Value calculated at average price at New York.
[2] Revised figure.

TABLE 5.—Mercury produced in the United States, 1910–58, by States, in 76-pound flasks

Year	Alaska	Arizona	Arkansas	California	Idaho	Nevada	Oregon	Texas	Utah	Washington	Other [1]	Total
1910				16, 985		69		3, 276				20, 330
1911				18, 612		69		2, 295				20, 976
1912				20, 254		2, 516		1, 964				24, 734
1913		224		15, 386		1, 623		2, 714				19, 947
1914		11		11, 154		2. 062		3, 103				16, 330
1915		(2)		14, 095		2, 296	(2)	4, 359			6	20, 756
1916		5		20, 768		2, 169	299	6, 223		74		29, 538
1917		39		23, 623	5	984	383	10, 649				35. 683
1918				22, 366	21	1, 030	693	8, 340				32, 450
1919				15, 005		746	429	4, 953				21, 133
1920				9, 719		82	24	3, 391				13, 216
1921				3, 015	1	(2)	(2)	(2)			3, 240	6, 256
1922				3, 360		(2)	2	(2)			2, 929	6, 291
1923				5, 375	(2)	(2)	(2)	(2)			2, 458	7, 833
1924		(2)		7, 861	(2)	(2)	(2)	(2)			2, 091	9, 952
1925		30		7, 514	(2)	532		(2)			977	9, 053
1926	(2)	(2)		5, 651	6	194		(2)		482	1. 208	7, 541
1927	(2)	(2)		5, 672		419	2, 055	(2)		559	2, 423	11, 128
1928		(2)		6, 977		2, 867	3, 710	(2)		(2)	4, 316	17, 870
1929	(2)	(2)		10, 139		4, 764	3, 657	(2)		1, 397	3, 725	23, 682
1930	(2)	(2)		11, 451		3. 282	2, 919	(2)		1, 079	2, 822	21, 553
1931	(2)	(2)	(2)	13. 448		2, 217	5, 011	(2)		560	3, 711	24, 947
1932	(2)	(2)	(2)	5, 172		474	2, 523	(2)		407	4, 046	12, 622
1933			(2)	3, 930		387	1, 342	(2)	(2)	(2)	4. 010	9, 669
1934		(2)	488	7, 808		300	3, 460	(2)		330	3, 059	15, 445
1935		(2)	304	9, 271		190	3, 456	(2)		106	4, 191	17, 518
1936		(2)	(2)	8, 693		211	4, 126	(2)	25	(2)	3, 514	16, 569
1937		37	(2)	9, 743		198	4, 264	(2)		(2)	2, 266	16, 508
1938	(2)		(2)	12, 277		336	4, 610	(2)		(2)	768	17, 991
1939		(2)	364	11, 127	(2)	828	4, 592	(2)			1, 722	18, 633
1940	162	740	1, 159	18, 629	(2)	5, 924	9, 043	(2)	53	(2)	2, 067	37, 777
1941	(2)	873	2, 012	25, 714	(2)	4, 238	9, 032	(2)	19	(2)	3, 033	44, 921
1942	(2)	701	2, 392	29, 906	(2)	5, 201	6, 935	(2)	(2)	(2)	5, 711	50, 846
1943	786	541	1, 532	33, 812	4, 261	4, 577	4, 651	1, 769				51, 929
1944	(2)	548	191	28, 052	(2)	2, 460	3, 159	1, 095			2, 183	37, 688
1945	(2)	(2)	(2)	21, 199	627	4, 338	2, 500	(2)			2, 099	30, 763
1946	699	95	11	17, 782	868	4, 567	1, 326					25, 348
1947	127			17, 165	886	3, 881	1, 185					23, 244
1948	100			11, 188	543	1, 206	1, 351					14, 388
1949	100			4, 493		4, 170	1, 167					9, 930
1950				3, 850		680	5					4, 535
1951		(2)		4, 282	357	1, 400	1, 177	(2)			77	7, 293
1952	28			7, 241	887	3, 523	868					12, 547
1953	40			9. 290	(2)	3, 254	648	(2)			1, 105	14, 337
1954	1, 046	163		11, 262	609	4, 974	489					18, 543
1955	(2)	477		9, 875	1, 107	5, 750	1, 056	(2)			690	18, 955
1956	3, 280	(2)		9, 017	3, 394	5, 859	1, 893	(2)			734	24, 177
1957	5, 461	28		16, 511	2, 260	6, 313	3, 993	(2)		(2)	59	34, 625
1958	3, 380	53		22, 365	2, 625	7, 336	2, 276	(2)		(2)	32	38, 067

[1] Includes States shown as "(2)".
[2] Included with "Other." Bureau of Mines not at liberty to publish separately.

TABLE 6.—Mercury ore treated and mercury produced in the United States [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
1954	174, 083	18, 524	8. 1	1957 [2]	309, 632	34, 058	8. 4
1955	222, 740	18, 819	6. 4	1958	328, 155	37, 209	8. 6
1956	244, 148	24, 109	7. 5				

[1] Excludes mercury produced from placer operations and from cleanup activity at furnaces and other plants.
[2] Revised figures.

Of the 101 producing mines in 1958 (120—revised figure for 1957), 8 mines, each producing 1,000 flasks or more, supplied 85 percent of the total output. The leading producers were as follows:

State:	*County*	*Mine*
Alaska	Aniak district	Red Devil.
California	Lake	Abbott.
	San Benito	New Idria.
	San Luis Obispo	Buena Vista.
	Sonoma	Mount Jackson (including Great Eastern).
Idaho	Washington	Idaho-Almaden.
Nevada	Humboldt	Cordero.
Oregon	Malheur	Bretz.

In addition to the foregoing mines, the following produced 100 flasks or more during 1958:

State:	*County*	*Mine*
Alaska	Aniak district	Schaefer's Cinnabar.
California	Kings	Little King (Fredana).
	Napa	Oat Hill.
	San Benito	San Carlos.
	Santa Barbara	Gibraltar.
	Santa Clara	Guadalupe, New Almaden mine and dumps.
	Trinity	Altoona.
Idaho	Valley	Hermes.
Nevada	Esmeralda	B&B.
	Humboldt	Red Ore.
	Pershing	Hillside.
Oregon	Douglas	Bonanza.
	Jefferson	Horse Heaven.

These 22 mines produced 97 percent of the total domestic output.

Secondary.—Less metal was produced from all secondary sources in 1958 than in any year since the compilation of these data was begun in 1954. Mercury was reclaimed from dental amalgam, oxide and acetate sludges, and battery scrap, as well as from the dismantling of a plant using mercury.

TABLE 7.—Production of secondary mercury in the United States, in 76-pound flasks

Year:	*Quantity*
1954	6,100
1955	10,030
1956	5,850
1957	5,800
1958	5,400

CONSUMPTION AND USES

Industrial consumption of mercury in 1958 was virtually the same as in 1957. Although most uses required more mercury, less metal was used for installing and expanding chlorine and caustic soda plants than in 1957. However, enlargement of chlorine and caustic soda capacity through installation of a new plant at New Martinsville, W.Va., and expansions at existing plants at Calvert City, Ky., and Longview, Wash., helped maintain the high rate of consumption.

Consumption of mercury in pharmaceuticals made the most noteworthy gain, increasing 61 percent, and dental preparations took 27 percent more than in 1957. The quantity of mercury required to replace losses in chlorine and caustic soda manufacture rose 13 percent and for electrical apparatus advanced 2 percent.

Among the uses that required less metal in 1958 were catalysts, which declined 5 percent, and agricultural uses, which dropped 1 percent. Consumption of mercury in industrial and control instruments was unchanged from 1957.

TABLE 8.—Mercury consumed in the United States, in 76-pound flasks

Use	1949–53 (average)	1954	1955	1956	1957	1958
Pharmaceuticals	3,091	1,846	1,578	1,600	1,751	2,815
Dental preparations [1]	1,074	1,409	1,177	1,328	1,371	1,741
Fulminate for munitions and blasting caps	262	106	90	11		
Agriculture (includes insecticides, fungicides, and bactericides for industrial purposes)	5,946	7,651	7,399	9,930	6,337	6,270
Antifouling paint	1,830	512	724	511	568	749
Electrolytic preparation of chlorine and caustic soda	1,699	2,137	3,108	3,351	4,025	4,547
Catalysts	1,954	594	729	871	859	816
Electrical apparatus [1]	9,454	10,833	9,268	9,764	9,151	9,335
Industrial and control instruments [1]	5,703	5,185	5,628	6,114	6,028	6,054
Amalgamation	172	203	217	239	244	248
General laboratory	677	1,129	976	984	894	968
Redistilled [1]	7,670	9,281	9,583	9,483	9,703	9,448
Other	8,615	1,910	16,708	9,957	11,958	9,626
Total	48,147	42,796	57,185	54,143	52,889	52,617

[1] A breakdown of the "redistilled" classification showed ranges of 53 to 39 percent for instruments, 15 to 5 percent for dental preparations, 44 to 17 percent for electrical apparatus, and 17 to 8 percent for miscellaneous uses in the period 1949–57, compared with 43 percent for instruments, 10 percent for dental preparations, 36 percent for electrical apparatus, and 11 percent for miscellaneous uses in 1958.

STOCKS

Consumers' and dealers' stocks of mercury were less than half those on hand at the end of 1957, and, except for 1955 and 1944, were the smallest since compilation of these data was begun in 1940. Withdrawal of metal from inventories for installation of a new chlorine and caustic soda plant and for expansions at existing plants was largely responsible for the drop.

Stocks held by domestic producers usually comprise only a small part of the total for the industry. These stocks decreased 2,900 flasks

TABLE 9.—Stocks of mercury producers and consumers and dealers, in 76-pound flasks

End of year	Producers	Consumers and dealers	Total
1949–53 (average)	2,190	27,440	29,630
1954	186	22,300	22,486
1955	928	9,100	10,028
1956	1,210	21,100	22,310
1957 [1]	3,588	21,800	25,388
1958	674	10,600	11,274

[1] Revised figures.

in 1958 ostensibly because producers completed deliveries to GSA before the Government purchase-price program expired.

In addition to the stocks of metal shown in table 11, the National Stockpile contained inventories of mercury that may not be disclosed.

PRICES

The annual price of mercury in the United States averaged 7 percent less in 1958 than in 1957. At the beginning of 1958, prices ranged from $225–$230 a flask; they fluctuated between this range and $239–$243 through August; and rose to $240–$243 a flask on September 2. Thereafter, the quotation dropped gradually until late December when it ranged from $218–$222 a flask, and continued at that range to the end of the year.

In London mercury was quoted at £69 (equivalent to $193.20) a flask at the beginning of the year. The price rose to £77–£78 ($215.60–$218.40) in early March, then dropped to £76 10s. ($214.20) about the first of May, and remained there through the third week in July. The price then rose to £79 ($221.20), dropped to £78 ($218.40) about mid-October, to £74 ($207.20) in late November, and continued at that level through December. The annual average was $214.98 a flask, 7 percent lower than 1957.

TABLE 10.—Average monthly prices per 76-pound flask of mercury at New York and London

Month	1956		1957		1958	
	New York [1]	London [2]	New York [1]	London [2]	New York [1]	London [2]
January	$273.04	$248.38	$255.00	$236.94	$220.69	$199.74
February	267.58	245.03	255.00	236.96	221.86	210.83
March	258.78	242.90	255.00	238.28	231.69	218.19
April	266.56	240.41	255.00	239.85	231.08	218.33
May	265.23	240.61	255.00	248.12	229.23	215.40
June	258.12	243.27	255.00	254.26	228.12	215.05
July	255.00	238.30	254.31	248.81	230.04	217.31
August	255.00	233.50	251.11	240.43	237.77	221.60
September	255.00	232.38	244.75	238.13	238.20	221.46
October	254.77	232.51	231.62	213.06	232.77	220.07
November	255.00	233.73	226.96	197.23	227.05	216.02
December	255.00	234.11	225.00	193.60	220.18	207.48
Average	259.92	238.68	246.98	232.36	229.06	214.98

[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.

FOREIGN TRADE[3]

Imports.—Imports of mercury for consumption in the United States in 1958 (exclusive of 10,000 flasks received through barter from Spain) were 52 percent less than the quantity received in 1957 and the smallest since 1947. Of the 20,200 flasks imported for consumption in 1958, Spain supplied 42 percent; Mexico, 41 percent; Italy, 6 percent; and the Philippines, 5 percent. Except for 1955, receipts from Italy were the smallest since shipments of mercury were resumed following World War II and Italy dropped to third place among the principal suppliers of mercury. The quantity received from Chile was the largest since 1944. Of the principal mercury-producing countries, only Mexico shipped more metal to the United States in 1958 than in 1957. Small quantities of mercury were received from Canada, Bolivia, Colombia, Peru, and Yugoslavia.

In addition to the mercury received through barter, 829 flasks from Spain and 274 from Italy entered the country for the U.S. Government; 47 flasks of scrap mercury were received from Canada duty free under certain public laws.

Imports of various mercury compounds, usually insignificant, were less than half the 1957 quantity. Of the 8,685 pounds (18,891 in 1957) of mercuric chloride, corrosive sublimate, mercurous chloride (calomel), oxide (red precipitate) and other mercury preparations received in 1958, 3,484 pounds came from the United Kingdom, 2,800 from Yugoslavia, 1,689 from Spain, 500 from France, 210 from Canada, and 2 from Israel; 440 pounds of vermilion reds was imported from Italy.

[3] Figures on U.S. 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 in 76-pound flasks

[Bureau of the Census]

Country	1949–53 (average)		1954		1955		1956		1957		1958	
	Flasks	Value (thousand)	Flasks	Value (thousand)	Flasks	Value (thousand)	Flasks	Value (thousand)	Flasks	Value (thousand)	Flasks	Value (thousand)
North America:												
Canada	193	$35	115	$31	114	$37	80	$21	66	$16	50	$7
Honduras	2	(1)										
Mexico	6,584	917	8,887	1,730	10,250	2,546	11,536	2,618	5,280	1,023	8,247	1,506
Total	6,779	952	9,002	1,761	10,364	2,583	11,616	2,639	5,346	1,039	8,297	1,513
South America:												
Bolivia	4	1									9	2
Chile							25	6			514	102
Colombia									15	4	80	12
Peru	1	(1)			95	26	372	89	244	52	319	61
Total	5	1			95	26	397	95	259	56	922	177
Europe:												
Denmark	60	4										
Germany	50	8										
Italy	36,827	4,083	22,180	3,394	629	179	16,810	3,934	8,056	1,869	1,133	221
Netherlands	215	17					20	5				
Spain	20,966	2,448	29,884	4,875	5,458	1,302	15,713	3,667	25,276	5,677	[2] 8,486	1,721
Sweden	348	34										
Switzerland	41	5										
United Kingdom	170	11			1	(1)	350	78	2,500	560	(3)	(1)
Yugoslavia	6,235	827	3,891	754	3,807	1,059	2,350	579	568	132	220	46
Total	64,912	7,437	55,955	9,023	9,895	2,540	35,243	8,263	36,400	8,238	[2] 9,839	1,988
Asia:												
India	5	1										
Japan	755	39										
Philippines											1,100	236
Turkey							60	13				
Total	760	40					60	13			1,100	236
Africa: Morocco	10	2										
Grand total	72,466	8,432	64,957	[4] 10,784	20,354	5,149	47,316	11,010	42,005	9,333	[2] 20,158	3,914

[1] Less than $1,000.
[2] In addition, 10,000 flasks were received through barter.
[3] Less than 1 flask.
[4] Data known to be not comparable with other years.

TABLE 12.—Mercury imported (general imports) [1] into the United States, in 76-pound flasks

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	197	115	114	80	66	50
Honduras	2					
Mexico	6,818	9,374	10,310	12,502	5,991	8,346
Total	7,017	9,489	10,424	12,582	6,057	8,396
South America:						
Bolivia	4					9
Chile				125		1,160
Colombia					15	80
Peru	1		95	372	244	319
Total	5		95	497	259	1,568
Europe:						
Denmark	60					
Germany	50					
Italy	36,837	21,858	579	17,592	9,208	1,015
Netherlands	195			20		
Spain	19,602	29,859	5,524	18,104	25,993	[2] 8,636
Sweden	348					
Switzerland	41					
United Kingdom	(3)		1	564	2,500	(3)
Yugoslavia	6,442	4,057	4,325	2,590	1,432	220
Total	63,575	55,774	10,429	38,870	39,133	[2] 9,871
Asia:						
Japan	769					
Philippines						1,100
Turkey		54		60		
Total	769	54		60		1,100
Africa: Morocco	10					
Grand total	71,376	65,317	20,948	52,009	45,449	[2] 20,935

[1] Data are "general" imports; that is, they include mercury imported for immediate consumption plus material entering the country under bond.
[2] In addition, 10,000 flasks were received through barter.
[3] Less than 1 flask.

Exports.—Exports of mercury, usually small, were only one-sixth of the 1957 quantity and the smallest since 1951. A total of 320 flasks (1,919 in 1957) was exported in 1958, of which 63 (none) went to Taiwan, 41 (102) to Canada, 39 (41) to Cuba, 39 (56) to Venezuela, 36 (7) to Saudi Arabia, 21 (4) to Ecuador, 20 (4) to Mexico, 19 (25) to Colombia, 12 (none) to Indonesia, and the remainder in lots of less than 10 flasks to 7 other countries.

Reexports.—Reexports in 1958 totaled 934 flasks compared with 3,275 flasks in 1957 and were the smallest since 1955. Of the total reexported, 293 flasks (697) went to Canada, 225 (none) to West Germany, 150 (7) to Venezuela, 111 (1,855) to Japan, 110 (499) to the United Kingdom, 40 (153) to Taiwan, and 5 (15) to Cuba.

Tariff.—The duty of 25 cents a pound ($19 a flask) on imports of mercury, in effect since 1922, was continued.

TABLE 13.—Mercury exported from the United States

[Bureau of the Census]

Year	76-pound flasks	Value	Year	76-pound flasks	Value
1949–53 (average)	442	$68,370	1956	1,080	$284.418
1954	890	183,417	1957	1,919	483,892
1955	451	155,433	1958	320	95,003

TABLE 14.—Mercury reexported from the United States

[Bureau of the Census]

Year	76-pound flasks	Value	Year	76-pound flasks	Value
1949–53 (average)	713	$86,554	1956	2,025	$475,667
1954	1,436	257,342	1957	3,275	763,303
1955	267	77,664	1958	934	198,501

WORLD REVIEW

World output of mercury in 1958 rose slightly above that of 1957 to 248,000 flasks. Increased production in Mexico, Peru, and the United States more than offset reduced output in Italy owing to a 2-month labor strike.

TABLE 15.—World production of mercury, by countries,[1] in 76-pound flasks [2]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Mexico	7,489	14,755	29,881	19,530	21,068	22,568
United States	9,728	18,543	18,955	24,177	34,625	38,067
South America:						
Bolivia (exports)	4					10
Chile	291	243	526	575	678	[3] 600
Colombia			36		99	200
Peru		77	148	335	411	1,978
Europe:						
Austria	21	27	16	6	6	
Czechoslovakia [3] [4]	741	725	725	725	725	725
Italy	51,791	54,477	53,520	61,932	63,237	58,712
Spain	42,251	43,135	36,231	48,269	54,750	[3] 55,000
U.S.S.R.[3] [4]	11,700	12,300	12,300	([5])	([5])	([5])
Yugoslavia	14,140	14,446	14,591	13,228	12,328	12,270
Asia:						
China	[3] 3,000	[3] 10,000	[3] 11,500	([5])	([5])	([5])
Japan	3,022	10,264	4,990	8,334	11,872	10,298
Philippines			635	3,015	3,363	3,321
Taiwan		44	58			
Turkey		261	841	1,079	720	928
Africa:						
Algeria	23					
Tunisia			166	22		39
World total (estimate)	144,200	180,000	185,000	220,000	245,000	248,000

[1] Rumania and a few other countries may also produce a negligible quantity 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 exactly to totals shown because of rounding where estimated figures are included.
[3] Estimate.
[4] According to the 45th annual issue of Metal Statistics (Metallgesellschaft) through 1955.
[5] Data not available; estimate by author of chapter included in total.

Chile.—Virtually all of Chile's mercury production came from an old gold mine operated by Cia. Minera Tamaya near Punataqui, south of Ovalle. Due to an increase from 0.2 percent to 1.0 percent in average grade of ore mined, mercury output rose from about 60 flasks a month in 1957 to approximately 300 flasks a month in May 1958.[4]

Italy.—Despite the two additional large rotary furnaces installed in early 1958, mercury production in Italy dropped 7 percent from the preceding year because of labor strikes that lasted from September 22 to November 11.

Decreased exports of mercury from Italy caused stocks to accumulate to an estimated year's production by the end of 1958. Because of the excessive inventories and low prices, Italian mercury producers urged the Government to abolish the production tax of $51 a flask imposed in November 1954. However, no action was taken by the Italian Government in 1958.

On January 8 it was announced that mercury production of the Monte Amiata and Siele operations would be marketed by a joint sales office, Mercurio Italiano, Via Piemonte 38, Rome, Italy.

Philippines.—Mercury production in the Philippines in 1958 was virtually unchanged from 1957 despite the installation of the third 80-ton-per-day rotary furnace at the Palawan Quicksilver Mines, Inc.—Philippines' sole mercury producer—in June. The new furnace was expected to increase Palawan's monthly output from a range of 250–300 flasks to 350 flasks. Most of the production was exported to Japan

TABLE 16.—Exports of mercury from Italy, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1957	1958	Country	1957	1958
Argentina		308	India	487	3
Australia	197	136	Japan	2,680	
Austria	1,010	107	Netherlands	99	1,137
Belgium-Luxembourg	264	99	Poland	818	1,500
Brazil	4,052	400	United Kingdom	3,252	2,910
Canada	99	600	United States	4,151	949
Czechoslovakia	812	699	Other countries	580	183
France	4,363	1,389			
Germany, West	5,924	986	Total	28,788	11,406

[1] Compiled from Customs Returns of Italy.

TABLE 17.—Exports of mercury from Mexico, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1957	1958	Country	1957	1958
Canada	889	816	United States	10,637	16,606
France		541	Other countries	18	95
Germany	1,108	2,979			
Japan	5,340	1,149	Total	20,965	26,160
United Kingdom	2,973	3,974			

[1] Compiled from Customs Returns of Mexico.

[4] Dorr, Robert J. (first secretary), Production of Mercury Increases: State Department Dispatch 84, Santiago, Chile, July 25, 1958, 7 pp.

under long-term contracts, but some mercury was shipped to the United States. The grade of ore treated averaged between 4 and 4.5 pounds of mercury per ton.

TABLE 18.—Exports of mercury from Spain, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1957	1958	Country	1957	1958
Austria	181	60	Netherlands	3,749	1,026
Belgium-Luxembourg	856	305	Norway	300	60
Brazil	1,836	1,058	Portugal	341	253
Canada	651	220	Sweden	1,256	288
Denmark	4	1,151	Switzerland	618	1,481
Egypt	45	450	United Kingdom	6,482	10,283
Finland	1,340	100	United States	17,258	20,206
France	5,140	6,525	Other countries	262	203
Germany	4,450	3,237			
India	550	3,824	Total	46,497	50,730
Japan	1,178				

[1] Compiled from Customs Returns of Spain.

Tunisia.—Mercury production in Tunisia came from the Djebel Arja mine which was reopened in 1957.[5] A mercury recovery plant with a daily capacity of 15–20 tons of ore began operations in April 1958.

Turkey.—Two Federal Bureau of Mines publications[6] contained information on mercury deposits in Turkey.

United Kingdom.—Mercury was deleted from the United Kingdom list of goods embargoed for export to the Soviet bloc and China, effective January 2, 1959.

Foreign-trade data for the United Kingdom indicated that 14,100 flasks of mercury were consumed during 1958. Imports continued at the high rates of recent years, but reexports dropped sharply and the new supply of mercury available for consumption rose accordingly.

	1954	1955	1956	1957	1958
Imports	29,500	12,900	19,600	18,200	19,200
Reexports	6,600	3,300	4,000	15,300	5,100
Apparent consumption	22,900	9,600	15,600	2,900	14,100

[5] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 20–21.
[6] Nahai, L., The Mineral Industry of Turkey: Bureau of Mines Inf. Circ. 7855, 1958, 140 pp.; Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, pp. 42–57.

Reexports of mercury in 1957 and 1958, in 76-pound flasks, were as follows:

Destination:	1957	1958
India	341	1,124
Australia	389	654
Union of South Africa	298	521
Germany, West	821	458
Sweden	592	316
France	------	300
Netherlands	218	300
Belgium	259	264
Denmark	265	264
Finland	553	190
Hong Kong	275	153
United States	9,308	-----
Canada	1,129	-----
Other	862	596
Total	15,310	5,140

Yugoslavia.—Yugoslavia's mercury output, as usual, came from the old and famous Idria mine. Although the Idria plant was reconstructed and expanded, output was to continue virtually unchanged because of the decreasing grade of ore treated. Efforts toward increasing Yugoslavia's mercury production included exploration of ore deposits at Avala, near Beograd, around Idria, and areas in Montenegro and Bosnia.

TABLE 19.—Exports of mercury from Yugoslavia, by countries of destination, in 76-pound flasks [1]

[Compiled by Corra A. Barry]

Country	1957	1958 [2]	Country	1957	1958 [2]
Austria	953	285	Switzerland	1,010	400
France	410	506	United Kingdom	125	50
Germany, West	2,742	1,924	United States	1,201	----------
Japan	350	----------	Other countries	5	1
Sweden	60	70	Total	6,856	3,236

[1] Compiled from Customs Returns of Yugoslavia.
[2] January through September, inclusive.

TECHNOLOGY

The Federal Bureau of Mines published the results[7] of a laboratory study on the flotation of Alaskan cinnabar-stibnite ore and fluidized-bed roasting of the concentrate.

A report[8] of the Federal Geological Survey described the occurrence of quicksilver and the general geology of the Mazatzal Mountains quicksilver district in Arizona.

A simple and rapid analysis[9] of mercury in organic compounds consisted of burning the sample in an oxygen-filled flask, absorbing the mercury in concentrated nitric acid, adjusting the pH of the solution to 7.5, and titrating the mercury amperometrically with (ethylenedinitrilo) tetraacetic acid. When an organomercurial was burned in an oxygen-filled flask, the mercury was converted to Hg, Hg_2^{++}, and Hg^{++}. Concentrated nitric acid oxidized and fixed both of the lower forms as Hg^{++}. Then after adjusting the pH of the solution with sodium hydroxide, the mercury was titrated.

Experimental procedures and results were described for separating zinc, cadmium, and mercury as their anionic chloro complexes by an ion exchange chromatographic method. The metal chloro complexes were absorbed from a 0.01 molar hydrochloric acid solution by an anion exchange resin, Dowex 1, in the chloride form.[10]

Through the use of radioactive Hg–203 the mercury inventory in electrolytic cells of chlorine and caustic soda plants was determined with greater accuracy and at less cost than by the former procedure of draining each cell and weighing the mercury.[11] A measured quantity of Hg–203 was added to each mercury cell and mixed thoroughly. Then by measuring with a liquid-jacketed Geiger counter the activities of mercury samples taken from the cells and knowing the quantity of isotopes added to each cell, the mercury content of the system was calculated.

Information on temperature, cosmic ray activity, and atmospheric density was transmitted from U.S. satellites through the use of mercury batteries.[12] Selection of mercury battery packs weighing about 2 pounds as "powerplants" for the satellites stemmed from the advantages of mercury batteries over other dry cells—greater energy in relation to volume and weight, longer life, uniform rate of energy during entire life, and ability to withstand severe shock and acceleration.

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[7] Wells, R. R., Johnson, M. M., and Sterling, F. T., Recovering Mercury From Cinnabar-Stibnite Ore by Flotation and Fluidized-Bed Roasting: Bureau of Mines Rept. of Investigations 5433, 1958, 19 pp.

[8] Faick, J. N., Geology of the Ord Mine, Mazatzal Mountains Quicksilver District, Arizona: Geol. Survey Bull. 1042–R, 1958, pp. 685–698.

[9] Southworth, Burnett C., Hodecker, John H., and Fleischer, Kenneth D., Determination of Mercury in Organic Compounds: Anal. Chem., vol. 30, No. 6, June 1958, pp. 1152–1153.

[10] Berg, Eugene W., and Truemper, Joseph T., Ion Exchange Separation of Zinc, Cadmium, and Mercury in Aqueous and Partial Nonaqueous Media: Anal. Chem., vol. 30, No. 11, November 1958, pp. 1827–1830.

[11] Chemical Engineering, Radioisotopes Measure Mercury Inventory: Vol. 67, No. 18, Sept. 8, 1958, p. 64.

[12] Electrical Engineering, Mercury Batteries Used in U.S. Satellites: Vol. 77, No. 9, September 1958, p. 858.

Mica

By Milford L. Skow,[1] G. Richards Gwinn,[1] and Gertrude E. Tucker[2]

ALTHOUGH the quantity of mica of all types sold or used declined, the value of sheet mica increased because of relatively large sales of the better qualities. Even with the stimulus of highly subsidized prices for block mica, domestic production supplied only about 10 percent of national requirements, and industry continued to depend largely on imports for its supplies. Consumption of block, film, and splittings declined, but sales of scrap and ground mica showed a slight increase. Imports and exports also declined. World mine production remained at a high level for the fourth consecutive year.

TABLE 1.—Salient mica statistics

[Quantity and total value in thousands]

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Domestic mica sold or used by producers:						
Sheet mica:						
Pounds	647	669	642	888	690	660
Value	$696	$2,393	$3,370	$2,757	$2,492	$2,836
Average per pound	$1.08	$3.58	$5.25	$3.11	$3.61	$4.28
Scrap and flake mica:						
Short tons	65	81	95	86	92	93
Value	$1,640	$1,734	$2,058	$1,850	[1] $2,109	$2,065
Average per ton	$25.42	$21.39	$21.57	$21.43	$22.82	$22.12
Ground mica: [2]						
Short tons	69	80	106	91	96	98
Value	$3,822	$4,889	$6,558	$6,228	$6,073	$5,560
Consumption of block and film mica:						
Pounds	(3)	3,229	4,093	3,822	3,340	2,856
Value	(3)	$4,322	$5,607	$5,708	$4,651	$3,632
Consumption of splittings:						
Pounds	10,569	6,733	8,998	8,662	8,037	5,329
Value	$9,024	$4,132	$4,388	$4,435	$4,018	$2,720
Imports for consumption..short tons	15	9	16	14	12	10
Exports..do	2	3	3	5	5	5
Apparent consumption of sheet mica pounds	20,295	8,424	13,881	12,711	12,564	11,609
World: Production..do	236,000	285,000	320,000	305,000	320,000	320,000

[1] Revised figure.
[2] From domestic and some imported scrap mica.
[3] Available data are not comparable with data for succeeding years.

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) and the Office of Civil and Defense Mobilization (OCDM), which succeeded ODM on July 1, 1958. Muscovite block, film, and splittings were included in the

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

expanded list of minerals that were to be accepted in exchange for surplus crops in the barter program released by the U.S. Department of Agriculture in November 1958.

Defense Minerals Exploration Administration (DMEA).—The DMEA program of financial assistance for the exploration of unknown or undeveloped sources of strategic mica, which began in 1951 under the Defense Production Act of 1950, expired on June 30, 1958. The DMEA was succeeded by the Office of Minerals Exploration (OME), which assumed responsibility for all DMEA contracts still in force and for each project certified by DMEA as a discovery or development. A total of 297 contracts were executed under the DMEA program. By the expiration date, 276 of these contracts with a total value of $1,586,174, on which the Government spent $954,463, had been terminated and 7 had been canceled. Certificates of discovery or development were issued on 66 of these contracts, which had a total value of $484,949 and on which the Government had spent $357,095. This left 14 contracts still in force.

Office of Minerals Exploration.—This office, established in September 1958 in the U.S. Department of the Interior, succeeded DMEA. The OME program, which was activated on December 23, 1958, differs from the DMEA program in three important respects: (1) Applicants must provide evidence that funds cannot be obtained from commercial sources on reasonable terms; (2) interest will be charged from the dates Federal funds are disbursed to operators; and (3)

TABLE 2.—Defense Minerals Exploration Administration mica contracts in force during 1958, by States, counties, and mines

State and operator	Property	County	Contract		
			Date	Total value [1]	Status, Dec. 31, 1958
GEORGIA					
Boone, Homer	Taylor Prospect	Hart	July 1957	$5,252	Terminated.
Boone & Phillips	Mercer Prospect	Upson	November 1957	5,696	Do.
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					
Phillips, S. L.	Black Mountain	Buncombe	May 1957	5,376	Do.
Carolina Mining Co.	Upper Clark	Jackson	November 1956	5,240	Do.
Do	Moody	Macon	December 1957	4,492	Do.
Boone, Jeter, et al	Paul McMahan Prospect.	Mitchell	October 1957	6,288	Do.
Degroot, Buchanan & Buchanan.	Twiggs Prospect	do	February 1958	5,512	In force.
Empire Mica Co., Inc.	Cloudland Mine	do	January 1958	6,684	Do.
Grindstaff & Greene	Johnson	do	October 1957	6,624	Terminated.
Huskins, Paul	Big Ridge	do	do	4,208	Do.
McKinney, Howard	McKinney Prospect	do	May 1957	5,652	Do.
Phillips, S. L., and Ellis, C. W.	Avery Prospect	do	November 1957	6,080	Do.
Ward, A., & Love, R., et al.	Spencer Mine	Stokes	February 1958	3,260	In force.
Mitchell Lumber Co., Inc.	Banner Mine	Yancey	December 1957	9,864	Do.
Moody Rock Mining Co.	Moody Rock	do	May 1957	8,910	Terminated.
Murphy Mining Co.	Murphy	do	December 1956	4,236	Do.

[1] Government participation, 75 percent.

Government participation in any one contract may not exceed $250,000. Although many applications had been received, no contracts for mica were executed under the OME program in 1958. On December 31, 1958, only 4 of the 297 contracts executed under the DMEA program were in force. A total of 285 contracts aggregating $1,645,538 in value, on which the Government spent $984,391, had been terminated, and 8 had been canceled.

Defense Materials Service.—Mica purchases by the Government at three mica-purchasing depots of General Services Administration (GSA), which began in 1952, continued and by December 31, 1958, had yielded 1,291,854 pounds; 76 percent was the ruby variety. The quantity of Stained or better qualities of full-trimmed muscovite block obtained from Government purchases of domestic mica in 1958 was 15 percent more than in 1957. If diverted to the domestic fabricating industry, this quantity would have supplied about 13 percent of the total fabrication of muscovite block and film of these qualities, irrespective of grades.

There were two major revisions in the Government purchasing program that were of great assistance to miners. First, the time limit for applying for a participation certificate for Government assistance, which was to expire on June 30, 1958, was eliminated. Second, the requirement that a participant under the hand-cobbed program elect in advance the method of final settlement was eliminated, and an alternate method was established for final settlement and payment.

TABLE 3.—Yield of full-trimmed muscovite ruby and nonruby block mica from domestic purchases by GSA, 1958, 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	419	989	181	1,589	182	165	21	368
3	620	1,208	241	2,069	356	282	34	672
4	1,355	2,203	627	4,185	856	529	90	1,475
5	5,491	8,153	2,853	16,497	3,996	2,466	576	7,038
5½	4,180	6,186	2,322	12,688	2,708	1,826	570	5,104
6	21,875	40,152	16,650	78,677	16,783	18,076	5,772	40,631
Total	33,940	58,891	22,874	115,705	24,881	23,344	7,063	55,288
Franklin, N.H.:								
2 and larger	37	195	73	305				
3	87	224	119	430	(1)			(1)
4	269	437	330	1,036	2	2		4
5	1,297	2,011	1,433	4,741	20	22	5	47
5½	1,102	1,679	1,352	4,133	25	30	9	64
6	6,767	10,200	6,067	23,034	157	191	63	411
Total	9,559	14,746	9,374	33,679	204	245	77	526
Custer, S. Dak.:								
2 and larger	1	15	18	34				
3	2	77	58	137				
4	8	340	148	496				
5	81	2,071	849	3,001				
5½	84	1,869	678	2,631				
6	591	7,415	4,629	12,635				
Total	767	11,787	6,380	18,934				
Grand total	44,266	85,424	38,628	168,318	25,085	23,589	7,140	55,814

1 Less than 1 pound.

TABLE 4.—Yield of byproducts from domestic purchases of ruby and nonruby mica by GSA, 1958, by depots, in pounds

Depot	Ruby			Nonruby		
	Miscellaneous [1]	Punch	Scrap	Miscellaneous [1]	Punch	Scrap
Spruce Pine, N.C.	10,299	21,960	1,556,708	3,436	10,366	934,136
Franklin, N.H.	2,090	22,827	358,193	20	26	2,016
Custer, S. Dak.	2,448	15,948	276,807			
Total	14,837	60,735	2,191,708	3,456	10,392	936,152

[1] Includes some full-trimmed thins and block of lower than Heavy Stained qualities.

The Government purchasing program for domestic mica, which began in 1952, was scheduled to be terminated on June 30, 1962, unless the original quota of 25,000 short tons of hand-cobbed mica or its equivalent was reached before that date (90 pounds of full-trimmed mica equivalent to 1 ton of hand-cobbed mica).

The synthetic and natural mica research and development program of the Government and industry continued through 1958. GSA signed contracts with Horizons, Inc., and the National Bureau of Standards for research on reconstituting synthetic mica. A contract was also signed with the National Bureau of Standards for studies on properties of natural mica for electron-tube use. Contracts with Battelle Memorial Institute and Arthur D. Little, Inc., were terminated. By December 31, 1958, contracts for research and development on synthetic mica were in effect with Frankford Arsenal, General Electric Co., Horizons, Inc., Sylvania Electric Products, Inc., Bureau of Mines, National Bureau of Standards, and Synthetic Mica Co., under the industry-Government program certified by ODM.

Commodity Credit Corporation.—One contract for the purchase of phlogopite splittings was signed by the Commodity Credit Corporation. However, no additional barter contracts for muscovite block and film or phlogopite block mica were negotiated.

DOMESTIC PRODUCTION

Sheet Mica.—The decline continued in the quantity of sheet mica sold or used by producers. Although the quantity declined the value was higher because more sheet larger than punch and circle was sold. The increased output of relatively large sheet mica was attributed almost entirely to the stimulus provided by the subsidized prices paid by the Government for mica for the national stockpile.

Scrap and Flake Mica.—Scrap mica came from mines operated solely for the production of scrap mica, from trimmings obtained from sheet and built-up mica processing plants, from mica schists, and as a byproduct of feldspar mining. Flake mica came largely from the washing of clays and as a byproduct of feldspar flotation plants. Most factory scrap came from the three large mica processing areas, North Carolina, New Hampshire, and South Dakota. Scrap mica sold came principally from mines operated solely for the production of scrap mica.

TABLE 5.—Mica sold or used by producers in the United States

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
1949–53 (average)	566,771	$96,712	80,245	$599,301	647,016	$696,013	64,516	$1,640,122	64,840	$2,336,135
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	593,620	53,914	294,251	2,703,159	887,871	2,757,073	86,309	1,849,573	86,753	4,606,646
1957	425,737	34,341	264,315	2,458,121	690,052	2,492,462	[4] 92,438	[4] 2,109,463	[4] 92,783	[4] 4,601,925
1958:										
Arizona							1,717	25,170	1,717	25,170
Colorado							387	6,309	387	6,309
Georgia	6,865	824	8,237	80,757	15,102	81,581	(5)	(5)	(5)	(5)
Idaho			1,968	13,595	1,968	13,595	1	16	2	13,611
Maine	(5)	(5)	(5)	(5)	20,097	277,651	104	3,465	114	281,116
New Hampshire	(5)	(5)	(5)	(5)	[6] 80,151	[6] 637,290	314	11,548	354	648,838
New Mexico			1,791	18,397	1,791	18,397	787	24,466	788	42,863
North Carolina	366,643	30,070	155,058	1,691,879	521,701	1,721,949	50,897	1,041,036	51,157	2,762,985
South Carolina			1,144	7,528	1,144	7,528	(5)	(5)	(5)	(5)
South Dakota			16,772	67,882	16,772	67,882	1,003	24,241	1,011	92,123
Utah			12	29	12	29			(7)	29
Virginia			147	2,193	147	2,193			(7)	2,193
Undistributed [8]	2,497	150	98,889	922,357	1,138	7,566	38,137	928,381	38,144	1,025,056
Total	376,005	31,044	284,018	2,804,617	660,023	2,835,661	93,347	2,064,632	93,674	4,900,293

[1] Includes the full-trimmed mica equivalent of hand-cobbed mica, 1952–58.
[2] Includes small quantities of splittings in certain years.
[3] Includes finely divided mica recovered from mica and sericite schists, and as a byproduct of feldspar and kaolin beneficiation.
[4] Revised figure.
[5] Included under "Undistributed" to avoid disclosing individual company confidential data.
[6] Supersedes totals published in area report for New Hampshire.
[7] Less than 1 ton.
[8] Figures include Alabama, California, Connecticut, Montana, Pennsylvania, Tennessee, and States indicated by footnote 5.

Ground Mica.—Production of ground mica was reported by 27 grinders in 24 dry-grinding and 8 wet-grinding mills. James Stewart Co., Tombstone, Ariz., and Lawson-Boone Mica Co., Minpro, N.C., reported production of dry-ground mica for the first time. U.S. Mica Co., Inc., at Stamford, Conn., discontinued operations at its Wallington, N.J., dry-grinding plant. Minerals Engineering Co., Petaca Mines Divison, Petaca, N.M., also dscontinued dry grinding operations during the year.

TABLE 6.—Ground mica sold by producers in the United States, by methods of grinding

Year	Dry-ground		Wet-ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1949–53 (average)	58,413	$2,296,829	10,916	$1,525,132	69,329	$3,821,961
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
1958	85,106	3,714,962	12,423	1,845,102	97,529	5,560,064

CONSUMPTION AND USES

Sheet Mica.—Domestic consumption of 2.9 million pounds of block and film mica and 5.3 million pounds of splittings were respectively 14 and 34 percent less than in 1957.

Fabrication of block and film mica was reported by 24 companies in nine States. About 58 percent (1.6 million pounds) of the total was reported by 13 companies in three States—New Jersey (5), New York (4), and North Carolina (4).

The decline in consumption of splittings which began in 1956 continued through 1958 with a sharp drop of 34 percent in quantity and 32 percent in value compared with 1957.

Most of the splittings were muscovite from India (93 percent by weight), plus relatively small quantities of phlogopite from Madagascar and Canada. Eleven companies operating 12 plans in nine States reported the fabrication of splittings.

Built-Up Mica.—Of the mica splittings fabricated about 65 percent (2.8 million pounds) was reported by four companies, one each in Indiana, New Hampshire, New York, and Pennsylvania. The various forms of built-up mica produced were used principally for electrical insulation. Of the total consumed 74 percent comprised mica tape, used largely for winding armature coils and in other slot-type insulation where space is limited; segment plate, used mostly in the form of commutator segments and cones; and molding plate, used in the manufacture of commutator rings, channels, and mica tubes.

Reconstituted Mica.—This paperlike material produced from specially delaminated natural scrap mica was substituted for built-up mica in many applications. General Electric Co., Coshocton, Ohio, and Samica Corp. (subsidiary of Minnestota Mining & Manufacturing Co.), Rutland, Vt., were the only producers in 1958. Total output was essentially the same as that in 1957.

TABLE 7.—Fabrication of muscovite ruby and nonruby block and film mica and phlogopite block mica, by qualities and end-product uses in the United States, 1958, 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	160	18, 151	270	18, 581	3, 991	1, 860	5, 851	24, 432
Stained	6, 158	1, 207, 318	8, 988	1, 222, 464	2, 149	59, 427	61, 576	1, 284, 040
Lower than Stained [1]	221	392, 418	25, 961	418, 600	1, 193	1, 067, 868	1, 069, 061	1, 487, 661
Total	6, 539	1, 617, 887	35, 219	1, 659, 645	7, 333	1, 129, 155	1, 136, 488	2, 796, 133
Film:								
First quality	5, 516			5, 516		565	565	6, 081
Second quality	43, 581		100	43, 681		100	100	43, 781
Other quality	1, 959			1, 959				1, 959
Total	51, 056		100	51, 156		665	665	51, 821
Block and film:								
Good Stained or better [2]	49, 257	18, 151	370	67, 778	3, 991	2, 525	6, 516	74, 294
Stained [3]	8, 117	1, 207, 318	8, 988	1, 224, 423	2, 149	59, 427	61, 576	1, 285, 999
Lower than Stained	221	392, 418	25, 961	418, 600	1, 193	1, 067, 868	1, 069, 061	1, 487, 661
Total	57, 595	1, 617, 887	35, 319	1, 710, 801	7, 333	1, 129, 820	1, 137, 153	2, 847, 954
Phlogopite: Block (all qualities)			1, 524	1, 524		6, 967	6, 967	8, 491

[1] Includes punch mica.
[2] Includes first- and second-quality film.
[3] Includes other-quality film.

TABLE 8.—Fabrication of muscovite ruby and nonruby block and film mica in the United States, 1958, 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	3, 173	1, 496	695	18, 049	272	23, 685
Stained	21, 255	37, 402	55, 597	1, 027, 871	85, 720	1, 227, 845
Lower than Stained	102, 419	87, 841	85, 782	321, 083	458, 804	1, 055, 929
Total	126, 847	126, 739	142, 074	1, 367, 003	544, 796	2, 307, 459
Nonruby:						
Good Stained or better	528	219				747
Stained	113	5, 827	333	45, 601	4, 321	56, 195
Lower than Stained	11, 803	21, 603	4, 303	1, 225	392, 798	431, 732
Total	12, 444	27, 649	4, 636	46, 826	397, 119	488, 674
Film:						
Ruby:						
First quality	1, 554	1, 177	725	2, 225		5, 681
Second quality	6, 639	18, 744	8, 309	9, 054		42, 746
Other quality					1, 959	1, 959
Total	8, 193	19, 921	9, 034	11, 279	1, 959	50, 386
Nonruby:						
First quality			400			400
Second quality	100	365	270	300		1, 035
Other quality						
Total	100	365	670	300		1. 435

[1] Figures for block mica include "all smaller than No. 6" grade and "punch" mica.

TABLE 9.—Consumption and stocks of mica splittings in the United States, by sources, in thousands

	Canadian		Indian		Madagascan		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:								
1949–53 (average)	[1,2] 158	[1,2] $86	9,683	$8,394	728	$544	10,569	$9,024
1954	67	38	6,159	3,727	507	367	6,733	4,132
1955	(3)	(3)	8,204	3,845	[3] 794	543	8,998	4,388
1956	------	------	7,996	3,945	666	490	8,662	4,435
1957	(3)	(3)	7,531	3,617	[3] 506	[3] 401	8,037	4,018
1958	(3)	(3)	4,982	2,437	[3] 347	[3] 283	5,329	2,720
Stocks (Dec. 31):								
1949–53 (average)	[4] 95	[4] 57	6,798	6,681	457	414	7,350	7,152
1954	(3)	(3)	5,206	3,901	[3] 331	[3] 257	5,537	4,158
1955	(3)	(3)	6,191	3,623	[3] 401	[3] 302	6,592	3,925
1956	(3)	(3)	5,077	2,814	[3] 374	[3] 304	5,451	3,118
1957	(3)	(3)	4,942	2,594	[3] 325	[3] 267	5,267	2,861
1958	(3)	(3)	3,392	1,801	[3] 316	[3] 258	3,708	2,059

[1] Domestic included with Canadian, 1949–51.
[2] Mexican included with domestic and Canadian, 1950–51.
[3] Canadian included with Madagascan.
[4] Domestic and Mexican included with Canadian, 1949–50.

TABLE 10.—Built-up mica [1] sold or used in the United States, by kinds of product

Product	1957		1958	
	Thousand pounds	Value (thousands)	Thousand pounds	Value (thousands)
Molding plate	1,470	$3,520	909	$2,224
Segment plate	1,772	3,673	1,049	2,358
Heater plate	640	1,863	601	1,836
Flexible (cold)	588	1,851	361	1,277
Tape [2]	1,717	8,089	1,259	5,622
Other	228	1,003	165	768
Total	6,415	19,999	4,344	14,085

[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."

Other Substitutes for Sheet Mica.—The Farnam Manufacturing Co., Inc., Asheville, N.C., continued producing a heat-resistant electrical-insulation product using finely divided natural mica bonded with water-soluble aluminum phosphate. The material was produced in rigid sheets and various shapes.

Ground Mica.—Use of dry-ground mica increased and production of wet-ground mica declined in 1958. The ground mica was used mainly by the construction industry in roofing material, paint, wallpaper, and house-insulating products.

TABLE 11.—Ground mica sold by producers in the United States, by uses

Use	1957 Short tons	1957 Value (thousands)	1958 Short tons	1958 Value (thousands)
Roofing	29,629	$1,010	33,524	$1,033
Wallpaper	774	113	690	96
Rubber	8,579	779	9,622	750
Paint	22,619	1,856	20,114	1,791
Plastics	2,203	193	2,505	175
Welding rods	2,822	197	2,757	176
Joint cement	13,435	1,051	12,675	866
Miscellaneous [1]	16,271	874	15,642	673
Total	96,332	6,073	97,529	5,560

[1] Includes mica used for molded electric insulation, house insulation, Christmas-tree snow, annealing, well drilling, and other purposes.

PRICES

Government purchases of domestically produced full-trimmed and half-trimmed muscovite mica continued through 1958 at prices established in May 1956. Government prices for hand-cobbed mica remained unchanged from 1954 through 1958; however, purchasing procedures varied.

The 1958 prices offered by mica fabricators for roughly trimmed, domestic, clear sheet mica in North Carolina, as reported in the E&MJ Metal and Mineral Markets, ranged from 7 to 12 cents a pound for punch and $4 to $8 a pound for 6- by 8-inch sheet.

North Carolina scrap mica was quoted throughout the year at $20 to $30 a short ton, depending on quality. Prices for dry- and wet-ground mica were steady.

TABLE 12.—Prices for domestically produced muscovite mica purchased by the Government, 1958, 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

	Per short ton
Hand-cobbed mica:	
Ruby	$600
Nonruby	540

TABLE 13.—Price of dry- and wet-ground mica in the United States, 1958 [1]

[Oil, Paint and Drug Reporter]

	Cents per pound		Cents per pound
Dry-ground:		Wet-ground [2]—Continued	
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 and 1 cent higher west of the Rockies.
[3] Exwarehouse or freight allowed east of the Mississippi River.

FOREIGN TRADE [3]

Imports.—Mica imports for consumption declined about 14 percent in tonnage but rose 22 percent in value compared with 1957. The increase in value was attributed largely to the higher value reported for imports of block valued above 15 cents per pound, splittings, and film mica. However, general imports, according to compilations by the Tariff Commission, increased 7 percent over 1957. Brazil for the third consecutive year was the largest supplier of Good Stained and better block mica.

Exports.—Total exports of mica and mica products declined 11 percent below 1957. However, exports of unmanufactured mica exceeded 1 million pounds for the first time. The increased exports of unmanufactured mica, used chiefly by the electrical industry, suggested an increase in the number of countries producing electrical products.

TABLE 14.—Mica imported into and exported from the United States

[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
1949–53 (average)	2,889,024	$3,372,194	4,501	$70,538	8,894	$15,650,241	14,841	$19,092,973	1,885	$931,882
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	1,247,106	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
1958	2,181,056	5,091,982	4,064	48,169	5,053	8,800,108	10,208	13,940,259	4,741	1,217,011

[1] Data known to be not comparable with other years.

[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 15.—Mica imported for consumption in the United States, by kinds and countries of origin

[Bureau of the Census]

Country	Unmanufactured									
	Waste and scrap valued not more than 5 cents per pound				Untrimmed phlogopite mica from which no rectangular piece exceeding 1 by 2 inches 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
1949–53 (average)	831, 387	$6, 911	8, 169, 713	$63, 627	139, 049	$24, 347	382, 655	$41, 673	2, 367, 320	$3, 306, 174
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			10, 373, 171	56, 888			220, 460	16, 424	1, 621, 380	[1] 3, 342, 465
1958:										
North America:										
Canada									200	886
Mexico			43, 849	119					2, 772	3, 738
South America:										
Argentina									27, 996	33, 601
Brazil							363	32	943, 098	1, 861, 355
Europe:										
France									5	377
Germany, West									220	1, 070
Italy			34	464						
United Kingdom									5, 341	20, 331
Asia: India			6, 614, 969	36, 329			1, 100	106	1, 116, 937	2, 873, 682
Africa:										
Angola			775, 130	4, 495			8, 854	1, 044	44, 212	207, 418
British East Africa									17, 308	56, 001
Madagascar									7, 818	16, 093
Mozambique									888	403
Rhodesia and Nyasaland, Federation of									3, 249	14, 050
Sudan									695	1, 795
Union of South Africa			694, 631	6, 762						
Total unmanufactured			8, 128, 613	48, 169			10, 317	1, 182	2, 170, 739	5, 090, 800

See footnotes at end of table.

TABLE 15.—Mica imported for consumption in the United States, by kinds and countries of origin—Continued

Country	Manufactured—films and splittings							
	Not cut or stamped to dimensions				Cut or stamped to dimensions		Total films and splittings	
	Not above 12/10,000 inch in thickness		Over 12/10,000 inch in thickness					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1949–53 (average)	15, 503, 599	$11, 719, 661	1, 583, 174	$2, 869, 079	43, 767	$687, 455	17, 130, 540	$15, 276, 195
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	[2] 9, 303, 287	[1] 3, 871, 615	[2] 1, 936, 041	[1] 2, 569, 468	71, 652	[1] 1, 050, 799	[2] 11, 310, 980	[1] 7, 491, 882
1958:								
North America:								
Jamaica			200	277	86	255	286	532
Mexico			16, 138	18, 424	8, 424	166, 269	24, 562	184, 693
South America:								
Argentina			3, 508	4, 235			3, 508	4, 235
Brazil	11, 497	12, 021	908, 576	933, 254	185	1, 298	920, 258	946, 573
Europe:								
France	233	187					233	187
Germany, West			11, 382	14, 203	386	9, 510	11, 768	23, 713
Italy					2, 383	34, 150	2, 383	34, 150
Spain					2, 310	26, 465	2, 310	26, 465
United Kingdom	102, 282	30, 112	674	5, 664	6, 795	120, 116	109, 751	155, 892
Asia:								
India	6, 901, 140	4, 129, 138	1, 321, 757	2, 154, 483	11, 556	91, 060	8, 234, 453	6, 374, 681
Japan	23, 425	14, 737	2, 300	2, 172	8, 659	197, 217	34, 384	214, 126
Africa:								
British East Africa			400	550			400	550
French Somaliland	5, 842	3, 633					5, 842	3, 633
Madagascar	583, 844	361, 363	1, 984	1, 443			585, 828	362, 806
Sudan			1, 220	1, 166	100	460	1, 320	1, 626
Total films and splittings	7, 628, 263	4, 551, 191	2, 268, 139	3, 135, 871	40, 884	646, 800	9, 937, 286	8, 333, 862

Country	Manufactured—cut or stamped to dimensions, shape, or form		Manufactured					
			Mica plates and built-up mica		All mica manufactures of which mica is the component material of chief value		Ground or pulverized	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1949–53 (average)	73,776	$100,768	22,086	$126,526	29,966	$120,581	534,648	$26,171
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	31,904	[1] 44,099	37,866	[1] 85,933	103,924	[1] 406,952	46,000	2,760
1958:								
North America:								
Canada					4	217	46,000	2,797
Jamaica					140	290		
Mexico	1,511	3,097	209	442	11,016	37,326		
South America:								
Brazil					43,216	147,782		
Venezuela					1,720	6,337		
Europe:								
Belgium-Luxembourg			177	216	5,009	4,350		
Germany, West			20	579	164	3,619		
Italy					72	2,157		
Netherlands					1,642	4,648		
Spain					324	1,644		
Switzerland					70	1,293		
United Kingdom			20,755	23,066	25,678	195,819		
Asia:								
India	1,200	1,231	400	493	6,245	9,946		
Japan					1,156	18,831		
Africa: Madagascar							2,238	66
Total manufactured: Other	2,711	4,328	21,561	24,796	96,456	434,259	48,238	2,863

[1] Data known to be not comparable with other years.

[2] Changes in Minerals Yearbook 1957, p. 857, should read as follows: Manufactured films and splittings—Not cut or stamped to dimensions—Not above twelve ten thousandths of an inch in thickness—India 8,607,822 pounds; total Asia 8,629,422 pounds, total all countries 9,303,287 pounds; over twelve ten thousandths of an inch in thickness—India 907,100 pounds, total Asia 910,991 pounds, total all countries 1,936,041 pounds; total films and splittings: India 9,540,774 pounds; total Asia 9,581,525 pounds, total all countries 11,310,980 pounds.

TABLE 16.—Muscovite block and film mica, United States general imports, by qualities and principal sources,[1] in pounds

Quality	Countries						Total	
	India		Brazil		Other			
	1957	1958	1957	1958	1957	1958	1957	1958
Block:								
Good Stained and better	40,562	91,250	194,306	129,719	37,456	43,339	272,324	264,308
Stained	1,409,152	1,638,942	909,928	765,482	46,553	51,816	2,365,633	2,456,240
Heavy Stained	67,037	198,441	556,036	669,818	6,464	8,598	629,537	876,857
Lower	31,428	63,757	206,250	146,320	1,219	1,367	238,897	211,444
Total	1,548,179	1,992,390	1,866,520	1,711,339	91,692	105,120	3,506,391	3,808,849
Film:								
First quality	40,090	25,027			2,679	248	42,769	25,275
Second quality	97,386	73,913			935	802	98,321	74,715
Other quality	11,890	17,900			85		11,975	17,900
Total	149,366	116,840			3,699	1,050	153,065	117,890
Block and film:								
Good Stained and better [2]	178,038	190,190	194,306	129,719	41,070	44,389	413,414	364,298
Stained [3]	1,421,042	1,656,842	909,928	765,482	46,638	51,816	2,377,608	2,474,140
Heavy Stained	67,037	198,441	556,036	669,818	6,464	8,598	629,537	876,857
Lower	31,428	63,757	206,250	146,320	1,219	1,367	238,897	211,444
Total	1,697,545	2,109,230	1,866,520	1,711,339	95,391	106,170	3,659,456	3,926,739

[1] Compiled by U.S. Tariff Commission from official documents of the U.S. Bureau of Customs.
[2] Includes first- and second-quality film.
[3] Includes other-quality film.

TABLE 17.—Mica and manufactures of mica exported from the United States

[Bureau of the Census]

Country	Unmanufactured		Manufactured			
			Ground or pulverized		Other	
	Pounds	Value	Pounds	Value	Pounds	Value
1949–53 (average)	297,265	$60,801	3,272,074	$185,074	200,453	$686,007
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	911,006	46,391	9,256,170	520,557	541,432	983,446
1958:						
North America:						
British Honduras			33,000	1,647		
Canada	143,650	11,034	3,510,600	159,811	150,001	511,287
Cuba	120,000	3,120	109,000	7,018	1,297	4,450
Dominican Republic			11,000	880		
Guatemala			36,000	1,660		
Honduras			20,000	1,084		
Jamaica	29,310	18,850			1,000	1,000
Mexico	42,213	18,450	385,000	18,822	6,556	13,050
Netherlands Antilles					60	1,980
Panama, Republic of			100,000	5,587		
South America:						
Argentina			54,250	3,369	611	4,039
Brazil					2,422	10,052
Chile			11,000	545	1,819	8,625
Colombia	14,113	2,509	55,500	2,672	1,995	8,757
Ecuador			21,000	1,644		
Peru			140,050	6,240	4,000	4,019
Uruguay					86	1,569
Venezuela	200,930	3,351	1,673,800	76,055	1,715	3,920
Europe:						
Belgium-Luxembourg	112,000	7,660	380,140	28,042	12,750	4,510
Denmark			10,000	800		
France			415,635	33,736	8,896	13,130
Germany, West			331,420	26,235	4,327	13,378
Greece					30	1,600
Iceland			30,000	2,025		
Italy	150,000	3,987	397,200	21,518	12,700	12,978
Netherlands			45,000	2,613	13,457	11,409
Spain	7,885	7,984	26,472	3,475	1,665	7,357
Sweden					3,072	4,314
United Kingdom	2,060	4,664			2,217	13,863
Asia:						
Indonesia					376	3,252
Israel			10,000	800		
Japan	208,379	8,956	46,000	1,800	280	1,736
Korea, Republic of					2,567	7,242
Pakistan					1,224	1,537
Philippines			53,500	5,189	480	1,863
Taiwan			6,600	660		
Thailand					417	1,682
Africa:						
Belgian Congo					227	1,346
Union of South Africa			286,200	16,893	120	569
Oceania:						
Australia					2,695	10,865
French Pacific Islands					780	2,850
New Zealand					14,356	7,397
Total	1,030,540	90,565	8,198,367	430,820	254,198	695,626

WORLD REVIEW

World production of mica exceeded 300 million pounds for the fourth consecutive year.

Argentina.—Production of muscovite, the only mica recovered in Argentina, came from 10 or 12 relatively large mines and about 60 smaller operations in Cordoba, Catamarco, San Juan, and Tucuman Provinces. The Pirquitos mine in Cordoba Province was the largest producer of scrap mica.

TABLE 18.—World production of mica, by countries,[1] in thousand pounds [2]

[Compiled by Liela S. Price and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada (sales):						
Block	295	71	57	79	108	1,073
Splittings	7	2	---------	2	15	
Ground	1,556	937	944	1,493	910	
Scrap	1,464	699	639	269	247	
United States (sold or used by producers):						
Sheet	647	668	642	888	690	660
Scrap	129,033	162,146	190,864	172,618	184,876	186,694
South America:						
Argentina:						
Sheet	498	267	340	322	212	[3] 110
Scrap		132	2	2	2	
Brazil	3,935	3,962	3,051	2,926	3,265	[3] 3,100
Uruguay	2	---------	---------	---------	---------	---------
Europe:						
Austria	410	---------	---------	---------	---------	---------
Norway, including scrap	1,495	3,968	3,086	3,748	4,630	4,409
Spain	24	18	20	26	24	20
Sweden:						
Block	29	4	---------	---------	---------	---------
Ground	315	331	368	392	474	421
Asia:						
Ceylon	7	---------	(4)	---------	---------	---------
India (exports):						
Block	2,668	3,609	4,802	6,065	4,392	7,485
Splittings	20,478	10,855	16,475	14,663	16,643	14,314
Scrap	13,598	23,031	25,699	27,282	27,915	22,835
Taiwan, including scrap	231	44	---------	29	11	1
Africa:						
Angola:						
Sheet	40	24	33	53	46	46
Scrap and splittings	234	362	518	968	844	716
Kenya	7	---------	2	---------	---------	15
Madagascar (phlogopite):						
Block	545	101	62	77	139	223
Splittings	1,493	1,056	534	1,109	2,011	2,004
Morocco, Southern Zone:						
Sheet	7	11	---------	---------	---------	---------
Scrap	139	18	---------	---------	---------	---------
Mozambique, including scrap	71	2	29	26	66	4
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia, Sheet	15	7	4	3	1	2
Southern Rhodesia:						
Block	185	183	141	123	71	108
Scrap	686	---------	---------	---------	---------	---------
South-West Africa, scrap	77	---------	---------	---------	---------	---------
Sudan	---------	---------	---------	---------	4	441
Tanganyika (exports):						
Block	161	174	146	128	148	108
Ground	49	---------	---------	---------	---------	---------
Scrap	35	62	613	280	---------	24
Uganda	(4)	1	---------	---------	---------	---------
Union of South Africa:						
Sheet	13	4	11	1	2	1
Scrap	3,880	4,107	7,818	5,038	4,226	4,255
Oceania: Australia:						
Block	66	84	57	29	37	31
Scrap	26	82	20	---------	40	82
Damourite	1,254	1,151	977	1,058	1,455	[3] 1,100
World total (estimate) [1] [2]	236,000	285,000	320,000	305,000	320,000	320,000

[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 exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Less than 500 pounds.

Liquidation of the State price-controlling agency, Instituto Argentina de Promocion del Intercambio (IAPI), which had begun in 1955, was completed.

Most of the output was exported. Mexico and Italy were the principal export markets.[4] Exports to the United States were small compared with 1957, when the United States was the largest purchaser of Argentina mica. A large part of the mica exported to Mexico probably was processed there and shipped to the United States.

Brazil.—Muscovite block and film mica was mined in several States in Brazil, but the largest percentage of the production came from the States of Minas Gerais and Goiás. Purchases of mica for the United States stockpile in 1958, as in 1957, provided the main market and support for the Brazilian mica industry.[5]

Canada.—Mica production in Canada consisted mainly of phlogopite mica from southeastern Ontario and southwestern Quebec. The loss of most of the U.S. market for high-quality trimmed mica was the main reason for the decline in output.[6] In recent years Japan has been the major export market for sheet mica, Belgium for scrap mica and the United States for ground mica.

India.—Although India's total exports of mica decreased slightly, exports of block, a large part of which was of strategic quality, increased. The decline in exports of splittings and scrap was attributed to a reduced U.S. demand for splittings and the opening of a domestic market for scrap mica. A micanite factory at Jhumri-Telaiye, Bihar, with an annual capacity of 336 short tons, began operating in September 1957. Early in 1958 the manufacture of insulating brick was begun at two mica brick plants, one at Bhilwara, Rajasthan, and the other at Chanch, Bihar. The Bhilwara plant had a capacity of 3,000 bricks a day and the Chanch factory of 2,000 bricks a day. However, capacity production at the micanite and brick plants was not attained in 1958. A small quantity of dry-ground mica was produced in a cottage industry, but no wet-ground mica was produced.[7]

The Indian State Trading Corp. suggested the possibility of expanding exports of mica to the Sino-Soviet Bloc, especially U.S.S.R. and China.[8] A review of reliable but unofficial Indian export data for January-September 1957 and January-September 1958 showed that shipments to the Sino-Soviet Bloc countries accounted for about 2 percent of the total Indian exports of block and splittings and 12 percent of condenser films in January-September 1957 and not more than 3 percent of either category in January-September 1958. In contrast, exports to the United States for the same periods accounted for 32 and 48 percent, respectively, of Indian exports of block, splittings, and condenser films.

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[4] U.S. Embassy, Buenos Aires, Argentina, State Department Dispatch 1113: Jan. 26, 1959, p. 5.

[5] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 332: Sept. 23, 1958, p. 5.

[6] Reeves, J. E., Mica in Canada, 1957: Dept. Mines and Tech. Surveys, Ottawa, Canada, June 1958, pp. 1–4.

[7] U.S. Consulate, Calcutta, India, State Department Dispatch 684: May 25, 1959, pp. 1–2.

[8] U.S. Embassy, New Delhi, India, State Department Dispatch 320: Sept. 11, 1958, p. 1.

Madagascar.—The Société des Minerais de la Grande Ile was reported to be the largest producer of phlogopite splittings, accounting for about one-third the annual output.[9] The Murovato muscovite mica deposits of Madagascar were being investigated in an effort to provide a supply of muscovite mica for France thus reducing that country's dependence on India. In addition, deposits of phlogopite were discovered in the Mafilefy area in the extreme southern part of the island.

Rhodesia and Nyasaland, Federation of.—The New Africa Mica Co., Ltd., incorporated in Tanganyika, a subsidiary of Otto Gurdau Co. of New York, N.Y., established offices and a processing plant in Salisbury, Southern Rhodesia. It was anticipated that crude mica from Southern and Northern Rhodesia and Mozambique would be upgraded by skilled cutting and trimming.[10]

U.S.S.R.—Both muscovite and phlogopite mica are recovered in the U.S.S.R. Muscovite deposits are located in European U.S.S.R. and East Siberia, but phlogopite deposits have been found only in East Siberia, particularly in the Lake Baikal and Alden River regions.

Production data were not available, and only an estimate could be made of the annual output. However, trade statistics for 1957 showed exports of 306,495 pounds of mica valued at approximately $623,250, or about $2 a pound, to other Sino-Soviet bloc countries and imports from India of about 44,516 pounds of block and film mica valued at $472,000, or about $10 a pound.[11] These data suggested that the U.S.S.R. had a surplus of the lower qualities of mica but that the better qualities were in short supply.

TECHNOLOGY

Natural Mica.—The discovery of mica deposits in Indonesia,[12] and Pondicherry, India,[13] and the location, geology, and economic aspects of mica deposits in Georgia were reported.[14] The location of muscovite micas containing chromium and their physical properties were described,[15] also the occurrence of phlogopite mica in the blue ground at some diamond pipes.[16]

Investigations were made on the effect of the inclusion of titanium on the position of the optic axis [17] and the rate of thermal dehydra-

[9] Mining World (London), Graphite and Mica in Madagascar: Vol. 251, No. 6421, Sept. 12, 1958, pp. 278–279.
[10] Rhodesian Mining Journal, Rhodesian Mica: Vol. 30, No. 379, December 1958, p. 341.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, Spec. Supp. 56, January 1959, p. 10.
[12] Mining Journal (London), Mining Miscellany: Vol. 251, No. 6436, Dec. 26, 1958, p. 725.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 25.
[14] Grant, W. H., Geology of Hart County, Ga.: Georgia Geol. Survey Bull. 67, 1958, 75 pp.
[15] Nazarov, P. P., [Fuchsite From Krivoi Rog]: Zapiski Vsesoyuz. Mineral. Obshchestva, vol. 86, 1957, pp. 502–505; Chem. Abs., vol. 52, No. 6, Mar. 25, 1958, p. 4423g.
Lazarenko, E. K., [Chromium-Containing Micas]: Issledovanie Mineral. Syr'ya, Sbornik, 1955, pp. 112–123; Chem. Abs., vol. 52, No. 7, Apr. 10, 1958, p. 5218i.
[16] Kuryleva, N. A., [Petrography of the Siberian Kimberlites]: Zapiski, Vsesoyuz. Mineral. Obshchestva, vol. 87, 1958, pp. 233–237; Chem. Abs., vol. 52, No. 18, Sept. 25, 1958, p. 15362a.
[17] Emiliani, Francesco, [Crystal Chemical Studies of Micas. II. Chemical and Optical Investigations on Some Muscovites From Orthogneiss Pegmatites of Tares (Val Venosta)]: Rendiconti Soc. Mineral. ital., vol. 13, 1957, pp. 213–228; Chem. Abs., vol. 52, No. 14, July 25, 1958, p. 11668c.

tion of muscovite micas.[18] A method for recovering mica from nepheline syenite ore was described,[19] and data were reported on the equipment and processing used in a plant producing ground mica as a byproduct of feldspar production.[20]

The design and method of operating a machine for testing and evaluating the electrical qualities of block mica [21] and a machine for splitting mica books into sheets of desired thickness were described.[22] An improved method of treating phlogopite mica to form a dielectric material with superior resistivity characteristics was investigated,[23] and dielectric losses at high frequencies in muscovite mica having limonite and biotite inclusions were reported.[24]

The use of ground mica in a pearlescent-coating composition in paints was patented,[25] and data were reported on a new process for producing wet-ground mica.[26] The need for increased reliability, ruggedness, and life in electron-tube devices fostered a more critical examination of natural micas and their role in the electron tube.[27]

Synthetic Mica.—Research by the Federal Bureau of Mines continued on synthetic mica at the Electrotechnical Experiment Station, Norris, Tenn. Efforts were directed largely toward the growth of larger single crystals, the development of a useful reconstituted synthetic mica sheet, and the determination of the basic properties of synthetic mica.

Great interest was shown in producing a glassless synthetic mica sheet at least one-quarter inch thick suitable for fabricating high-quality dielectrics. Glass-bonded sheets were unsatisfactory for the higher frequencies. Water-swelling fluormicas and fluorbentonites were investigated. Interest in these materials was twofold: (1) To develop larger crystals of synthetic mica for delamination and reconstituted synthetic mica-sheet manufacture and (2) to develop smaller size crystals or plates for dielectric films.

Commercial production of synthetic mica flake, largely for use in glass-bonded mica ceramic materials, was continued by two companies. The use of synthetic mica in high-temperature strain-gage research was reported.[28] Several methods of fabricating synthetic mica flakes to form sheets or machinable products were investigated.

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[18] Holt, J. B., Cutler, I. B., and Wadsworth, M. E., Rate of Thermal Dehydration of Muscovite: Jour. Am. Ceram. Soc., vol. 41, No. 7, July 1958, pp. 242–246.

[19] Noblitt, H. L., Method of Recovering White Mica: U.S. Patent 2,857,051, Oct. 21, 1958.

[20] Trauffer, W. E., Georgia Feldspar Plant: Pit and Quarry, vol. 51, No. 4, October 1958, pp. 116–119.

[21] Central Glass and Ceramic Research Institute (India), Mica Grading Apparatus: Vol. 5, No. 3, July–September 1958, pp. 114–115.

[22] Ciaffa, I. A. (one-half assigned to B. Schneider and O. Marquad), Splitting Machines: U. S. Patent 2,844,138, July 22, 1958.

[23] Endicott, H. S., and Ledges, G. E. (assigned to General Electric Co.), Method of Treating Mica: U.S. Patent 2,863,721, Dec. 9, 1958.

[24] Vodop'yanov, K. A., and Vorozhtsova, I. G., [Dielectric Losses at High Frequencies in Muscovite Mica Having Limonite and Biotite Mineralogical Inclusions]: Izvest. Akad. Nauk S.S.S.R., Ser. Fiz., vol. 22, 1958, pp. 283–287; Chem. Abs., vol. 52, No. 15, Aug. 10, 1958, p. 12488c.

[25] Blank, R. E. (assigned to Sherwin-Williams Co.), Pearlescent Type Coating Composition: U.S. Patent 2,851,370, Sept. 9, 1958.

[26] Indian Mining Journal (Calcutta), India's Industrial Minerals: Vol. 6, No. 6, June 1958, p. 8.

[27] National Bureau of Standards, Properties of Natural Mica Essential to Electron Tube Use: Rept. 6341, Dec. 31, 1958, 7 pp.

[28] Brewer, G. A., Synthetic Mica High Temperature Strain Gage Research' Electronic News, vol. 3, No. 118, Dec. 1, 1958, p. 23.

These products ranged from a machinable ceramic material, in which the mica serves as a fusible bonding agent for the filler,[29] to a hot-pressed synthetic mica sheet, in which the surface pores are filled with ground glass or a similar inert filler.[30]

Built-Up and Reconstituted Products From Natural and Synthetic Mica.—Considerable attention was given to the production of mica sheet from reconstituted natural and synthetic flake mica. An improved mica paper, made with reconstituted natural mica treated with barium chloride or barium acetate, was patented.[31] A method was developed for making sheet mica of superior strength by curing a mixture of mica flakes, polybutadiene, and dialpha-cumyl peroxide.[32] An integrated sheet of mica flakes was manufactured, having a skeletal silica shell in the mica pores and cured orthophosphoric acid impregnating the silica shell.[33] Synthetic reconstituted mica flakes were also used to make recrystallized hot-pressed sheets of mica.[34] Tests on mica capacitors made from reconstituted mica paper showed that voltage strengths of the reconstituted products were only 30 percent as high as those of natural-mica capacitors,[35] although their insulation resistance values were equivalent.

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[29] Comeforo, J. E., and Hatch, R. A. (assigned to the United States of America as represented by the Secretary of the Interior), Machinable Ceramic Bonded Material and Method for Producing Same: U.S. Patent 2,829,061, Apr. 1, 1958.

[30] Barr, F. A. (assigned to Sylvania Electric Products, Inc.), Synthetic Mica Product: U.S. Patent 2,859,794, Nov. 11, 1958.

[31] Gaines, G. J., Jr. (assigned to General Electric Co.), Mica Paper: U.S. Patent 2,842,183, July 8, 1958.

[32] Safford, M. M., and Smith, E. J. (assigned to General Electric Co.), Polybutadiene Coated Mica Flakes, Process of Preparation, and Cured Composition: U.S. Patent 2,835,642, May 20, 1958.

[33] Heyman, M. D. (assigned to Integrated Mica Corp.), Phosphate-Impregnated Integrated Mica Sheet: U.S. Patent 2,865,426, Dec. 23, 1958.

[34] Barr, F. A. (assigned to Sylvania Electric Products, Inc.), Process for Preparing Synthetic Mica Product: U.S. Patent 2,863,720, Dec. 9, 1958.

[35] Sipovic, J., and Lunchick, A., Reconstituted Mica Paper for Capacitors: Mica Mold Electronic Mfg. Corp., Quarterly Rept. 3, January–March 1958, 31 pp.; Tech. Abs. Bull. U58–15, October 1958, p. 2629.

Molybdenum

By Wilmer McInnis[1] and Mary J. Burke[2]

UNITED STATES production of molybdenum contained in concentrate during 1958 was the lowest in 7 years, mainly because of the general industrial recession and the prolonged strike at the world's largest molybdenum mine.

Although consumption of molybdenum in all its forms declined, the consumption of molybdenum metal more than doubled owing to expanded use in missiles and aircraft. New facilities for producing the metal shapes were constructed.

Domestic exports reversed an upward trend that had persisted since 1951 and were the lowest in 5 years.

TABLE 1.—Salient molybdenum statistics, thousand pounds of contained molybdenum

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Concentrate:						
Production	38,073	58,668	61,781	57,462	60,753	41,069
Shipments:						
Total	40,464	64,021	64,709	57,126	57,143	42,328
Value (thousands)[1]	$37,289	$64,070	$66,919	$63,901	$67,605	$50,371
For export	4,825	12,974	12,046	14,736	17,543	11,649
Consumption	28,718	24,710	38,799	42,652	38,954	31,298
Imports for consumption	21	154	134	----------	27	1
Stocks, end of year [2]	9,345	5,317	2,730	2,920	7,093	5,643
Primary products: [3]						
Production	28,083	24,328	37,774	41,208	[4] 37,698	30,915
Shipments:						
To domestic destinations	27,481	23,717	35,935	39,082	[4] 34,621	29,918
For export [5]	1,522	1,640	2,671	3,738	2,244	1,441
Total	29,003	25,357	38,606	42,820	[4] 36,865	31,359
Consumption	([6])	([6])	([6])	33,497	[4] 30,016	24,231
Stocks [7]	4,527	3,430	3,156	2,812	5,789	8,081
World: Production (Mo in ore and concentrate)	47,300	70,500	75,000	70,300	76,200	56,500

[1] Largely estimated by Bureau of Mines.
[2] At mines and at plants making molybdenum products.
[3] Comprises ferromolybdenum, molybdic oxide, and molybdenum salts and metal.
[4] Revised figure.
[5] Reported by producers to the Bureau of Mines.
[6] Data not available.
[7] Producers' stocks, end of year.

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

DOMESTIC PRODUCTION

Domestic production of molybdenum contained in concentrate declined 32 percent compared with 1957—the lowest since 1951.

Molybdenum Mines.—The Climax mine in Lake County, Colo., was the only domestic mine producing chiefly molybdenum during 1958. Operations of the mine and mill were reduced from a 6-day to a 5-day week schedule at the beginning of the second quarter of 1958, and production during the quarter declined 34 percent compared with output in the first quarter of the year. The mine and mill were closed July 21 when the miners went on strike, and operations were not resumed until about mid October.

In New Mexico the Questa mine of the Molybdenum Corporation of America was not worked, but the company continued exploration of an adjoining large disseminated molybdenite deposit under a Defense Mineral Exploration Administration (DMEA) contract entered into in 1957.

Byproduct Sources.—Output of molybdenum at byproduct plants declined 12 percent compared with 1957, despite the entry of a new producer in April. Decreased demand for copper, causing several firms to cut operations from a 7-day to a 4-day week during part of the year, resulted in the lower output of molybdenum. Compared with 1957, the Kennecott Copper Corp. Utah Copper Division, Nevada Mines Division, and Chino Mines Division, decreased molybdenum output 18, 61 and 37 percent, respectively; Baghdad Copper Corp., 49 percent; American Smelting and Refining Co., 8 percent; Miami Copper Co., 40 percent; Phelps Dodge Corp. 13 percent. San Manuel Copper Corp. and Union Carbide Nuclear Co. increased output by 29 and 39 percent, respectively. Inspiration Consolidated Copper Corp. became the ninth domestic producer of molybdenum in April when it started recovering molybdenum as a byproduct of copper.

The molybdenite content of the copper ores ranged from 0.001 to 0.050 percent, and recovery averaged about 70 percent.

Duval Sulphur and Potash Co. nearly completed constructing a molybdenum recovery unit at its plant in Pima County, Ariz., and production was expected to begin during the first half of 1959. Pima Mining Co. conducted tests to determine the feasibility of recovering molybdenum from the copper ores of its mine in Pima County, Ariz.

CONSUMPTION AND USES

Domestic consumption of molybdenum contained in concentrate declined 20 percent compared with the quantity consumed in 1957, and was the lowest since 1954. Curtailed demand for molybdenum products in making iron and steel alloys was the prime reason for the sharp decrease, but exports of molybdic oxide and other primary molybdenum products also were less than during 1957. Of 31.3 million pounds of molybdenum contained in concentrate used during 1958, 92 percent was estimated to have been converted to molybdic oxide, the raw material used in producing virtually all other molybdenum products. Less than 1 percent was added directly to steel, and the remainder was used in making lubricants and other antifriction materials.

TABLE 2.—Production, shipments, and stocks of molybdenum products in the United States in thousand pounds of contained molybdenum

	Product					
	Molybdic oxide [1]		Metal powder		Ammonium molybdate	
	1957	1958	1957	1958	1957	1958
Received from other producers	[3] 2,189	2,901	5	----------	59	4
Gross production during year	34,687	28,093	[3] 1,084	2,499	[3] 471	871
Used to make other products listed here	[3] 6,968	7,694	----------	----------	[3] 276	669
Net production	[3] 27,719	20,399	[3] 1,084	2,499	195	202
Shipments:						
Domestic consumers	25,079	20,428	[3] 1,078	2,383	270	198
Export	1,917	1,210	1	----------	----------	----------
Total	26,996	21,638	[3] 1,079	2,383	270	198
Producers' stocks, end of year	4,681	6,172	156	272	65	74

	Product				Total	
	Sodium molybdate		Other [2]			
	1957	1958	1957	1958	1957	1958
Received from other producers	----------	1	----------	----------	[3] 2,253	2,906
Gross production during year	280	382	8,423	7,434	[3] 44,945	39,279
Used to make other products listed here	2	1	1	----------	[3] 7,247	8,364
Net production	278	381	8,422	7,434	[3] 37,698	30,915
Shipments:						
Domestic consumers	301	296	7,893	6,613	[3] 34,621	29,918
Export	----------	----------	326	231	2,244	1,441
Total	301	296	8,219	6,844	[3] 36,865	31,359
Producers' stocks, end of year	12	98	875	1,465	5,789	8,081

[1] Includes molybdic oxide briquets, molybdic acid, and molybdenum trioxide.
[2] Includes ferromolybdenum, calcium molybdate, phosphomolybdic acid, and molybdenum disulfide.
[3] Revised figure.

Consumption of molybdenum given in table 4 comprised an estimated 93 percent of the total molybdenum consumed in end products in the United States during 1958. Many small foundries and other consumers were not canvassed.

The quantity of powder consumed in making wire, rod, and other shapes increased 116 percent compared with 1957 mainly because of the wider use of molybdenum shapes in manufacturing parts for missiles and aircraft. To meet the increased demand, facilities for reducing molybdic oxide to metal were enlarged at several plants. A plant for producing over 800,000 pounds a year of arc-cast ingots was constructed at Coldwater, Mich. A pilot plant for fabricating molybdenum and other refractory metals in an inert atmosphere was being constructed under a Navy contract.[3]

[3] Iron Age, New Plant for Refractory Metals Will Feature Inert Atmosphere: Vol. 182, No. 20, Nov. 13, 1958, pp. 148–149.

TABLE 3.—Consumption of molybdenum products in the United States and stocks at plants of consumers in thousand pounds of contained molybdenum

Primary product	Consumption		Stocks, Dec. 31—	
	1957	1958	1957	1958
Molybdic oxide [1]	21,045	16,276	1,922	2,907
Calcium molybdate	158	148	25	35
Ferromolybdenum [2]	6,778	4,894	800	1,121
Molybdenum metal powder	[3] 1,103	2,164	112	100
Ammonium molybdate	59	53	10	9
Sodium molybdate	229	209	38	42
Other [4]	644	487	190	99
Total	[3] 30,016	24,231	3,097	4,313

[1] Includes molybdic oxide briquets, molybdic acid, and molybdenum trioxide.
[2] Includes molybdenum silicide.
[3] Revised figure.
[4] Includes molybdenum disulfide, thermite molybdenum, molybdenite concentrate added direct to steel

TABLE 4.—Consumption of molybdenum by class of manufacture in thousand pounds of contained molybdenum

Class	1957	1958	Class	1957	1958
Steel:			Molybdenum metal (wire, rod and sheet)	[1] 866	1,867
High speed	2,335	1,072	Chemicals:		
Other alloy including stainless	17,891	13,776	Catalysts	492	391
Castings	2,196	1,864	Colors	660	733
Gray and malleable castings	2,274	1,738	Other	75	27
Rolls (steel mill)	832	601	Lubricants	192	225
Welding rods	237	249	Miscellaneous [2]	321	301
High-temperature alloys	1,401	1,215	Total	[1] 30,016	24,231
Corrosion-and-heat-resisting castings	244	172			

[1] Revised figure.
[2] Includes research and magnetic alloys.

Among other relatively small but important uses of the metal products were the manufacturing of electronic parts, electrodes for glass melting, induction heating elements, and in metal spray applications for steel and other metals. A thin layer of molybdenum sprayed on ferritic steel was an excellent bond for a subsequent sprayed metal deposit.[4] The types of molybdenum coatings and their industrial uses were described.[5]

The consumption of purified molybdenum disulfide increased substantially compared with the quantity used in 1957. Its use in the manufacture of lubricants rose 12 percent compared with the preceding year, and the quantity used in friction materials, brake lining, and rubber products totaled 24,500 pounds compared with 23,000 pounds in 1957.

In 1958, approximately 2,000 pounds of molybdenum was reported used as a trace element in fertilizers, 6,000 pounds in making electrical contacts, and 6,000 pounds in producing molybdenum-bearing titanium alloys.

[4] Birchon, D., Metal Spraying: Effect of a Molybdenum Deposit on Adhesion and on Fatigue of Ferritic Steels: Metallurgia (Manchester, England), vol. 58, No. 350, December 1958, pp. 273–285.
[5] Schultze, H. W., Freeman, R. R., and Briggs, J. Z., Molybdenum Coatings: Materials in Design Engineering, vol. 49 No. 1, January 1959, pp. 76–81.

STOCKS

Stocks of molybdenum concentrate at mines and at plants making molybdenum products declined 20 percent. Stocks of molybdenum products at producers' and consumers' plants increased 40 and 39 percent, respectively.

PRICES AND SPECIFICATIONS

Molybdenum prices were increased by approximately 5 percent on November 1, 1958. Prices quoted by E&MJ Metal and Mineral Markets at the yearend, f.o.b. shipping point were: Molybdenite concentrate, 95 percent MoS_2 (Climax, Colo.) $1.25 pound of contained Mo plus cost of container; molybdic oxide, MoO_3, bags, $1.46, cans $1.47 per pound of contained Mo; ferromolybdenum, powdered $1.82, other sizes $1.76 per pound of contained Mo; calcium molybdate, ($CaOMoO_3$,) lump, packed, $1.50 per pound of contained Mo.

Prices on hydrogen-reduced molybdenum powders varied according to size and purity of the particles. Sylvania Electric Products Inc., produced 7 types that ranged in price from about $3.15 to $4.10 per pound.

Chemical and physical requirements of National Stockpile Purchase Specification P–74–R2, issued November 24, 1958, are shown per pound.

TABLE 5.—National Stockpile Purchase Specification P–74–R2 [1]

	Product			
	Molybdenum disulphide [2] (molybdenite)	Ferro-molybdenum grade A	Ferro-molybdenum grade B	Molybdic oxide
	Percent by weight (dry basis)	Percent by weight (dry basis)	Percent by weight (dry basis)	Percent by weight (dry basis)
Molybdenum	85.00	60.00	60.00	60.00
Carbon		2.50	.10	
Copper	.60	.50	.50	.50
Lead	.15			.15
Phosphorus	.06	.10	.10	.05
Silicon		1.00	1.00	
Sulfur		.20	.20	.25
Tin-plus arsenic	.15			

[1] Physical requirements: Ferromolybdenum shall pass a screen with 1-inch square openings. Molybdenum disulfide and molybdic oxide shall be in powder form.
[2] The free-moisture content shall not exceed 4 percent.

FOREIGN TRADE[6]

Imports.—General imports of molybdenum classified as metal contained in ore and concentrate totaled 1,344 pounds, valued at $5,530, all from the United Kingdom. Both the molybdenum content (60 percent) and value indicated the material was purified molybdenite rather than ore or concentrate. Imports of ferromolybdenum totaled 112,776 pounds (gross weight), valued at $138,347, all from Canada, and sheets, wire, and other forms not specially provided for totaled 22,698 pounds, valued at $360,236.

Exports.—Decreased demand for molybdenum in most industrial countries of Europe and in Japan caused a decline in exports of molybdenum concentrate and molybdic oxide from the United States, reversing an upward trend that had persisted since 1951.

Ferromolybdenum exports during 1958 totaled 226,246 pounds (gross weight), valued at $244,755. Canada received 87 percent of the total exports; the remainder was shipped to eight other countries. Molybdenum wire valued at $214,803 was shipped to 12 countries, and semifabricated forms (such as rod, sheet, and tubes) valued at $62,638 went to 11 countries.

Tariff.—Concessions granted under the General Agreement on Tariffs and Trade, reduced further the duty on several molybdenum products from all countries, except the U.S.S.R. and other designated Communist countries and areas. The duty on molybdenum ores and concentrates during 1958 was 31½ cents a pound of contained molybdenum through June 30 and 30 cents a pound thereafter. Forms containing over 50 percent molybdenum, molybdenum carbide or combinations not specially provided for were: Ingots, shots, bars or scrap molybdenum carbide, 22.5 percent ad valorem through June 30 and 20.5 percent ad valorem during the remainder of the year; and sheet, wire, or other forms of molybdenum or molybdenum carbide, 27 percent ad valorem through June 30 and 25.5 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 was 25 cents a pound of contained molybdenum plus 7.5 percent ad valorem throughout 1958.

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[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 6.—Molybdenum ore and concentrate (including roasted concentrate) exported from the United States, by countries of destination.

[Bureau of the Census]

Country	1956		1957		1958	
	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value
North America:						
Canada	636,312	$783,384	4,567,836	$5,439,899	269,102	$227,375
Jamaica			528	367		
Total	636,312	783,384	4,568,364	5,440,266	269,102	227,375
South America: Brazil	4,136	5,736	1,652	1,148	745	1,455
Europe:						
Austria	863,280	1,206,601	314,722	469,278	709,354	1,028,021
Belgium-Luxembourg	732	1,336	24,100	35,083	12,000	17,640
France	3,383,634	3,870,034	3,371,629	4,140,673	3,095,004	3,824,630
Germany, West	5,562,604	6,399,830	5,807,870	7,200,117	3,612,401	4,493,555
Italy	204,949	241,134	572,070	754,786	503,441	666,217
Netherlands	272,543	381,661	162,612	194,190	93,923	157,402
Sweden	1,569,844	1,811,866	2,073,864	2,636,519	892,355	1,154,424
Switzerland	2,948	5,400			1,298	1,799
United Kingdom	3,719,668	4,239,817	5,044,886	6,199,113	2,766,797	3,465,074
Total	15,580,202	18,157,679	17,371,753	21,629,759	11,686,573	14,808,762
Asia: Japan	1,752,486	2,338,216	3,514,545	5,342,209	2,693	3,905
Oceania: Australia	7,871	10,547	9,201	14,715	3,825	3,165
Grand total	17,981,007	21,295,562	25,465,515	32,428,097	11,962,938	15,044,662

TABLE 7.—Molybdenum reported by producers as shipments for export from the United States, in thousand pounds of contained molybdenum

	1956	1957	1958
Concentrate (not roasted)	14,736	17,543	11,649
Roasted concentrate (oxide)	3,082	1,917	1,210
All other primary products	656	327	231

TABLE 8.—Molybdenum products exported from the United States, gross weight, in pounds

[Bureau of the Census]

	1956	1957	1958
Ferromolybdenum [1]	944,671	383,271	226,246
Metal and alloys in crude form and scrap	35,240	98,513	14,151
Wire	11,440	13,750	11,346
Powder	20,735	28,222	4,841
Semifabricated forms (mainly rods, sheets, and tubes)	4,853	4,289	20,878

[1] Ferromolybdenum contains about 60–65 percent molybdenum.

525707—59——51

WORLD REVIEW

The world production of molybdenum decreased 26 percent compared with 1957. United States and Chile produced 89 and 6 percent, respectively, of the free world total and virtually all the remainder came from small producers in Canada, Norway, and Japan. No reliable information was available on molybdenum production in the U.S.S.R.

NORTH AMERICA

Canada.—Production of molybdenum in Canada decreased 28 percent compared with output in 1957. Virtually the entire output came from the La Corne mine of Molybdenite Corporation of Canada, Ltd. The firm constructed a plant to produce lubricant grade molybdenum disulfide and increased its ore reserve by further development of the deposit.[7]

Several molybdenum prospects were under exploration during the year. Among the more promising were deposits in McTavish township, 24 miles northeast of Port Arthur, Ontario,[8] and in Echo township, 12 miles south of Webster Station, Ontario.[9]

SOUTH AMERICA

Chile.—The Chile Exploration Company (Chilex) a subsidiary of The Anaconda Co. began recovering molybdenum as a byproduct of copper at its Chuquicamata plant in July and operated the molybdenum recovery unit intermittently during the remainder of 1958. Output of molybdenum by the Braden Copper Co., a subsidiary of Kennecott Copper Corp., was hampered by a strike and by reduced demand for copper, the primary product.

Exports of molybdenum concentrate from Chile contained about 2,050,000 pounds of molybdenum. The United Kingdom received 42 percent of the total exports; West Germany and Sweden, 18 percent each; the Netherlands, 12 percent; and France, 10 percent.

Peru.—The Cuajone, Quellaveco, and Toquepola porphyry copper deposits in Southern Peru are reported to contain molybdenite. The latter deposit was being developed by the Southern Peru Copper Corp., but the firm had not announced any plans for molybdenum recovery.

EUROPE

Norway.—Molybdenum was produced from the Knaben mine. The deposit has been described as a contact-metamorphic type with a molybdenite content of about 0.10 to 0.20 percent.

U.S.S.R.—No direct information was available on Soviet production of molybdenum. According to data, taken largely from the November 1957 issue of Gornyy Zhurnal, several large porphyry copper deposits in the U.S.S.R. contain significant quantities of molybdenum.[10]

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[7] Northern Miner (Toronto), Molybdenite Corp., Building New Plant for New Product: Vol. 44, No. 11, June 5, 1958, pp. 1, 5.
[8] Northern Miner (Toronto), Molybdenum Assays Give Encouragement to Lindsay Expl'ns: Vol. 44, No. 44, Jan. 22, 1959, p. 2.
[9] Northern Miner (Toronto), Rio Canadian Expl'n Molybdenum Bet Looks Encouraging: Vol. 43, No. 49, Feb. 27, 1958, pp. 1, 15.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, pp. 18–21.

Production of molybdenum during 1957 was estimated to be about 9–10 million pounds.

ASIA

Turkey.—Exploration of a molybdenite deposit near the village of Gelemic, district of Bursa, Turkey, was discontinued and plans to build a flotation plant were abandoned. The work conducted during 1955–57 was reported to have proved a reserve of 500,000 tons of 0.4 percent Mo grade ore.[11]

TABLE 9.—World production of molybdenum in ores and concentrates, by countries,[1] in thousand pounds[2]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
Australia	4	(3)	2	(3)	2	----------
Austria	29	----------	18	2	----------	----------
Canada	159	452	833	842	785	567
Chile	2,771	2,663	2,817	3,122	2,998	2,972
Hong Kong	(3)	(3)	(3)	----------	----------	----------
Japan	150	450	439	534	600	683
Korea, Republic of	15	22	24	31	31	68
Mexico	----------	159	55	33	29	57
Norway	236	335	379	366	397	481
Peru	7	2	----------	----------	----------	(3)
Portugal	[4] 2	4	11	11	18	[5] 18
Sweden	4	----------	----------	----------	----------	----------
Union of South Africa	----------	----------	----------	----------	13	9
U.S.S.R.	(6)	(6)	(6)	(6)	[5] 9,300	[5] 9,300
United States	38,073	58,668	61,781	57,462	60,753	41,069
Yugoslavia	994	441	948	(6)	----------	----------
World total (estimate) [1]	47,300	70,500	75,000	70,300	76,200	56,500

[1] Molybdenum is also produced in China, North Korea, Rumania, and Spain, but production data are not available. Estimates by senior author of chapter are included in total.
[2] This table incorporates revisions of data published in previous Molybdenum chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Less than 500 pounds.
[4] Average for one year only, as 1953 was the first year of commercial production.
[5] Estimate.
[6] Data not available; estimate by senior author of chapter included in total.

TECHNOLOGY

Technological studies in molybdenum during 1958 ranged from ore sampling and mining to preparing high-purity metal and its alloys and evaluating their properties. Many data on the technology of molybdenum and its alloys presented at a symposium sponsored by the Office of Naval Research were published.[12]

The Bureau of Mines continued the study of rock mechanics to determine the factors necessary for preventing dilution of ore by waste material during caving and made statistical sampling studies to permit the calculation of ore reserves within a predetermined degree of accuracy. Other research by the Bureau included extraction of molybdenum from uranium plant solutions, preparation of ductile molybdenum and its alloys by bomb reduction of oxides, and shape-casting molybdenum.

[11] U.S. Embassy, Ankara, Turkey, State Department Dispatch 441: Jan. 19, 1959, p. 2.
[12] American Society for Metals (Cleveland, Ohio), The Metal Molybdenum: 1958, 696 pp.

Industry continued research to improve the recovery of molybdenum from its ores. The work on ore beneficiation included testing new flotation equipment, flotation reagents, and improved milling practices.

The technology of molybdenum described in literature and in patents[13] included many types of endeavor. Recovery studies included leaching of lowgrade molybdenum-bearing ores with a 3 percent solution of sodium hypochlorite followed by ion exchange concentration of molybdenum. Heating molybdenite with tin under vacuum at 1,200° to 1,300° C. and evaluation of fused salts electrolysis were investigated for preparing high-purity molybdenum.[14] In physical metallurgy, studies indicated molybdenum to be ductile in compression at all temperatures down to −196° C., and a patent was obtained on molybdenum-base alloys, containing various quantities of two metals selected from the following groups: Tungsten, titanium, vanadium, chromium, columbium, and tantalum.[15] The heat capacity measurements between 51° and 298° K., the entropy at 298.15° K, and heat-content measurements to 1,451° K. of Mo_3Si were published.[16] The oxidation rate of molybdenum in air at temperatures from 1,400° to 2,150° F. and coatings to protect molybdenum as well as the use of molybdenum as a coating for other metals were described in articles and patents.[17] Other technology included a patent on a method for electropolishing molybdenum and a patent on incorporating molybdenum disulfide (0.25 to 4.0 percent by weight) in polyamide articles.[18]

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Nickel

By Joseph H. Bilbrey, Jr.,[1] and Ethel R. Long [2]

THE SUPPLY of nickel in the United States in 1958 exceeded industrial demand for the first full year since 1949. The improved supply-demand position resulted from the combination of increased production, complete stockpile deferments, and decreased requirements for nickel in the United States. Production exceeded consumption to such a degree that the International Nickel Co. of Canada, Ltd., the largest producer, curtailed its output several times early in the year so that by July, it was operating at only 65 percent of capacity. In spite of the oversupply of nickel that had developed by mid-year, extensive development of new sources and expansion of existing facilities were continued.

The U.S. Government experienced difficulties in selling much of the product from its plant at Nicaro, Cuba. The accumulation of large stocks of unsold nickel caused curtailment of production at the Nicaro plant and closing of the plant at Crum Lynne, Pa., which had been engaged in producing nickel ingots from Nicaro sinter. The disturbed Cuban political situation brought temporary closing of the Nicaro plant and research facilities during the latter part of the year.

TABLE 1.—Salient statistics of nickel, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Mine production	----------	2,006	4,411	7,392	12,900	13,490
Plant production (primary) [1]	737	831	3,807	6,722	10,070	11,740
Secondary	7,782	8,605	11,540	14,860	[2] 12,037	7,411
Imports	102,000	132,000	142,000	143,000	140,000	90,000
Exports (gross weight)	6,969	14,245	20,601	44,526	13,415	14,032
Consumption	92,676	94,733	110,100	127,578	122,466	79,000
Stocks, Dec. 31 (consumer) [3]	7,717	10,594	[2] 9,001	12,672	25,282	13,279
Price, cents per pound	40–60	60–64½	64½	64½–74	74	74
Canada:						
Production	134,901	161,279	174,928	178,515	[2] 187,958	140,848
Exports	132,901	158,719	173,880	176,837	178,656	154,220
World: Production	183,000	238,000	263,000	283,000	314,000	245,000

[1] Comprises metal from domestic ore and nickel recovered as a byproduct of copper refining.
[2] Revised figure.
[3] Does not include scrap.

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

LEGISLATION AND GOVERNMENT PROGRAMS

No new contracts were entered into by the Government for the purchase of nickel during 1958. Deliveries continued on outstanding contracts with a few exceptions. The scheduled delivery of 24 million pounds from Inco to complete a 5-year contract for a total of 135 million pounds was postponed until 1960–61 by an amendment to the contract. Delivery by Inco of 6.7 million pounds also scheduled in 1958 to complete a second contract was deferred until 1959. All nickel scheduled for delivery to the Government in 1958, a total of approximately 135 million pounds, was diverted from the stockpile and offered to industry.

On January 20 the Business and Defense Administration (BDSA) issued Amendment 1 to DMS Regulation No. 1, thereby requiring producers of controlled materials to use the rating DO–B–5 in obtaining primary nickel as production material needed to fill orders for controlled materials. On March 10 DMS Regulation No. 1 was further amended to require a producer of controlled materials to use their customers' program identification for purchases of primary nickel instead of the B–5 symbol. The net effect of these two amendments was merely to enable the Government to obtain full information about the magnitude of defense purchases of nickel.

On May 9, two amendments were made to BDSA Regulation No. 2. One, BDSA Reg. 2, Dir. 7 Amdt. 1, allows a producer of nickel alloys for mandatory acceptance orders to dispose of nickel scrap without written permission from BDSA. The other, BDSA Reg. 2 Amdt. 5, allows producers who have acquired nickel through a priority authorization of BDSA to use the material for lower priority orders or to dispose of it in cases where the original purchase order was modified or cancelled.

The Department of Defense cancelled DOD directive 4000.0 of July 2, 1957, and replaced it with DOD directive 4000.4 of June 10, 1958. The cancellation of the 1957 directive eliminated nickel, among other items, from the DOD conservation list, thus eliminating all Department of Defense specification restrictions on the use of nickel.

DOMESTIC PRODUCTION

Mine Production.—Domestic mine production of nickel contained in ore was 5 percent higher than in 1957. The major part of the increase was due to the record of 846,500 dry short tons of ore mined by the Hanna Mining Co. (formerly Hanna Coal & Ore Corp.) from its deposit near Riddle, Oreg. The output of ore from the Hanna mine was 4 percent greater than in 1957.

The National Lead Co. continued to recover a pyrite concentrate containing cobalt and nickel from lead ore in southern Missouri. The total quantity of nickel in the concentrate was 30 percent more than in 1957. The Calera Mining Co. recovered a small amount of nickel as a byproduct of cobalt mining operations in Idaho.

Plant Production.—The Hanna Nickel Smelting Co. produced ferronickel from the ore mined from the nearby deposit in Riddle, Oreg.

TABLE 2.—Nickel produced in the United States, nickel content in short tons

	1949-53 (average)	1954	1955	1956	1957	1958
Primary:						
Byproduct of copper refining	737	639	451	623	502	502
Domestic ore	(1)	192	3,356	6,099	9,568	11,238
Secondary	7,782	8,605	11,540	14,860	[2] 12,037	7,411

[1] 11 tons produced in 1953—only production during period.
[2] Revised figure.

It smelted 846,500 dry short tons of ore to produce 23,793 tons of ferronickel, which contained 10,588 tons of nickel. Output of ferronickel was 16 percent higher than in 1957.

The Fredericktown Metals Refinery of the National Lead Co. in Fredericktown, Mo., produced 33 percent more nickel than in 1957. The National Lead Co. refinery at Crum Lynne, Pa., which reduced Nicaro oxide sinter to metal under a Government contract ceased operations on December 18.

A total of 502 tons of nickel was recovered as a byproduct of copper refining. This nickel was recovered in the form of sulfate from refineries at Carteret and Perth Amboy, N.J., Laurel Hill, N.Y., El Paso, Tex., and Tacoma, Wash. Shipments from these plants contained 506 tons of nickel.

In addition to the nickel sulfate recovered as a byproduct of copper refining, refined nickel salts (mainly sulfate) containing 2,409 tons of nickel were produced in the United States; total refined-salts production was 2,911 tons (nickel content). Shipments of salts to consumers contained 2,911 tons of nickel.

Secondary Nickel.[3]—The recovery of nickel from nonferrous scrap in the United States in 1958 totaled 7,400 short tons—a decrease of 38 percent from the 12,000 tons recovered in 1957, according to the Federal Bureau of Mines. The decrease was reflected in recovery of secondary nickel in all products except copper-base alloys, which increased 500 tons.

Recovery of nickel from ferrous nickel-base scrap is not included in the secondary nickel tables. Ferrous nickel-base alloys consist of alloys in which the metal of highest percentage is nickel but which contains so much iron, chromium, cobalt, or other constituents of ferrous alloys that they must be classed as ferrous alloys although they are also nickel-base. Examples are inconel and nichrome. Both nonferrous and ferrous nickel-base alloys may be used as alloying ingredients in ferrous alloys, but the second named cannot be used to make nonferrous alloys.

According to the American Metal Market, prices for nickel clippings and monel scrap were more stable in 1958 than in 1957—43.50 cents and 28.50 cents per pound, respectively, January through August, and 20 to 25 percent higher the last quarter of 1958. The spot-delivery price of grade F nickel ingot and shot was 78.48 cents per pound throughout the year.

[3] Prepared by A. J. McDermid.

TABLE 3.—Nickel recovered from nonferrous scrap processed in the United States, by kind of scrap and form of recovery, in short tons

Kind of scrap	1957 [1]	1958	Form of recovery	1957 [1]	1958
New scrap:					
Nickel-base	3,557	1,807	As metal	3,187	1,211
Copper-base	1,417	1,253	In nickel-base alloys	3,332	1,455
Aluminum-base	345	263	In copper-base alloys	1,971	2,457
			In aluminum-base alloys	460	369
Total	5,319	3,323	In ferrous and high-temperature alloys [2]	2,466	1,085
Old scrap:			In chemical compounds	621	834
Nickel-base	6,182	3,607			
Copper-base	402	360	Grand total	12,037	7,411
Aluminum-base	134	121			
Total	6,718	4,088			
Grand total	12,037	7,411			

[1] Revised figures.
[2] Includes only nonferrous nickel scrap added to ferrous and high-temperature alloys.

CONSUMPTION AND USES

Consumption of nickel in the United States was the lowest recorded since 1949 and was 35 percent under 1957. The largest percentage decline, 68 percent, was in nickel used for the production of anodes. This figure does not reflect accurately actual consumption by the electroplating industry for the year, as it reports consumption by the manufacturers of anodes. Probably much of the abnormally

TABLE 4.—Stocks and consumption of new and old nickel scrap in the United States in 1958, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks, end of year
Smelters and refiners:						
Unalloyed nickel	592	1,296	685	1,033	1,718	170
Monel metal	298	1,442	279	1,092	1,371	369
Nickel silver [1]	594	2,937	454	2,501	2,955	576
Miscellaneous nickel alloys	3	1,666	11	1,654	1,665	4
Nickel residues	55	162	79	15	94	123
Total	948	4,566	1,054	3,794	4,848	666
Foundries and plants of other manufacturers:						
Unalloyed nickel	671	576	401	588	989	258
Monel metal	74	466	63	394	457	83
Nickel silver [1]	2,175	6,652	6,223	136	6,359	2,468
Miscellaneous nickel alloys	35	168	3	173	176	27
Nickel residues	385	1,592	939	388	1,327	650
Total	1,165	2,802	1,406	1,543	2,949	1,018
Grand total:						
Unalloyed nickel	1,263	1,872	1,086	1,621	2,707	428
Monel metal	372	1,908	342	1,486	1,828	452
Nickel silver [1]	2,769	9,589	6,677	2,637	9,314	3,044
Miscellaneous nickel alloys	38	1,834	14	1,827	1,841	31
Nickel residues	440	1,754	1,018	403	1,421	773
Total	2,113	7,368	2,460	5,337	7,797	1,684

[1] Excluded from totals because it is copper-base scrap although containing considerable nickel.

large 1957 consumption for anodes remained in suppliers stocks and the anodes actually were not consumed in electroplating tanks until 1958.

TABLE 5.—Nickel (exclusive of scrap) consumed in the United States, by forms, in short tons of nickel

Form	1949-53 (average)	1954	1955	1956	1957	1958
Metal	68, 284	67, 241	83, 357	96, 403	94, 765	61, 768
Oxide powder and oxide sinter	13, 794	16, 191	18, 785	20, 742	17, 049	12, 990
Matte	9, 145	9, 710	6, 219	8, 875	9, 047	3, 309
Salts [1]	1, 453	1, 591	1, 739	1, 558	1, 605	933
Total	92, 676	94, 733	110, 100	127, 578	122, 466	79, 000

[1] Figures estimated to represent about 60 percent of total in 1957-58.

TABLE 6.—Nickel (exclusive of scrap) consumed in the United States, by uses in short tons of nickel

Use	1949-53 (average)	1954	1955	1956	1957	1958
Ferrous:						
Stainless steels	20, 848	20, 399	26, 520	32, 883	26, 986	23, 039
Other steels	16, 921	13, 637	18, 977	17, 413	15, 882	14, 510
Cast irons	3, 969	4, 115	5, 431	5, 819	5, 534	3, 851
Nonferrous [1]	28, 715	31, 197	29, 361	35, 840	33, 449	18, 048
High-temperature and electrical-resistance alloys	6, 681	6, 597	8, 669	11, 373	9, 837	7, 435
Electroplating:						
Anodes [2]	10, 792	13, 460	14, 627	15, 952	23, 354	7, 693
Solutions [3]	868	1, 323	1, 357	1, 074	1, 131	734
Catalysts	1, 332	1, 344	1, 525	2, 001	2, 113	1, 165
Ceramics	272	304	417	425	358	337
Magnets	2, 278	681	882	933	902	636
Other		1, 676	2, 334	3, 865	2, 920	1, 552
Total	92, 676	94, 733	110, 100	127, 578	122, 466	79, 000

[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 used for production of anodes plus cathodes used as anodes in plating operations.
[3] Figures estimated to represent about 60 percent of total in 1957-58.

TABLE 7.—Nickel (exclusive of scrap) in consumers' stocks in the United States, by forms, in short tons of nickel

Form	1949-53 (average)	1954	1955	1956	1957	1958
Metal	5, 305	8, 477	6, 904	9, 684	21, 082	10, 608
Oxide powder and oxide sinter	1, 328	1, 372	1, 447	1, 976	3, 037	2, 404
Matte	769	255	181	424	787	3
Salts	315	490	469	588	376	264
Total	7, 717	10, 594	9, 001	12, 672	25, 282	13, 279

PRICES

The domestic price of electrolytic nickel remained unchanged at 74 cents per pound, duty paid, f.o.b. Port Colborne, Ontario. On July 14, 1958, the International Nickel Co. of Canada, Ltd., reduced the price of its nickel oxide from 70.25 cents per pound, unpacked at Copper Cliff, Ontario, to 69.6 cents per pound, packaged, f.o.b. port of entry to put it on an equivalent competitive basis with nickel oxide from Nicaro, Cuba, which sold for 69 cents per pound throughout the year.

FOREIGN TRADE [4]

Imports of nickel into the United States dropped 36 percent to the lowest figure recorded since 1950. Canada was again the principal source of imports. Matte, slurry, and residues shipped from Canada were processed at the Huntington, W. Va., plant of the International Nickel Co., Inc.

Since January 1, 1948, U.S. duty on refined nickel has been 1¼ cents a pound. Nickel ore, oxide powder and sinter, matte, slurry, and residues are duty free.

The nickel exported from the United States was principally contained in nickel and nickel-alloy metals in ingots, bars, rods and other crude forms and scrap. The chief foreign markets were the United Kingdom (5,452 tons), Canada (3,660 tons), and West Germany (1,873 tons).

The U.S. Department of Commerce removed all remaining restrictions on the export of nickel, nickel alloys, and scrap.

TABLE 8.—Nickel products imported for consumption in the United States, in short tons

[Bureau of the Census]

Class	1949–53 (average)	1954	1955	1956	1957	1958
Ore and matte	12,825	14,135	9,088	12,820	13,177	4,574
Metal (pigs, ingots, shot, cathodes, etc.)[1]	76,519	97,263	109,404	106,534	[2] 99,787	62,793
Oxide powder and oxide sinter	19,358	32,264	32,896	[3] 32,955	[3] 37,080	29,622
Slurry [4]	(5)	(5)	(5)	37	211	260
Refinery residues [6]	(7)	211	89	1,946		211
Scrap [1]	851	444	464	1,078	410	271
Total: Gross weight	109,553	144,317	151,941	155,370	150,665	97,731
Nickel content (estimated)	102,000	132,000	142,000	143,000	140,000	90,000

[1] Separation of metal from scrap on basis of unpublished tabulations.
[2] Revised figure.
[3] Figures for 1956 include, but for 1957 exclude, 1,524 tons received from Cuba in December 1956 but not included in figures of Bureau of Census until 1957.
[4] Nickel-containing material in powders, slurry, or any form, derived from ore by chemical, physical, or any other means, and requiring further processing for the recovery therefrom of nickel or other metals.
[5] Not provided for in import schedule before July 1, 1956.
[6] Reported to Bureau of Mines by importers.
[7] Data not available.

[4] 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 9.—New nickel products imported for consumption in the United States, by countries, in short tons

[Bureau of the Census]

Country	Metal		Oxide powder and oxide sinter				Slurry, etc.[1]			
	1957	1958	1957		1958		1957		1958	
	Gross weight	Gross weight	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content
North America:										
Canada	[2] 90,824	61,254	12,762	9,620	7,177	5,392	211	62	260	68
Cuba			[3] 24,318	[3] 21,598	22,445	19,650				
Mexico	1									
Total	[2] 90,825	61,254	[3] 37,080	[3] 31,218	29,622	25,042	211	62	260	68
Europe:										
France		3								
Germany, West	165									
Norway	8,442	1,441								
Sweden	25	50								
United Kingdom	[2] 173	26							(4)	(4)
Total	[2] 8,805	1,520							(4)	(4)
Asia: Japan	157	19								
Total	[3] 99,787	62,793	[3] 37,080	[3] 31,218	29,622	25,042	211	62	260	68

Country	Ore and matte				Refinery residues [5]			
	1957		1958		1957		1958	
	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content	Gross weight	Nickel content
North America:								
Canada	13,177	9,103	4,574	3,129			211	62

[1] Nickel-containing material in powder, slurry, or any form, derived from ore by chemical, physical, or any other means, and requiring further processing for the recovery therefrom of nickel or other metals.
[2] Revised figure.
[3] Excludes 1,524 tons of oxide sinter containing 1,359 tons of nickel received in December 1956 but not included in figures of Bureau of the Census until 1957.
[4] Less than 1 ton.
[5] Reported to Bureau of Mines by importers.

TABLE 10.—Nickel products exported from the United States, by classes

[Bureau of the Census]

Class	1956		1957		1958	
	Short tons	Value	Short tons	Value	Short tons	Value
Ore, concentrate, and matte	27,331	$555,660			10	$1,485
Nickel and nickel-alloy metals in ingots, bars, rods, and other crude forms, and scrap	15,116	15,262,575	11,940	$11,965,309	11,957	13,721,729
Nickel and nickel-alloy metal sheets, plates, and strips	1,245	2,756,171	816	2,124,371	863	2,320,857
Nickel and nickel-alloy semifabricated forms, not elsewhere classified	626	1,877,705	508	1,796,505	563	2,491,121
Nickel-chrome electric resistance wire, except insulated	208	836,036	151	631,625	154	678,426
Nickel catalysts	(1)	(1)	(1)	(1)	485	1,022,945
		21,288,147		16,517,810		20,236,563

[1] Not separately classified.

WORLD REVIEW

World output of nickel dropped 22 percent in 1958 to the lowest level recorded since 1952. The main reasons for the drop were the decreased consumption in the United States, which led to the curtailing of production in Canada and Cuba; the strike at the International Nickel Co. in Canada, which led to an estimated production loss of 28,000 tons of nickel; and the collapse of the export market for New Caledonian ore, which resulted in drastically decreased ore production in New Caledonia.

TABLE 11.—World mine production of nickel, by countries, in short tons of contained nickel[1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada[2]	134,901	161,279	174,928	178,515	187,958	140,848
Cuba (content of oxide)	4,554	14,545	15,138	16,062	22,245	19,782
United States:						
Byproduct of copper refining	737	639	451	623	502	502
Recovered nickel in domestic ore refined	11	192	3,356	6,099	9,568	11,238
Total	140,203	176,655	193,873	201,299	220,273	172,370
South America:						
Bolivia (exports—content of ore)				4	2	
Brazil (content of ferronickel)	[3] 20	[3] 30	57	70	[3] 90	[3] 80
Total	20	30	57	74	92	80
Europe:						
Finland (content of nickel sulfate)	[3] 75	89	133	164	89	125
Greece				386	(4)	(4)
U.S.S.R. (content of ore) [3] [5]	33,600	46,000	48,000	52,000	55,000	55,000
Total	33,675	46,089	48,133	52,550	(4)	(4)
Asia:						
Burma (content of speiss)	157	116	72	127	74	367
Iran (content of ore) [6]	14	17	13	18	17	[3] 17
Total	171	133	85	145	91	384
Africa:						
Morocco: Southern zone (content of cobalt ore)	67	162	167	142	94	204
Rhodesia and Nyasaland, Federation of: Southern Rhodesia (content of ore)	3	14	4	45	73	4
Union of South Africa (content of matte and refined nickel)	1,229	2,112	2,598	3,624	4,562	[3] 3,800
Total	1,299	2,288	2,769	3,811	4,729	4,008
Oceania: New Caledonia [7]	7,639	13,000	18,000	25,000	33,000	[3] 13,000
World total (estimate)	183,000	238,000	263,000	283,000	314,000	245,000

[1] This table incorporates a number of revisions of data published in previous Nickel chapters.
[2] Comprises refined nickel and nickel in oxide produced and recoverable nickel in matte exported.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] According to the 45th annual issue of Metal Statistics (Metallgesellschaft), except 1958.
[6] Year ended Mar. 21 of year following that stated.
[7] Comprises nickel content of matte and ferronickel produced in New Caledonia and estimate (by senior author) of recoverable nickel in ore exported. Mine production (nickel content of ore) was as follows: 1949–53 (average), 9,073 tons; 1954, 15,100 tons; 1955, 27,200 tons; 1956, 32,500 tons, 1957, 47,000 tons; and 1958, 15,600 tons.

NORTH AMERICA

Canada.—Production of nickel during 1958 declined 25 percent for the first decrease in production since 1950. Nearly all Canadian nickel was produced from copper-nickel ores by the following companies: The International Nickel Company of Canada, Ltd., and Falconbridge Nickel Mines, Ltd., in the Sudbury district, Ontario; Sherritt Gordon Mines, Ltd., in the Lynn Lake area, Manitoba; and North Rankin Nickel Mines, Ltd., in the Rankin Inlet area, Northwest Territories.

Mounting stocks of nickel caused International Nickel to make production cuts of 10 percent in March and May and to drop to a 4-day workweek in July, thus bringing production down to 65 percent of capacity. On September 24, the International Union of Mine, Mill and Smelter Workers called a strike against the company, which halted all company operations in Ontario. The strike, which involved some 14,000 employees at Sudbury and Port Colborne, was not settled until December 22 and caused an estimated production loss of about 28,000 tons of nickel. The total effect of the reduced production rates and the strike was a decrease in ore production from Inco mines in the Sudbury district to only 9,457,000 tons in 1958 as compared with 16,049,000 tons in 1957.[5] Although ore production decreased 41 percent, deliveries of nickel to customers declined only 29 percent and amounted to 102,900 short tons, compared with 145,025 tons in 1957.

Long-range development continued at operating Inco mines in the Sudbury district, but the company's major effort was directed toward the development of the new nickel-mining project at Thompson, Manitoba. Sinking of the 2,100-foot mine production shaft was completed, and construction of surface facilities proceeded ahead of schedule. Many houses were completed and occupied in the new town of Thompson, which was being built for a population of 8,000. The Thompson post office was officially opened June 18. Smelter operations at Thompson were scheduled to begin in July 1960. Inco continued its extensive exploration of ore possibilities in Northern Ontario, Saskatchewan, the Northwest Territories, Alaska, and Australia. Property examinations were made in Africa, the East Indies, Mexico, and South and Central America.

Falconbridge Nickel Mines Limited set new production records for the ninth consecutive year. Nickel deliveries were 24,255 short tons—an increase of over 3 percent from 1957. Ore production of 2,087,000 tons, up 4 percent from 1957, came mainly from the five operating mines—Falconbridge, East, Hardy, McKim and Longvack—in the Sudbury district. Some ore was also derived from development at the Fecunis mine, and additional ore was purchased from the Norduna mine. Development was continued at the Onaping mine, but no ore was produced. Ores and concentrates delivered to treatment plants increased 7 percent to 2,151,000 tons.

A new smelter was blown-in January 16, 1958, and operated satisfactorily throughout the year. By the yearend the treatment plants

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[5] The International Nickel Co. of Canada, Ltd., 1958 Annual Report, p. 14.

were capable of operating at the planned annual capacity of 55 million pounds.

Falconbridge explored in several areas in Ontario, Manitoba, and Quebec, but no deposits of economic significance were discovered.[6]

Sherritt Gordon Mines, Ltd., mined and milled 892,000 tons of ore from the property at Lynn Lake, Manitoba—a 7 percent increase over 1957. At the refinery at Fort Saskatchewan, Alberta, the company produced 11,107 short tons of nickel from its own production and purchased concentrates—an increase of nearly 11 percent over 1957. In addition, 1,397 tons of nickel was produced from toll-refining concentrates from several sources during the first 8 months of 1958.[7]

Although production increased, profits dropped sharply mainly because of higher recovery costs resulting from a decrease in the grade of ore treated. To offset the higher costs at the mine, the previously planned expansion of milling capacity was initiated, and a second hydroelectric plant was completed. These changes will make it possible to handle more low-grade ore in the future to maintain nickel metal production at a high level.

North Rankin Nickel Mines, Ltd., most northerly nickel-copper operation in Canada, completed its first full year of production. The mine and mill are at Rankin Inlet, Northwest Territories, on the west shore of Hudson Bay, about 320 miles north of Churchill, Manitoba. All concentrates were shipped to the Sherritt Gordon plant at Fort Saskatchewan.

Mining and milling were done throughout the year by Eskimo labor, and concentrates were stockpiled to await the 6-week shipping season, which begins in August and ends early in October. A total of 2,197 tons of nickel in concentrates was shipped in 1958, and 430 tons was stockpiled at the property when the shipping season closed.[8]

North Rankin began an expansion program to raise mill capacity to more than 250 tons of nickel per month. Adequate shipping was arranged to take care of the increased production. In addition, exploration of the west coast of Hudson Bay was planned for the spring of 1959 in an effort to develop new sources of ore for the company.

Nickel Rim Mines, Ltd., suspended operations on May 31, 1958, because it could not produce at the open market price of nickel. The company mined low-grade ore in the Sudbury district and was able to operate only under contracts that called for premium-priced nickel. Nickel Rim concentrates were refined by Sherritt Gordon, and at closing the company had enough nickel in stock to fulfill all existing premium-price contracts.[9]

Western Nickel, Ltd., began operations at Choate, British Columbia, early in 1958, operated for a few months, and then closed down in August, owing to modification and partial cancellation of its premium-price European sales contracts.[10] Nickel concentrate pro-

[6] Falconbridge Nickel Mines, Ltd., Thirtieth Annual Report: 1958, pp. 5–9.
[7] Sherritt Gordon Mines, Ltd., Annual Report: 1958 pp. 3–4.
[8] Mining Journal (London), Canada's Sub-arctic Nickel Mine: Vol. 251, No. 6433, Dec. 5, 1958, p. 634.
[9] Northern Miner (Toronto), Nickel Rim Hopes for Nickel Upturn Funds Are Low: Vol. 44, No. 15, July 3, 1958, p. 7.
[10] Northern Miner (Toronto), Operations Suspended by Western Nickel: Vol. 44, No. 20, Aug. 7, 1958, p. 2.

duced during this brief period of operation was shipped to the Sherritt Gordon refinery.

Quebec Ascot Copper Corp., Ltd., and R. M. Nickel Mines, Ltd. (financed by Quebec Ascot) conducted extensive diamond-drilling operations on the Quebec Ascot property in the Noranda area. Preliminary results were very encouraging; selected samples had as high as 18.5 percent nickel.[11]

Cuba.—Production of nickel from the U.S. Government-owned plant at Nicaro dropped 11 percent in 1958, partly because of reduction in operation brought about by large decreases in sales and accompanying accumulation of stocks and partly owing to interruptions in operation caused by the Cuban revolution. The 1958 production was divided into 4,706 tons of oxide powder, averaging 77.44 percent nickel plus cobalt, and 17,924 tons of oxide sinter, averaging 90.04 percent nickel plus cobalt.

The nickel produced by the Nicaro plant in 1958 had a much higher cobalt content and a slightly higher iron content than competitive products produced in Canada. During the time that nickel was in short supply, this higher impurity content did not affect sales of the product; during 1958 an oversupply of nickel developed, and consumers turned to the purchase of higher purity products, with the result that sales of Nicaro products dropped sharply. Research directed towards improving and diversifying the Nicaro products was done at the plant throughout 1958, but these activities were halted during the last quarter of the year by increased activity of the Cuban revolution in that area.

Construction of the mining and concentrating facilities of the Moa Bay Mining Co., a subsidiary of the Freeport Sulphur Co., continued on schedule at Moa Bay, Cuba. Mining was scheduled to begin during the third quarter of 1959. Nickel and cobalt concentrates from this plant will be shipped by special tanker to a refinery in Port Nickel, La., for recovery of the metal.

Dominican Republic.—Minera y Beneficiadora Falconbridge Dominicana C. por A., a subsidiary of Falconbridge Nickel Mines, Ltd., carried on extensive exploration in the Dominican Republic, which led to a substantial increase in the estimated quantity of potential ore.

EUROPE

Finland.—The Pori Metal Works recovered 125 tons of nickel as nickel sulfate in 1958. Development of the nickel-copper deposit at Katalahati was done by Outokumpu Oy. Mining of the deposit, which contains an estimated 3 million tons of ore, was scheduled to begin during the latter part of 1959.[12] Discovery of a new nickel deposit at Uusi Haapala Saaminki has been reported.[13]

France.—The refinery of Société le Nickel, at Le Havre, continued to process matte from New Caledonia. Preliminary figures indicate a production of about 7,165 short tons of nickel metal in 1958 as compared with the final figure of 7,122 tons in 1957.

[11] Precambrian (Winnipeg), Mining * * * in Quebec: Vol. 31, No. 11, November 1958, p. 104.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 21.
[13] Mining Journal (London), Mining Miscellany: Vol. 251, No. 6436, Dec. 26, 1958, p. 725.

The Société le Nickel has made arrangements to use the Sherritt Gordon refining process in its new refinery under construction at Le Havre.[14]

Greece.—Ore mining for the nickel plant at Larymna was halted in June 1958. Lack of demand for the rather low-grade product led to the closing of the Larymna facilities. Approximately 275,000 short tons of ore and 22,000 tons of pellets (4.8 percent nickel) were in unsold stocks at the time.

Norway.—The sole nickel producer in Norway, the Falconbridge Nikkelverk Aktieselskap at Kristiansand continued to increase its output during 1958. Production of 26,002 short tons of electrolytic nickel, an increase of 11 percent from 1957, was entirely from matte from the Falconbridge operations in Canada.

ASIA

Burma.—Production of nickel in the form of speiss was continued as a byproduct of lead-zinc mining at the Bawdwin mine of the Burma Corp., Ltd.

Japan.—Production of nickel in Japan dropped to less than half of the 1957 level. Total output was 3,987 short tons of pure nickel and 13,234 tons of ferronickel as compared with 7,994 tons of pure nickel and 37,184 tons of ferronickel in 1957. Most of the metal came from New Caledonia ore. Production was reduced because of less demand in the foreign market. When nickel was scarce, Japan exported half of its production of nickel at premium prices, but the premium-price market for nickel ceased in late 1957.

Philippines.—The Nickel Law enacted by the Philippine Government in 1957 to attract foreign capital for developing nickeliferous deposits in the Surigao Minerals Reservation, was amended in 1958 to make its provisions more attractive.[15]

Turkey.—A large nickel silicate deposit was discovered near Ciftehan, 70 miles northwest of Adana in South Turkey.[16]

OCEANIA

Australia.—A rich nickel-ore deposit, estimated to contain enough nickel to meet the needs of Australia for 40 years, was discovered near Beaconsfield, northern Tasmania.[17]

New Caledonia.—Production of nickel ore in New Caledonia was only 651,500 short tons—less than one-third of the 1,983,000 tons produced in 1957. The principal reason for the decrease was loss of the Japanese market. Japan imported only 174,725 short tons of ore from New Caledonia in 1958, compared with 1,122,954 tons in 1957. Exports of ore to France dropped 79 percent to only 15,274 tons, and no ore was exported to Australia in 1958. Most mines were forced to close down, and others operated at a reduced level during 1958.

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[14] Sherritt Gordon Mines, Ltd., Quarterly Report to Shareholders: Third Quarter, 1958.
[15] Philippines Bureau of Mines, Minerals News Service, No. 31, August 1958, 7 pp.
[16] Mining World, vol. 20, No. 8, July 1958, p. 79.
[17] Iron and Coal Trades Review (London), Commonwealth Aid Urged for Tasmanian Nickel Find: Vol. 77, No. 4714, Sept. 26, 1958, p. 753.

In spite of the very poor year expansion of the Pointe Doniambo facilities was continued. Operation of one of four scheduled electric furnaces was begun as power reached Noumea from the completed Yate Dam hydroelectric installation.[18]

TABLE 12.—Production of nickel matte and ferronickel by Société le Nickel in short tons

[New Caledonian Mining Service]

Product	1957	1958
Matte:		
Gross weight	10,647	9,697
Nickel content	7,802	7,202
Ferronickel:		
Gross weight	14,747	10,153
Nickel content	3,569	2,525

TABLE 13.—Nickel ore and nickel products exported from New Caledonia, in short tons

[New Caledonian Mining Service]

Product	1957	1958
Ore:		
Gross weight	1,218,604	189,596
Nickel content	28,000	4,550
Matte:		
Gross weight	11,839	9,513
Nickel content	8,715	7,060
Ferronickel:		
Gross weight	15,903	10,524
Nickel content	3,849	2,609

TECHNOLOGY

Nickel research by the Bureau of Mines included development of a process for producing a very high purity nickel, studies on the electrolytic separation of nickel and cobalt, and small-scale tests on the separation of nickel and cobalt by solvent extraction. The results of Bureau work on the upgrading of cobalt-nickel stockpiles were published.[19] A report on research by the Bureau of Mines for GSA on electrolytic separation of nickel and cobalt also was published.[20]

Industry was especially active in developing nickel bearing, high-temperature, high-strength alloys for use in jet engines and missiles. The General Electric Co. developed three new alloys (J–1610, J–1650, and DCM), for jet-engine use. J–1610 (also known as René 41) is a precepitation hardening nickel-base alloy for use in the 1,600°–1,800° F. range. It is considered to be one of the strongest high-temperature alloys yet developed that can be forged, formed, and welded. It has

[18] U.S. Consulate, Suva, Fiji, State Department Dispatch 95: Mar. 24, 1959, p. 1.

[19] Fine, M. M., Vahrenkamp, G. J., Lankenau, A. W., and Moreland, O. N., Upgrading Cobalt-Nickel Stockpiles by the Roast-Flotation Process: Bureau of Mines Rept. of Investigations 5388, 1958, 10 pp.

[20] Ferrante, M. J., Good, P. C., and Gruzensky, P. M., Electrolytic Separation Studies of Nickel and Cobalt From Nicaro-Plant Products: Bureau of Mines Rept. of Investigations 5394, 1958, 30 pp.

the following nominal percentage composition: C 0.09, Cr 19, Mo 10, Ti 3.1, Al 1.5, Ni balance. J–1650 is a cobalt-base alloy for use in the 1,600°–1,900° F. range. It can be formed and welded. It has the following nominal percentage composition: C 0.20, B 0.02, Ni 27, Cr 19, W 12, Ti 3.8, Ta 2, Co balance. The third alloy DCM (from the initials of E. L. Dunn, M. E. Cieslicki, and J. B. Moore, its three developers), is a nickel-base alloy for use in the 1,800° F. range, especially designed for casting turbine blades.[21] It has the following nominal percentage composition: C 0.08 max., Mn 0.10 max., Si 0.15, S 0.015 max., Cr 14–16, Ti 3.35–3.65, B 0.070–0.090, Al 4.4–4.8, Mo 4.5–6.0, Fe 4.0–6.0, Cu 0.10 max., Ni balance. All three alloys are produced by vacuum-melting.

Allegheny Ludlum Steel Corp. developed D-979, a new high-temperature nickel-base alloy for use up to 1,600° F.[22] D–979 is produced by consumable electrode vacuum-melting.

Westinghouse Electric Corp. developed Nicrotung, a tungsten-bearing nickel-base high-temperature alloy for use in the as-cast condition.[23] Nicrotung has the following nominal percentage composition: Cr 12, Co 10, W 8, Al 4, Ti 4, C 0.10, B 0.05, Zr 0.05, Ni balance. Nicrotung must be prepared by vacuum or inert-gas melting and casting.

A new nickel-base alloy, Nimonic 105, was added to the Nimonic series of alloys. Nimonic 105 has a much greater resistance to creep at high temperatures than other Nimonic alloys and improved resistance to the type of high-temperature corrosion caused by fuels in gas turbine engines.

The American Iron and Steel Institute assigned the designation D319 to a new type of stainless steel, developed as a modification of AISI Type 316.[24] D319 has a higher resistance to corrosion than Type 316 and will replace it in some uses. Production of D319 has begun, and when enough demand develops, the new steel will be designated AISI Type 319. D319 has the following nominal percentage composition: C 0.07 max., Mn 2.00 max., Si 1.00 max., P 0.045 max., S 0.030 max., Cr 17.5–19.5, Ni 11–15, Mo 2.25–3.00, and Fe balance.

Metachemical Processes, Ltd., of Crawley, England, announced the development of a new process for producing thin electro forms of a file-hard electrolytic nickel deposit.[25] This new material, called Micrograin nickel is now being used on leading edges of aircraft propellers to guard the deicer elements against hail and stones. Many other applications requiring smooth, hard surfaces were predicted.

A new chemical method of nickel-plating magnesium was developed by the Dow Chemical Co.[26] The process, which can also be used for plating other metals, deposits a uniform, strongly adherent coating of nickel, which contains 7 to 9 percent phosphorus.

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[21] Wilson, J. E., Two New 1,800° F. Alloys for Cast Turbine Blades—DCM Alloy: Metal Progress, vol. 74, No. 5, November 1958, pp. 83–87.
[22] American Metal Market, A. L. Develops Two New Hi-Temp Alloys: Vol. 65, No. 83, Apr. 30, 1958, p. 12.
[23] Brown, J. T., Two New 1,800° F. Alloys for Cast Turbine Blades—Nicrotung: Metal Progress, vol. 74, No. 5, November 1958, pp. 83–87.
[24] American Metal Market, New Cr-Ni-Mo Stainless D319 Is Approved: Vol. 65, No. 203, Oct. 21, 1958, p. 11.
[25] Steel, New, Hard Nickel: Vol. 142, No. 17, Apr. 28, 1958, p. 115.
[26] American Metal Market, Nickel Plating on Magnesium by Immersion: Vol. 65, No. 105, May 30, 1958, pp. 1–7.

A nickel catalyst, nonpyrophoric without the use of a protective medium, was developed by the Chemtrom Corp.[27] This type of catalyst should be safer and easier to handle than previous types of nickel-powder catalysts.

A number of patents were issued on the separation of nickel and cobalt,[28] chemical plating processes,[29] alloys for various uses,[30] recovery of nickel from ores,[31] and the use of the carbonyl process for producing nickel and nickel powders.[32]

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[27] Chemical Week, Nickel Catalyst: Vol. 83, No. 17, Oct. 25, 1958, p. 106.

[28] Benoit, R. L., Lin, W. C., and Mackiw, V. N. (assigned to Sherritt Gordon Mines, Ltd.), Separation of Nickel From Cobalt: U.S. Patent 2,822,262, Feb. 4, 1958.

Benoit, R. L., and Mackiw, V. N. (assigned to Sherritt Gordon Mines, Ltd.), Separating Nickel From Solutions Containing Nickel and Cobalt: U.S. Patent 2,822,264, Feb. 4, 1958.

Lonza Electric and Chemical Works, Ltd., Separating Cobalt and Nickel: British Patent 785,350.

Reynand, F., and Terraz, G. (assigned to Société d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine), Process of Separating Nickel and Cobalt: U.S. Patent 2,842,427, July 8, 1958.

Schaufelberger, F. A. (assigned to Chemical Construction Corp.), Process of Separating Cobalt and Nickel Values: U.S. Patent 2,845,333, July 29, 1958.

Conn, J. B., and Humphrey, W. K. (assigned to Merck & Co., Inc.), Separation of Cobalt From Nickel: U.S. Patent 2,848,322, Aug. 19, 1958.

[29] Gutzeit, G., Talmey, P., and Lee, W. G. (assigned to General American Transportation Corp.), Chemical Nickel Plating Processes and Baths Therefor: U.S. Patent 2,819,187, Jan. 7, 1958.

Metheny, D. E., and Talmey, P. (assigned to General American Transportation Corp.), Processes of Chemical Nickel Plating: U.S. Patent 2,819,188, Jan. 7, 1958.

Gutzeit, G., Talmey, P., and Lee, W. G. (assigned to General American Transportation Corp.), Chemical Nickel Plating Processes and Baths Therefor: U.S. Patent 2,822,293, Feb. 4, 1958.

Gutzeit, G., Talmey, P., and Lee, W. G. (assigned to General American Transportation Corp.), Chemical Nickel Plating Processes and Baths Therefor: U.S. Patent 2,822,294, Feb. 4, 1958.

[30] Clark, C. A. (assigned to The International Nickel Co., Inc.), Nickel-Cobalt Alloy Magnetostrictive Element: U.S. Patent 2,836,492, May 27, 1958.

Warin, M. P. (assigned to Etablissements Charles Bertolus), Thermionic Cathode Cores Composed of Nickel-Rhenium Alloy: U.S. Patent 2,858,207, Oct. 28, 1958.

Spooner, N. F. (assigned to The Hoskins Manufacturing Co.), Nickel Base Alloy for Use as an Electrical Resistance Element: U.S. Patent 2,858,208, Oct. 28, 1958.

Foreman, J. W. (assigned to The Duriron Co., Inc.), Nickel Base Alloys: U.S. Patent 2,864,696, Dec. 16, 1958.

[31] Hixson, A. N., and Bare, C. B. (assigned to Bethlehem Steel Co.), Method of Recovering Nickel From Nickel and Iron Bearing Ores: U.S. Patent 2,829,963, Apr. 8, 1958.

Birner, M. J. A. (90 percent assigned to Joseph J. Schedel), Method for Recovering Nickel From Ores: U.S. Patent 2,831,751, Apr. 22, 1958.

Queneau, P. E., and Illis, A. (assigned to The International Nickel Co., Inc.), Treatment of Nickel-Containing Laterite Ores: U.S. Patent 2,850,376, Sept. 2, 1958.

[32] West, D. H., and Simpson, A. B. (assigned to The International Nickel Co., Inc.), Method of Producing Nickel by the Carbonyl Process: U.S. Patent 2,835,557, May 20, 1958.

Llewelyn, D. M., Simpson, A. B., and West, D. H. (assigned to The International Nickel Co., Inc.), Production of Nickel or Iron Powder: U.S. Patent 2,844,456, July 22, 1958.

Oestreicher, E., and Schlecht, L. (assigned to Badische Anilin- & Soda- Fabrik Aktiengesellschaft), Manufacture of Nickel Powder: U.S. Patent 2,851,348, Sept. 9, 1958.

Nitrogen Compounds

By E. Robert Ruhlman[1]

ANNUAL capacity of the atmospheric nitrogen industry in the United States in 1958 totaled nearly 5 million short tons of equivalent nitrogen compared with 4.75 million for 1957. The 1958 output was about 85 percent of the year-opening capacity.

TABLE 1.—Salient statistics of the nitrogen compounds industry, in thousand short tons[1]

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production of anhydrous ammonia, nitrogen equivalent	1,670	2,432	2,895	2,985	3,286	3,308
Imports of nitrogen compounds, gross weight	1,601	1,927	1,685	1,564	1,480	1,374
Exports of nitrogen compounds, gross weight	554	433	913	1,082	1,218	704
Consumption of nitrogen compounds, nitrogen equivalent, for years ending June 30	1,704	2,552	2,731	2,755	3,014	3,250
World: Production of nitrogen compounds, nitrogen equivalent, for years ending June 30	5,412	8,049	8,062	8,847	9,436	10,569

[1] This table incorporates a number of revisions of data published in previous Nitrogen Compounds chapters.

DOMESTIC PRODUCTION

The upward trend in anhydrous ammonia production continued, and a new record high was reached in 1958. The 30-ton-per-day anhydrous ammonia plant of Apache Powder Co., at Benson, Ariz., was operating at capacity by the middle of 1958. The California Ammonia Co., organized by Best Fertilizers Co. and a group of California farmers, was constructing a new ammonia plant at Lathrop, Calif., with an announced capacity of 100 tons per day. Coastal Chemical Corp. was obtaining ammonia from its parent company, Mississippi Chemical Corp., pending completion of an anhydrous ammonia plant at Pascagoula, Miss. Cooperative Farm Chemicals Corp. was expanding its ammonia production and storage facilities at Lawrence, Kans. E. I. du Pont de Nemours & Co. was building a new anhydrous ammonia plant at Gibbstown, N.J. Southwestern Agrochemical Corp. and First Mississippi Corp. announced plans to construct a 60-ton-per-day ammonia plant at Chandler, Ariz., to be operated by a jointly-owned company. Standard Oil Company of California was expanding its plant capacity at Richmond, Calif., to 330 tons of ammonia per day. Output is marketed by a subsidiary, California Spray-Chemical Co. Hydrogen for ammonia production at the United States Steel Corp.,

[1] Commodity specialist.

Geneva Works, Provo, Utah, was obtained from coke-oven gas. A flowsheet was published for this plant, showing production of ammonia, nitric acid, and ammonium nitrate solution and prills.[2]

TABLE 2.—Major nitrogen compounds produced in the United States, in short tons

Commodity	1949–53 (average)	1954	1955	1956	1957	1958 [3]
Ammonia (NH_3):						
Synthetic plants [1]	1,795,320	2,736,478	3,251,599	3,378,362	[2]3,734,213	3,831,425
Coking plants	235,316	221,809	269,607	251,292	[2]261,527	190,930
Total anhydrous ammonia	2,030,636	2,958,287	3,521,206	3,629,654	[2]3,995,740	4,022,355
Total N equivalent	1,669,711	2,432,481	2,895,347	2,984,519	[2]3,285,697	3,307,583
Principal ammonium compounds:						
Aqua ammonia, 100 percent NH_3:						
Synthetic plants [1]	(4)	53,943	39,341	[2]36,723	40,683	(4)
Coking plants	23,584	16,104	16,621	17,681	[2]17,341	14,967
Total aqua ammonia	(4)	70,047	55,962	[2]54,404	[2]58,024	(4)
Ammonium sulfate, 100 percent $(NH_4)_2SO_4$:						
Synthetic plants [1]	799,005	943,825	1,172,779	1,095,782	[2]1,039,822	1,094,038
Coking plants	846,926	822,818	981,326	882,700	[2]908,903	640,871
Total ammonium sulfate	1,645,931	1,766,643	2,154,105	1,978,482	[2]1,948,725	1,734,909
Ammonium nitrate, 100 percent NH_4NO_3 solution [1]	1,320,972	1,885,463	[2]2,082,446	[2]2,182,558	[2]2,586,007	2,520,964
Ammonium chloride, 100 percent NH_4Cl, gray and white [1]	(4)	28,443	30,192	29,712	23,472	(4)
Ammoniating solutions, 100 percent N [1]	(4)	444,705	468,519	490,320	563,423	638,272
Diammonium phosphate, NH_3 content	----------	----------	(4)	6,067	[2]9,689	10,618

[1] Data from Bureau of the Census Facts for Industry series.
[2] Revised figure.
[3] Preliminary figures.
[4] Data not available.

Output of ammonium sulfate was 25 percent less in 1958 compared with 1957, mainly as a result of increased world supply and curtailed steel production. The United States Steel Corporation began producing granulated ammonium sulfate at Pittsburgh, Pa.

Production of urea ($CO(NH_2)_2$) for fertilizers and chemicals continued to expand in 1958. Expansion of producing facilities was reported by the Nitrogen Division, Allied Chemical & Dye Corp., at South Point, Ohio, and by W. R. Grace and Co. at Woodstock, Tenn. New plants were either planned or being constructed by Cooperative Farm Chemicals Association, Lawrence, Kans.; Hercules Powder Co., Hercules, Calif.; Mississippi Chemical Corp., Yazoo City, Miss.; Monsanto Chemical Co., El Dorado, Ark.; Spencer Chemical Co., Henderson, Ky.; and Sun-Olin Chemical Co. (jointly-owned by Olin Mathieson Chemical Corp. and Sun Oil Co.), North Claymont, Del.

Ammonium nitrate facilities continued to expand to meet the growing demand from both fertilizer and explosive uses. The American Cyanamid Co. ammonium nitrate plant at New Castle, Pa., began operating during 1958; Ketona Chemical Corp. was constructing a plant at Ketona, Ala.; and California Spray-Chemical Corp. announced plans for a plant at Kennewick, Wash. The Mississippi

[2] Blast Furnace and Steel Plant, Nitrogen Plant at Geneva Works: Vol. 46, No. 12, December 1958, pp. 1318A, 1318B, 1318D.

Chemical Corp. expanded its nitric acid and ammonium nitrate facilities at Yazoo City, Miss., during early 1958.

The production of ammonium perchlorate, a solid propellant for rockets, continued to expand. American Potash and Chemical Corp. and Pennsylvania Salt Manufacturing Co. were making ammonium perchlorate at Henderson, Nev., and Portland, Oreg., respectively. HEF, Inc., jointly-owned by Hooker Electrochemical Co. and Foote Mineral Co., was constructing a plant at Columbus, Miss.

Randall Mills Corp., a subsidiary of New Pacific Coal & Oils, Ltd., of Toronto, Canada, continued to produce bat guano from Bat Cave on the south rim of the Grand Canyon. The guano, containing about 10 percent nitrogen (N) and small quantities of potash (K_2O) and phosphate (P_2O_5), was pulverized and packaged for sale as garden fertilizer. Purex Corp. of California was marketing the guano at retail prices of 69 cents for 1-pound packages and $1.89 for 3 pounds.

CONSUMPTION AND USES

Agriculture continued to be the leading consumer of nitrogen compounds. Over 2.3 million short tons of contained nitrogen was consumed by agriculture in the year ended June 30, 1958. The principal nitrogen materials, in order of importance as fertilizer in 1957–58, were: (1) Ammonium nitrate, (2) anhydrous ammonia, (3) ammonium sulfate, (4) sodium nitrate, (5) aqua ammonia, and (6) urea.

The major industrial uses of nitrogen compounds in the United States were: (1) Explosives manufacture, (2) synthetic fiber manufacture, (3) plastics and resins manufacture, (4) papermaking, (5) metal refining and processing, and (6) oil refining.[3]

The use of ammonium nitrate in field-compounded explosives continued to increase in 1958. It was estimated that 200,000 tons was used in these explosives in 1957 and 250,000 tons in 1958, compared with 175,000 tons in 1956. Concomitant with this increase, there was a decrease in the use of nitrogen compounds in fixed explosives, but the total consumption of nitrogen in explosives increased. For references to ammonium nitrate in field-compounded explosives, see the technology section.

PRICES

Prices of most nitrogen compounds were lower at the end of 1958 than at the beginning. Decreases ranged from 5 to 13 percent. The price of cyanamide was slightly higher than in 1957; the price of ammonium sulfate remained the same.

FOREIGN TRADE [4]

Imports of major nitrogen compounds in 1958 continued their downward trend and were 7 percent less than in 1957.

Exports were 42 percent less than in the preceding year. The decrease resulted largely from smaller ammonium sulfate shipments, reflecting increased world supply of ammonium sulfate.

[3] Organisation for European Economic Co-Operation (Paris), Industrial Uses of Nitrogen in the United States: Project 371, 1957, 132 pp.

[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 3.—Prices of major nitrogen compounds in 1958, per short ton

[Oil, Paint and Drug Reporter of the dates listed]

Commodity	Jan. 6, 1958	Dec. 29, 1958	Effective date of change
Chilean nitrate, port, warehouse, bulk	$46.25	$40.50	Nov. 17.
Sodium nitrate, synthetic, domestic, c.l. works, crude, bulk	45.25	40.50	Nov. 17.
Ammonium sulfate, coke ovens, bulk	32.00	32.00	
Cyanamide, fertilizer-mixing grade, 21 percent N, granular, Niagara Falls, Ontario, bagged.	55.00	57.00	Mar. 10.
Ammonium nitrate, fertilizer grade 33.5 percent N:			
Canadian, eastern, c.l., shipping point, bags	72.00	65.00	Oct. 6.
Western, domestic, works, bags	72.00	[1] 65.00	Oct. 6.
Anhydrous ammonia, fertilizer, tanks, works	88.00	[2] 84.00	Oct. 6.
Ammonium-nitrate-dolomite compound, 20.5 percent N, Hopewell, Va., bags.	49.75	44.50	Oct. 20.
Urea:			
Industrial, 46 percent N, bags, c.l., ton lots, delivered Eastern	125.00	125.00	
Agricultural, 45 percent N, bags, c.l., 30-ton minimum, delivered Eastern.	110.00	110.00	

[1] Quoted at $60 per ton from Aug. 4 to Oct. 6.
[2] Quoted at $80 per ton from Aug. 4 to Oct. 6.

TABLE 4.—Major nitrogen compounds imported for consumption into and exported from the United States, in short tons

[Bureau of the Census]

	1957	1958
Imports:		
Industrial chemicals: Anhydrous ammonia	----------	----------
Fertilizer materials:		
Ammonium nitrate mixtures:		
Containing 20 percent or more nitrogen	352,805	335,281
Ammonium phosphates	169,471	158,722
Ammonium sulfate	164,729	186,881
Calcium cyanamide	[1] 57,898	57,334
Calcium nitrate	60,055	88,446
Nitrogenous materials, n.e.s.:		
Organic	3,334	16,491
Inorganic and synthetic, n.e.s	9,160	11,624
Potassium nitrate, crude	642	546
Potassium-sodium nitrate mixtures, crude	25,393	23,508
Sodium nitrate	584,945	446,100
Urea, n.e.s	51,281	48,706
Exports:		
Industrial chemicals:		
Anhydrous ammonia	67,946	[2] 30,109
Ammonium nitrate	7,897	8,288
Fertilizer materials:		
Ammonium nitrate	[1] 138,743	82,133
Ammonium phosphates and other nitrogenous phosphatic type fertilizer materials	80,289	49,542
Ammonium sulfate	[1] 792,982	386,838
Anhydrous ammonia and aqua (ammonia content)	(3)	36,520
Nitrogenous chemical materials, n.e.s	[1] 126,684	39,775
Urea	----------	68,120
Sodium nitrate	3,581	3,167

[1] Revised figure.
[2] Not comparable to earlier data. Ammonia content shown; also includes chemical grade aqua.
[3] Not separately classified.

WORLD REVIEW

According to the report of Aikman (London), Ltd., both world production and consumption of nitrogen (excluding the U.S.S.R.) in 1957–58 increased 12 percent compared with 1956–57. Detailed data in table 6 show that the United States supplied 27 percent of the world production and consumed 27 percent of the world total of fertilizer nitrogen.

TABLE 5.—Revised estimates of world production and consumption of nitrogen, years ended June 30, 1954–58, in thousand short tons [1]

[Aikman (London), Ltd.]

Year	Estimated production		Estimated consumption	
	For agriculture	For industry	In agriculture	In industry
1953-54	5,956	1,155	5,933	1,155
1954-55	6,767	1,281	7,464	1,281
1955-56	7,464	1,383	6,948	1,383
1956-57	7,910	1,526	7,713	1,526
1957-58	8,878	1,692	8,630	1,692

[1] Exclusive of U.S.S.R.

TABLE 6.—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	1957-58 [1]	1955-56	1956-57	1957-58 [1]
Australia	18	25	26	20	31	36
Austria	142	148	173	35	41	45
Belgium	249	256	287	94	97	87
Brazil	4	6	6	26	36	36
Canada	224	211	215	52	41	41
Ceylon	----	----	----	23	29	29
Chile	198	284	284	28	38	38
Denmark	----	----	----	98	106	108
Egypt	29	35	35	127	173	173
Finland	19	23	24	40	47	45
France	441	473	539	420	444	533
Germany: East	320	331	342	264	264	264
West	829	986	1,168	520	581	635
Greece	----	7	10	46	60	74
India	90	89	90	156	181	203
Indonesia	----	----	----	27	28	28
Israel	2	11	14	13	13	15
Italy	378	403	468	280	300	300
Japan	776	860	974	639	650	701
Korea (South)	----	----	----	161	175	161
Mexico	14	14	14	124	159	152
Netherlands	332	364	419	203	213	229
Norway	197	235	240	42	50	51
Peru	46	48	31	48	51	39
Philippines	7	9	9	33	14	14
Portugal	25	23	15	52	62	63
Spain	49	50	60	189	190	228
Sweden	29	36	40	92	99	96
Switzerland	12	12	13	12	12	13
Taiwan (Formosa)	19	20	25	83	91	130
Union of South Africa	9	14	19	29	26	36
United Kingdom	341	368	386	327	341	344
United States	2,178	2,269	2,369	1,875	2,064	2,167
Yugoslavia	14	6	6	42	56	105
World total [2]	7,372	7,984	8,717	6,926	7,593	7,998

[1] Preliminary figures.
[2] Exclusive of U.S.S.R.; includes quantities for minor producing and consuming countries not listed above.

NORTH AMERICA

Canada.—The ammonia plant of Canadian Industries, Ltd., at Millhaven, Ontario, began operating early in 1958.[5] The 200-ton-per-day plant used fuel oil as the source of hydrogen.

[5] Chemical Engineering, New Ammonia Plant Uses Fuel Oil Feed: Vol. 65, No. 8, Apr. 21, 1958, pp. 68–70.

Cuba.—Plans were announced by Compañía Cubana del Nitrógeno, S.A., for constructing a nitrogenous fertilizer plant in Matanzas.[6] Products were to include ammonia, nitric acid, ammonium nitrate, ammonium sulfate, urea, and nitrogenous solutions.

Mexico.—Anhydrous ammonia production in 1958 was estimated at 22,000 tons by Guanos y Fertilizantes, S.A., the only Mexican producer.[7] New plants were planned by Fertilizantes del Bajio, S.A., Salamanca, and Fertilizantes de Monclova, Monclova.

Trinidad.—Federation Chemicals, Ltd., a subsidiary of W. R. Grace & Co., was constructing a nitrogenous fertilizer plant about 27 miles from Port of Spain.[8] Products of the 100-ton-per-day plant will include ammonium sulfate and urea. Production was scheduled for 1959.

SOUTH AMERICA

Argentina.—An ammonium sulfate plant rated at 20,000 tons per year was being constructed at Rio Tercero. A second sulfate plant was being planned in conjunction with the San Nicolas steel plant.[9]

Brazil.—The ammonia and calcium nitrate plant of Fertisa Fertilizanto Minas Gerais, S.A., began operating during the year, and produced 375 tons of calcium nitrate per day. A nitrogenous fertilizer plant was under construction adjoining a petroleum refinery in Rio de Janeiro. Nitrogenie, S.A., in cooperation with Toya Koatsu of Japan, started construction of a plant adjacent to the Mataripe refinery in Bahia to produce ammonia, calcium nitrate, and urea.

Chile.—Nitrate production totaled 1.4 million short tons, down 3 percent from the previous year.[10] Anglo-Lautaro Nitrate Co. and Cía Salitrera de Tarapacá y Antofagasta (Costan) supplied 75 and 14 percent respectively of the 1958 output. The following plants shut down in 1958; San Martin oficina (Government-owned), Santa Rosa oficina, and the Prosperidad oficina (Costan-owned). These plants all used the Shanks process. Other Shanks-process plants were reported in financial difficulties.

The 1958 sodium nitrate and potassium nitrate prices were $34.48 and $43.55, respectively, per short ton, f.a.s. Chilean port.

TABLE 7.—Exports of nitrate from Chile, 1958, by countries of destination, in thousand short tons

Country of destination	Thousand short tons	Country of destination	Thousand short tons
Argentina	34	Japan	12
Australia and New Zealand	14	Netherlands	32
Belgium	30	Peru	19
Brazil	60	Spain	219
Denmark	18	Sweden	36
Egypt	50	United Kingdom	14
France	112	United States	483
India	18	Other countries	120
Italy	24	Total	1,295

[6] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, pp. 36–37.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, January 1959, pp. 28–30.
[8] Chemical Trade Journal and Chemical Engineer (London), The Trinidad Fertiliser Factory: Vol. 143, No. 3725, Oct. 24, 1958, p. 994.
[9] Commercial Fertilizer, Argentina: Vol. 98, No. 1, January 1959, p. 64.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, pp. 36–39.

Colombia.—Industria Colombiana de Fertilizantes, S.A., was constructing an anhydrous ammonia plant at Barrancabermeja; completion was scheduled for 1960.[11]

Peru.—To supplement the decreasing output of guano, a petrochemical plant to produce ammonia, ammonium sulfate, and ammonium nitrate was completed. Sodium and potassium nitrate deposits were reported discovered in the Balsas District, Amazonas Department.[12]

EUROPE

Austria.—Nitrogenous fertilizer output by the Oesterreichische Stickstoffwerke at Linz again increased in 1958. Urea production was begun during the year. Shipments of calcium nitrate to Communist China were reported.[13]

Belgium.—Carbochimique, S.A., was constructing a 20-ton-per-day urea plant at Tertre.[14] Completion was scheduled for 1959.

Bulgaria.—Production of nitrogenous fertilizers totaled 210,000 tons in 1957.[15] The 1958–62 5-year plan included construction of an ammonium nitrate plant and expansion of urea production at the Stalin Chemical Combine.[16]

Czechoslovakia.—Output of nitrogenous fertilizer in 1958 totaled 119,000 short tons compared with 82,000 tons in 1957.[17] Plans were announced to construct a nitrogenous fertilizer plant in Sala, southern Slovakia, to utilize natural gas from nearby deposits.[18]

France.—Plans were announced by the Office Nationale Industriel de l'Azote (O.N.I.A.) to expand facilities of the Toulouse ammonia plant to enable production of 660 tons per day.[19] The urea plant also was being enlarged.

Germany, West.—German nitrogen capacity totaled 590,000 short tons at the beginning of 1958, with completion of the 47,000-ton-per-year ammonia plant of Ruhröl Chemie and the ammonium sulfate plant of Krupp Kohlechemie.[20] The ammonium sulfate plant (55,000 tons per year) of Stickstoffwerke Krefeld G.m.b.H. at Krefeld was scheduled to begin production during the year.[21]

Greece.—The Greek Government contracted with Societá Ammonia Casale of Italy and Uhde G.m.b.H. of West Germany to construct a nitrogen plant at Ptolemais.[22] It was planned to use lignite from the adjoining Bodossakis mine as the source of hydrogen for producing 350,000 tons of nitrate fertilizer per year.

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[11] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, p. 33.
[12] Mining Journal (London), Mining Miscellany: Vol. 252, No. 6437, Jan. 2, 1959, p. 16.
[13] Chemical Age (London), Austrian Nitrogen Production Increased: Vol. 80, No. 2040, Aug. 16, 1958, p. 266.
Chemical Trade Journal and Chemical Engineer (London), Austrian Fertiliser for China: Vol. 143, No. 3722, Oct. 3, 1958, p. 779.
[14] Chemical Trade Journal and Chemical Engineer (London), New Urea Plant for Belgium: Vol. 144, No. 3735, Jan. 2, 1959, p. 44.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, p. 41.
[16] Chemical Week, Reds Step Up Chemical Pace: Vol. 83, No. 18, Nov. 1, 1958, p. 22.
[17] Chemical Age (London), Czechoslovakia Increases Chemical Production: Vol. 81, No. 2069, Mar. 7, 1959, p. 408.
Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, p. 41.
[18] Chemical Trade Journal and Chemical Engineer (London), Another Nitrogen Plant for Czechoslovakia: Vol. 143, No. 3723, Oct. 10, 1958, p. 860.
[19] Chemical Trade Journal and Chemical Engineer (London), Nitrogen Products in France: Vol. 143, No. 3715, Aug. 15, 1958, pp. 367–368.
[20] Chemical Week, Nitrogen-Germany: Vol. 83, No. 17, Oct. 25, 1958, p. 37.
[21] Chemical Age (London), Ammonium Sulphate Plant for West Germany: Vol. 80, No. 2052, Nov. 8, 1958, p. 766.
[22] Chemical Trade Journal and Chemical Engineer (London), Greek Fertilizer Plant Decision: Vol. 143, No. 3714, Aug. 8, 1958, p. 330.

Hungary.—The nitrogenous fertilizer plant of Borsod Integrated Chemical Plant began producing during the latter part of 1958.[23] This plant, at Borsod, with an annual capacity of 146,000 tons, was financed by the U.S.S.R. Production of ammonia by the Tisza Chemical Complex had not started by the end of the year.[24]

Ireland.—Investigations were underway to construct a nitrogenous fertilizer plant in Ireland to use local peat and limestone.

Norway.—Capacity of the nitrogenous fertilizer plant of Norsk Hydro totaled 250,000 tons of contained nitrogen.[25] This company employed over 8,000 people and produced ammonium nitrate, ammonium nitrate-limestone, sodium nitrate, and urea. About 75 percent of sales was exported.

Poland.—Nitrogenous fertilizer output totaled 220,000 tons of contained nitrogen in 1957.[26]

Portugal.—Completion of the anhydrous ammonia and the ammonium sulfate plants of Amoniaco Portugues' at Estarreja was reported at midyear. The total capacity for ammonium sulfate at the end of 1958 was 198,000 tons.[27]

Spain.—The Sociedad Española de Fabriaciones Nitrogenadas, S.A. planned to increase ammonium sulfate capacity.[28] New ammonium sulfate plants also were planned by Cia. Espanola Petroleos S.A. at Las Palmas and by the Cepsa Oil Refinery in the Canary Islands.[29]

United Kingdom.—Fison's, Ltd., was constructing an ammonium nitrate plant at Stanford-le-Hope capable of producing 140,000 tons per year.[30] Completion was scheduled for early 1959.

U.S.S.R.—Production of nitrogenous fertilizer (N content) totaled 827,000 tons in 1957–58 compared with 784,000 tons in 1956–57.[31] Continued growth of the fertilizer industry was planned.

Yugoslavia.—Two new calcium-ammonium nitrate plants, each with a capacity of 132,000 tons per year, were planned; one at Lukavac, Sisak, and the other at Kosovka, Mitrovika.[32] Both plants were to be at least partly financed with United States funds.[33]

ASIA

China.—The ammonium nitrate plant of Lanchow Chemical Works began producing at the end of 1958.[34] A 100,000-ton-per-year am-

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[23] Chemical Week, Fertilizer-Hungary: Vol. 83, No. 17, Oct. 25, 1958, p. 37.

[24] Chemical Week, Plastics and Fertilizers—Hungary: Vol. 82, No. 15, Apr. 12, 1958, p. 24.

[25] Fertiliser and Feeding Stuffs Journal (London), Norway's Nitrogen Industry: Vol. 48, No. 1, Jan. 1, 1958, p. 14.

[26] Fertiliser and Feeding Stuffs Journal (London), Vol. 49, No. 6, Sept. 6, 1958, p. 227.

[27] Commercial Fertilizer, Portugal Made Self-Sufficient by New Sulfate Capacity: Vol. 98, No. 1, January 1959, p. 65.

[28] Chemical Age (London), Spanish Fertiliser Output Increasing: Vol. 80, No. 2040, Aug. 16, 1958, p. 265.

[29] Chemical Age (London), Sulphate of Ammonia Plant for Canary Islands: Vol. 79, No. 2014, Feb. 14, 1958, p. 322.
Chemical Trade Journal and Chemical Engineer (London), Ammonium Sulphate Plant for Las Palmas: Vol. 143, No. 3728, Nov. 14, 1958, p. 1166.

[30] Chemistry and Industry, No. 46, Nov. 15, 1958, p. 1521.

[31] Fertiliser and Feeding Stuffs Journal (London), World Nitrogen: Vol. 49, No. 1, July 2, 1958, pp. 13–14.

[32] Chemical Age (London), Production of Chemical Fertilisers in Yugoslavia: Vol. 80, No. 249, Oct. 25, 1958, p. 689.

[33] Commercial Fertilizer, U.S.S.R. Credit Withdrawal Points to U.S. Aid Bid: Vol. 97, No. 2, August 1958, p. 44.

[34] Chemical Trade Journal and Chemical Engineer (London), Chinese Ammonium Nitrate: Vol. 144, No. 3736, Jan. 9, 1959, p. 97.

monia plant was being constructed at Tsinan, Shantung Province.[35] An ammonium sulfate plant was being constructed at Hofei in Anhwei Province. Completion was scheduled for 1960.[36] Other plants were planned.[37]

India.—Ammonium sulfate production totaled 372,000 tons from the Government-owned Sindri plant during the year ending March 31, 1958.[38] The urea plant was completed during 1958, and trial runs were underway. New nitrogenous fertilizer plants were planned at Trombay, Rourkela, and Neiveli.[39]

Iran.—A contract was signed by Societá Montecatini and the Government of Iran in 1958 for construction of a nitrogenous fertilizer plant at Schiraz.[40] Natural gas from Gasharan will be used to produce 110 tons of ammonia per day.

Italian and French companies were jointly building an ammonium nitrate plant to use natural gas from the Kermanshah oil fields for producing 90,000 tons of ammonium nitrate per year.[41]

Iraq.—Ammonia Casale of Switzerland was awarded a contract to construct the 250,000-ton-per-year ammonium sulfate plant at Basra.[42]

Israel.—Production of liquid nitrogenous fertilizers began during 1958.[43] The nitric acid plant also was completed during the year.

Japan.—Japan Gas-Chemical Industries, Ltd., announced plans for doubling its ammonia and urea plant.[44]

Korea, North.—A 14,900-ton-per-year ammonium nitrate plant was scheduled for completion at the end of 1958.[45]

Korea, South.—The 250-ton-per-day urea plant on the Han River at Chung Ju was nearly completed at the end of the year.[46] The plant, built by U.S. companies, will consume over 550 tons of coal daily from nearby coal fields. Construction of a second Korean urea plant began during 1958 at Cholla, Namdo Province. Annual capacity was to be 94,000 short tons.

Pakistan.—The ammonium sulfate plant of the Pakistan Industrial Development Corp. at Daudkhel began operating during the year.[47] Other nitrogenous fertilizer plants were being constructed at Fenchuganj in East Pakistan and at Multan, West Pakistan.[48]

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[35] Chemical Trade Journal and Chemical Engineer (London), Ammonia—Soda Plant for Tientsin: Vol. 143, No. 3721, Sept. 26, 1958, p. 739.
[36] Chemical Age (London), Harbin is New Development Area for China's Chemicals: Vol. 80, No. 2040, Aug. 16, 1958, p. 266.
[37] Chien, Hsu, Communist China Plans Fertilizer Plants in 2,000 Counties to Produce 15 Million Annual Tons by 1967: Comm. Fert., vol. 97, No. 3, September 1958, pp. 24–26.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 2, February 1959, p. 33.
[39] Chemical Trade Journal and Chemical Engineer (London), Another Fertiliser Plant for India?: Vol. 143, No. 3722, Oct. 3, 1958, p. 815.
[40] Chemical Age (London), Montecatini to Co-Operate in Persian Fertiliser Plant: Vol. 81, No. 2060, Jan. 3, 1959, p. 22.
[41] Chemical Age (London), Iran's New Fertiliser Plant: Vol. 80, No. 2057, Dec. 13, 1958, p. 997.
[42] Commercial Fertilizer, Iraq: Vol. 97, No. 3, September 1958, p. 51.
[43] Fertiliser and Feeding Stuffs Journal (London), Israeli Fertilisers: Vol. 49, No. 12, Dec. 3, 1958, p. 522.
[44] Commercial Fertilizer, Japan: Vol. 97, No. 6, December 1958, p. 32.
[45] Chemical Age (London), Expansion of Korea's Fertiliser Industry: Vol. 80, No. 2059, Dec. 27, 1958, p. 1062.
[46] Chemical and Engineering News, Fertilizer for Korea: Vol. 36, No. 48, Dec. 1, 1958, p. 71.
[47] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 5, May 1958, pp. 32–34.
[48] Fertiliser and Feeding Stuffs Journal (London), Pakistan-More Fertiliser Plant: Vol. 48, No. 10, May 7, 1958, p. 473.

Taiwan.—Three Government-owned fertilizer companies produced nitrogenous fertilizer for local use.[49] Taiwan Fertilizer Co., with five plants in operation and one under construction, produced calcium cyanamide; Kaohsiung Ammonium Sulphate Works also produced calcium cyanamide in one plant; and Hwalien Nitrogen Fertilizer Works produced nitrochalk in one plant.

Turkey.—The nitrogen plant at Kutahya, scheduled for completion in 1959, will produce 121,000 tons per year of nitrogenous fertilizer, 10,000 tons of nitric acid, and 1,000 tons of ammonium nitrate for explosive use.[50]

AFRICA

Egypt.—The Aswan fertilizer plant was being constructed by German and French companies.[51] Scheduled for completion in 1960, this plant was to have a capacity of 425,000 tons of calcium ammonium nitrate per year.

Union of South Africa.—Werkspoor N.V. of the Netherlands was constructing a 300-ton-per-day urea plant for African Explosives and Chemical Industries, Ltd., at Modderfontein.[52]

OCEANIA

Australia.—Production of ammonium sulfate from six plants totaled 109,000 tons in 1956–57, 45 percent above the preceding year. The ammonium sulfate plant of the Electrolytic Zinc Co. of Australia, at Risdom, was being operated at its initial capacity of 58,000 tons per year at the beginning of 1958. Plans were announced to expand annual capacity to 62,000 tons.

An ammonium sulfate plant at Rockhampton, Queensland, was being considered by the State Government and Mount Morgan, Ltd.[53] Raw materials and electricity for the 100,000-ton-per-year plant were reported available.

New Zealand.—The New Zealand Government was considering establishment of a fertilizer-nitrogen plant to utilize large coal deposits.[54]

TECHNOLOGY

Reviews of the technologies used by the atmospheric nitrogen industry were published.[55]

Production of nitrogen compounds by nuclear radiation, using uranium oxide or cobalt–60, was being tested in pilot plants.[56]

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[49] Agricultural Chemicals, American Equipment Furnishes Formosa Fertilizer Plants: Vol. 13, No. 6, June 1958, pp. 82, 85.

[50] Fertiliser and Feeding Stuffs Journal (London), Fertiliser Plant in Turkey: Vol. 48, No. 13, June 18, 1958, p. 600.

[51] Fertiliser and Feeding Stuffs Journal (London), Egypt's New Plant: Vol. 49, No. 6, Sept. 10, 1958, p. 232.

[52] Fertiliser and Feeding Stuffs Journal (London), South African and Belgian Urea Plants: Vol. 48, No. 3, Jan. 29, 1958, p. 117.

[53] Foreign Commerce Weekly, Ammonium Sulfate Plant Proposed in Australia: Vol. 60, No. 15, Oct. 13, 1958, p. 16.

[54] Fertiliser and Feeding Stuffs Journal (London), Fertiliser From Coal: Vol. 49, No. 8, Oct. 8, 1958, p. 333.

[55] Industrial and Engineering Chemistry, Fifty Years of Fertilizer Progress: Vol. 50, No. 5, May 1958, pp. 40A–43A.

Walmsley, W. C., Chemicals From Atmospheric Nitrogen: Jour. South African Institute of Min., and Met., vol. 58, No. 9, April 1958, pp. 415–437.

[56] Chemical and Engineering News, Nitric Acid Via Radiation Lies Ahead: Vol. 36, No. 38, Sept. 22, 1958, p. 62.

Fertiliser and Feeding Stuffs Journal (London), Nuclear Fixation: Vol. 48, No. 11, May 21, 1958, p. 508.

A new process for the production of fertilizer using nitric acid was reported.[57]

A continuous process for manufacturing calcium nitrate utilized staged evaporation to turn out a 95 percent $CA(NO_3)_2$.[58]

Research on producing high-analysis nitrogenous fertilizer materials continued.[59]

Studies to minimize nitrogen losses in fertilizer production and storage were underway during 1958.[60]

The practice of supplying nitrogen by ureaforms was discussed at the Fertilizer Industry Round Table in Washington, D.C., on October 1, 1957.[61]

The increasing use of liquid fertilizer was further stimulated by the development of new solutions and the publication of handbooks.[62]

Sodium nitrite was used to prevent steel corrosion for short periods.[63] The use of ammonia in gasfication of coal to prevent deposition and corrosion in water-tube boilers was reported.[64]

A new use for byproduct nitrogen from oxygen plants was as an annealing gas for steel.[65]

New ammonium nitrate processing techniques reported during the year permitted a reduction in required plant investment[66] and output of a product with improved physical properties.[67] The use of diatomite from different localities for coating ammonium nitrate was evaluated.[68]

Ammonium nitrate is one component of solid propellants used in Russian artillery rockets.[69] Other nitrogen compounds were being studied in the United States for inorganic polymers in solid propellants.[70]

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[57] Chemical Engineering, New Steps Smooth Nitric Route to Fertilizer: Vol. 65, No. 22, Nov. 3, 1958, pp. 60–62.

[58] Fertiliser and Feeding Stuffs Journal (London), Calcium Nitrate Produced by Continuous Evaporation: Vol. 48, No. 4, Feb. 12, 1958, pp. 155–156, 173.

[59] Agricultural Chemicals, DAP in Production of High-Analysis Fertilizers: Vol. 13, No. 4, April 1958, pp. 61, 63.
Chemical Age (London), Upgrading Coke Oven Ammonia: Vol. 79, No. 1, Jan. 4, 1958, p. 12.

[60] Agricultural Chemicals, Nitrogen Losses in Ammoniation: Vol. 13, No. 3, March 1958, pp. 30–32; No. 4, April 1958, pp. 34–38, 117, 119; No. 5, May 1958, pp. 32–34.
Hignett, T. P., Better Nitrogen Recovery: Farm Chemicals, vol. 121, No. 6, June 1958, pp. 41–48.
Sauchelli, V., Nitrogen-Phosphorus Relationships: Agr. Chem., vol. 13, No. 10, October 1958, pp. 69, 135.
Taylor, R. D., Some General Principles in Ammoniation and Granulation: Farm Chem., vol. 121, No. 3, March 1958, pp. 29–31.

[61] Agricultural Chemicals, Fertilizer Production: Vol. 13, No. 2, February 1958, pp. 34–35.
Chemical Age (London), Urea-Formaldehyde: Vol. 80, No. 2053, Nov. 15, 1958, p. 796.
O'Donnell, J. M., Cicione, R. J., and Graw, F. V., Urea-Formaldehyde Reactions in the Fertilizer Industry: Comm. Fert., vol. 96, No. 5, May 1958, pp. 58–59.

[62] Agricultural Chemicals, New Ammoniating Solutions Offer Fertilizer Mixer Easier Granulating Regardless of Weather Conditions: Vol. 13, No. 10, October 1958, p. 39.
Agricultural Chemicals, Liquid Fertilizers: Vol. 13, No. 2, February 1958, pp. 45, 124–125.

[63] Chemical Age (London), Corrosion Protection by Sodium Nitrite Solutions: Vol. 80, No. 2040, Aug. 16, 1958, p. 266.

[64] Chemical Age (London), BCURA Tests on Dolomite and Ammonia as Anti-Corrosion Additives: Vol. 80, No. 2034, July 5, 1958, p. 34.

[65] Bennett, K. W., Waste Nitrogen Finds a Home: Iron Age, vol. 182, No. 24, Dec. 11, 1958, p. 97.

[66] Chemical and Engineering News, Nitrate Comes Down to Earth: Vol. 36, No. 34, Aug. 25, 1958, p. 50.

[67] Agricultural Chemicals, Offers Dust Free, Non-Caking Ammonium Nitrate: Vol. 13, No. 12, December 1958, p. 66.

[68] Kadey, F. L., Jr., Photomicrographic Evaluation of Diatomites on Ammonium Nitrate Fertilizers: Agr. Chem., vol. 13, No. 5, May 1958, pp. 39–41, 117.

[69] Missiles and Rockets, Assess Fuel Binders for Red Rocket Propellants: Vol. 3, No. 6, May 1958, p. 151.

[70] Chemical Age (London), USAF Rocket Propellant Studies Contract for US Borax Research: Vol. 80, No. 2040, Aug. 16, 1958, pp. 265–266.

Improvements or new techniques reported in the utilization of ammonium nitrate as an explosive included the use of less primer,[71] development of an aqueous slurry of ammonium nitrate and TNT,[72] and experimental use underground.[73] The use of ammonium nitrate in field-compounded explosives was the subject of several technical papers.[74]

[71] Chemical and Engineering News, New Explosive Under Test: Vol. 36, No. 46, Nov. 17, 1958, p. 43.

[72] Rock Products, New Blasting Technique Cuts Cost: Vol. 61, No. 12, December 1958, pp. 70–71, 118.

[73] Elizondo, J. B., Ammonium Nitrate Blasting Underground: Min. Cong. Jour., vol. 44, No. 11, November 1958, pp. 42–44.

[74] Bigley, A. C., The Use and Economy of Ammonium Nitrate Fertilizer Grade in the Open Pit Operations of the Anaconda Company in the Western United States and Mexico: Pres. at Annual Meeting, AIME, New York, Feb. 16–20, 1958, 5 pp.

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Chemical Week, Bolstering the Case for Low-Cost Explosives: Vol. 83, No. 18, Nov. 1, 1958, pp. 46–47, 50, 52.

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Latourette, W. I., Powder Keg: A New Product Is Blasting Its Way Into the Explosives Market: Barron's, vol. 38, No. 38, Sept. 22, 1958, pp. 11–12.

Patterson, L. J., Blasting With Ammonium Nitrate: Pres. at Ann. Meeting, AIME, New York, Feb. 16–20, 1958, 4 pp.

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Tikker, D. T., New Developments in the Use of Ammonium Nitrate as an Explosive: Pres. at 8th Ann. Drilling and Blasting Symposium, School of Mines and Metallurgy, University of Minnesota, Minneapolis, Minn., Oct. 2–4, 1958.

Perlite

By L. M. Otis[1] and James M. Foley[2]

PRODUCTION of crude perlite was 12 percent less than in 1957, terminating a period of consistent growth since 1946.

DOMESTIC PRODUCTION

Crude Perlite.—The quantity of crude perlite used by producers in their own plants was 11 percent less than in 1957, although the quantity of crude sold by producers to be expanded by others was 2 percent greater.

Twelve companies with 14 mines in 6 States operated in 1958, the same as in 1956–57.

New Mexico continued to be the largest crude-perlite producing State, with 255,000 short tons mined, comprising 69 percent of total crude production. Other producing States in order of output were: Nevada, California, Arizona, Colorado, and Utah.

Expanded Perlite.—Crude perlite was expanded by 60 companies at 85 plants in 28 States.

California with 12 plants had the greatest number of expanding operations, followed by Pennsylvania with 6, New York and Texas with 5 each, and Illinois and New Jersey with 4 plants each.

TABLE 1.—Crude and expanded perlite produced and sold or used by producers in the United States

Year	Crude perlite						Expanded perlite		
	Mined (thousand short tons)	Sold		Used at own plant to make expanded material		Total sold and used (thousands)	Produced (thousand short tons)	Sold	
		Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)			Short tons (thousands)	Value (thousands)
1949–53 (average)	148	95	$643	43	$249	138	123	120	$6,324
1954	261	155	1,376	65	386	220	196	195	10,279
1955	335	198	1,779	88	503	286	247	246	12,585
1956	350	207	1,940	103	610	310	263	264	13,122
1957	422	194	1,730	107	832	301	249	245	12,511
1958	372	197	1,624	95	840	292	241	239	12,373

[1] Commodity specialist.
[2] Supervisory statistical assistant.

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Plans were made to develop a perlite deposit about 1 mile from Silver Cliff, Colo., and to ship the crushed and sized ore to Denver for exfoliation.[3]

A decision in the Utah U.S. District Court held that perlite, which had to be expanded in a rotary kiln to make it marketable, could use the income from the sale of the expanded perlite in bags for the basis of computing percentage depletion.[4]

A damage suit was filed in Denver District Federal Court against Great Lakes Carbon Corp. by residents of Florence, Colo., claiming that perlite dust and sediment had impaired their health.[5]

After 5 years of operation at Florence, Colo., Great Lakes Carbon Corp. closed its plant, and a new operation with a capacity of 30 tons per hour will take its place at Antonito, Colo. The decision to terminate the operation at Florence was influenced by damage and injunction suits brought by residents who claimed that the operation was a health hazard.

TABLE 2.—Expanded perlite produced and sold by producers in the United States

State	1957				1958			
	Produced (thousand short tons)	Sold			Produced (thousand short tons)	Sold		
		Thousand short tons	Value (thousand dollars)	Average value per ton		Thousand short tons	Value (thousand dollars)	Average value per ton
California	24	24	$1,288	$54.75	22	22	$1,292	$58.16
Florida	8	8	474	57.55	8	8	532	67.08
Illinois	22	22	1,214	53.93	23	23	1,373	59.60
Kansas	1	1	64	49.55	1	1	50	49.34
Michigan	9	9	420	47.56	(1)	(1)	(1)	(1)
Missouri	4	4	290	64.40	(2)	(2)	(2)	(2)
New Jersey	7	7	359	54.35	10	10	631	61.33
New York	19	19	841	43.12	19	19	897	46.57
Pennsylvania	17	17	975	57.86	14	14	795	55.00
Texas	9	9	488	56.37	7	7	437	59.16
Other Western States [3]	51	49	2,208	44.73	53	51	2,211	43.10
Other Eastern States [4]	78	76	3,890	51.49	84	84	4,155	50.77
Total	249	245	12,511	50.98	241	239	12,373	51.83

[1] Included under "Other Eastern States" to avoid disclosing individual company confidential data.
[2] Included under "Other Western States" to avoid disclosing individual company confidential data.
[3] Includes Arizona, Colorado, Iowa, Louisiana, Minnesota, Missouri (1958 only), Nebraska, Nevada, New Mexico, Oklahoma (1957 only), Oregon, and Utah.
[4] Includes Indiana, Maryland, Massachusetts, Michigan (1958 only), North Carolina, Ohio, Tennessee, Virginia, and Wisconsin.

CONSUMPTION AND USES

Expanded Perlite.—The following end-use percentages were computed from a Bureau of Mines canvass of perlite expanders—65 percent in building-plaster aggregate, 16 percent in aggregate for concrete, 2 percent as fillers, 2 percent as filter aids, and 15 percent in miscellaneous uses, which included oil-well drilling muds, oil-well concrete, loose fill insulations, horticulture, insecticides, catalysts, refractory brick and shapes, and absorbents.

[3] Engineering and Mining Journal, vol. 159, No. 4, April 1958, p. 164.
[4] Mining Record, Perlite Tax Case Brings Decision: Vol. 69, No. 1, Jan. 2, 1958, p. 8.
[5] National Lime Association, Limeographs: Vol. 24, November 1957, pp. 33, 34.

Technical progress in manufacturing filter aids promises to show a sharp increase in this use for expanded perlite.

The Perlite Institute estimated that 53 percent of all construction plaster applied in the United States in 1957 used perlite aggregate, compared with 44 percent in 1955.[6]

PRICES

The average value of crude perlite, crushed, cleaned, and sized, f.o.b. producer's plants, sold to expanders, was $8.24 per short ton, 8 percent less than in 1957. The average value of this crude material, used by prime producers in their own expanding plants, was $8.84, an increase of 14 percent over 1957. The weighted average price of these 2 classifications of crude perlite was $8.44 per ton, compared with $8.50 in 1957.

The average price of expanded perlite, $51.83 per ton, was slightly higher than in 1957.

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 same act.

In 1957, 15,000 short tons of U.S. crude perlite was used in Canada, compared with 13,000 tons in 1956. Canada and South America were importers of expanded perlite from the United States.

WORLD REVIEW

Canada.—In 1953, 1,112 tons of perlite valued at $11,120 was shipped from British Columbia deposits to the expanding plant of Western Gypsum Products Ltd., Calgary, Alberta. There has been no production reported since.

Development work was done on deposits of perlite at Francois Lake, British Columbia, about 18 miles by road from Burns Lake on the Canadian Northern Railway. Other deposits have been found in British Columbia at Empire Valley, northwest of Clinton.[7]

Deposits have also been reported from the Queen Charlotte Islands and the Cariboo. Perlite of rather poor quality occurs near Nipigon, Ontario. The belt of Tertiary volcanic rocks extending north through the Okanagan and Fraser Valleys was suggested as a favorable prospecting area for perlite.[8]

Cuba.—The first Cuban perlite expanding plant was built in Havana. The planned capacity of the $300,000 plant was 300,000 4-cubic foot bags per year.[9]

Iceland.—Late in 1957 arrangements had been completed between the newly formed companies, Perlite H. F., of Iceland, and Viking Minerals, Inc., of the United States, for mining perlite from a large

[6] California Mining Journal, Perlite's Use Expands: Vol. 27, No. 7, March 1958, p. 30.
[7] Dominion Bureau of Statistics, The Miscellaneous Nonmetal Mining Industry (Canada), 1956, p. 30.
[8] Western Miner and Oil Review (Vancouver, British Columbia), vol. 31, No. 7, July 1958, p. 40.
[9] Pit and Quarry, Perlite Plant Costing $300,000 to be Built in Havana, Cuba: Vol. 51, No. 6, December 1958, p. 111.

deposit at Priest Mountain, on the edge of the Langjokull glacier. The American company, which had already conducted laboratory tests on the Icelandic perlite, will be given an initial 100 tons for marketing tests in the eastern-seaboard construction and chemical industries. This will permit a decision as to whether the product can be sold in the eastern United States competitively with perlite from Western States. The Icelandic company, through an affiliate (Bruni H. F.), will distribute perlite to the local construction-industry market, and the American company also has been granted distribution rights abroad.[10]

TECHNOLOGY

Patents.—A method was patented making a thermal insulation with 45 to 94 percent expanded perlite, 5 to 20 percent diatomite, and up to 15 percent asbestos fiber.[11]

A patent covering rigid thermal insulation products consists of mixing lime and diatomite in water, grinding the mixture to 150-mesh, and adding fibrous material, such as asbestos, and exfoliated vermiculite or expanded perlite. A dispersing agent, such as bentonite, may be added to the mixing water.[12]

A patent was issued for a heat- and sound-insulating material, made by mixing a thermosetting phenol resin and expanded perlite heated to 250° C. to 300° C. for 2 minutes.[13]

A patented insulating refractory consists of expanded perlite, diatomite, bentonite, $CaC1_2$, and water blass.[14]

A method of making lightweight thermal insulation was patented. An aqueous slurry of expanded perlite, basic magnesia, chrysotile asbestos fiber, and activated clay is filtered, and the resulting filter cake heated to about 220° F. for 4 hours. The dried product weighs about 6 pounds per cubic foot.[15]

The use of raw kyanite concentrate and expanded perlite in a lightweight insulating firebrick composition was patented.[16]

A lightweight insulating refractory was patented, consisting of 16 to 20 percent expanded perlite, 35 to 67½ percent calcined bauxite, 5 to 15 percent raw kyanite, and 2½ to 5 percent water-soluble aluminum phosphate binder.[17]

The manufacture of waterproofed lightweight aggregate from expanded perlite or exfoliated vermiculite by coating with asphalt was patented.[18]

[10] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, p. 28.

[11] Cook, H. A., Fleming, R. E., and Heilman, R. H. (assigned to the Philip Carey Mfg. Co., Cincinnati, Ohio), Thermal Insulating Material and Method of Making Same: U.S. Patent 2,884,380, Apr. 28, 1959.

[12] Smith, E. C. W., and Blakeley, J. D., Canadian Patent 572,338, Mar. 17, 1959.

[13] Ito, S., and Haruhara, M. (assigned to Tokyo Shibaura Electric Co.), Japanese Patent 6,386, Aug. 17, 1957.

[14] Hamano, T. (assigned to the Bureau of Industrial Technics), Japanese Patent 9875, Nov. 26, 1957.

[15] Houston, H. H., and McCollum, L. S. (assigned to International Minerals & Chemical Corp., a corporation of New York), Perlite Insulation Material: U.S. Patent 2,878,131, Mar. 17, 1959.

[16] Lesar, A. R., and Charles, G. W. (assigned to A. P. Green Fire Brick Co.), Use of Raw Kyanite Concentrates and Expanded Perlite in a Lightweight Insulating Firebrick Composition: Canadian Patent 570,503, Dec. 12, 1958.

[17] Lesar, A. R., and Charles, G. W. (assigned to A. P. Green Fire Brick Co., Mexico, Mo.), Lightweight Insulating Firebrick and Method of Manufacture: U.S. Patent 2,865,772, Dec. 23, 1958.

[18] Sucetti, G. (assigned to Zonolite Co.), Manufacture of Waterproofed Lightweight Aggregate: Canadian Patent 569,677, Feb. 18, 1958.

A patented method of forming a sprayed insulated coating consists of heating and spraying a water-soluble thermosetting resin through a stream of heated expanded perlite or other lightweight aggregate and projecting the heated material against a surface, where the resin polymerizes.[19]

A patented method of producing a water-resistant coating for lightweight aggregate was described. A hotbed of expanded aggregate is sprayed with an aqueous emulsion of asphalt.[20]

A wallboard composition was patented consisting of calcined gypsum, expanded perlite, and a small amount of organic fiber or glass fiber.[21]

A Canadian patent described a method of continuously manufacturing lightweight building slabs, using gypsum or cement as the binder with the lightweight aggregate.[22]

A patent described the use of lightweight masonry panels simulative of brickwork in wall structures, using portland cement and expanded perlite.[23]

A method of manufacturing insulating blocks from anhydrite and expanded perlite was patented.[24]

A patented method of producing building blocks and sheets utilizes portland cement, expanded perlite, and a small amount of aluminum sulfate, copper sulfate, calcium chloride, and hydrated lime. The mixture is slurried, extruded or pressed into shapes, and the product cured by heat or steam.[25]

A patent was issued on a process for making a dry-mix oil-well drilling fluid with $CaCl_2$, expanded perlite, and an emulsifying agent such as blown-tall oil, ammonium lineolate, etc.[26]

A method of controlled fracturing of expanded perlite was patented in which a product is made that is suitable for a filter aid or filler.[27]

A composition for breakable trap and skeet targets was patented, consisting of ground limestone, coal-tar pitch, a paraffinic oil, and a small percentage of a low-density bulking agent, such as perlite.[28]

A horizontal kiln suitable for expanding perlite was patented and described.[29]

Expanded perlite is mentioned as a filler in a patented plaster stabilizer: A mixture of alum and lime are reacted in water, and the dried product added to calcined gypsum and the filler.[30]

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[19] McReynolds, R. W. (one-half assigned to A. R. Moulin, New Orleans, La.), Method and Apparatus for Coating a Surface With Lightweight Aggregate: U.S. Patent 2,870,039, Jan. 20, 1959.

[20] Sucetti, G. (assigned to Zonolite Co.). Light Weight Water Resistant Aggregate and Method of Making the Same: U.S. Patent 2,824,022, Feb. 18, 1958.

[21] Riddell, W. C., and Kirk, G. B. (assigned to U.S. Gypsum Co., Chicago, Ill.), Cementitious Composition: U.S. Patent 2,853,394, Sept. 23, 1958.

[22] Sterrett, R. W. (assigned to Zonolite Co.), Canadian Patent 560,850, July 22, 1958.

[23] Brouk, J. J., Wall Embodying Masonry Panels. U.S. Patent 2,825,221, Mar. 4, 1958.

[24] (Assigned to Badische Bau und Kunststoff G.m.b.H.), Manufacture of Insulating Blocks From Anhydrite and Expanded Perlite: German Patents 940,097 and 942,076, Mar. 8, 1956, and Apr. 26, 1956.

[25] Rodsky, B. (37½ percent each assigned to J. C. Boyd and W. E. Boyd), Building Material: U.S. Patent 2,858,227, Oct. 28, 1958.

[26] Watkins, T. E. (assigned to Socony Mobil Oil Co., Inc., New York, N.Y.), Component for Well Treating Fluid: U.S. Patent 2,876,197, Mar. 3, 1959.

[27] Gindoff, S., McCollum, L. S., and Polanco, A., Jr. (assigned to International Minerals & Chemical Corp., Chicago, Ill.), Apparatus for the Production of Finely Divided Materials: U.S. Patent 2,853,241, Sept. 23, 1958.

[28] Allison, A. G., and Slyh, J. A. (assigned to Remington Arms Co.), Target Composition: U.S. Patent 2,831,778, Apr. 22, 1958.

[29] Pierce, H. L., Apparatus for Expanding Earth Materials, U.S. Patent 2,807,048, Sept. 24, 1957.

[30] Schneiter, H. J., and Oshida, O. A. (assigned to National Gypsum Co.), Gypsum Plaster Set Stabilizer: U.S. Patent 2,820,714. Jan. 21, 1958.

Phosphate Rock

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

MARKETABLE production of phosphate rock in the United States and in the world increased 6 percent and 7 percent, respectively. U.S. exports were 10 percent lower, largely because of increased world competition.

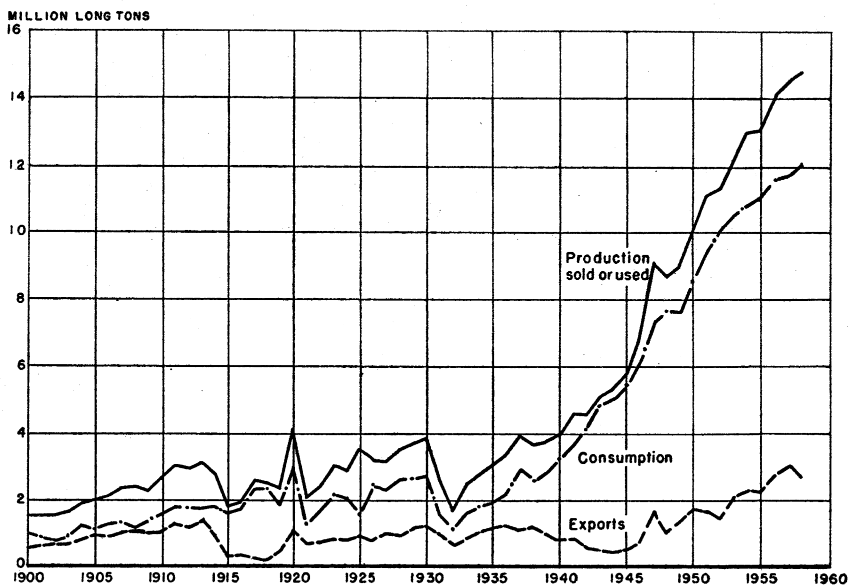

FIGURE 1.—Marketed production, apparent consumption, and exports of phosphate rock, 1900–1958.

DOMESTIC PRODUCTION

Production of phosphate-rock ore and of marketable phosphate rock increased 2 percent and 6 percent, respectively. Florida continued as the leading producer of marketable rock.

In the Florida land-pebble field, some 5,800 people were employed at a weekly payroll of about $1/2 million in 1958. Armour Fertilizer

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

Co. was constructing a new plant near Davenport. Davison Chemical Co. was expanding its facilities at Fort Pierce. International Minerals & Chemical Corp. (IMCC) opened a new mineralogical laboratory in Mulberry to handle inorganic chemistry, chemical processing and engineering, minerals beneficiation, and mineralogy. IMCC moved its main office from Chicago, Ill., to Old Orchard Road, Skokie, Ill.

TABLE 1.—Salient statistics of the phosphate-rock industry, in thousand long tons and thousand dollars

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Mine production ... quantity	[1] 40,139	45,586	39,671	52,198	45,460	46,459
P_2O_5 content ... do	[1] 5,102	5,745	4,984	5,752	[2] 5,315	5,805
Marketable production ... do	11,067	13,821	12,265	15,747	13,976	14,879
P_2O_5 content ... do	3,550	4,360	3,887	4,960	4,356	4,668
Value at mines	$65,669	$86,669	$75,379	$97,922	$87,689	$93,693
Average per ton	$5.93	$6.27	$6.15	$6.22	$6.27	$6.30
Sold or used by producers:						
Florida ... quantity	8,269	9,730	9,565	10,528	10,644	10,573
P_2O_5 content ... do	2,774	3,235	3,196	3,473	3,507	3,500
Value at mines	$48,131	$60,030	$59,179	$65,602	$67,946	$67,353
Average per ton	$5.82	$6.17	$6.19	$6.23	$6.38	$6.37
Tennessee ... quantity	1,445	1,701	1,699	1,663	1,778	1,923
P_2O_5 content ... do	395	438	448	434	459	501
Value at mines	$10,565	$12,012	$12,579	$12,792	$11,857	$13,160
Average per ton	$7.31	$7.06	$7.40	$7.69	$6.67	$6.84
Western States ... quantity	1,122	1,613	1,921	1,920	2,175	2,218
P_2O_5 content ... do	319	451	536	525	598	605
Value at mines	$5,568	$9,468	$11,146	$10,838	$11,915	$12,256
Average per ton	$4.96	$5.87	$5.80	$5.64	$5.48	$5.53
Total United States ... quantity	10,836	13,044	13,186	14,111	14,597	14,714
P_2O_5 content ... do	3,488	4,123	4,180	4,432	4,564	4,606
Value at mines	$64,264	$81,510	$82,904	$89,232	$91,718	$92,769
Average per ton	$5.93	$6.25	$6.29	$6.32	$6.28	$6.31
Imports [3] ... quantity	91	122	117	110	110	108
Value	$1,650	$3,081	$2,703	$2,626	$3,090	$2,944
Average per ton	$18.06	$25.25	$23.05	$23.90	$28.21	$27.21
Exports [4] ... quantity	1,643	2,279	2,183	2,685	3,010	2,694
P_2O_5 content ... do	547	752	720	876	977	887
Value at mines	$10,275	$14,971	$14,269	$15,649	$20,070	$18,060
Average per ton	$6.25	$6.57	$6.54	$5.83	$6.67	$6.70
Apparent consumption ... quantity	9,284	10,887	11,120	11,536	11,697	12,128
World: Production ... do	24,320	29,970	30,170	33,850	32,560	34,870

[1] Production for 1953 only.
[2] Revised figure.
[3] Data on P_2O_5 content not available.
[4] As reported to the Bureau of Mines by domestic producers.

TABLE 2.—Mine production of crude phosphate rock ore in the United States, by States, in thousand long tons

Year	Florida		Tennessee [1]		Western States [2]		Total United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
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	[3] 4,173	2,752	587	2,124	555	45,460	[3] 5,315
1958	41,084	4,556	3,003	625	2,372	624	46,459	5,805

[1] Includes brown rock, white rock, and blue rock, 1954–58.
[2] Includes Idaho, Montana, Utah, and Wyoming.
[3] Revised figure.

TABLE 3.—Marketable production of phosphate rock in the United States, by States, in thousand long tons

Year	Florida[1]		Tennessee[2]		Western States[3][4]		Total United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1949–53 (average)	8,408	2,814	1,453	394	1,206	342	11,067	3,550
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
1958	10,851	3,593	1,903	495	2,125	580	14,879	4,668

[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 1954–58, and white rock in 1953–58.
[3] Mine production of ore (rock), plus a quantity of washer and drier production.
[4] Includes Idaho, Montana, Utah, and Wyoming.

Hooker Electrochemical Co., which consolidated with Oldbury Electrochemical Co. in 1956, merged with Shea Chemical Co. during 1958 to form the Hooker Chemical Corp. The four plants of Shea Chemical Co. comprised the Phosphorus Division of the new company.

Location of phosphate-rock plants and the flow of materials for making fertilizer and elemental phosphorous in the Western field were published.[3]

San Francisco Chemical Co. employed several mining methods in its underground phosphate-rock mines in northeast Utah.[4] Room and pillar, shrinkage stoping, sublevel stoping, and various modifications of each were used in different mines; stoping accounted for 39 percent of the operating costs. Ore from the Utah mines was upgraded at Leefe, Wyo., by flotation; lubricating oil and sulfonated vegetable oil were used as frother; diesel oil and fatty acid as collectors.[5] Fluosolids roasters to further upgrade the ore were under construction. San Francisco Chemical Co. and Stauffer Chemical Co. continued to investigate the large, low-grade deposit in the Brush Creek area, near Vernal, Utah. Production of ore for beneficiation tests was reported.

The planned beneficiation process of the Central Farmers Fertilizer Co. plant at Georgetown, Idaho, included washing, screening, and desliming, followed by calcination. Scheduled capacity of the mine was 1,600 tons per day, half direct-shipping ore and half to be upgraded. Reserves totaled 80 million tons. Products were to include acid-grade phosphate rock, phosphoric acid, and triple superphosphate. In 1958 Western Fertilizer Association merged with and made its phosphate holdings in Idaho available to Central Farmers Fertilizer Co.

Monsanto Chemical Co. was planning to use 100-ton ore carriers by constructing an 11-mile private highway from its phosphate-rock mine to the elemental phosphorus plant.

[3] Prater, L. S., Agricultural Minerals: Idaho Bureau of Mines and Geology, Moscow, Idaho, Inf. Circ. 3, December 1958, 17 pp.
[4] Wideman, F. L., Mining Inclined Beds of Phosphate Rock, San Francisco Chemical Co. Mines, Rich County, Utah: Bureau of Mines Inf. Circ. 7849, 1958, 27 pp.
[5] Dayton, S. H., How San Francisco Chemical Floats Western Phosphate: Mining World, vol. 20, No. 10, September 1958, pp. 47–51, 79.
Intermountain Industry and Mining Review, San Francisco Chemical Co.'s New Plant Recovers Low Grade Phosphate Ores: Vol. 60, No. 12, December 1958, pp. 22–24, 29.

Western Phosphates, Inc., announced plans for a 10-percent expansion of producing facilities at its fertilizer plant near Garfield, Utah. Products include phosphoric acid, triple superphosphate, and ammonium phosphates. The United Heckathorn Co. of Richmond, Calif., was considering the construction of a synthetic cryolite plant adjacent to the Western Phosphate plant at Garfield, Utah, to recover the fluorine liberated in phosphate-rock processing.

The Russell Luke phosphate lease near Elliston, Mont., was acquired by the Bunker Hill Co. of San Francisco. The company was considering construction of a superphosphate fertilizer plant at an undetermined site, where the sulfuric acid from its plant at Kellogg, Idaho, can be used.

A low fluorine phosphate-rock deposit near San Antonio, Uvalde County, Tex., was being explored by Twin Star Industries, Inc.

CONSUMPTION AND USES

Apparent consumption of phosphate rock again set a new record, rising 4 percent above 1957.

Phosphate rock was sold or used principally for ordinary superphosphate (31 percent in 1958 and 33 percent in 1957), elemental phosphorus (24 percent in 1958 and 23 percent in 1957), exports (18 percent in 1958 and 21 percent in 1957), triple superphosphates including wet-process phosphoric acid (18 percent in 1958 and 16 percent in 1957) and direct application to the soil (6 percent in 1958 and 5 percent in 1957).

The U.S. Department of Agriculture reported that 2,036,000 long tons of available P_2O_5 was consumed in fertilizer in the year ending June 30, 1958, compared with 2,057,000 tons in the preceding year. These figures include 2 percent of the P_2O_5 in Florida soft rock used for direct application and 3 percent of the P_2O_5 in all other phosphate rock used for direct application.

TABLE 4.—Phosphate rock sold or used by producers and apparent consumption in the United States, in thousand long tons and thousand dollars

Year	Sold or used		Apparent consumption [1]
	Quantity	Value at mines	Quantity
1949-53 (average)	10,836	$64,264	9,284
1954	13,044	81,510	10,887
1955	13,186	82,904	11,120
1956	14,111	89,232	11,536
1957	14,597	91,718	11,697
1958	14,714	92,769	12,128

[1] Quantity sold or used by producers plus imports minus exports.

TABLE 5.—Florida phosphate rock sold or used by producers, by kinds

Year	Hard rock		Soft rock [1]	
	Thousand long tons	Value at mines (thousands)	Thousand long tons	Value at mines (thousands)
1949–53 (average)	67	$513	80	$430
1954	74	585	90	554
1955	92	739	72	466
1956	103	872	59	376
1957	80	682	56	401
1958	76	639	51	405

Year	Land pebble		Total	
	Thousand long tons	Value at mines (thousands)	Thousand long tons	Value at mines (thousands)
1949–53 (average)	8, 122	$47, 188	8, 269	$48, 131
1954	9, 566	58, 891	9, 730	60, 030
1955	9, 401	57, 974	9, 565	59, 179
1956	10, 366	64, 354	10, 528	65, 602
1957	10, 508	66, 863	10, 644	67, 946
1958	10, 446	66, 309	10, 573	67, 353

[1] Includes material from waste-pond operations.

TABLE 6.—Tennessee phosphate rock [1] sold or used by producers

Year	Thousand long tons	Value at mines (thousands)	Year	Thousand long tons	Value at mines (thousands)
1949–53 (average)	1, 445	$10, 565	1956	1, 663	$12, 792
1954	1, 701	12, 012	1957	1, 778	11, 857
1955	1, 699	12, 579	1958	1, 923	13, 160

[1] Includes small quantity of Tennessee blue rock in 1954–58, white rock in 1952–58, and Virginia apatite in 1949.

TABLE 7.—Western States phosphate rock sold or used by producers

Year	Idaho [1]		Montana [2]		Total	
	Thousand long tons	Value at mines (thousands)	Thousand long tons	Value at mines (thousands)	Thousand long tons	Value at mines (thousands)
1949–53 (average)	687	$2, 409	[3] 435	[3] $3, 159	1, 122	$5, 568
1954	879	4, 300	734	5, 168	1, 613	9, 468
1955	1, 122	5. 551	799	5, 595	1, 921	11, 146
1956	1, 206	6, 044	714	4, 794	1, 920	10, 838
1957	1, 418	6, 589	[3] 757	[3] 5, 326	2, 175	11. 915
1958	1, 393	6, 297	825	5, 959	2, 218	12, 256

[1] Idaho includes Utah in 1950–52, and Wyoming in 1949–50.
[2] Montana includes Utah in 1953–55, and Wyoming in 1951–58.
[3] Includes Wyoming data published in previous Phosphate Rock chapters as follows: 1949–53 (average): 63,000 long tons valued at $421,000, for 1951–52; 1957: 182,000 long tons valued at $1,197,000.

TABLE 8.—Phosphate rock sold or used by producers in the United States, 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
1957								
Below 60	142	1	1,506	85	1,237	57	2,885	20
60 to 66	245	2	(2)	(2)	(2)	(2)	372	2
68 basis, 66 minimum	2,170	20	77	4	637	29	2,884	20
70 minimum	1,246	12	[2] 172	[2] 10	[2] 301	[2] 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
1958								
Below 60	130	1	1,576	82	1,300	59	3,006	21
60 to 66					(2)	(2)	252	2
68 basis, 66 minimum	1,120	11	259	13	560	25	1,687	11
70 minimum	1,983	19	87	5	[2] 357	[2] 16	2,427	16
72 minimum	2,996	28	1	(3)			2,997	20
75 basis, 74 minimum	3,613	34					3,613	25
77 basis, 76 minimum	[4] 731	7			1	(3)	732	5
Total	10,573	100	1,923	100	2,218	100	14,714	100

[1] Bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Some 60 to 66 grade included with 70 minimum grade.
[3] Less than 0.5 percent.
[4] Includes some higher grade rock.

TABLE 9.—Phosphate rock sold or used by producers in the United States, 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
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
1958								
Domestic:								
Agricultural:								
Ordinary superphosphate	4,421	1,491	(1)	(1)	(1)	(1)	4,594	1,548
Triple superphosphate	[2] 2,281	[2] 743	[1] 100	[1] 28	[1,2] 496	[1,2] 161	[2] 2,704	[2] 875
Nitraphosphate	(3)	(3)	-------	-------	(3)	(3)	(3)	(3)
Direct application to soil	704	220	96	28	10	3	810	251
Stock and poultry feed	268	85	-------	-------	(4)	(4)	268	85
Fertilizer filler	-------	-------	114	24	-------	-------	120	25
Other [5]	4	1			2	(4)		
Total agricultural	7,678	2,540	310	80	508	164	8,496	2,784
Industrial:								
Elemental phosphorus, ferrophosphorus, phosphoric acid	593	195	1,609	420	1,317	319	3,519	934
Other [6]	1	(4)	4	1	-------	-------	5	1
Total industrial	594	195	1,613	421	1,317	319	3,524	935
Exports [7]	2,301	765	-------	-------	393	122	2,694	887
Grand total	10,573	3,500	1,923	501	2,218	605	14,714	4,606

[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 a 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 1958 were 4 percent greater than in 1957; they did not include quantities of crude ore reported by producers except as noted.

TABLE 10.—Stocks of phosphate rock in the United States, in thousand long tons

Source	In producers' hands Dec. 31 [1]			
	1957		1958	
	Rock	P_2O_5 content	Rock	P_2O_5 content
Florida	2,332	775	2,610	868
Tennessee [2]	285	79	265	73
Western States	[3] 1,144	[3] 285	1,051	260
Total	[3] 3,761	[3] 1,139	3,926	1,201

[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 closing prices of Florida land pebble phosphate rock, as quoted by the Oil, Paint and Drug Reporter, decreased slightly from those at the beginning of the year because the price of fuel oil dropped, despite a rise in hourly wages. Prices were changed at various times during the year and were 5 cents a ton below the closing prices from March 10 to October 13. Prices for Tennessee and Western States phosphate rock were not quoted in the trade journals.

TABLE 11.—Prices per long ton of Florida land pebble unground, washed, and dried phosphate rock, in bulk, carlots, at mine, in 1958, by grades

[Oil, Paint and Drug Reporter]

Grades (percent B.P.L.) [1]	Jan. 6	Dec. 29
68/66	$5.26	$5.16
70/68	5.66	5.56
72/70	6.31	6.21
75/74	7.31	7.21
78/76	8.31	8.21

[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 [6]

Imports.—Crude phosphate-rock imports into the United States in 1958 were 1 percent less than in 1957. Curaçao, Makatea Islands, and Mexico supplied 82 percent, 12 percent, and 6 percent, respectively, of total imports. Imports of normal, concentrated, and ammoniated superphosphates, all from Canada, increased 73 percent over 1957.

[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 of fertilizer-grade ammonium phosphate originated mostly in Canada; small quantities came from Mexico and West Germany. Other phosphatic fertilizer materials were imported mainly from Peru, Belgium-Luxembourg, Egypt, Yugoslavia, the United Kingdom, and Argentina.

TABLE 12.—Phosphate rock and phosphatic fertilizers imported for consumption in the United States

[Bureau of the Census]

Fertilizer	1957		1958	
	Long tons	Value	Long tons	Value
Phosphates, crude, not elsewhere specified	109,546	$3,090,481	108,182	$2,944,075
Superphosphates (acid phosphate):				
Normal (standard), not over 25 percent P_2O_5 content	71	[1] 3,196	83	3,830
Concentrated (treble), over 25 percent P_2O_5 content	598	38,909	495	33,253
Ammoniated	433	27,806	1,329	95,389
Total superphosphates	1,102	[1] 69,911	1,907	132,472
Ammonium phosphates, used as fertilizer	151,313	[1] 11,504,968	141,716	10,216,355
Bone dust, or animal carbon and bone ash, fit only for fertilizer	9,592	[1] 530,670	10,282	609,469
Guano	16,685	1,542,385	8,135	718,168
Slag, basic, ground, or unground	111	1,354	160	6,861
Dicalcium phosphate (precipitated bone phosphate) all grades	1,685	101,545	4,078	244,354

[1] Data known to be not comparable with 1958.

Exports.—Total exports of phosphate rock in 1958, as reported by the Bureau of the Census, decreased 10 percent compared with 1957. Beginning with 1958, all types of Florida phosphate rock were combined into one class. Japan continued to be the major recipient of Florida rock (42 percent), followed by Netherlands (11 percent), Canada (9 percent), the United Kingdom (9 percent), Italy (8 percent), and West Germany (8 percent). Exports of "Other phosphate rock," mainly to Canada, decreased 5 percent in 1958 compared with 1957. A major part of phosphate rock exported to Canada was reimported into the United States in the form of manufactured fertilizers. Superphosphate exports were 9 percent less than in 1957 and went mainly to Canada, Brazil, and the Republic of Korea.

TABLE 13.—Phosphate rock exported from the United States, by grades and countries of destination

[Bureau of the Census]

Grade and country	1957		1958	
	Long tons	Value	Long tons	Value
Florida phosphate rock:				
North America:				
Canada	224,052	$2,347,175	220,452	$2,009,824
Cuba	24,712	180,621	20,718	146,298
El Salvador			357	11,369
Mexico	64,827	450,937	45,261	278,713
Nicaragua	45	1,832		
South America:				
Brazil	47,852	497,605	61,420	622,761
Chile	1,989	18,029		
Colombia	1,004	15,715	1,503	24,025
Ecuador	256	3,662		
Peru	2,933	26,400	1,472	13,336
Uruguay	14,078	132,560	8,329	106,600
Venezuela			201	4,916
Europe:				
Czechoslovakia			7,494	67,899
Denmark	31,322	267,129	29,405	266,408
Germany, West	163,949	1,317,398	180,860	1,483,693
Greece			12,412	82,105
Italy	152,889	1,534,051	184,042	1,706,537
Netherlands	282,165	2,440,185	258,778	2,202,522
Norway			8,333	75,497
Spain	232,445	2,078,786		
Sweden	64,822	656,961	66,017	651,163
Switzerland	2,980	26,224		
United Kingdom	240,246	2,008,191	219,360	1,760,499
Asia:				
India			2,986	27,053
Japan	1,067,229	7,752,285	1,006,043	7,417,176
Philippines	3,752	34,448	31,370	279,681
Taiwan	49,437	444,897	19,894	190,160
Viet-Nam, Laos and Cambodia	447	6,175	[1] 2,661	[1] 41,272
Africa:				
Union of South Africa	16,690	166,870	16,028	145,214
United Arab Republic (Egypt Region)	3,278	32,780		
Total Florida phosphate rock	2,693,399	22,440,916	2,405,396	19,614,721
Other phosphate rock:[2]				
North America:				
Canada	421,279	5,582,680	407,780	5,547,572
Costa Rica	228	2.588		
Cuba	44	640	301	3,541
El Salvador	357	5,453	163	3,061
Mexico			434	16,294
South America:				
Brazil	9,228	130,925	3,972	46,578
Venezuela	36	745		
Asia:				
Iran			9	500
Japan	1,626	23,752		
Philippines	18	1,300	18	1,282
Total other phosphate rock	432,816	5,748,083	412,677	5,618,828
Grand total	3,126,215	28,188,999	2,818,073	25,233,549

[1] Viet-Nam.
[2] Includes colloidal matrix, sintered matrix, soft phosphate rock, and Tennessee, Idaho, and Montana rock.

TABLE 14.—Superphosphates (acid phosphates) exported from the United States by countries of destination

[Bureau of the Census]

Destination	1957		1958	
	Long tons	Value	Long tons	Value
North America:				
Bahamas	259	$6,522	54	$2,949
British Honduras	201	12,704	156	9,934
Canada	190,281	5,294,049	191,525	5,995,049
Costa Rica	2,322	119,553	1,030	49,352
Cuba	63,507	1,670,948	33,046	1,124,337
Dominican Republic	6,944	319,500	6,574	406,401
El Salvador	804	49,642	1,023	51,347
Guatemala	262	13,291	138	7,353
Mexico	13,396	816,648	11,061	892,321
Nicaragua	346	25,987	45	3,075
Panama	18	1,053	97	7,759
Trinidad and Tobago	912	59,017	440	29,542
Other	219	14,590	230	14,133
South America:				
Bolivia	134	11,550		
Brazil	107,173	5,012,552	121,119	6,130,663
British Guiana	135	8,396		
Chile	5,484	338,965	11,837	741,810
Colombia	28,995	1,896,509	10,923	754,155
Ecuador	119	7,999	576	33,614
Peru	5,920	138,437	605	41,560
Venezuela	7,888	335,190	2,603	175,098
Europe:				
Greece	9,498	553,967	9,465	512,190
Ireland			10,454	320,119
Sweden			107	6,860
Asia:				
Indonesia	246	16,797		
Iran	62	4,243		
Korea, Republic of	102,385	5,913,463	97,103	5,765,781
Pakistan	4,591	254,080		
Philippines	2,204	139,651		
Africa:				
Belgian Congo	1,322	2,800		
Rhodesia and Nyasaland, Federation of	3,125	161,480		
Union of South Africa	2,672	160,509	179	11,120
Total	561,424	23,360,092	510,390	23,086,522

WORLD REVIEW

NORTH AMERICA

Mexico.—Low-fluorine phosphate rock was mined in Nuevo León and Zacatecas. Nearly 7,000 tons was exported to the United States for use in stock and poultry feed. Beneficiation studies were underway.[7]

Netherlands Antilles.—The feasibility of reopening the phosphate-rock deposits on the southeast coast of Aruba was studied.[8]

SOUTH AMERICA

Brazil.—Improved dock facilities at Recife and a railroad to the beneficiation plant were being constructed to service the phosphate-rock mine at Olinda, Pernambuco.[9] The reserve at Olinda was esti-

[7] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, January 1959, pp. 30–31.
[8] U.S. Consulate, Aruba, Netherlands Antilles, State Department Dispatch 31: Jan. 16, 1959, 2 pp.
[9] Mining Journal (London), Brazil's Growing Mineral Industry: Vol. 250, No. 6385, Jan. 3, 1958, pp. 12–14.

TABLE 15.—World production of phosphate rock, by countries,[1] in thousand long tons[2]

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

Country [1]	1949-53 (average)	1954	1955	1956	1057	1958
North America:						
United States	11,067	13,821	12,265	15,747	13,976	14,879
West Indies:						
Jamaica (guano)	[3] 1	1	1	(4)	(4)	(4)
Netherlands Antilles (exports)	100	124	109	104	105	85
Total	11,168	13,946	12,375	15,851	14,081	14,964
South America:						
Brazil [5]	12	64	123	123	123	123
Chile:						
Apatite	47	41	52	58	[5] 54	[5] 54
Guano	39	43	41	24	34	[5] 34
Peru (guano)	[5] 295	289	285	331	280	[5] 157
Venezuela	--------	--------	--------	30	30	--------
Total [5]	393	437	501	566	521	368
Europe:						
Belgium	63	26	19	13	16	18
France	89	117	101	89	74	[5] 74
Spain	23	22	23	8	1	3
Sweden (apatite)	8	--------	--------	--------	--------	--------
U.S.S.R.:						
Apatite [5]	2,265	3,100	3,445	3,690	3,940	3,940
Sedimentary rock [5]	1,025	1,330	1,425	1,575	1,720	1,970
Total [1] [5]	3,720	4,840	5,260	5,620	6,000	6,250
Asia:						
British Borneo (guano)	1	1	(4)	(4)	(4)	(4)
China [5]	70	200	250	300	500	[6] 500
Christmas Island (Indian Ocean) exports	306	351	390	341	336	[5] 345
India (apatite)	2	2	6	9	9	15
Indonesia	2	6	[5] 6	[5] 6	4	(4)
Israel	[3] 13	54	84	118	148	[5] 250
Jordan	15	74	161	205	258	289
Philippines (guano)	10	2	(4)	8	4	8
Total [1] [5]	430	710	920	1,010	1,290	1,440
Africa:						
Algeria	675	761	740	596	596	556
Egypt	444	526	636	605	576	[5] 590
French West Africa (aluminum phosphate)	27	[7] 77	[7] 112	[7] 75	[7] 91	[7] 104
Madagascar	1	1	2	3	3	[5] 1
Morocco: Southern zone	4,014	4,940	5,245	5,435	5,480	6,236
Seychelles Islands (exports)	10	12	4	4	6	17
South-West Africa (guano)	1	1	2	--------	3	--------
Tunisia	1,699	1,795	2,166	2,044	2,035	2,243
Uganda	3	3	3	3	3	[8] 1
Union of South Africa	72	93	134	154	166	213
Total	6,946	8,209	9,044	8,919	8,959	9,961
Oceania:						
Angaur Island (exports)	145	122	137	--------	--------	--------
Australia	4	6	6	7	11	[5] 10
Makatea Island (French Oceania) (exports)	242	225	216	250	300	315
Nauru Island (exports)	1,015	1,178	1,401	1,333	1,105	1,234
Ocean Island (exports)	258	292	309	297	292	324
Total	1,664	1,823	2,069	1,887	1,708	1,883
World total (estimate) [1] [2]	24,320	29,970	30,170	33,850	32,560	34,870

[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 North Korea, and Poland are included in the total. No estimates included for North Viet-Nam.

[2] This table incorporates a number of revisions of data published in previous Phosphate Rock chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.

[3] Average for 1951-53.

[4] Less than 500 tons.

[5] Estimate.

[6] Data represents 1957 output, however, 1958 production was probably much greater.

[7] Includes calcium phosphate, production of which is reported in thousand long tons as follows: 1954—5; 1955—9; 1956—7; 1957—2; 1958—1.

[8] Exports.

mated to be 49 million tons, containing from 6 to 22 percent P_2O_5. Phosphate rock reportedly occurred in several other areas and on coastal islands.

Chile.—Near Santiago Cristalerias de Chile opened a new chemical plant [10] that produced phosphoric acid and other phosphate chemicals.

EUROPE

Estonia.—Discovery of a phosphate-rock deposit near Aseri containing about 100 million tons was reported.[11]

Poland.—Low-grade phosphate rock produced locally was used to manufacture fertilizer, containing 15 percent P_2O_5.[12] The phosphate rock was mixed with magnesium silicate, calcined, and ground. In addition, apatite concentrate is imported from the U.S.S.R. (163,000 tons in 1957).[13]

U.S.S.R.—Phosphatic fertilizers were manufactured from apatite concentrate from the Kola Peninsula and sedimentary phosphate rock from Kara-Tau.[14] Improved techniques for acidulating the Kara-Tau material were sought; the use of nitric acid was reported.[15] Increasing quantities of apatite concentrate were exported.[16]

ASIA

China.—Phosphate-rock deposits were reported in Szechwan Province.[17] A 300,000 ton-per-year phosphate-rock beneficiation plant was completed in Nanking.[18] New phosphate fertilizer plants at Nanking and Yangku began operating.

India.—Scattered deposits of apatite were reported in Bihar and southern Singbhum.[19] The commercial deposits contained from 20 to 25 percent P_2O_5.

Israel.—Discovery of a new phosphate-rock field near Ein Yahav in the Nagev Desert was reported.[20] Potential resources of the new field were estimated at 1 billion tons containing 26 percent P_2O_5, compared with 23.5 percent in the Oron field. Upgrading the Oron phosphate to 31 percent P_2O_5 by flotation [21] was being studied.

Jordan.—Jordan Phosphate Mines, S.A., arranged with Jugometal of Yugoslavia for technical assistance in expanding output of phosphate rock to 1 million tons per year by 1961.[22]

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[10] Chemical Age (London), New Chemical Plant for Chile: Vol. 80, No. 2049, Oct. 25, 1958, p. 690.

[11] Engineering and Mining Journal, Estonia: Vol. 159, No. 10, October 1958, p. 199.

[12] Fertiliser and Feeding Stuffs Journal (London), Thermophosphate: Poland's Latest Fertiliser: Vol. 48, No. 9, Apr. 23, 1958, p. 403.

[13] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 2, August 1958, p. 28.

[14] Cass, W. G., Phosphorus Fertilisers in the U.S.S.R.: Fertiliser and Feeding Stuffs Jour. (London); Vol. 50, No. 1, Jan. 14, 1959, pp. 15–16, 18, 23.

[15] Cass, W. G., Ammonium Nitrate From Acid-Decomposed Phosphates: Fertiliser and Feeding Stuffs Jour. (London), vol. 48, No. 6, Mar. 12, 1958, pp. 257–258, 261.

[16] Commercial Fertilizer, Russia—New Phosphate Capacity Poses Export Threat: Vol. 97, No. 3, September 1958, p. 36.

[17] Fertiliser and Feeding Stuffs Journal (London), Fertilisers in China: Vol. 48, No. 9, Apr. 23, 1958, pp. 407–408.

[18] Chemical Trade Journal and Chemical Engineer (London), Fertilisers in China: Vol. 143, No. 3721, Sept. 26, 1958, p. 738.

[19] Indian Mining Journal (Calcutta), vol. 5, No. 10, October 1957, pp. 49–50, 54.

[20] Fertiliser and Feeding Stuffs Journal (London), New Phosphate Field in Israel: Vol. 48, No. 1, Jan. 1, 1958, p. 25.

[21] Fertiliser and Feeding Stuffs Journal (London), New Phosphate Concentrating Plant: Vol. 49, No. 6, Sept. 10, 1958, p. 240.

[22] Chemical Trade Journal and Chemical Engineer (London), Jordan's Phosphate Resources: Vol. 142, No. 3689, Feb. 14, 1958, p. 390.

AFRICA

Angola.—Phosphate-rock deposits estimated to contain 15 million tons were reported. Plans were underway for development.[23]

Egypt.—A Government-owned company, Société Safaga pour les Phosphates, S.A.E., was formed to acquire the Egyptian Phosphate Co.[24]

Morocco.—Expansion of the phosphate industry continued. Larger locomotives and aluminum ore cars to haul tthe rock from Khouribga to Casablanca[25] were planned. Storage facilities and ship-building equipment were being enlarged during 1958. Compagnie Chimique Marocaine was constructing a triple superphosphate plant in Casablanca to produce 60,000 tons per year.[26] Under a 1-year trade agreement, China was to receive shipment of 500,000 tons of phosphate rock and 50,000 tons of superphosphates.[27]

Rhodesia and Nyasaland, Federation of.—African Explosives and Chemical Industries, Ltd., was developing the apatite deposit at Dorowa, Sabi Valley, to supply its fertilizer plant near Salisbury.[28] Test shipments of phosphate rock were made from the Tundulu Hill deposit by the Anglo-American Corp. for agricultural tests and experimental fertilizer manufacture. The deposit was estimated to contain more than 3 million tons.[29]

Tanganyika.—Discovery of a large phosphate-rock deposit 70 miles south of Arusha was reported by New Consolidated Gold Field, Ltd.[30] Exploration and studies on beneficiating and marketing were underway.

Uganda.—The Uganda Development Corp. announced plans to produce 400,000 tons of apatite a year from the Sukulu deposit.[31]

TABLE 16.—Exports of phosphate rock from Egypt, by countries of destination, in long tons [1] [2]

[Compiled by Corra A. Barry]

Country	1956	1957	Country	1956	1957
Belgium-Luxembourg	(3)	(3)	Japan	236,358	192,014
			Netherlands	[3] 1,511	(3)
Ceylon	36,899	41,886	Spain	31,099	[4] 2,461
Czechoslovakia	70,969	51,412	Union of South Africa	(3)	(3)
Germany, West	(3)	----------	Other countries	6,173	38,858
India	18,133	47,086			
Indonesia	3,440	(3)	Total	408,538	373,717
Italy	3,956	(3)			

[1] Compiled from Customs Returns of Egypt.
[2] This table incorporates a number of revisions of data published in the preceding Phosphate Rock chapter.
[3] Data not available.
[4] Detail shown by country of importation.

[23] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 36–37.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, pp. 28–29.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 6, June 1959, p. 39.
[26] Mining World, vol. 20, No. 13, December 1958, p. 70.
[27] Fertiliser and Feeding Stuffs Journal (London), Phosphate Agreement: Vol. 49, No. 14, Dec. 31, 1958, p. 590.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, p. 33.
[29] Fertiliser and Feeding Stuffs Journal (London), Nyasaland Phosphates: Vol. 49, No. 12, Dec. 3, 1958, p. 515.
[30] Mining Jounal (London), Tanganyika's Mining Industry in 1958: Vol. 252, No. 6446, Mar. 6, 1959, p. 258.
[31] Agricultural Chemicals, To Build in Uganda: Vol. 13, No. 11, November 1958, p. 100.

TABLE 17.—Phosphate rock exports from Algeria, Morocco, and Tunisia, by countries of destination, in long tons [1 2]

[Compiled by Corra A. Barry]

Country	1957	1958	Country	1957	1958
South America:			Asia:		
Brazil	46,757	45,190	China	----------	179,537
Chile	12,795	6,889	India	3,100	35,028
Uruguay	11,564	7,762	Indonesia	14,592	8,924
Europe:			Japan	90,288	156,942
Austria	40,353	61,710	Taiwan	----------	57,154
Belgium	436,309	549,393	Turkey	8,449	28,040
Czechoslovakia	21,544	51,868	Viet-Nam, Laos, and Cambodia	2,953	7,382
Denmark	207,264	226,854			
Finland	127,603	91,630	Africa:		
France	1,505,286	1,708,842	Canary Islands	14,916	18,680
Germany:			Union of South Africa (incl. Federation of Rhodesia and Nyasaland)	379,394	389,836
East	(3)	57,875			
West	668,707	734,239			
Greece	101,791	158,149			
Ireland	68,319	117,078	Oceania: Australia	----------	12,283
Italy	1,121,892	1,105,945	Intercountry shipments [4]	415,278	465,746
Netherlands	375,554	442,299			
Norway	75,524	48,766	Total	7,926,676	9,119,034
Poland	254,982	259,644			
Portugal	248,916	220,228	Algeria	602,916	605,306
Spain	622,110	914,650	Morocco: Southern Zone	5,385,859	6,278,861
Sweden	243,038	203,766			
Switzerland	23,587	21,999	Tunisia	1,937,901	2,234,867
United Kingdom	729,118	693,558			
Yugoslavia	54,693	31,148			

[1] Compiled from Customs Returns of Algeria, Morocco, and Tunisia.
[2] This table incorporates some revisions of data published in the preceding Phosphate Rock chapter.
[3] Data not available.
[4] Trade between Algeria, Morocco, and Tunisia.

Union of South Africa.—The completed development of a fourth open pit at Phalaborwa made 2.5 million tons of ore, containing 8 to 9 percent P_2O_5, available for mining. Additional flotation equipment and magnetic separators were installed increasing recovery to 64 percent of the P_2O_5 in the ore.[32] African Metals Corp. continued to produce phosphate rock at Langebaan near Capetown. The rock was upgraded in a washing plant at Belleville to a product containing 7 percent available and 17 percent total P_2O_5 and sold for direct application to the soil.[33]

OCEANIA

Nauru Island.—The announced plans for expanding phosphate-rock-loading facilities included conveyor belts and cantilever loading arms.[34]

Solomon Islands.—Phosphate-rock deposits on Bellona Island were estimated to contain 8 million tons of low and intermediate grades.[35]

TECHNOLOGY

Apatite accounts for both dispersal and concentration of uranium in nature.[36] In apatite it was believed that uranium replaces calcium in

[32] South African Mining and Engineering Journal, Phosphate Development Corporation (Pty) Limited: Vol. 69, No. 3432, pt. 2, Nov. 21, 1958, pp. 1062–1063.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, pp. 37–38.
[34] Fertiliser and Feeding Stuffs Journal (London), Bulk Handling for Nauru: Vol. 48, No. 13, June 18, 1958, p. 592.
[35] Grover, J. C., Developments in the Solomons During 1958: Min. Jour. (London), vol. 252, No. 6447, Mar. 13, 1959, pp. 282–283.
[36] Altschuler, Z. S., Clarke, R. S., Jr., and Young, E. J., Geochemistry of Uranium in Apatite and Phosphorite: Geol. Survey Prof. Paper 314–D, 1958, 90 pp.

the molecule. Two rare-earth phosphates[37] and the complex family of pegmatite phosphate minerals were discussed.[38]

Further geologic data on the Western phosphate-rock deposits was published.[39] According to a new theory of phosphate-rock deposition, phosphate oolites were formed by replacement of calcium carbonate pellets.[40]

Joint Venture, Inc., North Carolina, planned to investigate mining techniques applicable to the phosphate-bearing sands in Beaufort County, N.C. These deposits (described in the 1957 Phosphate Rock chapter) extend from the south shore of the Pamlico River, east of Washington, northeast past Belhaven into Hyde County.[41] Depth increases to the north.

Progressively lower grade phosphate-rock ore has been utilized as a result of improved technologies.[42] High-grade phosphate-rock concentrate was obtained by dry beneficiation;[43] the results were dependent on the mineral association and nature of the silica impurity. A beneficiation process suitable for all grades of phosphate rock was sought.[44] Mining various grades compared with mining the whole deposit as a unit was studied.

In three plants in the United States, phosphate rock was acidulated with nitric acid by a French process,[45] which neutralizes the hygroscopic calcium nitrate at an early stage. Research continued on producing and utilizing superphosphoric acid, containing 75 to 77 percent P_2O_5.[46] New techniques for producing and measuring wet-process phosphoric acid were described.[47]

The research program of the Tennessee Valley Authority in fiscal year 1958–59 included development of processes to recover fluorine and other marketable byproducts from phosphate rock. Research continued in 1958 on high-analysis and improved-form fertilizers.[48]

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[37] Milton, Chas., Axelrod, J. M., Caron, M. K., and MacNeil, F. S., Gorceixite From Dale County, Ala.: Amer. Min., vol. 43, No. 7–8, July–August 1958, pp. 688–694.

[38] Fisher, D. J., Pegmatite Phosphates and Their Problems: Amer. Min., vol. 43, No. 3–4, March–April 1958, pp. 181–207.

[39] Gulbrandsen, R. A., Petrology of the Mead Park Member of the Phosphoria Formation at Coal Canyon, Wyo.: Geol. Survey Open File Rept., 1958, 176 pp.

[40] Emigh, G. D., Petrography, Mineralogy, and Origin of Phosphate Pellets in the Phosphoria Formation: Idaho Bureau of Mines and Geology (Moscow, Idaho) Pamphlet 114, May 1958, 60 pp.

[41] Brown, P. M., The Relation of Phosphorites to Ground Water in Beaufort County, N.C.: Econ. Geol., vol. 53, No. 1, January–February 1958, pp. 85–101.

[42] Ruhlman, E. Robert, Phosphate Rock, Part I, Mining, Beneficiation, and Marketing: Bureau of Mines Inf. Circ. 7814, January 1958, 33 pp.

[43] Northcott, E., and Oberg, F. N., Application of Electrostatics to Concentration of Coarse Pebble Phosphate: Min. Eng., vol. 10, No. 10, October 1958, pp. 1084–1086.

[44] Deco Trefoil, Phosphate Recovery-Flowsheet Study: Vol. 22, No. 1, Bull. M7–F59, January–February 1958, pp. 11–12.

[45] Chemical Engineering, Complex Fertilizer Made Simple: Vol. 65, No. 21, Oct. 20, 1958, pp. 61, 64.

[46] Agricultural Chemicals, Phosphoric Acid of High Concentration: Vol. 13, No. 1, January 1958, pp. 53, 97.

McKnight, D., and Striplin, M. M., Jr., Phosphoric Acid of High Concentration: Agr. Chem., vol. 13, No. 8, August 1958, pp. 33–34.

[47] Chemical Age (London), Prayon Process Used for Production of Phosphoric Acid: Vol. 79, No. 2019, Mar. 22, 1958, pp. 540, 542.

Strauss, W. I., Use of Magnetic Meter for Metering Viscous Fluids: Agr. Chem., vol. 13, No. 2, February 1958, p. 71.

[48] Agricultural Chemicals, Fetilizer Granulation: Vol. 13, No. 1, January 1958, pp. 28–29, 97.

Chemical Age (London), Dorr-Oliver Plant for Production of Fertilisers: Vol. 79, No. 2019, Mar 22, 1958, pp. 542, 544.

Chemical and Engineering News, Outlook Bright for Cal Meta: Vol. 36, No. 38, Sept. 22, 1958, pp. 60–61.

Jackson, A. S., The Cone Mixer and Normal Super: Fam Chem., vol. 121, No. 4, April 1958, pp. 10–11, 18.

Silverberg, J., and Hoffmeister, G., Jr., Liquid Fertilizers From Diammonium Phosphate: Com. Fert., vol. 97, No. 2, August 1958, pp. 28–29.

Terman, G. L., and Silverberg, J., High Analysis Fertilizers: Farm Chem., vol. 121, No. 6, June 1958, pp. 27, 31–32.

The first of two volumes, covering all aspects of organic and inorganic phosphorus chemistry, was published.[49]

New techniques reportedly required increasing quantities of phosphorus compounds in insecticides and pesticides.[50] Phosphoric acid and other phosphorus compounds were considered as stabilizers that increase the load-bearing capacity of soils.[51] The use of organic phosphate coatings on metal was reported to improve paint adhesion, protect against corrosion, increase lubricity of friction surfaces, and facilitate mechanical deformation of metals.[52] A new technique for coating molybdenum with chromium to protect against oxidation employed phosphoric acid for etching.[53]

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[49] Van Wazer, J. R., Phosphorus and Its Compounds: Vol. 1: Chemistry: Interscience Publishers, New York, 1958, 968 pp.

[50] Chemistry and Industry (London), Pestilence in Store: No. 43, Oct. 25, 1958, p. 1380. Agricultual Chemicals, Emulsifiers: Vol. 13, No. 11, November 1958, pp. 28–29, 113.

[51] Michaels, A. S., Williams, P. M., and Randolph, K. B., Acidic Phosphorus Compounds as Soil Stabilizers: Ind. Eng. Chem., vol. 50, No. 6, June 1958, pp. 889–894.

[52] Gehman, Hugh, A Review of the Phosphate Coatings: Iron Age, vol. 182, No. 11, Sept. 11, 1958, p. 94.

[53] Chemical and Engineering News, Coating for Molybdenum: Vol. 36, No. 48, Dec. 1, 1958, p. 98.

Platinum-Group Metals

By J. P. Ryan [1] and Kathleen M. McBreen [2]

LOW DEMAND, declining prices, and sharply reduced world production were the salient features of the platinum-group-metal industry in 1958. Domestic consumption and net imports declined for the second successive year but at a much slower rate than in 1957.

The price of platinum continued to fall in 1958, reaching $51–$55 near the end of the year, the lowest in more than 10 years. The price of palladium also declined in 1958 to the lowest level in 24 years. The decline in prices was attributed to the falling off of industrial demand, reduced platinum requirements of petroleum refiners, and the impact of large quantities of Soviet metal on the market.

World production of platinum-group metals was sharply reduced because of the curtailment of operations by the two leading producers, Rustenburg Platinum Mines, Ltd., in the Transvaal and International Nickel Co. of Canada, Ltd., in Ontario. Development of the platinum-bearing nickel deposits and construction of production facilities in Manitoba, Canada, was continued by International Nickel Co. of Canada, Ltd.; mine and smelter production was scheduled to begin in July 1960.

LEGISLATION AND GOVERNMENT PROGRAMS

The regulations established on March 23, 1953, under the Defense Materials System by Business and Defense Services Administration of the U.S. Department of Commerce included platinum-group metals and remained in effect throughout 1958. Orders for military or atomic-energy uses had priority ratings and took precedence over unrated orders.

All platinum-group metals, including semimanufactures of such metals, required a validated license for export to Soviet bloc countries—Communist China, Hong Kong, Macao, and Communist-controlled areas of Viet-Nam and Laos.

Platinum-group metals were eligible for 50-percent financial assistance under the program of the Defense Minerals Exploration Administration (DMEA) and its successor agency, Office of Mineral Exploration (OME); no projects were active in 1958.

DOMESTIC PRODUCTION

New Metals Recovered.—Domestic mine production of platinum-group metals from platinum- and gold-placer deposits and from gold and copper ores declined about 23 percent. Platinum-group metals

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

TABLE 1.—Salient statistics of platinum-group metals, in troy ounces

	1949-53 (average)	1954	1955	1956	1957	1958
United States: Production:						
Mine production from crude platinum placers, and byproduct platinum-group metals recovered largely from domestic gold and copper ores	32,019	24,235	23,170	21,398	18,531	14,322
Value	(1)	$1,767,995	$1,874,271	$1,884,487	$1,428,642	$738,178
Refinery production:						
New metal:						
Platinum	44,753	47,421	52,011	50,516	37,109	35,409
Palladium	7,488	4,605	6,123	4,389	4,031	5,913
Other	5,930	4,740	3,347	3,745	6,088	6,873
Total	58,171	56,766	61,481	58,650	47,228	48,195
Secondary metal:						
Platinum	31,255	31,330	32,901	60,916	49,022	36,426
Palladium	28,482	31,190	26,124	37,774	31,294	38,883
Other	3,938	3,179	5,311	7,579	7,205	6,205
Total	63,675	65,699	64,336	106,269	87,521	81,514
Consumption:						
Platinum	235,326	320,215	467,065	430,644	347,983	264,361
Palladium	185,068	234,537	351,663	399,991	367,287	395,100
Other	26,530	27,194	32,083	28,277	[2] 28,755	30,912
Total	446,924	581,946	850,811	858,912	[2] 744,025	690,373
Stocks in hands of refiners, importers, and dealers, Dec. 31:						
Platinum	177,610	243,040	304,462	353,778	306,988	295,274
Palladium	134,540	115,299	153,092	163,730	154,005	151,572
Other	41,374	43,538	45,534	47,025	46,196	46,580
Total	353,524	401,877	503,088	564,533	507,189	493,426
Imports for consumption:						
Unrefined materials	45,958	52,528	50,953	41,221	[2] 32,794	36,252
Refined metals	420,874	553,916	958,987	992,656	[2] 649,219	634,179
Total	466,832	606,444	1,009,940	1,033,877	[2] 682,013	670,431
Exports: (Except manufactures)	37,957	28,452	28,968	42,072	40,354	47,368
World: Production	700,000	940,000	1,080,000	1,100,000	1,310,000	880,000

[1] Data not available.
[2] Revised figure.

recovered by domestic refiners from both domestic and foreign ores increased slightly, all metals except platinum and osmium sharing in the gain. Of the total new metal production, 89 percent was recovered from crude platinum and 11 percent as a byproduct of gold and copper ores, the same proportion as in 1957.

Secondary Metals Recovered.—Refiners recovered 7 percent less platinum-group metals from scrap, sweeps, and outmoded jewelry than in 1957. Recoveries of all metals except palladium were lower. In addition, about 563,000 ounces of wornout catalysts, spinnerets, laboratory ware, and other equipment was returned by industry for reworking or refining on toll. The refined metals so recovered (or their equivalent in new metals) are returned to consumers for reuse and are not included in the total for secondary metals.

Domestic ores and secondary materials furnished about 14 percent of domestic requirements of platinum-group metals.

TABLE 2.—New platinum-group metals recovered by refiners in the United States, by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1949-53 (average)	44,753	7,488	3,036	1,212	962	720	58,171
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	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
1958							
From domestic—							
Crude platinum	8,016	294	1,685	368	271	22	10,656
Gold and copper refining	1,009	4,397					5,406
Total	9,025	4,691	1,685	368	271	22	16,062
From foreign—							
Crude platinum	26,384	1,222	1,461	646	958	1,462	32,133
Total	35,409	5,913	3,146	1,014	1,229	1,484	48,195

TABLE 3.—Secondary platinum-group metals recovered in the United States, in troy ounces

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1949-53 (average)	31,255	28,482	1,012	413	698	1,815	63,675
1954	31,330	31,190	734	258	1,156	1,031	65,699
1955	32,901	26,124	1,499	231	1,763	1,818	64,336
1956	60,916	37,774	1,751	447	3,246	2,135	106,269
1957	49,022	31,294	1,406	398	3,014	2,387	87,521
1958	36,426	38,883	1,223	335	2,639	2,008	81,514

CONSUMPTION AND USES

Domestic consumption of platinum-group metals, as indicated by industrial sales, was about 7 percent lower than in 1957. Consumers in the United States continued to absorb about three-fourths of the world production of platinum-group metals. Reduced demand for platinum from the petroleum-refining industry and lower requirements of palladium by electrical industries were the chief factors in the drop.

Platinum sales decreased 24 percent. Chemical uses continued to absorb most of the platinum, accounting for 57 percent of total sales compared with 70 percent in 1957. Of all platinum-group metals sold, about 37 percent went to the chemical industry where their catalytic properties were used in producing such products as high-octane gasoline, nitric and sulfuric acids, pharmaceuticals and petrochemicals.

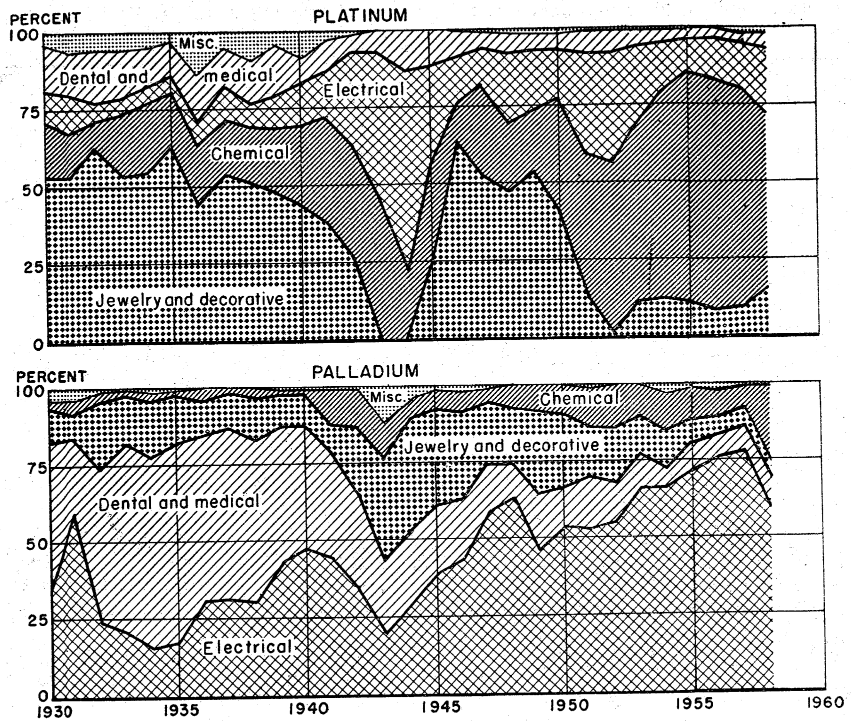

FIGURE 1.—Sales of platinum and palladium to various consuming industries in the United States, 1930–58, as percent of total.

Sales of palladium increased 8 percent owing to the sharp increase in demand from the drug and chemical industries. Nearly two-thirds of the palladium sales were for electrical or electronic uses. Electrical industries, the leading consumers of platinum-group metals for the second successive year, accounted for 43 percent of total sales.

Platinum and platinum alloys had many industrial applications based principally on their outstanding resistance to chemical corrosion, resistance to oxidation (especially at high temperature), superior catalytic properties, and high electrical conductivity. Such applications included laboratory utensils, equipment for handling molten glass and for drawing Fiberglas, spinnerets for extruding synthetic fiber, thermocouples, electric-furnace windings, pressure rupture disks, insoluble anodes, catalytic gauze for ammonia oxidation, supported catalyst for producing high-octane gasoline, gas ignitors, spark-plug electrodes, electrical contacts, and dental and medical devices. Palladium, the second most abundant and important metal of the platinum group, had many applications similar to those of platinum and was alloyed with a wide range of elements for electrical, chemical, jewelry, and brazing uses. Palladium was used to a greater extent for low-current electrical contacts than all other metals combined. Both platinum and palladium were also used extensively for jewelry and decorative purposes.

TABLE 4.—Platinum-group metals sold to consuming industries in the United States, in troy ounces

Industry	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1957							
Chemical	243,226	25,936	492	116	12,610	426	282,806
Electrical	52,574	285,576	1,723	30	[1] 1,665	1,487	[1] 343,055
Dental and medical	11,514	29,131	290	6	243	197	41,381
Jewelry and decorative	34,102	21,257	2,750		[1] 2,337	954	[1] 61,400
Miscellaneous	6,567	5,387	[1] 63	795	[1] 598	1,973	[1] 15,383
Total	347,983	367,287	[1] 5,318	947	17,453	5,037	[1] 744,025
1958							
Chemical	[1] 148,276	93,215	1,161	340	12,790	435	257,483
Electrical	53,553	238,815	2,166	38	1,714	643	296,929
Dental and medical	[1] 14,414	36,139	193	4	51	271	51,003
Jewelry and decorative	42,391	25,129	3,343	3	3,523	1,293	75,682
Miscellaneous	[1] 5,727	1,802	79	316	503	2,046	9,276
Total	264,361	395,100	6,942	701	18,581	4,688	690,373

[1] Revised figure.

The minor platinum-group metals—iridium, rhodium, and ruthenium—were used principally as alloying elements added to platinum and palladium to improve their properties. Palladium was successfully tested as a diffusion barrier for refractory base-metal claddings to improve thermal-shock resistance and to extend continuous oxidation life. Iridium crucibles and containers were used to an increasing extent because of the metal's superior performance under high-temperature conditions.

Hot platinum grids were used in oxidizing ionized metal vapor to test the feasibility of ion propulsion for space vehicles.

Palladium-gold alloys were used as thermal fuse elements for protecting electric furnaces, because they have the required narrow melting range combined with freedom from corrosion or deterioration under high-temperature conditions.

STOCKS

Total working stocks of platinum-group metals held by refiners and dealers, in process or in transit at the end of the year, were about 3 percent less than at the end of 1957. Stocks of all metals except rhodium and ruthenium declined. Large quantities of platinum-group metals also were held in Government stockpiles.

PRICES

The continued small demand for platinum by domestic petroleum refiners and the persistent pressure of selling by the U.S.S.R. at discount prices forced a steady decline in the price in 1958 to the lowest level in more than a decade. Soviet sales also brought a corresponding decline in the price of palladium to the lowest level since 1934. Supplies for the European free market came chiefly from the U.S.S.R., and prices quoted usually were less than those quoted for metal of South African and Canadian origin.

TABLE 5.—Stocks of platinum-group metals held by refiners, importers, and dealers in the United States, December 31, 1954–58, in troy ounces

Year	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1954	243,040	115,299	14,715	4,174	12,164	12,485	401,877
1955	304,462	153,092	13,830	4,396	14,983	12,325	503,088
1956	353,778	163,730	13,248	4,092	17,764	11,921	564,533
1957	306,988	154,005	13,272	4,420	18,998	9,506	507,189
1958	295,274	151,572	10,548	4,241	20,883	10,908	493,426

Market prices of the platinum-group metals, as published by E&MJ Metal and Mineral Markets, were as follows per fine troy ounce: Platinum declined steadily with frequent price changes from a peak of \$76–\$80 at the beginning of the year to a low of \$51–\$55 at the end of the year. Palladium prices dropped from \$21–\$22½ to \$19–\$21 an ounce in January, \$17–\$19 in May, and \$15–\$17 in July, remaining unchanged thereafter to the end of the year. Iridium prices dropped from \$100–\$110 to \$70–\$80 in January and remained unchanged thereafter. Similarly, the price of osmium dropped from \$80–\$100 to \$70–\$90 in January and was unchanged thereafter. Rhodium and ruthenium prices remained unchanged during the year at \$118–\$125 and \$45–\$55, respectively.

Activity in the "platinum futures" market on the New York Mercantile Exchange was much greater than in 1957, and several 50-ounce contracts were traded. Part of the unusually heavy trading in November was generated by the sale of scrap platinum by the U.S. Army Signal Corps.

FOREIGN TRADE [3]

Imports.—United States imports of platinum-group metals, including palladium acquired under the Government's barter program, declined 2 percent in 1958. Imports of refined palladium increased 10 percent, rhodium imports increased slightly, and ruthenium imports increased threefold, but these gains were more than offset by the decrease in imports of platinum and iridium.

Foreign countries furnish more than 85 percent of domestic requirements of platinum-group metals. Imports from Canada and the United Kingdom, which normally supply the bulk of United States imports, dropped 43 percent in 1958 compared with 1957 and accounted for only 40 percent of the total. In contrast, imports of platinum-group metals from the Soviet Union increased threefold, and imports (largely of Soviet origin) from other continental European countries increased 75 percent over 1957 and accounted for approximately 56 percent of the total in 1958.

Exports.—Exports of platinum-group metals from the United States in 1958 increased 17 percent. The United Kingdom, West Germany, and Canada were the largest buyers, taking about 85 percent of total exports.

[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 6.—Platinum-group metals imported for consumption in the United States

[Bureau of the Census]

Year	Troy ounces	Value (thousands)	Year	Troy ounces	Value (thousands)
1949-53 (average)	466,832	$27,273	1956	1,033,877	[1] $57,755
1954	606,444	[1] 35,285	1957	[2] 682,013	[1 2] 35,783
1955	1,009,940	[1] 48,163	1958	670,431	24,972

[1] Data known to be not comparable with years before 1954.
[2] Revised figure.

WORLD REVIEW

World output of platinum-group metals decreased to the lowest level since 1953.

Canada.—The output of platinum-group metals in Canada, the second-ranking world producer, dropped 29 percent to 295,300 ounces,

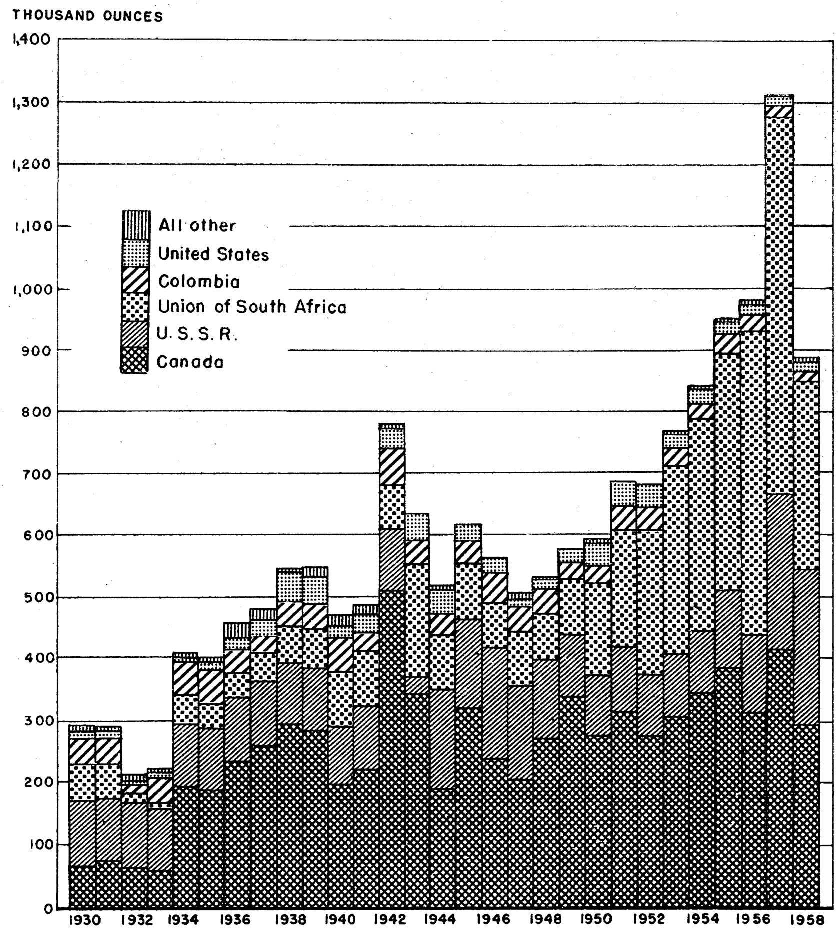

FIGURE 2.—World production of platinum-group metals, 1930–58.

TABLE 7.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 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
1957											
North America:											
Canada		125			[3] 113,597	124,505			11,800	50	[3] 250,077
Mexico			9								9
Total		125	9		[3] 113,597	124,505			11,800	50	[3] 250,086
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					[3] 13,392	6,139					[3] 19,531
Netherlands					[3] 8,191	17,600			100		[3] 25,891
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		[3] 1,436		2,829	130,779	72,558	1,431	126	4,529	1,814	[3] 215,502
Total	175	[3] 1,936		2,829	[3] 186,304	203,021	1,431	126	4,629	1,814	[3] 402,265
Asia:											
Japan			[3] 1,473								[3] 1,473
Lebanon			343		1,302				200		1,845
Philippines						12					12
Total			[3] 1,816		1,302	12			200		[3] 3,330
Oceania: Australia				22							22
Grand total: Troy ounces	1,572	[3] 26,328	[3] 2,043	2,851	[3] 301,611	327,558	1,431	126	16,629	1,864	[3] 682,013
Value	$119,420	$1,935,958	$159,965	$167,563	[3] $25,216,683	$6,303,385	$108,612	$8,506	[4] $1,687,527	$75,407	[3] [4] $35,783,026

1958											
North America:											
Canada		55			68,539	42,141	5		10,400		121,140
Mexico						110					110
Total		55			68,539	42,251	5		10,400		121,250
South America:											
Chile			226								226
Colombia		19,619			3,019						22,638
Total		19,619	226		3,019						22,864
Europe:											
Czechoslovakia					3,215						3,215
France					1,344	51,513					52,857
Germany, West			5,129			1,302					6,431
Italy			3,693								3,693
Netherlands					3,093	24,633					27,726
Norway		1,400			1,725	2,325					5,450
Switzerland					32,379	152,405					184,784
U.S.S.R.					31,416	62,167					93,583
United Kingdom		561		1,450	103,033	23,418	1,151	145	6,880	7,758	144,396
Total		1,961	8,822	1,450	176,205	317,763	1,151	145	6,880	7,758	522,135
Asia:											
Japan			2,938								2,938
Lebanon			76								76
Total			3,014								3,014
Oceania: Australia			1,105			63					1,168
Grand total: Troy ounces		21,635	13,167	1,450	247,763	360,077	1,156	145	17,280	7,758	670,431
Value		$1,341,317	$823,320	$85,452	$15,363,045	$5,210,719	$77,914	$8,304	$1,803,162	$259,009	$24,972,242

[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] Data known to be not comparable with 1958.

TABLE 8.—Platinum-group metals exported from the United States, by countries of destination [1]

[Bureau of the Census]

Year and destination	Platinum (ore, concentrates, ingots, bars, 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	
1949-53 (average)	9,844	$827,026	28,113	$801,576	$929,661
1954	17,009	1,220,617	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					
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
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
1958					
North America:					
Canada	4,828	311,194	1,416	39,359	1,755,915
Cuba	60	3,976	30	564	2,793
Mexico	685	57,648	795	16,400	125,397
Other North America					3,338
Total	5,573	372,818	2,241	56,323	1,887,443
South America:					
Brazil	137	12,206			12,638
Colombia					3,727
Peru					8,292
Uruguay	324	20,868			
Venezuela	32	590	236	4,660	6,749
Other South America					3,322
Total	493	33,664	236	4,660	34,728

See footnotes at end of table.

TABLE 8.—Platinum-group metals exported from the United States, by countries of destination[1]—Continued

Year and destination	Platinum (ore, concentrates, ingots, bars, 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 [3] (value)
	Troy ounces	Value	Troy ounces	Value	
1958					
Europe:					
France					$11,201
Germany, West	3,619	$229,963	4,556	$174,555	19,337
Iceland					19,800
Netherlands	834	48,156			
Spain			1,154	28,848	33,035
Switzerland	1,623	156,503	10	580	4,228
United Kingdom	22,662	375,272	3,327	76,971	19,058
Other Europe			442	12,263	16,302
Total	28,738	809,894	9,489	293,217	122,961
Asia:					
India	41	4,324			
Japan	230	12,650	327	25,175	26,680
Philippines					7,758
Taiwan					11,868
Other Asia					6,433
Total	271	16,974	327	25,175	52,739
Africa					2,957
Oceania					1,738
Grand total	35,075	1,233,350	12,293	379,375	2,102,566

[1] Quantities are gross weight.
[2] Beginning January 1, 1952, quantity not recorded. Quantity, troy ounces: 1949—20,702, 1950—12,640, 1951—17,348.
[3] Owing to changes in classification, data not strictly comparable with years before 1955.

the lowest since 1952. Canadian mines, which recovered platinum-group metals as a byproduct of nickel-copper ores, again contributed about one-third of the total world production.

The platinum-group-metals content of the measured ore reserve of the Sudbury basin was estimated at 6.9 million ounces, comprising 3 million ounces of platinum and 3.9 million ounces of other platinum-group metals, chiefly palladium. The platinum-metals content of the ore reserves of the Mystery-Moak Lakes nickel deposits was unofficially estimated at approximately half that of the Sudbury ores.[4]

Colombia.—The declining trend in production of platinum-group metals in Colombia continued for the sixth successive year, dropping about 19 percent in 1958.

The drop in the price of platinum handicapped operations of the leading producer, South American Gold & Platinum Co., in Choco and Narino by reducing reserves that could be mined profitably. The company curtailed dredging activity and anticipated a continuation of the declining production trend. Reserves were estimated at 69 million cubic yards of dredging gravels containing 0.566 grains of crude platinum and 1.882 grains of crude gold, equivalent to 17.7 cents per cubic yard.[5]

[4] Ottawa, Canada, State Department Dispatch 75: July 24, 1958.
[5] South American Gold & Platinum Co., 42d Annual Report 1958, p. 6.

TABLE 9.—World production of platinum-group metals, in troy ounces [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada:						
Platinum: Placer and from refining nickel-copper matte	138,340	154,356	170,494	151,357	199,565	144,565
Other platinum-group metals: From refining nickel-copper matte	163,861	189,350	214,252	163,451	216,582	150,720
United States: Placer platinum and from domestic gold and copper refining	32,019	24,235	23,170	21,398	18,531	14,322
Total	334,220	367,941	407,916	336,206	434,678	309,607
South America: Columbia: Placer platinum	28,429	28,465	27,526	26,215	19,830	16,036
Europe: U.S.S.R.: Placer platinum and from refining nickel-copper ores [2]	135,000	200,000	250,000	250,000	250,000	250,000
Asia: Japan:						
Palladium from refineries	441	248	221	218	233	[3] 200
Platinum from refineries		1,347	628	483	354	443
Total	441	1,595	849	701	587	643
Africa:						
Belgian Congo: Palladium from refineries [4]	21	176	---------	160	325	[3] 325
Ethiopia: Placer platinum	389	230	[3] 350	[3] 300	[3] 300	180
Sierra Leone: Placer platinum	8	---------	---------	---------	[5] 5	[5] 8
Union of South Africa:						
Platinum-group metals from platinum ores	190,837	338,162	381,732	484,574	603,704	[3] 300,000
Osmiridium from gold ores	6,699	6,266	7,021	6,696	5,361	[3] 5,000
Total	197,954	344,834	389,103	491,730	609,695	305,513
Oceania:						
Australia:						
Placer platinum	5	23	7	12	20	[3] 10
Placer osmiridium	46	16	21	26	66	42
New Guinea	3	5	10	9	14	28
New Zealand: Placer platinum	3	1	---------	---------	---------	---------
Total	57	45	38	47	100	80
World total (estimate) [1]	700,000	940,000	1,080,000	1,100,000	1,310,000	880,000

[1] This table incorporates a number of revisions of data published in previous Platinum chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] Revised estimates are based on imports, as reported by the United States and Western European countries, and estimates of internal consumption.
[3] Estimate.
[4] Includes platinum.
[5] Exports.

Union of South Africa.—Reversing the rising trend of the past 10 years, production of platinum-group metals dropped to about half that in 1957. The output of osmiridium recovered as a byproduct of treating gold ores declined for the third successive year.

The commissioning of the new reduction plant and production facilities, completed under the expansion program of 1956–57 by Rustenburg Platinum Mines, Ltd., was deferred, and output of platinum-group metals was cut back in line with reduced industrial demand and the decline in metal prices.

TECHNOLOGY

Platinum used as a protective film significantly reduced the resistivity of titanium anodes and improved the efficiency of the electrode system of electrolytic cells used in manufacturing various chemicals and for water purification.[6]

Thermionic valves, developed by a British research station for use in submarine telephone-cable repeaters, were built around a platinum core. Problems connected with the use of thermionic valves and the advantages of using a core of platinum were described.[7]

The development of the Houdry process, in which platinum catalysts are used not only to produce octane blending stocks for motor and aviation fuels but also to produce a wide range of aromatics and pure hydrogen, was described by an official of the Houdry Process Corp.[8] The official also stated that total world re-forming capacity may reach 2 million barrels daily by 1960, with platinum catalysts used in most of the installations.

Considerable progress has been made in the use of platinum oxidation catalysts for purifying contaminated air exhausted from industrial processes. Several applications of catalytic combustion as a means of controlling air pollution were described in a research survey on platinum metals.[9]

An improved low-cost method of plating platinum for high-temperature and other exacting industrial applications was developed during the year. The platinum electroplate produced by the new process is said to have superior corrosion resistance at high temperatures and is expected to be used in high-temperature connectors and circuitry for missile and rocket manufacturing, also in silicon and germanium transistors.

United States and British patent offices again issued more than 100 patents in 1958 on the preparation, regeneration, and use of platinum-group metal catalysts in producing various chemicals and petrochemicals.[10] Additional patents were issued on the use of platinum-group metals in manufacturing electrical, chemical, and miscellaneous products.

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[6] Cotton, J. B., Platinum-faced Titanium for Electrochemical Anodes: Platinum Metals Review, vol. 2, No. 2, April 1958, pp. 45–47.

[7] Metson, G. H., Platinum-cored Thermionic Valves in the Transatlantic Telephone Cable: Platinum Metals Review, vol. 2, No. 1, January 1958, pp. 2–6.

[8] Peavy, Claude C., The Importance of Platinum in Petroleum Refining: Platinum Metals Review, vol. 2, No. 2, April 1958, pp. 48–52.

[9] Houdry, J. H., Platinum Oxidation Catalysts in the Control of Air Pollution: Platinum Metals Review, vol. 2, No. 4, October 1958, pp. 110–116.

[10] Platinum Metals Review, vol. 2, Nos. 1–4, 1958.

Potash

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

DESPITE a 5 percent cutback in potash production in the United States, both sales and apparent consumption increased nearly 10 percent. The total supply of potash (K_2O equivalent), including stocks, available in the United States in 1958, was 2.7 million short tons. The capacity of the United States potash industry reached 2.5 million tons of K_2O during 1958.

Late in 1958 one company began producing potash in Saskatchewan, Canada; two other companies were developing deposits. World production totaled 8.8 million tons.

DOMESTIC PRODUCTION

United States production of marketable potassium salts decreased 5 percent from the record high in 1957. This lower output, the first decrease since 1949, resulted from curtailed production from June through September owing to labor strikes.

TABLE 1.—Salient potash statistics, thousand short tons and thousand dollars

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production of potassium salts (marketable)____quantity__	2,581	3,322	3,514	3,679	3,840	3,640
Approximate equivalent K_2O__do____	1,481	1,949	2,067	2,172	2,266	2,147
Value [1]____	$54,060	$72,950	$78,602	$82,107	$84,612	$75,000
Sales of potassium salts by producers____quantity__	2,492	3,270	3,405	3,572	3,625	3,954
Approximate equivalent K_2O__do____	1,427	1,918	2,006	2,103	2,137	2,336
Value at plant____	$52,104	$71,819	$76,176	$79,768	$79,628	$81,577
Average per ton____	$20.91	$21.96	$22.37	$22.33	$21.97	$20.64
Imports of potash materials__quantity__	322	225	331	334	339	399
Approximate equivalent K_2O__do____	171	119	178	181	182	216
Value____	$11,513	$8,387	$11,769	$12,018	$11,823	$13,679
Exports of potash materials__quantity__	112	117	229	398	467	507
Approximate equivalent K_2O__do____	62	66	130	226	234	254
Value____	$5,802	$5,463	$9,203	$14,937	$17,506	$18,276
Apparent consumption of potassium salts____quantity__	2,702	3,378	3,507	3,508	3,497	3,846
Approximate equivalent K_2O__do____	1,536	1,971	2,054	2,058	2,085	2,298
World: Production (marketable):						
Approximate equivalent K_2O__do____	5,800	7,300	8,000	8,300	8,700	8,800

[1] Derived from reported value of "Sold or used."

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

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 were the same as in 1957 (see Minerals Yearbook, Vol. 1, 1957, p. 950).

Mine production of crude potassium salts in 1958 in the Carlsbad region of New Mexico dropped 5 percent from the record high of 1957. The calculated grade of the crude salts mined increased to 18.89 percent K_2O equivalent compared with 18.85 percent (revised) in 1957.

All six companies in the Carlsbad region—Duval Sulphur & Potash Co., International Minerals & Chemical Corp., National Potash Co., Potash Company of America, Southwest Potash Corp., and United States Borax & Chemical Corp.—mined sylvinite (potassium and sodium chlorides) and processed the ore to yield various grades of muriate. International Minerals & Chemical Corp. also mined and processed langbeinite to yield potassium sulfate and potassium-magnesium sulfate.

Production in New Mexico was cut back extensively during the summer as a result of labor strikes and economic shutdowns. Shorter workweeks and 2- to 5-week complete shutdowns were reported by most producers. National Potash Co. and United States Potash Co., a Division of United States Borax & Chemical Corp., were closed by a 7-week and a 4-week labor strike, respectively.

Increased mechanization was reported from the Carlsbad area. The United States Potash Co., Division of United States Borax & Chemical Corp., completely mechanized the new mining area at the No. 3 shaft with continuous mining machines and belt conveyors. The underground facilities at this shaft and the surface haulage road to the No. 1 shaft were also completed. Trucks with a 50-ton capacity were used to transfer ore to the crushing plant. The Potash Company of America reported that conversion to continuous mining machines of their own design was completed, and that a new shuttle car was designed. International Minerals & Chemical Corp. installed

TABLE 2.—Production and sales of potassium salts in New Mexico, in 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
1949-53 (average)	6,845	1,424	2,249	1,285	46,367	2,170	1,237	44,652
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	[3] 2,430	3,528	2,080	77,197	3,353	1,977	73,243
1958	12,224	2,309	3,355	1,978	69,106	3,650	2,157	75,343

[1] Sylvite and langbeinite.
[2] Derived from reported value of "Sold or used."
[3] Revised figure.

additional belt conveyors and conducted preliminary experiments with ammonium nitrate as an explosive. The main office of the company was moved from Chicago to Skokie, Ill., adjacent to its research center.

In New Mexico, National Potash Co., which began producing in 1957, entered into a marketing agreement with Central Farmers Fertilizer Co., a federation of regional cooperatives. Central Farmers controlled the National production for its members use or for resale through outlets in more than 12 Western States. This cooperative group also had nitrogen-production facilities in Kansas and Minnesota and was developing a phosphate-rock deposit in Idaho.

The Farm Chemical Resources Development Corp. completed one shaft in 1957 east of Carlsbad, N. Mex., but did not start the required second shaft or the refinery during 1958. Activity during the year was limited to refinery design. The company is jointly owned by the National Farmers Union, Kerr-McGee Oil Industries, and Phillips Chemical Co.

The Delhi-Taylor Oil Corp. obtained approval for revoking a Federal power-reserve restriction in the Cane Creek area, east of Moab, Utah. Water rights and a tailing-disposal area also were arranged. Development had not begun at the end of 1958.

The Calunite Corp., formerly a producer of alunite at Marysvale, Utah, was acquired by Hydrocarbon Chemicals, Inc. Plans were announced to expand the production and marketing of fertilizer containing alunite in California. No alunite has been produced since 1955.

The American Potash & Chemical Corp. expanded its chemical operations by acquiring the Lindsay Chemical Co. at West Chicago, Ill., and moved its headquarters to 3000 West Sixth St., Los Angeles, Calif.

CONSUMPTION AND USES

The apparent consumption of potash in the United States during 1958 reached a record high, 10 percent above 1957.

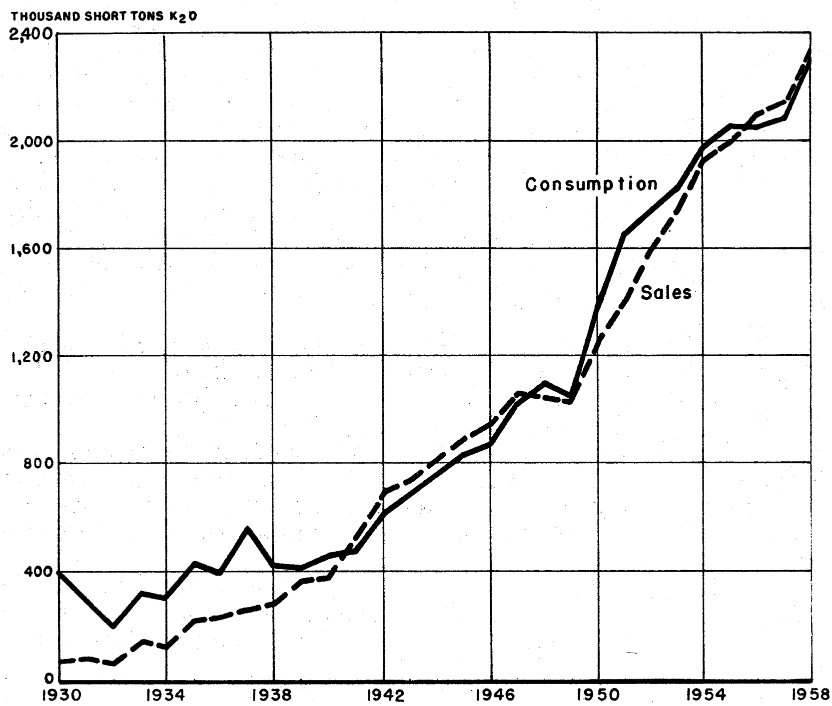

FIGURE 1.—Comparison of apparent domestic consumption of potash (K_2O) and sales of domestic producers of potash in the United States, 1930–58.

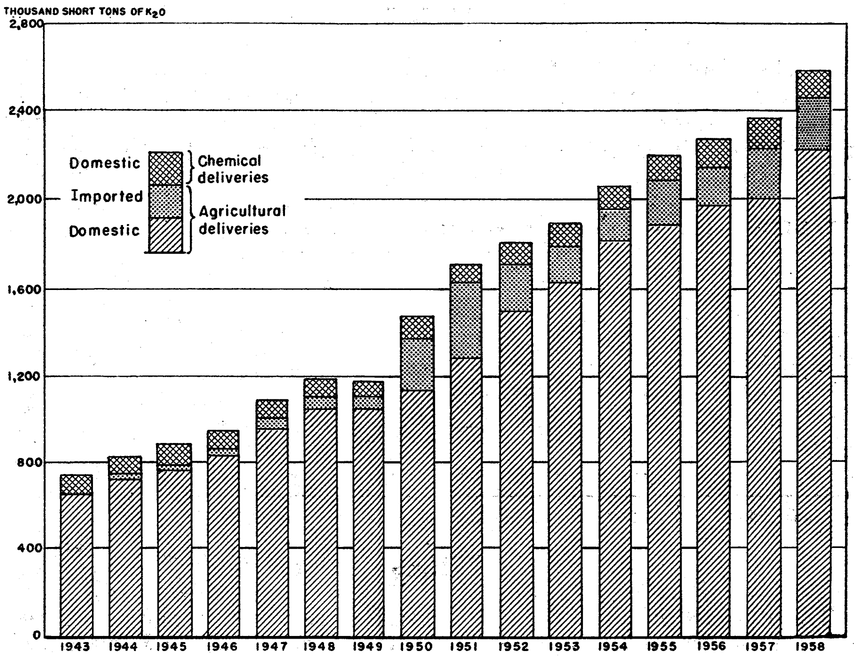

FIGURE 2.—Potash deliveries by use groups in North America, 1944–58.
[American Potash Institute]

TABLE 3.—Deliveries of potash salts in 1958, by States of destination, in short tons of K_2O

[American Potash Institute]

State	Agricultural potash	Chemical potash
Alabama	73,939	7,056
Arizona	1,430	----------
Arkansas	35,358	50
California	18,890	4,973
Colorado	969	21
Connecticut	3,735	313
Delaware	8,225	555
District of Columbia	670	----------
Florida	131,360	886
Georgia	150,366	421
Idaho	737	----------
Illinois	229,931	2,164
Indiana	171,223	1,459
Iowa	64,088	342
Kansas	2,524	498
Kentucky	46,121	5,367
Louisiana	26,761	1,190
Maine	8,032	51
Maryland	77,158	876
Massachusetts	19,956	172
Michigan	69,906	706
Minnesota	71,893	----------
Mississippi	35,010	48
Missouri	47,072	1,490
Montana	67	----------
Nebraska	2,889	14
Nevada	----------	503
New Hampshire	75	65
New Jersey	33,448	1,599
New Mexico	215	1
New York	39,644	57,836
North Carolina	103,737	300
North Dakota	2,428	----------
Ohio	167,124	4,344
Oklahoma	3,011	390
Oregon	4,850	287
Pennsylvania	43,135	1,404
Rhode Island	2,130	----------
South Carolina	61,370	----------
South Dakota	607	----------
Tennessee	77,093	----------
Texas	58,572	5,261
Utah	148	84
Vermont	2,991	----------
Virginia	116,406	700
Washington	6,501	1,183
West Virginia	893	7,694
Wisconsin	67,971	126
Wyoming	----------	96
Total	2,090,659	110,525

STOCKS

Stocks of potash (K_2O) reported by producers at the end of 1958 were below those in 1957. This decrease resulted from the production cutback during the summer of 1958. Yearend stocks in the potash industry are not entirely unsold because inventories anticipating orders for the spring planting season that begins in February are included.

TABLE 4.—Stocks of potassium salts in the United States, thousand short tons

Year	Number of producers	Stocks on hand Dec. 31	
		Potassium salts	Equivalent potash (K_2O)
1949–53 (average)	9	153	88
1954	10	526	312
1955	11	633	372
1956	10	739	440
1957	11	[1] 939	[1] 560
1958	11	625	371

[1] Figure includes an inventory adjustment during the year, as reported by producers.

PRICES

The 1958–59 prices of domestic potash were about 10 percent lower than in the preceding year. Prices varied with the date of shipment.

The American Potash & Chemical Corp. quoted agricultural-grade Trona muriate of potash, 60 percent K_2O minimum, f.o.b. Trona, Calif., in bulk, in carlots of not less than 40 tons, at 42 to 46.5 cents per unit of K_2O, according to date of shipment for the 1958–59 season; and Trona sulfate of potash at 70 to 75 cents per unit. These prices were for contracts signed before July 1, 1958. On contracts made after this date, the price was 2 cents per unit higher.

Prices, as finally revised for New Mexico potash, were quoted by producers, f.o.b. Carlsbad, in bulk, minimum carlots of 40 tons at 30 to 34½ cents per unit of K_2O for standard grade muriate (60 percent K_2O minimum); 30½ to 35 cents per unit for granular muriate (60 percent K_2O minimum); 17.65 cents per unit of K_2O (22 percent K_2O minimum) for manure salts; 59.5 to 67.5 cents per unit K_2O (50 percent K_2O minimum) for potassium sulfate; and $13.65 per ton for Sul-Po-Mag (22 percent K_2O and 18 percent MgO). These prices applied to material contracted for before July 1, 1958, and varied with date of shipment. Additional charges for bagged material ranged from $4.50 to $6.35 per ton.

FOREIGN TRADE[3]

Imports.—Imports of fertilizer and chemical potash materials were 18 percent higher than in 1957, according to the Bureau of the Census. West Germany, France, East Germany, Spain, and Chile continued to be the principal supplying countries. The material credited to Belgium-Luxembourg was of French origin.

The American Potash Institute statistics showed imports of 330,504 short tons (191,242 tons of K_2O) of potassium chloride and potassium sulfate. The origin of the potash was given as follows: West Germany—91,358 tons of chloride (54,984 tons K_2O) and 40,585 tons of sulfate (20,510 tons K_2O); France—80,555 tons of chloride (48,333 tons K_2O) and 28,100 tons of sulfate (14,050 tons K_2O); East Germany—57,811 tons of chloride (34,108 tons K_2O); and Spain—32,095 tons of chloride (19,257 tons K_2O).

Exports.—Exports of potash material continued upward to a new high, 8 percent above 1957 according to the Bureau of the Census. Japan, the major market, received 47 percent of exports. Countries in the Western Hemisphere received over 38 percent of United States exports of potash materials.

[3] 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 5.—Potash materials imported for consumption in the United States, 1957–58

[Bureau of the Census]

Material	Approximate equivalent as potash (K_2O) (percent)	1957				1958			
		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	[1] 254,015	[1] 149,869	[1] 82.4	[1] $6,754,890	297,344	175,433	81.3	$8,101,815
Potassium nitrate, crude	40	642	257	.1	74,005	546	218	.1	60,973
Potassium-sodium nitrate mixtures, crude	14	25,393	3,555	2.0	884,674	23,508	3,291	1.5	922,838
Potassium sulfate, crude	50	[1] 49,141	[1] 24,571	[1] 13.5	[1] 1,722,865	65,822	32,911	15.3	2,344,104
Other potash fertilizer materials	6					3,048	183	.1	100,870
Total fertilizer		329,191	[1] 178,252	98.0	9,436,434	390,268	212,036	98.3	11,530,600
Used chiefly in chemical industries:									
Bicarbonate	46	12	6		3,093				
Bitartrate:									
Argols	20	3,361	672		516,739	2,041	408		334,690
Cream of tartar	25	512	128		242,021	459	115		214,492
Carbonate	61	5	3		[2] 748	221	135		29,485
Caustic	80	268	214		98,118	541	433		163,687
Chlorate and perchlorate	36	369	133		104,964	466	168		110,321
Chromate and dichromate	40	2	1	2.0	637	2	(3)	1.7	701
Cyanide	70	787	551		443,284	805	564		453,796
Ferricyanide	42	295	124		178,154	276	116		156,096
Ferrocyanide	44	685	301		267,250	544	239		207,088
Nitrate	46	1,610	741		184,300	2,045	941		236,754
Permanganate	29	394	114		164,178	6	2		2,612
Rochelle salts	22	16	4		7,353	89	20		39,751
All other	50	1,183	592		175,874	1,060	530		199,091
Total chemical		9,499	3,584	2.0	[2] 2,386,713	8,555	3,671	1.7	2,148,564
Grand total		338,690	181,836	100.0	[2] 11,823,147	398,823	215,707	100.0	13,679,164

[1] Revised figure.
[2] Data known to be not comparable with 1958
[3] Less than 1 ton.

TABLE 6.—Potash materials imported for consumption in the United States, 1957–58, 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
1957													
Algeria	943											943	$159,580
Argentina	167											167	30,265
Belgium-Luxembourg						(2)	22				143	[3] 165	[3] 89,129
Chile				8				25,112				25,120	875,125
France	377			22	212	[3] 45,355	565			16,371	21	[3] 62,923	[3] 2,249,128
Germany:													
East						60,335			17		96	60,448	1,476,859
West			55		426	[3] 84,551	55	281	1,593	[3] 32,770	169	119,900	3,828,496
Italy	650	319									12	981	246,022
Latvia [4]						11,664						11,664	262,720
Morocco	167											167	26,769
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
Tunisia	134											134	20,360
United Kingdom	8	80		2	126						80	296	136,059
Other countries					23						11	34	19,429
Total	3,361	512	268	369	787	[3] 254,015	642	25,393	1,610	[3] 49,141	2,592	338,690	11,823,147
1958													
Algeria	428											428	67,250
Belgium-Luxembourg [4]						13,486				2,100	123	15,709	570,772
Chile								23,483				23,483	920,223
France	245			33	189	69,207	421		13	23,029	33	93,170	3,175,083
Germany:													
East						50,116			33		96	50,245	1,290,018
West			215	5	456	137,320	125	25	1,977	40,693	3,506	184,322	5,705,448
Italy	612	249							22		66	949	251,313
Morocco	222											222	36,623
Netherlands					5						1,135	1,140	304,487
Portugal	534											534	82,155
Spain		110				27,209						27,319	844,890
Sweden			326	315								641	208,568
Switzerland				108								108	24,610
United Kingdom		100		5	134						286	525	183,000
Other countries					21	6					1	28	14,724
Total	2,041	459	541	466	805	297,344	546	23,508	2,045	65,822	5,246	398,823	13.679,164

[1] Approximate equivalent as potash (K_2O): 1957 42 percent; 1958, 39 percent.
[2] Revised to none.
[3] Revised figure.
[4] Believed to be country of shipment.

TABLE 7.—Potash materials exported from the United States, 1957–58, by countries of destination

[Bureau of the Census]

Destination	Fertilizer				Chemical			
	1957		1958		1957		1958	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	86,731	$3,110,930	91,158	$3,124,254	5,495	$856,935	6,685	$1,093,723
Costa Rica	1,536	77,135	1,811	97,562	20	10,752	27	9,677
Cuba	20,324	652,156	18,537	591,232	71	21,982	62	21,900
Dominican Republic	275	10,850	996	34,398	4	1,583	9	4,600
El Salvador	682	30,333			2	3,130	23	6,930
Guatemala	287	8,111	537	21,498	48	12,525	20	5,747
Honduras	80	4,418	65	5,736	7	2,070	12	3,990
Mexico	10,484	273,390	14,995	398,832	587	134,531	784	155,428
Panama	150	9,589	31	1,158			1	2,380
Other North America	50	1,602	262	15,626	3	8,078	(1)	107
Total	120,599	4,178,514	128,392	4,290,296	6,237	1,051,586	7,623	1,304,482
South America:								
Argentina					8	5,601		
Brazil	18,694	755,190	56,725	1,954,977	57	22,989	501	53,954
Chile	2,756	58,702	440	23,476	62	19,166	24	12,486
Colombia	675	28,307	320	12,254	84	28,532	90	22,715
Ecuador	55	2,435			24	7,560	10	2,729
Peru	450	23,433			2	5,198	4	2,465
Uruguay	2,917	107,232					(1)	636
Venezuela	574	31,360	55	2,315	112	26,038	237	58,068
Other South America	20	1,540			3	5,130	3	5,277
Total	26,141	1,008,199	57,540	1,993,022	352	120,214	869	158,330
Europe:								
Belgium-Luxembourg					4	5,188	20	10,080
France					3	4,826		
Germany, West					36	10,954	39	14,663
Italy					86	16,475	104	25,774
Sweden			400	19,032	601	29,810	401	20,803
United Kingdom			3,529	105,182	48	27,051	230	72,736
Other Europe					(1)	244	6	3,002
Total			3,929	124,214	778	94,548	800	147,058
Asia:								
India					4	2,967	16	13,323
Japan	284,324	9,832,804	240,525	7,913,191	1	4,000	(1)	3,060
Korea, Republic of	6,613	294,000	299	10,886	31	12,897	20	5,628
Philippines	2,420	128,224	14,261	490,043	262	75,572	149	43,350
Taiwan			20,571	690,285	8	2,400	(1)	450
Vietnam, Laos, and Cambodia	100	3,528						
Other Asia			11	573	6	3,194	42	12,316
Total	293,457	10,258,556	275,667	9,104,978	312	101,030	227	78,127
Africa:								
Belgian Congo					3	5,383	7	11,565
Union of South Africa			17,785	581,612	28	12,380	41	26,230
Other Africa			50	2,750	6	2,072	1	730
Total			17,835	584,362	37	19,835	49	38,525
Oceania:								
Australia					80	22,628	302	71,610
New Zealand	19,502	650,854	13,442	380,707			1	685
Total	19,502	650,854	13,442	380,707	80	22,628	303	72,295
Grand total	459,699	16,096,123	496,805	16,477,579	7,796	1,409,841	9,871	1,798,817

[1] Less than 1 ton.

WORLD REVIEW

NORTH AMERICA

Canada.—In late 1958 the Potash Company of America, Ltd., (P.C.A.) at Floral, Saskatchewan, began mining potash, but its refinery, with facilities for handling 4,000 tons of ore per day, had not begun producing by the yearend. Announced annual capacity of the P.C.A. plant was 360,000 tons K_2O. Facilities at the plant site can store 120,000 tons. The reported cost of the mine and refinery of P.C.A. totaled $20 million. International Ore and Fertilizer Co. was appointed sales agent in the Far East for P.C.A. Canadian potash.

The shaft of International Minerals & Chemical Corp., 12 miles northeast of Esterhazy, was sunk to 1,170 feet by the end of 1958. The first 300 feet was frozen before shaft sinking. A second freezing station was established at the 1,150 level to consolidate the Blairmore formation, a 200-foot water-bearing zone. Shaft sinking was stopped until freezing was completed. Surface construction was about half finished by the end of the year. Production was scheduled for late 1960 at a rated annual capacity of more than 400,000 tons K_2O.

TABLE 8.—World production of potash (marketable, unless otherwise stated) in equivalent K_2O, by countries,[1] 1949–53 (average) and 1954–58, in short tons [2]

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

Country [1]	1949-53 (average)	1954	1955	1956	1957	1958
North America: United States	1,480,689	1,948,721	2,066,706	2,171,584	2,266,481	2,147,670
Crude (including brines)[3]	1,619,004	2,170,969	2,326,946	2,479,463	2,615,808	2,478,724
South America: Chile	3,650	550	11,000	12,000	11,000	[4] 11,000
Europe:						
France	1,191,387	1,192,083	1,310,961	1,463,006	1,545,267	[4] 1,613,000
Crude [3]	1,099,382	1,361,734	1,490,764	1,653,465	1,736,800	1,832,039
Germany:						
East [4]	1,387,800	1,488,000	1,582,000	1,598,000	1,653,000	1,700,000
Crude [3 4]	1,602,800	1,720,000	1,820,000	1,840,000	1,900,000	1,960,000
West	1,189,900	1,783,394	1,870,848	1,823,000	1,862,000	1,892,000
Crude [3]	1,420,650	2,135,000	2,227,000	2,166,000	2,190,000	2,222,000
Spain	187,626	243,166	242,539	263,468	251,460	[4] 236,000
U.S.S.R.[4]	377,600	593,700	870,500	983,600	1,040,000	1,100,000
Asia:						
Israel	683	[4] 12,000	[4] 12,000	[4] 31,000	[4] 50,000	[4] 80,000
Japan	234	454	461	474	[4] 1,650	[4] 1,900
Africa: Eritrea	786					
Oceania: Australia	369					
World total (marketable) (estimate)[1 2]	5,800,000	7,300,000	8,000,000	8,300,000	8,700,000	8,800,000

[1] China, Ethiopia, Italy, Korea, and Poland are also 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 exactly to totals shown because of rounding where estimated figures are included.
[3] To avoid duplicating figures, data on crude potash are not included in the total.
[4] Estimate.

Continental Potash Corp. stopped shaft sinking early in 1958 at a depth of 1,675 feet. The shaft must be sunk an additional 1,800 feet to reach the potash beds. Freezing of 200 feet of water-bearing formation was planned before shaft sinking was to be resumed.

The total potash reserve of Saskatchewan was calculated at 17.7 billion tons of K_2O.[4] The area included 76,000 square miles between

[4] Goudie, M. A., Middle Devonian Potash Beds of Central Saskatchewan: Dept. of Mineral Resources, Saskatchewan, Rept. 31, 1957, 81 pp.

the east and west boundaries of Saskatchewan and the 53d and 51st parallels. Assuming 40 percent mine recovery and 90 percent refinery recovery, total recoverable reserve was 6.4 billion tons of K_2O. The following limitations were used in calculating the reserve: In zones of multiple beds, only 1 bed was included; bed thickness was limited to between 5 and 10 feet; and a K_2O content averaging 25 percent or more.

EUROPE

Denmark.—Extensive potash beds, disclosed by oil-well drilling, were being investigated—a preliminary to possible recovery.

TABLE 9.—Exports of potash materials from France, 1956–57, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1956	1957	Country	1956	1957
North America:			Asia:		
Canada	15,311	30,516	Ceylon	26,240	21,279
Cuba		14,979	China (incl. Taiwan)	32,659	31,734
Martinique	7,743	7,014	India	10,389	12,657
United States	64,092	55,734	Japan	242,787	140,720
South America:			Turkey	11,941	661
Brazil	10,923	25,242	Africa:		
Colombia		7,055	Algeria	16,810	18,350
Europe:			Morocco: Southern Zone	2,743	4,431
Austria	30,046	29,343	Rhodesia and Nyasaland, Federation of	2,711	8,068
Belgium-Luxembourg	175,738	186,714	Union of South Africa	6,560	17,299
Denmark	13,121	58,933	Oceania:		
Finland	6,699	3,481	Australia	8,656	27,916
Ireland	36,418	40,771	New Zealand	18,823	16,860
Italy	57,798	58,188	Other countries	68,512	92,687
Netherlands	182,204	145,136			
Norway	17,728	16,648			
Sweden	41,455	49,797	Total	1,454,804	1,468,080
Switzerland	43,523	54,502			
United Kingdom	297,662	279,504			
Yugoslavia	5,512	11,856			

[1] Compiled from Customs Returns of France. Figures include salts, carbonate, chloride, and nitrate of potash.
[2] This table incorporates revisions of data published in the preceding Potash chapter.

Germany, East.—East German producers placed more emphasis on producing high analysis salts (containing 60 percent K_2O) and potash-magnesia salts.

Production from the Marx Engels mine was reported as 200,000 tons of K_2O in 1958.[5] Mine capacity was given as 6,000 tons of ore per day and the refinery capacity as 1,100 tons per day of 60 percent K_2O product.

East German government officials contracted with the State Trading Corp. of India for exchange of potash for ammonium sulfate.[6]

Germany, West.—West German potash producers applied to their government for registration as a "rationalization and export cartel."[7] Increased competition in foreign markets, and the need for basic research, increased efficiency, and uniform prices in Germany were cited as the reasons for the action.

[5] Fertiliser and Feeding Stuffs Journal (London), German Democratic Republic: British Visit to Potash Mines: Vol. 40, No. 10, May 7, 1958, pp. 481–482.
[6] Chemical Age (London), Indian Fertiliser Contract: Vol. 79, No. 2026, May 10, 1958, p. 880.
[7] Chemical Age (London), West German Potash Producers May Form Cartel: Vol. 79, No. 2032, June 21, 1958, p. 1161.

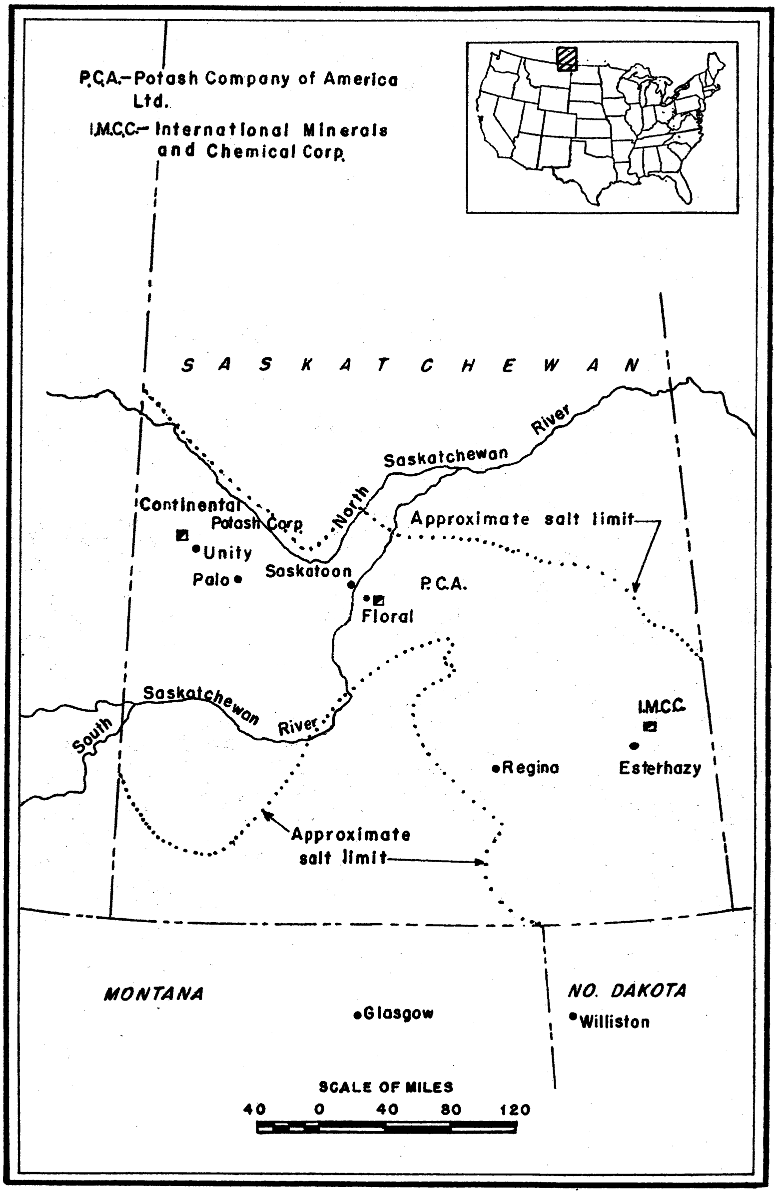

FIGURE 3.—Extent of the Canadian potash field and location of potash mines.

Production and local consumption in 1958 continued to increase; exports were 8 percent lower than in 1957. The potash subsidy of 1956 was scheduled to be reduced from 25 percent to 15 percent early in 1959. Potash prices remained firm during the year.

Italy.—Sicily received a part of a World Bank loan to Italy, allocated mostly for developing potash deposits reported in 1957.[8]

[8] Mining Journal (London), Potash in Sicily: Vol. 250, No. 6394, Mar. 7, 1958, p. 265.

TABLE 10.—Exports of potash materials from West Germany, 1957–58, by countries of destination, in short tons [1][2]

[Compiled by Corra A. Barry]

Country	1957	1958	Country	1957	1958
North America:			Asia:		
Canada	22,520	21,590	Ceylon	9,800	11,312
Puerto Rico	1,301	9,949	India	12,609	8,896
United States	113,516	132,650	Indonesia	2,762	2,275
South America:			Japan	152,415	164,307
Brazil	27,757	28,733	Korea, Republic of	4,244	7,937
Colombia		574	Malaya	5,614	6,107
Dominican Republic	8,278	5,518	Taiwan	17,306	8,322
Europe:			Turkey		
Austria	29,291	34,626	Africa:		
Belgium-Luxembourg	165,473	137,463	Rhodesia and Nyasaland, Federation of	14,889	12,239
Denmark	230,557	157,316	Union of South Africa	14,574	19,674
Greece	11,814	2,894	Oceania:		
Ireland	15,686	18,185	Australia	18,341	23,510
Italy	37,545	39,121	New Zealand	14,454	20,839
Netherlands	184,319	188,167	Other countries	45,004	33,505
Norway	2,780	9,355			
Poland	16,532		Total	1,509,241	1,381,913
Sweden	32,815	31,141			
Switzerland	29,719	35,605			
United Kingdom	162,983	208,744			
Yugoslavia	104,343	1,359			

[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 previous Potash chapter.

Spain.—The sixth International Potash Congress was held at Madrid, Spain, September 16–19, 1958. The theme of this meeting, sponsored by the International Potash Institute was the plant-soil-water relationship to potash fertilizer.

TABLE 11.—Exports of potash materials from Spain, 1956–57, by countries of destination, in short tons [1][2]

[Compiled by Corra A. Barry]

Country	1956	1957
North America: United States	18,045	57 935
Europe:		
Belgium-Luxembourg	63,614	53,556
Ireland	970	1,364
Italy	19,407	22,156
Netherlands	12,644	25,739
Norway	40,619	59,416
Portugal	17,626	19,769
United Kingdom	48,831	73,093
Asia:		
Japan	59,784	41,189
Other countries		8,060
Total	281,540	362,277

[1] Compiled from Customs Returns of Spain.
[2] This table incorporates a number of revisions of data published in the previous Potash chapter.

ASIA

China.—Brine deposits of Chalhan Lake, Chinghai Province, were reported to contain potash. Plans were announced to construct a 200,000-ton-per-year fertilizer plant.[9]

Israel.—Expansion plans for operations of The Dead Sea Works,

[9] Mining Journal (London), vol. 252, No. 6439, Jan. 16, 1959, p. 69.

Ltd., made by Construction Aggregates Co. of the United States, included recommendations to enclose areas of the Dead Sea for use as evaporating pans and to construct a pipeline to transport the potash from Sodom to a seaport. Port facilities at both Haifa on the Mediterranean Sea and Eilat on the Red Sea were being expanded to facilitate larger potash exports.

Early work on extracting potash from the Dead Sea and the granting of the concession for mineral rights of the Dead Sea in 1929 were the subject of a book.[10]

Jordan.—In 1958 the Arab Potash Co. was constructing a pilot plant and rehabilitating the evaporating area formerly used by the Palestine Potash Co. Commercial production was scheduled to begin in 1963.

AFRICA

Tunisia.—The salt lakes, locally called chotts or sebkas, were reported to contain a minimum of 750,000 tons K_2O in addition to sodium chloride, magnesium chloride, and magnesium sulfate.[11] Norsk Hydro of Norway, at the request of the Tunisian government, was investigating the recovery of the potash by addition of an organic reagent.

TECHNOLOGY

Increased recovery through pillar mining in Carlsbad potash mines caused subsidence over large areas.[12] Subsidence of 7½ feet was recorded with no apparent fracturing of underground formations. Studies were underway to determine subsidence rates, angles of subsidence, and other related phenomena.

The Atomic Energy Commission (AEC) cooperating with New Mexico potash producers was planning an underground nuclear detonation as a part of the AEC Project Plowshare. The test would determine the feasibility of power generation and radioisotope production. The site selected for the proposed blast was 25 miles southeast of Carlsbad and less than 5 miles south of the International Minerals & Chemical Corp. potash mine.

Clay slime, associated predominantly with the high-grade potash ore in New Mexico, must be separated from the ore before amine flotation.[13] An ore containing 1 percent clay, half of which is montmorillonite, will absorb about 2½ pounds of amine per ton. In addition to extensive washing and desliming, a variety of clay-blocking agents are used to minimize amine reagent losses.

Dry beneficiation techniques were successful in laboratory-scale experiments and attempts were being made to develop continuous methods of producing 60 percent K_2O muriate.[14] The process consists of heat-treating the ore and dropping it into a horizontal electric field, where the oppositely charged minerals were separated. Fines and sulfate minerals in the ore were causing incomplete separation.

[10] Novomeysky, M. A., Given to Salt: Max Parrish and Co., Ltd. (London), 1958, 282 pp.
[11] Chemical Trade Journal and Chemical Engineer (London), Potash From Tunisia?: Vol. 142, No. 3693, Mar. 14, 1958, p. 608.
[12] Miller, E. H., and Pierson, F. L., Underground Movement and Subsidence Over United States Potash Company Mine: Pres. at Ann. Meeting, AIME, New York, Feb. 16–20, 1958, 3 pp.
[13] Downey, J. M., Notes on Potash Production: Min. Eng., vol. 10, No. 12, December 1958, pp. 1253–1256.
[14] LeBaron, I. M., and Knopf, W. C., Application of Electrostatics to Potash Beneficiation: Min. Eng., vol. 10, No. 10, October 1958, pp. 1081–1083.

The potash content of beneficiated potassium chloride and sulfate was measured by Geiger counters.[15] Results showed promise that this technique could be used for plant control in potash, feldspar, and other potassium-bearing operations.

The process, based mainly on evaporation and crystallization, for obtaining potash from Searles Lake, Calif., brines containing about 3.2 percent K_2O was described.[16] Potassium chloride is sold crude, is refined to produce a high-grade chloride, or is converted to potassium sulfate.

Recovery of potash from sea water using a regenerable organic precipitant was discussed in an article on technologies of fertilizer raw materials.[17]

The grain size of potash was receiving more attention by fertilizer manufacturers.[18] Three sizes of potassium chloride were available: 6- to 14-mesh, 10- to 28-mesh, and minus-28-mesh. The four general uses of agricultural potash—sidedressing, plow-down, blending, and mixing—require different grain sizes for optimum results.

Potash sources for liquid fertilizer manufacture were investigated during the year.[19] Important properties of potash materials for soluble fertilizer include solubility, purity, and compatibility with other materials used in the process, and plant availability.

Results of investigations concerning the fixation of potassium by certain mica minerals were published.[20] Fixation, long a concern of agronomists, was being investigated by mineralogists in studying the origin of mineral deposits.

The use of potassium carbonate to produce a marketable natural gas from sour gas was reported to lower investment, fuel, and maintenance costs.[21]

New uses of potassium compounds reported during 1958 included the production of a high-temperature insulator.[22] Fibers with less than 1/25,000 inch in diameter of potassium titanate were twice as effective as any known thermal insulator between 1,300° and 2,100° F. The same product may find use as a filter medium.

Crystals of pure potassium chloride were obtained by using graphite crucibles.[23] Crystals produced in platinum crucibles contained as much as 2 p.p.m. of platinum, which affected its properties in such uses as photography, scintillation counters, crystal counters, radiation dosimetry, and infrared detection.

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[15] Knopf, W. C., and Samsel, G., The Geiger Counter as a Control Tool in Processing Potassium-Bearing Ores: Min. Eng., vol. 10, No. 10, October 1958, pp. 1094–1096.

[16] California Division of Mines, Department of Mineral Resources, Potash: Mineral Information Service, vol. 11, No. 4, Apr. 1, 1958, pp. 1–6.

[17] Industrial and Engineering Chemistry, Fifty Years of Fertilizer Progress: Vol. 50, No. 5, May 1958, pp. 40A–43A.

[18] Agricultural Chemicals, Potash Sizes: Part I, vol. 13, No. 6, June 1958, pp. 28–30, 125, 127: Part II, vol. 13, No. 7, July 1958, pp. 34–36.

[19] Kapusta, E. C., Potash in Liquid Fertilizer Manufacture: Comm. Fert., vol. 97, No. 6, December 1958, pp. 24–26, 29.

[20] Weaver, C. E., The Effects and Geologic Significance of Potassium Fixation by Expandable Clay Minerals Derived From Muscovite, Biotite, Chlorite, and Volcanic Material: Am. Mineral., vol. 43, No. 9–10, September–October 1958, pp. 839–861.

[21] Chemical Engineering, Hot Potash Plus MEA Treats Sour Gas: Vol. 65, No. 4, Feb. 24, 1958, p. 55.

[22] Chemical Trade Journal and Chemical Engineer (London), Fibrous Potassium Titanate: Vol. 143, No. 3729, Nov. 21, 1958, p. 1218.

[23] Chemical and Engineering News, Graphite Crucibles Give Pure Potassium Chloride: Vol. 36, No. 17, Apr. 28, 1958, p. 57.

Pumice

By L. M. Otis [1] and James M. Foley [2]

THE QUANTITY of pumice and pumiceous materials sold or used by producers in the United States in 1958 was 8 percent greater than in 1957 and the average price increased 6 percent.

DOMESTIC PRODUCTION

Production was reported from 16 States (including Hawaii), the same number as in 1957. Output came from 85 companies, individuals, or Government agencies, at 88 properties, compared with 79 different producing entities at 83 separate operations in 1957.

The total production of pumice and related materials was 2 million short tons, 8 percent more than in 1957. New Mexico with 11 active operations had the greatest pumice output in 1958, followed by Arizona with 6 producers. California with 32 operating pumice mines held third place after being the largest producing State for the 5 preceding years.

The Williamson Cascade Pumice Co. of Bend, Oreg., was sold to the Boise Cascade Corp. of Boise, Idaho, including two processing plants and 3,000 acres of pumice-bearing land.[3]

TABLE 1.—Pumice [1] sold or used by producers in the United States

Year	Pumice and pumicite		Volcanic cinder		Total	
	Quantity (thousand short tons)	Value (thousand)	Quantity (thousand short tons)	Value (thousand)	Quantity (thousand short tons)	Value (thousand)
1949–53 (average)	826	$2,515	(2)	(2)	(2)	(2)
1954	957	2,499	690	$475	1,647	$2,974
1955	842	2,442	962	927	1,804	3,369
1956	887	3,222	595	1,527	1,482	4,749
1957	1,055	3,091	772	1,537	1,827	4,628
1958	925	3,091	1,048	2,196	1,973	5,287

[1] Includes volcanic cinder.
[2] Includes 612,000 short tons of volcanic cinder in 1953, valued at $430,000. Volcanic cinder not reported before 1953.

Superlite Builders Supply Co. of Phoenix, Ariz., began shipping volcanic ash by rail from its mines, 12 miles east of Flagstaff, to its block plant in Phoenix.

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[1] Commodity specialist.
[2] Supervisory statistical assistant.
[3] Pit and Quarry, Williamson Cascade Pumice Sold to Boise Cascade Corp.: Vol. 50, No. 8, February 1958, p. 80.

TABLE 2.—Pumice sold or used by producers in the United States [1]

States	1957		1958	
	Thousand short tons	Value (thousand)	Thousand short tons	Value (thousand)
Arizona	397	$640	401	$1,025
California	459	1,510	377	1,670
Colorado	25	53	34	65
Hawaii	266	493	260	481
Idaho	100	168	108	172
Nevada	(2)	(2)	(2)	(2)
New Mexico	321	756	507	959
North Dakota	2	2	11	11
Oregon	124	294	138	331
Utah	36	148	41	84
Washington	(2)	(2)	(2)	(2)
Wyoming	49	40	45	40
Other States [3]	48	524	51	449
Total	1,827	4,628	1,973	5,287

[1] Includes Hawaii.
[2] Included with "Other States" to avoid disclosing individual company confidential data.
[3] Includes States indicated by footnote 2, and Kansas, Nebraska, Oklahoma, and Texas.

CONSUMPTION AND USES

The consumption of volcanic cinder rose 36 percent to over 1 million tons, reflecting increased use of low-quality pumiceous material for aggregate, road surfacing, fire-retardant plaster, and similar purposes.

Railroads used 34 percent of the total pumice output for ballast, compared with 44 percent in 1957; concrete aggregate and admixtures consumed 44 percent compared with 34 percent in the preceding year. The remainder was used for road surfacing, insulation, brick manufacture, acoustic plaster, and various abrasive and miscellaneous purposes. Abrasives formerly constituted the principal uses for pumice, but since World War II the large-scale demand for lightweight aggregate and other construction applications has far exceeded all abrasive uses.

TABLE 3.—Pumice sold or used by producers in the United States, by uses

	1957		1958	
	Thousand short tons	Value (thousand)	Thousand short tons	Value (thousand)
Abrasive:				
Cleansing and scouring compounds	17	$500	26	$612
Other abrasive uses	4	117	(1)	(1)
Acoustic plaster	4	67	2	41
Concrete admixture and concrete aggregate	628	1,884	862	2,562
Railroad ballast	798	1,063	666	874
Other uses [2]	376	997	417	1,198
Total	1,827	4,628	1,973	5,287

[1] Included with "Other uses".
[2] Insecticides, insulation, brick manufacture, filtration, other abrasive uses (1958 only), roads (surfacing and ice control), absorbents, soil conditioner, and miscellaneous uses.

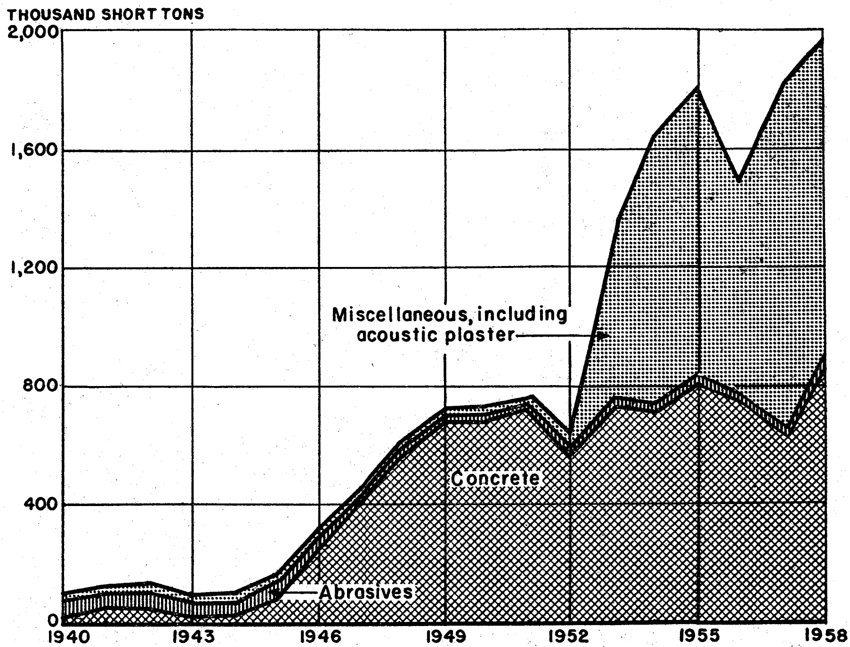

FIGURE 1.—Trends in pumice by uses, 1940–58.

PRICES

Nominal price quotations covering domestic and imported prepared pumice are carried regularly in trade publications. The Oil, Paint and Drug Reporter quoted the following average prices for 1958, per pound, bagged, in ton lots: Domestic, coarse to fine, \$0.03625; imported, Italian, silk-screened, coarse, \$0.0650; the same but fine, \$0.040. Imported, Italian, sun-dried, coarse, was quoted at \$58 to \$60 per ton.

E&MJ Metal and Mineral Markets quoted nominal year-end prices for pumice in 1958, per pound, f.o.b. New York or Chicago, in barrels: Powdered, 3 cents to 5 cents; lump, 6 cents to 8 cents.

The average value for the 652,000 short tons of crude pumice sold or used in 1958 was \$1.92 per ton, 8 percent higher than 1957, and the average for 1,321,000 tons of prepared pumice was \$3.06, an increase of 3 percent. The weighted average of the two categories was \$2.68, 6 percent more than in 1957.

The average price per ton for pumice used as concrete aggregate and admixture was \$2.97 a ton, about the same as in 1957. Cleansing and scouring compounds of suitable quality averaged \$23.86 a ton, a drop of 18 percent from 1957; the price of pumice used for other abrasive purposes averaged \$72.44, compared with \$29.79 in the preceding year.

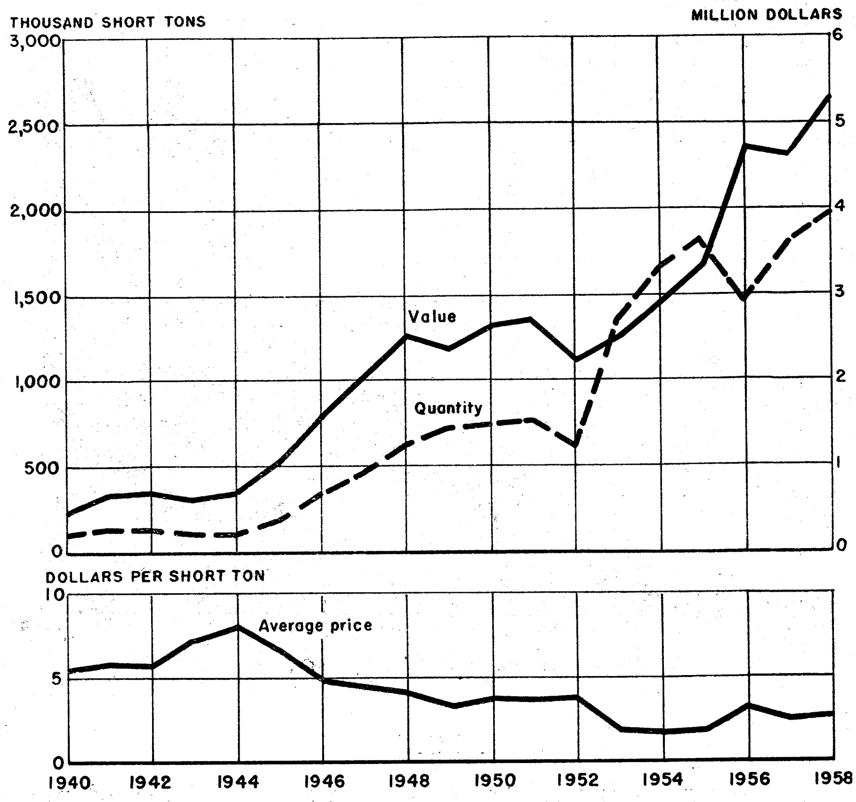

FIGURE 2.—Total value, quantity, and price per ton of pumice, 1940–58.

FOREIGN TRADE [4]

Imports.—Pumice valued at less than $15 a ton comprised 95 percent of total pumice imports, compared with 93 percent in 1957. Of the total imports, 79 percent came from Greece and averaged $6.96 a ton. Imports from Italy had an average value of $11.62 a ton. These values were $8.05 and $14.48, respectively, in 1957. All pumice imports valued at over $15 a ton came from Italy. The average value in this class was $18.38 a ton.

Exports.—In 1957, 78,000 short tons of pumice was shipped to Canada from the United States, compared with 110,000 tons in 1956. Mexico received 155 tons in 1957 and only 5 tons in 1956.

Tariff.—Duty per pound on imported pumice in January 1957 was: Crude valued at $15 a ton and under, 0.0475¢; crude valued over $15 a ton, 0.12¢; wholly or partly manufactured, 0.475¢. On June 30, 1957, tariff rates were reduced to 0.045¢ for pumice valued at $15 a ton and under; and 0.45¢ for wholly or partly manufactured pumice.

[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.—Pumice imported for consumption in the United States, by countries

[Bureau of the Census]

Country	Crude or unmanufactured				Wholly or partly manufactured				Manufactured, n.s.p.f.	
	1957		1958		1957		1958		1957	1958
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Value	
Azores	26	$1,485			19	$1,283				
Canada					21	1,671				
Germany, West							2	$397	$13,247	$12,513
Greece	28,571	230,095	31,857	$221,590						
India									269	896
Italy	6,513	57,615	6,756	52,905	2,084	66,836	1,871	47,344		595
Japan									61	267
Portugal	72	2,087								
United Kingdom									299	472
Total	35,182	291,282	38,613	274,495	2,124	69,790	1,873	47,741	13,876	14,743

WORLD REVIEW

Austria.—Production of trass, a trachytic rock formed from pumice particles consolidated by silicification, was 23 percent less than in 1957.

Canada.—Lightweight concrete aggregate was produced using pumice from the United States at a plant in Vancouver, B.C. A second Canadian plant, under construction, planned to use pumice for concrete block. Pumicite deposits have been found in Alberta, Saskatchewan, and British Columbia, but no production has been recorded since 1943 when 50 tons was mined.

TABLE 5.—World production of pumice, by countries,[1] in short tons [2]

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

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
Argentina [3]			49,604	15,708	20,278	[4] 20,000
Austria: Trass	31,063	51,601	53,050	37,511	38,875	29,784
Egypt	500	441	154	[4] 170	[4] 170	[4] 110
France:						
Pumice	15,355	11,133	10,141	14,337	9,370	[4] 9,400
Pozzolan	135,743	296,207	352,650	423,041	402,343	[4] 402,000
Germany, West (marketable)	[4] 2,200,000	2,218,950	3,105,207	3,966,111	3,261,735	3,255,121
Greece:						
Pumice	23,531	34,409	33,069	77,162	61,242	99,208
Santorini earth	38,918	38,581	40,234	93,696	87,634	88,185
Iceland		12,125	[4] 14,600	[4] 19,000	15,102	[4] 15,000
Italy:						
Pumice	101,568	166,915	181,892	211,959	221,990	
Pumicite	41,094	40,400	16,722	18,150	37,302	[4] 3,100,000
Pozzolan	1,154,837	1,657,290	1,452,282	2,750,702	2,897,620	
Kenya				1,831	2,319	821
New Zealand	9,686	9,916	8,670	8,527	16,991	25,851
Spain (Canary Islands)	825	529	944	1,681		
United States (sold or used by producers)	714,000	1,647,000	1,804,000	1,482,000	1,827,000	1,973,000
World total (estimate) [1] [2]	4,500,000	6,290,000	7,200,000	9,200,000	9,000,000	9,100,000

[1] Pumice is also produced in Japan, Mexico, U.S.S.R., and a few other countries, but data on production are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Pumice chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included.
[3] Includes volcanic ash and cinders, and pozzolan.
[4] Estimate.

Greece.—Pumice stone deposits are found on the islands of Santorine and Yali, Dodecanese. The Greek firm, Lava Co., in cooperation with the Panamanian firm, Compania Maritima Volgan, has invested $418,000 in a project and was developing deposits on the island of Yali.[5]

TECHNOLOGY

Patents.—A method of manufacturing hydraulic cement from pozzolanic materials was patented; the mixture consisted of 60 percent pumice, 15 percent gypsum, and 25 percent portland cement.[6]

A method of coating pumice particles with a water-resistant material was patented. The bed of pumice particles was heated to between 600° and 800° F. and then sprayed with an aqueous emulsion of asphalt. The water vaporizes on contact with the hot pumice, leaving a steam dispersion of asphalt throughout the bed and substantially waterproofing each particle.[7]

An issued patent covered the use of 50-percent to 80-percent sized pumicite with the remainder a harder abrasive of substantially equidimensional grain size, such as emery, garnet, silicon carbide, or fused alumina.[8]

A method of purifying air by impregnating pumice stone with ferric acetate was patented. The air carrying fumes to be eliminated is conducted through the impregnated mass and is thus purified.[9]

A premixed, precoated concrete aggregate that can be bagged, stored, and readily poured from the bag was patented. It consists of gravel, sand, and a lightweight aggregate, such as pumice. The sand and gravel is precoated with a hygroscopin, calcium, or magnesium salt and later with a bituminous emulsion.[10]

A waterproof, sound-deadening tile was patented, made of 150 parts coarse pumice, 25 parts pumice powder, 10 parts portland cement, and 5 parts pumicite. The mixture is first kneaded, then poured into a mold and agitated. After hardening, the tile is coated with a polyester resin and polished.[11]

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[5] U.S. Embassy, Athens, Greece, State Department Dispatch No. 893, May 26, 1958.
[6] Chappell, Jules A., British Patent 789,086, Jan. 15, 1958.
[7] Sucetti, G. (assigned to Zonolite Co., Chicago, Ill.), Lightweight Water Resistant Aggregate and Method of Making the Same: U.S. Patent 2,824,022, Feb. 18, 1958.
[8] Smiley, W. D. (assigned to C. B. H. Morrison, Fresno, Calif.), Abrasive Composition: U.S. Patent 2,830,884, Apr. 15, 1958.
[9] Bollinger, K. (assigned to Colasit, A. G., Wimmis, Switzerland), Method for Purifying Air Contaminated By Acid or Nitrons Impurities: U.S. Patent 2,856,259, Oct. 14, 1958.
[10] Sucetti, G., Construction and Cooling Materials: U.S. Patent 2,861,004, Nov. 18, 1958.
[11] Nagasawa, K., Japanese Patent 5185, 1957.

Quartz Crystal (Electronic Grade)

By G. Richards Gwinn [1] and Gertrude E. Tucker [2]

DOMESTIC consumption of natural Electronic-grade quartz crystal and production of piezoelectric units in 1958 decreased 13 and 8 percent, respectively, compared with 1957. Production of synthetic Electronic-grade quartz crystal reached the commercial stage.

DOMESTIC PRODUCTION

There was no domestic production of natural Electronic-grade quartz crystal in 1958. In a letter dated March 12, 1959, the Bureau of Mines was notified that the output of synthetic quartz by Sawyer Research Products, Inc., was 3,670 pounds, and sales were 384 pounds.[3] The company reported that synthetic quartz is twin-free and yields maximum recovery of usable material with a marked reduction in overall labor costs.

Large synthetic quartz crystals, reportedly of excellent quality, also were produced by the Bell Telephone Co. on a pilot-plant scale at the Western Electric Co. at North Andover, Mass.[4]

CONSUMPTION

Consumption of raw quartz crystal in the United States in 1958, for producing piezoelectric units, reached 158,300 pounds, a decline of 13 percent compared with 1957. Forty-three consumers, representing 40 companies in 17 States, reported to the Bureau of Mines in 1958. The number of piezoelectric units produced was 5.2 million, a decrease of 8 percent from the preceding year. The yield, 33.1 units per pound, was just under the record high of 33.6 reported in 1956. This high yield reflected the overall trend toward an increased output of small units and continued improvement in crystal-cutting technology. Forty-two of the forty-three quartz crystal consumers also produced finished piezoelectric units; one produced only semifinished blanks. About 77 percent (121,300 pounds) of the total quartz consumed was reported by 25 consumers in 7 States—Pennsylvania, New Jersey, Illinois, Missouri, Wisconsin, New York, and Ohio.

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[1] Commodity specialist.
[2] Statistical assistant.
[3] Sawyer Research Products, Inc., letter to the Bureau of Mines: Mar. 12, 1959.
[4] Chemical and Engineering News, Quartz: Out of the Lab: Vol. 36, No. 51, Dec. 22, 1958, pp. 24–25.

Piezoelectric units were produced at 58 plants (55 companies) in 22 States. About 77 percent of the total units produced were manufactured in 27 plants in 9 States—Pennsylvania, New Jersey, Missouri, Illinois, Wisconsin, Colorado, Iowa, Kansas, and Nebraska. Oscillator plates produced in all 22 States comprised 93 percent of the piezoelectric quartz crystal units manufactured. Filter and telephone-resonator plates, transducer crystals, radio bars, and other miscellaneous uses supplied the remaining 7 percent.

TABLE 1.—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

[Thousands]

Year	Estimated imports of Electronic- and Optical-grade quartz crystal [1] [2]			Consumption of raw Electronic-grade quartz (pounds)	Piezoelectric units	
	Quantity (pounds)	Value	Value per pound		Production (number)	Number per pound of raw quartz
1949–53 (average)	712	$1,883	$2.64	269	3,848	14.3
1954	613	1,563	2.55	134	3,654	27.3
1955	705	1,394	1.98	134	4,090	30.5
1956	521	1,142	2.19	150	5,045	33.6
1957	432	652	1.51	[3] [4] 182	[3] [4] [5] 5,687	[3] 31.2
1958	274	341	1.24	[4] 158	[4] [5] 5,243	33.1

[1] Figures for 1949–52 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 1953–58 are imports of Brazilian pebble, valued at 35 cents or more per pound.
[3] Revised figure.
[4] Figure is not comparable with 1954–56.
[5] Excludes finished crystal units reported produced from reprocessed blanks and crystals cut from raw quartz previously reported, as follows: 1957: 100,000; 1958: 267,000.

PRICES

There were no important changes in the prices of natural Electronic-grade quartz crystal sold domestically in 1958. Prices for Class 1 crystals of 201 to 300 grams ranged from about $10 to $12 per pound; 301- to 500-gram crystals were $14 to $18 per pound; and large crystals of the 701- to 1,000- and 1,001- to 2,000-gram weight groups were sold at about $30 and $40 per pound, respectively.

Prices for synthetic or cultured quartz as released in July 1958 ranged from $27.50 to $35 per pound, depending on the sizes and quantities involved.

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 [5]

The decline in imports of Electronic- and Optical-grade quartz crystal, which began in 1956, continued through 1958. Of the total imports, Brazil supplied 244,000 pounds (89 percent) and Japan 23,-

[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.

900 pounds (9 percent). The remaining 6,000 pounds was furnished by Canada, the United Kingdom, France, Madagascar, and the Union of South Africa. Shipments from France were believed to have originated in Madagascar. Inasmuch as production of Electronic-grade quartz had not been reported in the Union of South Africa, it was believed that imports credited to that country represented largely transshipment of material originating in Madagascar. In 1958, as in the previous year, part of the imports credited to Japan comprised material sent from the United States for partial processing.

Imports of quartz valued at less than 35 cents per pound—classed as lasca—totaled 199,000 pounds valued at $15,090 compared with 1,114,000 pounds valued at $77,300 in 1957. All lasca received came from Brazil and was obtained from rejects of Electronic-grade quartz crystal production. The drastic decline in imports of lasca reflected not only the decrease in the Brazilian output of Electronic-grade quartz but also a decline in demand for Fusing-grade quartz.

Exports and reexports of quartz crystal in 1958 were valued at $285,452 and $81,409, respectively. These totals represented an apparent increase in exports and a decline in reexports compared with 1957. Because of changes in the tariff classifications in 1958, however, the values reported for the 2 years were not comparable. Canada, the United Kingdom, and Japan, in the order named, were the principal countries of destination for exports in 1958, and the United Kingdom and Canada were also the principal countries of destination for reexports.

WORLD REVIEW

Brazil.—Exports of Electronic- and Fusing-grade quartz crystal from Brazil in 1958 totaled 1,554,525 pounds valued at US$340,000, a sharp decline in both quantity and value from the 1957 total.[6] Lasca or Fusing-grade quartz in 1958, as in the previous year, furnished a large part of the total quartz exported.

Exports for 1957 were about 3,055,627 pounds, valued at $1,087,000. Although a breakdown is not available, a relatively large percentage of the total was Fusing-grade material.[7]

Madagascar.—The production of Electronic-grade quartz crystal in Madagascar in 1957 reached 30,429 pounds valued at US$118,285, and exports reached 33,516 pounds valued at US$347,428.[8] Production for the first half of 1958 was 5,292 pounds valued at US$24,683. Exports for this same period were 14,112 pounds valued at US$75,702.[9]

U.S.S.R.—Production data on Electronic-grade quartz crystal in the U.S.S.R. are not available. Trade statistics for 1956 showed imports from Communist China of 136,710 pounds valued at about US$762,500,[10] and for 1957, 99,215 pounds valued at US$858,000.[11] These

[6] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 1265: Apr. 29, 1959, p. 5.

[7] U.S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 407: Oct. 7, 1958, p. 2.

[8] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 88, Sept. 26, 1958, p. 1.

[9] U.S. Consulate, Johannesburg, Union of South Africa, State Department Dispatch 29, Aug. 12, 1958, p. 1; Dispatch 75, Sept. 12, 1958, p. 1.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, Spec. Supplement No. 55, September 1958, p. 30.

[11] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, Spec. Supplement 56, January 1959, p. 24.

data suggest that the U.S.S.R. did not have readily available an adequate supply of Electronic-grade quartz crystal. The discovery of an Electronic-grade quartz crystal weighing 70 tons was reported in the U.S.S.R. in 1958.[12]

TECHNOLOGY

The discovery of a vein of massive transparent quartz at Little Switzerland, N.C.,[13] and a description of the quartz crystals found on the coastal region of southeast Madagascar[14] were reported.

Data were given on the use of fused quartz in the production of special shapes such as rods, cubes, briquets, and prisms.[15] The Bell Telephone Laboratories reported that its process for producing synthetic Electronic-grade quartz crystal would be available for licensing to other manufacturers.[16] Additional data on the mechanism of the growth of synthetic quartz crystal[17] and the requirements for high-frequency quartz filter crystals[18] were reported. A method of producing a quartz-crystal unit in the low-frequency range that will withstand mechanical vibration and high shock was described.[19]

The effects of nuclear radiation on natural quartz piezoelectric crystals[20] and the effects of fast neutrons on the physical constants of crystalline quartz[21] were reported.

A brief review of the development and growth of the use of quartz-crystal units for frequency control and efforts to produce international standards for these units was reported.[22] The Institute of Radio Engineers (IRE) published standards on piezoelectric crystals.[23]

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[12] Mining Journal (London), vol. 251, No. 6426, Oct. 17, 1958, p. 421.
[13] Engineering and Mining Journal, vol. 159, No. 5, May 1958, p. 168.
[14] Boulanger, Jacques [Geology and Prospecting of the Coastal Region of Southeast Madagascar]: Territory of Madagascar, Trav. Bur. Geol., No. 87, 1958, pp. 1–104; Ceram. Abs., vol. 52, No. 21, Nov. 10, 1958, p. 18111h.
[15] Ceramic News, vol. 12, No. 4, April 1958, p. 26.
[16] Electronic News, vol. 3, No. 120, Dec. 15, 1958, p. 16.
[17] Zimonyi, G. [Mechanism of the Growth of Quartz Crystals]: Acta Phys. Acad. Sci. Hung., vol. 8, No. 1–2, 1957, pp. 119–127; Ceram. Abs., vol. 41, No. 6, June 1958, p. 160.
[18] Sykes, R. A., High Frequency Crystals: Proc. 12th Ann. Symposium on Frequency Control, U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J., May 6, 1958, pp. 475–499.
[19] Wolfskill, J. M., Ruggedization of Low Frequency Crystal Units: Proc. 12th Ann. Symposium on Frequency Control, U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J., May 6, 1958, pp. 211–240.
[20] Graham, F. E., and Donovan, A. F., Pile Irradiation of Quartz Crystal Units: Proc. 12th Ann. Symposium on Frequency Control, U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J., May 6, 1958, pp. 101–130.
[21] Mayer, G. F. J. [Effects of Fast Neutrons on Some Physical Constants of Crystalline Quartz and Fused Silica]: Jour. Phys. Radium, vol. 18, 1957, p. 109; Ceram. Abs., vol. 52, No. 17, September 1958, p. 14271h.
[22] Sykes, R. A., The Magic Crystal: Magazine of Standards, vol. 29, No. 6, June 1958, pp. 161–162.
[23] Institute of Radio Engineers Proceedings, IRE Standards on Piezoelectric Crystals; Determination of the Elastic, Piezoelectric, and Dielectric Constants—The Electromechanical Coupling Factor: Vol. 46, April 1958, pp. 767–778.

Rare-Earth Minerals and Metals

By Walter E. Lewis [1]

MINE SHIPMENTS of domestic rare-earth oxides in 1958 were about one-half those of 1957. The Union of South Africa was the principal source of supply of monazite concentrate. The demand for thorium to fill Government contracts resulted in a continuing surplus of the monazite-coproduct rare-earth metals and compounds.

LEGISLATION AND GOVERNMENT PROGRAMS

The Office of Minerals Exploration (OME), successor agency to Defense Minerals Exploration Administration (DMEA), continued Government financial participation in exploration of monazite and rare-earth minerals. The Government will contribute not more than 50 percent of the total allowable costs of exploration.[2]

DOMESTIC PRODUCTION

Concentrate.—Mine shipments [3] of rare-earth and thorium concentrates in 1958 totaled 2,021 short tons valued at $286,000 and included monazite, bastnaesite, and thorite. Of this total 987 tons of monazite and bastnaesite concentrates contained about 625 tons of rare-earth oxides (REO), which was approximately a 55-percent decrease below 1957. Part of the decrease may have been due to the lessened demand for ilmenite and rutile, which caused a reduction in byproduct monazite output.

Monazite was produced as a byproduct with rutile, ilmenite, and zircon concentrates by Rutile Mining Co., Duval County, 5 miles east of Jacksonville, Fla., and Marine Minerals, Inc., at the Horse Creek mine near Aiken, S.C. Monazite was recovered as a byproduct at the Baumhoff-Marshall, Inc., plant at Boise, Idaho, and euxenite concentrate was produced by Porter Bros. Corp., at Bear Valley, Valley County, Idaho. Molybdenum Corp. of America produced bastnaesite concentrate from its Mountain Pass (Calif.) property.

Metals and Compounds.—The processors of rare-earth concentrates were Davison Chemical Division, W. R. Grace & Co., Pompton Plains, N.J.; Heavy Minerals Co., Chattanooga, Tenn.; Lindsay

[1] Assistant chief, Branch of Rare and Precious Metals.
[2] 85th Congress, 5.3817, Public Law 85–701, Aug. 21, 1958.
[3] See also the Thorium chapter in this volume.

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Chemical Division, American Potash and Chemical Corp., West Chicago, Ill.; Lunex Co., Pleasant Valley, Iowa; Maywood Chemical Works, Maywood, N.J.; Michigan Chemical Co., St. Louis, Mich.; Molybdenum Corp. of America, Pittsburgh, Pa.; Research Chemicals, Inc., Burbank, Calif.; and St. Eloi Corp., Newtown, Ohio; Mallinckrodt Chemical Works, St. Louis, Mo., under subcontract from Porter Bros. Corp., continued to recover columbium-tantalum oxides from Idaho euxenite concentrate. A residue containing rare-earth elements also was recovered and was stockpiled by the General Services Administration.

Most of the ore and concentrate processors could supply small quantities (gram or pound lots) of the separated rare-earth metals and compounds either from inventory or on custom basis. Purity specifications of different processors ranged widely.

Misch metal and other rare-earth-metal alloys were produced 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.; American Metallurgical Products, Co., Pittsburgh, Pa.; and Electro Metallurgical Co., Niagara Falls, N.Y.

A 40-percent equity in Heavy Minerals Co. held by Crane Co. was acquired by Vitro Corp. of America.[4] Vitro thus gained 87½ percent ownership in the company; the minority interest was held by the French Société de Produits Chimiques des Terres Rares, a subsidiary of Compagnie Pechiney.

In early 1958, Lindsay Chemical Co. was merged with American Potash and Chemical Corp. and became Lindsay Chemical Division of that company.

CONSUMPTION AND USES

Apparent consumption of rare-earth elements in 1958 is estimated at about 1,600 short tons of rare-earth oxides.

Uses for the unseparated rare-earth elements and those separated only roughly into subgroups accounted for the major part of the output; however, separated rare-earth elements (of varying purity) were offered for sale by the major processors. The market for rare-earth materials, both the compounds and separated metals, failed to develop according to forecasts, but this did not deter the industry from expanding its processing facilities and attempting to develop new uses for the materials.

Uses for the rare-earth elements remained essentially the same as in 1957. The large-volume uses continued to be for metals and alloys, in the glass industry, and for electrodes in arc lighting. Both Government and industry are continuing research and experimentation on possible applications of the rare-earth metals in steelmaking and in the nuclear energy and electronics industries.

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[4] Crane Co., Interim Report to Shareholders for First Nine Months of 1958: 836 South Michigan Ave., Chicago 5, Ill.

STOCKS

Demand for thorium (produced from monazite) to fill Government contracts and nonenergy uses of thorium resulted in a continuing surplus of the lighter rare-earth compounds and metals. The surplus stocks were held by industry. The rate of Government stockpiling of thorium will determine the annual buildup of surplus rare-earth stocks.

PRICES

Monazite prices were quoted nominally by E&MJ Metal and Mineral Markets throughout 1958 at the same levels as in 1957: Per pound, c.i.f. U.S. ports, 55 percent total rare-earth oxides, including thorium, massive, 14 cents; and sand, 55-percent grade, 15 cents; 66 percent, 18 cents; and 68 percent, 20 cents. Prices on large-tonnage contracts also remained unchanged from 1957, averaging about $250 per short ton of concentrate delivered containing 45 percent rare-earth oxides and 6 percent thorium oxide.[5] Small-lot prices of imported monazite ranged from $100 to $200 per short ton delivered.

Prices of misch metal ranged between $3.00 and $3.50 per pound, depending upon the quantity ordered. Prices of the separated rare-earth elements and compounds continued to decrease in 1958, but not at the rate that was noted in 1957. The continuing drop in metal and compound prices was attributed to advances in extraction and separation technology, rapid expansion of processing facilities, and competition among major producers. Prices of rare-earth and yttrium metals and compounds varied widely between different producers,

TABLE 1.—Range of prices of rare-earth and yttrium compounds and metals [1]

Compounds or metals	Unit of weight	Price range
Rare-earth chemical compounds: (Oxide, sulfate, hydrate, carbonate, chloride, nitrate, acetate, fluoride, and oxalate).	Pound	$0.25-1.65
Yttrium oxide with rare-earth oxides	do	11.00-18.00
Yttrium oxide	do	60.00-80.00
Yttrium metal	do	180.00-300.00
Lanthanum, cerium, praseodymium, neodymium, or samarium metals.	Gram	.33-.66
Europium metal	do	9.25-13.90
Terbium metal	do	3.75-5.62
Gadolinium, dysprosium, holmium, or erbium metals	do	.73-1.10
Thulium metal	do	4.62-6.93
Ytterbium metal	do	1.26-1.89
Lutetium metal	do	8.58-12.87
Lanthanum oxide	Pound	7.15-13.20
Cerium oxide (optical grade)	do	1.85-1.90
Neodymium oxide	do	35.00-40.00
Praseodymium oxide	do	40.00-50.00
Samarium oxide	do	50.00-60.00
Europium or terbium oxides	do	850.00-900.00
Gadolinium oxide	do	105.00-125.00
Dysprosium, erbium, or holmium oxides	do	105.00-125.00
Ytterbium oxide	do	160.00-200.00
Thulium oxide	do	1,200.00-1,500.00

[1] Quoted by Lindsay Chemical Division, American Potash and Chemical Corp., December 1958.

[5] Kremers, Howard E., Rare Earths: Eng. Min. Jour., vol. 160, No. 2, February 1959, pp. 106, 155.

owing in part to the analysis, quantity, and purity of the products being quoted. Table 1 lists a range of prices as released in December 1958.

FOREIGN TRADE [6]

Imports.—Imports of cerium metal, ferrocerium, and misch metal in 1958 totaled 11,754 pounds valued at $48,721. Of this quantity, Austria shipped 58 percent, West Germany 24 percent, Japan 12 percent, United Kingdom 5 percent, and France 1 percent. The ferrocerium and cerium metal and alloy imports for 1958 exceeded those of 1957 by 3,697 pounds and by $21,068 in value. All imports of cerium compounds were from France and totaled 52,371 pounds valued at $84,868.

Monazite concentrate was imported from the Union of South Africa, but data cannot be published because it would disclose company confidential information.

Exports.—Exports of cerium ores, metals, and alloys totaled 29,998 pounds valued at $23,717. France received 76 percent of this total, Canada 20 percent, and Italy 4 percent. Cerium lighter flints or ferrocerium exports totaled 7,720 pounds valued at $47,077. Canada was the principal recipient, receiving 70 percent of the total exported; the remainder, in decreasing order of the quantity received, was exported to Cuba, Venezuela, Honduras, Mexico, Colombia, the Dominican Republic and Saudi Arabia.

Tariff.—Tariff rates for monazite concentrates, cerium metals, alloys, and compounds, ferrocerium, and yttrium were unchanged from 1957. The rate on cerium and misch metal was $1 per pound; ferrocerium and other cerium alloys (including lighter flints), $1 per pound plus 12½ percent ad valorem; cerium compounds (chemical), 30 percent ad valorem; rare-earth ores and concentrates duty free. Yttrium ores and concentrates were also duty free. Yttrium is classified under paragraph 5 of the Tariff Act of 1930 as Chemical Compounds, Elements, and Salts Not Specifically Provided For; thus the yttrium salts and metals carry 10½ percent ad valorem.

WORLD REVIEW

ASIA

India.—The statement in the 1957 Minerals Yearbook Minor Metals chapter (p. 1340) that a plant at Alwaye, Travancore, was operated by a division of the French Compagnie Pechiney was in error. It was operated by Indian Rare Earths (Private) Ltd., Bombay, and was owned jointly by the Federal Government of India and the State of Kerala.

The monazite deposits of India were described.[7] Beach placers

[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.

[7] Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Proceedings: September 1958, vol. 2, Survey of Raw Material Resources; United Nations, Geneva, 843 pp. Specifically, the following papers:
Mahadevan, V., Narayana Das, G. R., and Nagaraja Rao, N., Prospecting and Evalution of Beach Placers Along the Coastal Belt of India: Pp. 103–106.
Shirke, V. G., and Chatterji, B. D., Monazite Sands of Bihar and West Bengal: Pp. 713–715.

along the southwestern coast are estimated to contain over 1.4 million tons of monazite. There are also large monazite placer deposits in the States of West Bengal and Bihar. An estimate of the total reserve was planned upon completion of the investigations in the area.

AFRICA

Egypt.—Deposits of monazite-bearing black sands occur along the northern beaches of the Nile Delta. It was estimated that along 8 kilometers of beach about 25 million tons of black sand minerals is available, containing about 200,000 tons of monazite.[8]

Union of South Africa.—Four different types of South African monazite deposits, including veins, pegmatites, carbonatites, and placers, were described in a report.[9] The geology and reserves of Monazite and Mineral Venture's mine near Van Rhynsdorp in the Western Cape Province were discussed. This mine was the country's only active monazite producer in 1958, and it was announced that, as of March 31, 1959, the mine would go on a care-and-maintenance basis. The reason given was that existing sales contracts in the United States had not been renewed and that efforts to find new markets for its monazite had been unsuccessful.[10]

TECHNOLOGY

Advance information was released by the Bureau of Mines on its research program on high-purity metals and the development of high-purity electrolytic cerium and yttrium. High-purity cerium metal, almost totally free of iron, carbon, and hydrogen, was made experimentally in a specially designed, airtight, electrolytic cell under controlled pressures and a shielding blanket of inert gas, such as helium. High-purity yttrium was produced under controlled atmosphere and pressure by a technique similar to the Kroll process, which is used to produce titanium and zirconium. Ridding the metal of dissolved gases (primarily oxygen) resulted in changing it from a brittle to a ductile material that could be cold-rolled.

The status of rare-earth elements for industrial applications was covered in detail.[11] The ferromagnetic properties of rare-earth iron garnets make them valuable for microwave and other electronic applications, and development of uses in high-temperature refractories and cermets appeared promising.

The nuclear cross sections of several of the rare-earth metals are high, and they may have a use in the nuclear energy industry. Trade publications detailed the possible uses of rare-earth metals as poisons in nuclear reactors.[12] The high-cross-section rare-earth metals are

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[8] Higazy, R. A., and Naguib, A. G., A Study of the Egyptian Monazite-Bearing Black Sands: Work cited in footnote 7, pp. 658–662.

[9] Pike, D. R., Thorium and Rare Earth Bearing Minerals in the Union of South Africa: Work cited in footnote 7, pp. 91–96.

[10] U.S. Embassy, Johannesburg, Union of South Africa, State Department Dispatch 283: Apr. 16, 1959, p. 20.

[11] Hines, Dr. Richard C., Rare Earths for Industrial Applications: Materials in Design Engineering, vol. 48, No. 6, November 1958, pp. 144, 146, 148, 150, 152, 154, 156, 158, 160, 162.

[12] Ransohoff, J. A., Rare Earths as Nuclear Poisons, I and II: Lindsay Chemical Division, American Potash and Chemical Corp., West Chicago, Ill., July 1958 and August 1958, 11 pp. and 7 pp.

suitable as control-rod neutron absorbers and are most likely to be preferable in reactors where temperatures are high. Specific rare-earth elements of greatest interest were gadolinium, samarium, dysprosium, europium, and, to a lesser extent, erbium.

Research that has been in progress for about 6 years on the effect of rare-earth elements as additives in steelmaking continued in 1958.

A technical report under Air Force Contract AF 33(616)–5293 was prepared on rare-earth metals.[13] Rare-earth-element chemical, physical, and nuclear properties were discussed in detail; separation and extraction techniques were also presented, with possible alloy systems.

The principal published sources of technologic information on the rare-earth metals and compounds continued to be industry brochures, price lists, and bulletins detailing metallurgical applications (ferrous and nonferrous), properties, prices, and analyses.[14]

Details were given of a method for processing monazite sand developed at the Ames Laboratory.[15] Concentrated sulfuric acid is mixed with the sand at elevated temperatures to form a slurry. The slurry is diluted, and the monazite sulfate solution is separated from the undissolved residue. The acidity of the solution is adjusted to a pH value of between 0.4 and 3, oxalic acid anions are added to precipitate the thorium and rare-earth elements as oxalates. The oxalate precipitate is calcined, converting the oxalates to oxides. The calcined precipitate is dissolved in nitric acid, and the thorium and cerium are separated from other rare-earth elements by solvent extraction with tributyl phosphate. Further separation of the other rare-earth elements would require ion-exchange techniques.

The sintering characteristics of europium, samarium, gadolinium, and dysprosium were investigated at various temperatures.[16] The oxides were sintered into dense ceramic bodies at temperatures ranging from 1,500° to 1,800° C. Dysprosium oxide had the lowest coefficient of expansion and was the most stable of the group investigated.

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[13] Love, Bernard, Selection and Evaluation of Rare or Unusual Metals for Application to Advanced Weapons Systems, Part I. A Literature Survey: Office of Technical Services, U.S. Department of Commerce, June 1958, 174 pp.

[14] Prochovnick, Ammiel, Literature Search Relating to Metallurgical Applications of the Rare Earths: Davison Chemical Co., Division of W. R. Grace and Co., Box 488, Pompton Plains, N.J., 1958, 42 pp.

New Process Metals, Inc., References to the Use of Rare-Earth Metals in Ferrous Alloys, Nonferrous Alloys and in the Electronic Industry: 46–65 Manufacturers Place, Newark, 5, N.J., 1958, 9 pp.

Heavy Minerals Co., Rare Earth Chemicals, Thorium, Heavy Minerals: Chattanooga, Tenn., 1958, 12 pp.

Lindsay Chemical Division, American Potash and Chemical Corp., Technical Data, Thorium, Rare-Earth, and Yttrium Chemicals: West Chicago, Ill., 1959.

Michigan Chemical Corp., Rare-Earth Data Sheets: Rare Earths and Thorium Division, St. Louis, Mich., 1959.

Research Chemicals Inc., Catalog Sheet: P.O. Box 431, 170 West Providencia, Burbank, Calif., 1957, and 1958.

Mallinckrodt Chemical Works, Mallinckrodt Misch Metal, St. Louis, Mo., 1958, 4 pp.

[15] Welt, Martin A., Smutz, Morton (assigned to the United States of America as represented by the Atomic Energy Commission), Method of Processing Monazite Sand: U.S. Patent 2,849,286, Dec. 2, 1957.

[16] Ploetz, G. L., Krystyniak, C. W., and Dumas, E. W., Sintering Characteristics of Rare-Earth Oxides: Jour. Am. Ceram. Soc., December 1958, vol. 41, No. 12, pp. 551–554.

Salt

By R. T. MacMillan [1] and James M. Foley [2]

SALT output in the United States in 1958 decreased slightly for the second year. Declines in brine and evaporated salt, and a slight increase in rock salt were noted.

DOMESTIC PRODUCTION

Salt was produced at 85 facilities in the United States and Hawaii. Michigan was the leading salt-producing State with about 19 percent of the total. New York and Texas each had about 18 percent; and Louisiana, Ohio, and California represented about 16, 11, and 6 percent, respectively. These six States produced about 88 percent of the total salt output.

About 50 percent of the salt was produced by 4 companies in 12 plants, 33 percent came from 9 companies in 14 plants, and the remaining 62 plants supplied 17 percent of the output.

TABLE 1.—Salient statistics of the salt industry [1]

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Sold or used by producers:						
Dry salt:						
Evaporated (manufactured) thousand short tons	3,510	3,722	3,976	4,018	3,984	3,761
Rock salt do	4,216	4,825	5,293	5,623	5,341	5,407
Total do	7,726	8,547	9,269	9,641	9,325	9,168
Value (thousands)	$56,151	$73,308	$80,840	$88,412	$96,602	$99,484
Average per ton	$7.27	$8.58	$8.72	$9.17	$10.36	$10.85
In brine thousand short tons	10,810	12,114	13,424	14,565	14,519	12,743
Value (thousands)	$10,244	$32,180	$42,437	$47,727	[2] $52,285	$42,002
Total salt thousand short tons	18,536	20,661	22,693	24,206	23,844	21,911
Value [3] (thousands)	$66,395	$105,488	$123,277	$136,139	[2] $148,887	$141,486
Imports for consumption thousand short tons	[2] 33	161	186	368	[2] 651	611
Value (thousands)	[2] $105	$879	$1,161	$2,354	[2] $3,523	$3,368
Exports thousand short tons	318	385	407	336	391	363
Value (thousands)	$2,883	$3,086	$3,023	$2,464	$2,591	$2,273
Apparent consumption thousand short tons	[2] 18,251	20,437	22,472	24,238	[2] 24,104	22,159
World: Production thousand short tons	59,035	66,700	71,200	74,200	77,350	81,800

[1] Includes Hawaii (1952–58).
[2] Revised figure.
[3] Values are f.o.b. mine or refinery and do not include cost of cooperage or containers.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

Over 1 million tons of salt was produced by each of 5 plants; 7 plants reported production ranging from 500,000 to 1 million tons each; and 33 plants each produced 100,000 to 500,000 tons. Of the remaining plants, 26 produced less than 10,000 tons each.

The portion of the total salt produced and used as brine decreased from 61 percent in 1957 to 58 percent in 1958.

TABLE 2.—Salt sold or used by producers in the United States [1]

State	1957		1958	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
California	1,330	8,721	1,297	(2)
Kansas	1,018	10,353	1,073	11,348
Louisiana	3,461	18,944	3,442	18,960
Michigan	5,225	41,072	4,267	33,018
New Mexico	53	429	31	275
New York	3,691	28,002	3,896	30,609
Ohio	2,825	16,936	2,443	17,443
Oklahoma	7	63	4	41
Texas	4,612	17,104	3,843	15,114
Utah	221	2,013	184	2,275
West Virginia	648	2,642	627	2,784
Other States [3]	763	[4] 2,712	805	9,633
Total [1]	23,854	[4] 148,991	21,912	141,500

[1] Includes Puerto Rico as follows: 1957: 10,000 tons, $104,000; 1958: 1,000 tons, $14,000.
[2] Included with "Other States" to avoid disclosing individual company confidential data.
[3] Includes States indicated by footnote 2, and Alabama, Colorado, Hawaii, Nevada, and Virginia.
[4] Revised figure.

TABLE 3.—Salt sold or used by producers [1] in the United States, by methods of recovery

Method of recovery	1957		1958	
	Short tons (thousand)	Value (thousand dollars)	Short tons (thousand)	Value (thousand dollars)
Evaporated:				
Bulk:				
Open pans or grainers	400	11,005	327	9,300
Vacuum pans	2,159	36,665	1,982	39,965
Solar	1,146	6,583	1,173	6,695
Pressed blocks	289	6,064	280	6,413
Rock:				
Bulk	5,286	35,062	5,354	35,753
Pressed blocks	55	1,327	53	1,372
Salt in brine (sold or used as such)	14,519	[2] 52,285	12,743	42,002
Total	23,854	[2] 148,991	21,912	141,500

[1] Includes salt sold or used in Hawaii and Puerto Rico.
[2] Revised figure.

CONSUMPTION AND USES

Apparent consumption of salt was about 8 percent less than in the preceding year. Chlorine manufacturing continued as the most important single market for salt during the past 4 years. In soda ash manufacture, formerly the most important use of salt, less salt was consumed for the second consecutive year.

State and local governments consumed substantially greater quantities of salt, chiefly for road stabilization and ice and snow removal from highways. Chemicals other than chlorine and caustic consumed over 1 million tons of salts. The consumption of salt in all chemicals, including chlorine and caustic, was about 68 percent of the total output in 1958.

TABLE 4.—Evaporated salt sold or used by producers in the United States [1]

State	1957		1958	
	Thousand short tons	Value (thousand dollars)	Thousand short tons	Value (thousand dollars)
Kansas	372	7,260	373	7,963
Louisiana	128	2,692	131	2,959
Michigan	835	16,747	826	17,145
New York	(2)	(2)	(2)	(2)
Oklahoma	7	63	4	41
Texas	127	2,931	118	3,215
Utah	(2)	(2)	176	2,225
Other States [3]	2,525	30,624	2,134	28,825
Total [1]	3,994	60,317	3,762	62,373

[1] Includes Puerto Rico as follows: 1957: 10,000 tons, $104,000; 1958: 1,000 tons, $14,000.
[2] Included with "Other States" to avoid disclosing individual company confidential data.
[3] Includes States indicated by footnote 2, and California, Hawaii, Nevada, New Mexico, Ohio, and West Virginia.

TABLE 5.—Rock salt sold by producers in the United States

Year	Thousand short tons	Value (thousand dollars)	Year	Thousand short tons	Value (thousand dollars)
1949–53 (average)	4,216	21,431	1956	5,623	36,040
1954	4,825	28,320	1957	5,341	36,389
1955	5,293	31,978	1958	5,407	37,125

TABLE 6.—Pressed-salt blocks sold by original producers of salt in the United States

Year	From evaporated salt		From rock salt		Total	
	Short tons (thousand)	Value (thousand dollars)	Short tons (thousand)	Value (thousand dollars)	Short tons (thousand)	Value (thousand dollars)
1949–53 (average)	278	3,828	65	757	343	4,585
1954	284	4,929	60	1,012	344	5,941
1955	286	5,070	57	1,038	343	6,108
1956	269	4,968	52	994	321	5,962
1957	289	6,064	55	1,327	344	7,391
1958	280	6,413	53	1,372	333	7,785

TABLE 7.—Salt sold or used by producers in the United States, by classes and consumers or uses, in thousand short tons

Consumer or use	1957				1958			
	Evaporated	Rock	Brine	Total	Evaporated	Rock	Brine	Total
Chlorine	648	1,314	6,734	8,696	469	1,226	6,034	7,729
Soda ash	(1)		(1)	7,221	(1)	(1)	6,164	6,180
Textile and dyeing	64	135		199	68	145		213
Soap (including detergents)	36	6		42	32	6		38
All other chemicals	171	420	452	1,043	158	454	445	1,057
Meatpackers, tanners, and casing manufacturers	(1)	486	(1)	884	(1)	(1)		799
Fishing	25	11		36	25	9		34
Dairy	57	6		63	52	7		59
Canning	173	36		209	172	50		222
Baking	111	4		115	109	4		113
Flour processors (including cereal)	55	3		58	57	3		60
Other food processing	77	32		109	65	24		89
Ice manufacturers and cold-storage companies	(1)	43	(1)	79	(1)	(1)		71
Feed dealers	575	267		842	566	292		858
Feed mixers	171	65		236	158	55		213
Metals	(1)	67	(1)	150	(1)	(1)		127
Ceramics (including glass)	(1)	(1)		18	(1)	(1)		24
Rubber	(1)	144	(1)	209	(1)	54	(1)	103
Oil	(1)	72	(1)	127	(1)	68	(1)	124
Paper and pulp	(1)	94	(1)	135	(1)	104	(1)	141
Water-softener manufacturers and service companies	(1)	252	(1)	383	(1)	198	(1)	319
Grocery stores	582	151		733	572	161		733
Railroads	14	55		69	11	46		57
Bus and transit companies	(1)	(1)		38	(1)	(1)		35
States, counties, and other political subdivisions (except Federal)	(1)	1,456	(1)	1,544	(1)	(1)		1,706
U.S. Government	22	18		40	22	21		43
Miscellaneous	420	156		576	516	(1)	(1)	765
Undistributed [2]	793	48	7,333		710	2,480	100	
Total	3,994	5,341	14,519	23,854	3,762	5,407	12,743	21,912

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.
[2] Includes some exports and consumption in Territories, oversea areas administered by the United States and Puerto Rico.

PRICES

Prices quoted in Oil, Paint and Drug Reporter for rock and table salt, vacuum, common fine, increased slightly in the early part of 1958 and were steady through the remainder of the year. In January the price of rock salt in paper bags, carlots, f.o.b. New York, was quoted at $1.07½ per 100 pounds; table salt, vacuum, common fine, on the same basis, was quoted at $1.32½. These prices increased in February to $1.09 and $1.34 for rock and table salt, respectively, and continued at this level to the end of the year.

The average value of dry salt was $10.85—a 5-percent increase over 1957. Salt in brine averaged $3.30 per ton of contained salt—an 8-percent decrease compared with 1957.

TABLE 8.—Distribution (shipments) of evaporated and rock salt produced in the United States,[1] by destination, in thousand short tons

Destination	1957		1958	
	Evaporated	Rock	Evaporated	Rock
Alabama	23	224	22	170
Arizona	14	14	14	13
Arkansas	11	57	18	27
California	539	103	648	78
Colorado	77	22	61	20
Connecticut	12	41	12	62
Delaware	7	4	7	5
District of Columbia	5	4	5	3
Florida	17	47	18	57
Georgia	29	62	35	65
Idaho	27	2	24	2
Illinois	234	327	221	287
Indiana	132	117	121	124
Iowa	131	111	115	114
Kansas	51	197	53	187
Kentucky	32	115	37	147
Louisiana	23	167	25	176
Maine	9	116	8	129
Maryland	42	94	41	89
Massachusetts	42	141	42	147
Michigan	141	261	130	229
Minnesota	131	58	118	70
Mississippi	13	44	14	51
Missouri	78	73	73	84
Montana	24	4	23	2
Nebraska	58	55	55	58
Nevada	6	132	6	137
New Hampshire	5	117	4	134
New Jersey	111	194	108	202
New Mexico	19	41	23	25
New York	189	906	184	1,035
North Carolina	68	103	73	101
North Dakota	16	9	16	8
Ohio	235	325	228	311
Oklahoma	29	32	26	31
Oregon	112	(2)	103	(2)
Pennsylvania	143	147	138	160
Rhode Island	10	15	9	14
South Carolina	16	25	18	22
South Dakota	23	15	25	14
Tennessee	39	96	42	86
Texas	93	209	63	192
Utah	43	(2)	56	5
Vermont	6	45	6	57
Virginia	97	64	72	68
Washington	329	(2)	291	(2)
West Virginia	156	84	22	96
Wisconsin	138	83	126	89
Wyoming	15	1	13	2
Other [3]	194	238	170	222
Total	3,994	5,341	3,762	5,407

[1] Production from Puerto Rico included.
[2] Included with "Other" to avoid disclosing individual company confidential data.
[3] Includes shipments to Territories, oversea areas administered by the United States, exports, and some shipments to unspecified destinations.

FOREIGN TRADE [3]

Salt imported for consumption in the United States decreased about 6 percent. The chief suppliers of imported salt were Canada with 60 and the Bahamas with 20 percent of the total. Imports from both countries decreased, but increased from the Dominican Republic and Mexico.

[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 Census.

Exports of salt from the United States decreased about 7 percent compared with 1957. About 65 percent of the exports were shipped to Canada and 32 percent to Japan.

Total salt exports were less than 2 percent of the U.S. production in 1958, and imports less than 3 percent.

Tariff.—The duty on bulk salt imported into the United States was reduced from $0.018 to $0.017 per hundred pounds, effective July 1, 1958. This was in accordance with the agreement at the 11th meeting of the Contracting Parties of the General Agreement on Tariffs and Trade at Geneva 1956. Duty on packaged salt was unchanged at $0.035 per 100 pounds.

TABLE 9.—Salt shipped to the Commonwealth of Puerto Rico and oversea areas administered by the United States

[Bureau of the Census]

Territory	1957		1958	
	Short tons	Value	Short tons	Value
American Samoa	76	$3,796	142	$5,426
Guam	59	6,059	86	9,383
Puerto Rico	10,672	828,800	12,480	999,899
Virgin Islands	167	16,281	82	10,906
Wake	1	1,753	(1)	620
Total	10,975	856,689	12,790	1,026,234

[1] Less than 1 ton.

TABLE 10.—Salt imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957		1958	
	Short tons	Value	Short tons	Value
North America:				
Bahamas	134,473	$463,112	123,847	$481,158
Canada	[1] 402,648	[1] 2,797,860	366,834	2,600,399
Dominican Republic	37,559	148,145	46,644	189,691
Jamaica	11,984	26,751	4,086	11,670
Mexico	53,541	60,766	69,631	85,389
Total	[1] 640,205	[1] 3,496,634	611,042	3,368,307
Europe: Italy	10,640	26,060		
Asia: Japan			1	152
Grand total	[1] 650,845	[1 2] 3,522,694	611,043	3,368,459

[1] Revised figure.
[2] Data known to be not comparable with 1958.

TABLE 11.—Salt imported for consumption in the United States, by classes

[Bureau of the Census]

Year	In bags, sacks, barrels, or other packages (dutiable)		Bulk (dutiable)	
	Short tons	Value	Short tons	Value
1949-53 (average)	2,855	$35,417	29,719	$101,374
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	[1] 426,596	[2] 616,344	[2] 3,096,098
1958	43,864	558,902	567,179	2,809,557

[1] Data known to be not comparable with other years.
[2] Revised figure.

TABLE 12.—Salt exported from the United States, by countries

[Bureau of the Census]

Country	1957		1958	
	Short tons	Value	Short tons	Value
North America:				
Bermuda			27	$2,270
Canada	261,109	$1,485,668	235,454	1,268,704
Central America:				
Canal Zone	145	13,476	152	11,098
Costa Rica	102	3,150	373	15,546
El Salvador	65	2,457	65	2,421
Guatemala	130	5,910	30	2,877
Honduras	485	11,500	456	12,483
Nicaragua	650	16,140	605	15,115
Panama	280	14,473	24	7,234
Mexico	4,921	180,443	3,550	142,425
West Indies:				
Bahamas	18	2,600	23	3,990
Cuba	5,858	156,970	5,681	156,639
Dominican Republic	307	22,979		
Haiti	49	5,000	59	5,145
Netherlands Antilles	446	37,265	326	28,842
Other West Indies	19	2,650	12	1,104
Total	274,584	1,960,681	246,837	1,675,893
South America	160	22,050	51	8,232
Europe	9	6,250	82	17,908
Asia:				
Japan	114,814	526,083	115,321	494,472
Korea, Republic of	144	5,214	68	2,197
Philippines	237	18,466	136	13,468
Saudi Arabia	299	19,016	262	35,078
Vietnam, Laos, and Cambodia	190	5,338	[1] 91	[1] 3,645
Other Asia	20	8,401	22	4,781
Total	115,704	582,518	115,900	553,641
Africa	10	720	4	4,618
Oceania	240	18,830	135	13,118
Grand total	390,707	2,591,049	363,009	2,273,410

[1] Laos.

WORLD REVIEW

Canada.—Construction work continued on two new salt mines—one at Pugwash, Nova Scotia,[4] and the other at Goderich, Ontario. The rock-salt mine at Malagash was scheduled to close when the new mine at Pugwash began producing.

The new mine at Goderich on Lake Huron has a 16-foot shaft penetrating a 40-foot seam of salt at a depth of 1,750 feet. Operated by Sifto Salt, Ltd. (formerly Dominion Rock Salt Co.), the new mine was expected to produce 200,000 tons annually, which would replace part of the salt imported by Sifto from the United States.[5]

Denmark.—A small production of salt from the large deposit in West Jutland was initiated by the Cheminova Corp. The salt was used in producing chlorine. Denmark continued to be a large importer of salt.[6]

TABLE 13.—World production of salt by countries,[1] 1949–53 (average), and 1954–58, in thousand short tons [2]

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

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	902	963	1,254	1,599	1,772	2,361
Costa Rica	7	4	6	[3] 6	49	[3] 33
Guatemala	14	13	18	15	18	18
Honduras	8	[3] 11	[3] 11	15	13	[3] 11
Mexico	184	247	[3] 248	[3] 265	[3] 265	[3] 265
Nicaragua	13	17	11	11	10	11
Panama	6	8	11	9	9	7
Salvador	[3] 25	42	54	55	55	[3] 55
United States:						
Rock salt	4,212	4,825	5,293	5,623	5,342	5,407
Other salt	14,337	15,845	17,411	18,593	18,512	16,504
West Indies:						
British:						
Bahamas	89	149	60	154	192	112
Leeward Islands (exports)	7	5	6	1	1	[3] 1
Turks and Caicos Islands	37	11	7	15	18	[4] 21
Cuba	61	61	71	71	75	75
Dominican Republic:						
Rock salt	3	47	20	36	51	49
Other salt	13	15	20	1	(5)	18
Haiti	[3] 26	33	33	50	[3] 11	[3] 11
Netherlands Antilles	2	[3] 3	[3] 3	1	1	[3] 1
Total	19,946	22,299	24,537	26,520	26,394	24,960
South America:						
Argentina:						
Rock salt	1	1	2	3	2	[3] 2
Other salt	442	579	432	413	359	[3] 358
Brazil	967	744	640	880	880	[3] 882
Chile	50	50	57	[3] 55	[3] 55	[3] 55
Columbia:						
Rock salt	140	190	193	214	228	241
Other salt	41	40	45	41	106	71
Ecuador	26	39	55	28	26	23
Peru	77	93	99	112	126	119
Venezuela	78	91	68	42	95	97
Total [1]	1,839	1,844	1,608	1,805	1,894	1,865

See footnotes at end of table.

[4] Canadian Mining and Metallurgical Bulletin, Review of the Mineral Industry of Nova Scotia,: Vol. 51, No. 557, September 1958, p. 547.
[5] Northern Miner, Goderich Salt Mine to Start Producing Late Next Year: Vol. 44, No. 33, Nov. 6, 1958, pp. 17, 24.
[6] U.S. Embassy, Copenhagen, Denmark, State Department Dispatch 817, Apr. 29, 1959, p. 2.

TABLE 13.—World production of salt by countries,[1] 1949–53 (average), and 1954–58, in thousand short tons—Continued

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
Europe:						
Austria:						
Rock salt	1	1	1	1	1	1
Other salt	366	395	438	481	568	567
Bulgaria	99	91	36	64	[3] 66	[3] 66
Czechoslovakia	151	150	147	[3] 169	177	[3] 176
France:						
Rock salt and salt from springs	2,526	2,716	2,837	2,139	3,109	2,971
Other salt	685	564	805	625	613	908
Germany:						
East	[3] 1,653	[3] 1,653	1,676	1,863	1,935	[3] 1,935
West (Marketable):						
Rock salt	2,507	3,142	3,361	3,591	3,598	3,558
Brine salt	308	343	369	356	357	370
Greece	98	87	79	103	99	105
Italy:						
Rock salt and brine salt	951	1,134	1,105	1,112	1,153	1,140
Other salt	1,031	817	948	946	488	370
Malta	3	3	1	2	1	[3] 2
Netherlands	463	564	645	690	804	876
Poland:						
Rock salt	755	421	424	435	417	[3] 441
Other salt		871	939	963	1,017	[3] 992
Portugal (exports)	23	2	1	4	3	3
Rumania	477	531	624	929	936	[3] 937
Spain:						
Rock salt	383	440	467	535	565	610
Other salt	865	918	874	714	926	2,509
Switzerland	121	128	134	131	144	138
U.S.S.R.[3]	6,100	7,200	7,200	7,200	7,200	7,200
United Kingdom:						
Great Britain:						
Rock salt	51	49	78	111	99	130
Other salt	4,575	4,965	5,195	5,472	5,480	5,389
Northern Ireland	13	12	14	10	8	[3] 8
Yugoslavia	133	152	150	160	163	[3] 173
Total [1] [3]	24,700	27,700	28,900	29,200	30,300	31,900
Asia:						
Aden	332	235	308	239	222	164
Afghanistan	25	29	24	25	[6] 63	[3] 66
Burma	53	107	117	96	128	122
Cambodia	29	45	96	26	[3] 33	33
Ceylon	53	57	41	121	95	20
China [3]	4,300	6,100	6,830	7,280	8,820	11,500
Cyprus	3	6	----------	[4] 6	[4] 7	[4] 6
India:						
Rock salt	6	4	6	4	4	4,558
Other salt	2,982	3,039	3,228	3,551	3,041	
Indonesia	389	143	51	120	383	303
Iran [7]	[3] 185	[3] 276	294	309	331	[3] 331
Iraq [7]	18	34	21	[3] 22	[3] 22	[3] 22
Israel	13	26	31	29	35	37
Japan	472	474	619	693	917	1,166
Jordan	4	11	9	12	11	12
Korea, Republic of	186	198	390	217	407	481
Lebanon [3]	7	4	6	6	6	3
Pakistan:						
Rock salt	169	164	157	181	174	198
Other salt	198	281	290	211	333	197
Philippines	58	53	88	71	122	154
Portuguese India	23	14	[3] 17	7	11	6
Ryukyu Islands	3	3	6	6	3	4
Syria	17	14	15	36	37	[3] 44
Taiwan	271	428	496	363	427	489
Thialand [3]	304	330	330	330	220	330
Turkey:						
Rock salt	29	29	31	33	10	40
Other salt	319	459	529	386	494	498
Vietnam	116	117	71	97	87	107
Yemen	[8] 110	110	110	28	[3] 100	----------
Total [3]	10,674	12,790	14,210	14,500	16,550	20,900

See footnotes at end of table.

TABLE 13.—World production of salt by countries,[1] 1949–53 (average), and 1954–58, in thousand short tons—Continued

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
Africa:						
Algeria	91	109	114	117	132	[3] 132
Angola	54	61	64	89	57	76
Belgian Congo	1	1	(5)	1	(5)	(5)
Canary Islands	13	1	21	19	17	[3] 17
Cape Verde Islands	20	23	24	24	24	17
Egypt	541	496	443	584	569	[3] 500
Eritrea	173	202	203	148	220	132
Ethiopia: Rock salt	15	15	17	[3] 13	[3] 13	[3] 17
French Equatorial Africa	4	7	6	[3] 6	[3] 6	[3] 6
French Somaliland	73	65	20	8	2	----------
French West Afirca [3]	60	24	11	3	3	6
Ghana [3]	24	24	24	24	24	24
Italian Somaliland [3]	3	6	6	6	4	3
Kenya	21	21	29	24	25	21
Libya	12	17	17	19	[3] 17	14
Mauritius	3	3	4	4	4	4
Morocco:						
Northern zone	(5)	10	10	[3] 11	14	[3] 13
Southern zone:						
Rock salt	10	3	18	6	57	67
Other salt	44	39	31	40		
Mozambique	11	14	17	13	[3] 13	[3] 13
South-West Africa:						
Rock salt	6	6	7	6	7	7
Other salt	30	46	58	83	66	89
Sudan	53	62	57	60	60	[3] 58
Tanganyika	9	24	26	31	29	33
Tunisia	136	182	147	149	165	176
Unganda	8	8	10	10	11	[3] 11
Union of South Africa	151	172	154	189	161	241
Total [1 3]	1,567	1,662	1,539	1,688	1,701	1,678
Oceania:						
Australia [3]	313	425	413	457	485	485
New Zealand	(5 9)	2	3	13	9	23
Total	313	427	416	470	494	508
World total (estimate) [1 2]	59,035	66,700	71,200	74,200	77,350	81,800

[1] In addition to the countries listed, salt is produced in Albania, Bolivia, Hungary, Madagascar, and Nigeria, but figures of production are not available. Estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Salt chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Exports.
[5] Less than 500 tons.
[6] Year ended Mar. 20 of year following that stated.
[7] Year ended Mar. 31 of year following that stated.
[8] Average for 1 year only, as 1953 was first year of commercial production.
[9] Average for 1952-53.

Japan.—The salt requirements of Japan were met largely by imports as only 20–25 percent was supplied by domestic production. Before World War II the chief suppliers had been China and Formosa. Since the war, salt had been obtained from several sources. Bulk-salt imports from China were resumed in 1953.[7]

Korea, Republic of.—A spring drought permitted an unusually large output of salt by solar evaporation of sea water in Korea. Increased exports were expected to absorb the surplus.

Netherlands.—A new saltworks, having a smaller capacity than the Hengelo works, was under construction at Delfzjil. It is part of a

[7] U.S. Embassy, Tokyo, Japan, State Department Dispatch 1570, June 26, 1958, p. 6.

newly developed chemical industry for producing chlorine, caustic soda, soda ash, and other chemicals from a nearby salt deposit.[8]

Yemen.—An agreement with Japan provided that half the rock-salt production of the Salif mine would be purchased by Japan. With new machinery from West Germany the mine was expected to resume production in 1959.[9]

TECHNOLOGY

A mathematical discussion of the process of recovering salt by solar evaporation of sea water was published. Significant variables in the process were enumerated, and a theory accounting for these variables was developed and expressed in simultaneous differential equations. As numerical treatment of the equations was involved, a differential analyzer was used to evaluate the equations for both "steady state" and transient operating conditions.

Among the variables encountered in operating a salt field are the following: (1) rate of natural evaporation, (2) rainfall, (3) salinity of initial sea water, (4) bittern concentration at which the salting process terminates, and (5) rate of leakage or seepage of brine from the system. Other factors that must be considered are the changing evaporation rate with increasing salinity of the brines and the variation in the seepage rate in various parts of the system.

Although a salt field may be designed by empirical methods, the procedure recommended was to calculate the ratio of the concentrating area to the crystallizing area using the equations developed by the author. The crystallizing area, where the salt is deposited, is much smaller but more expensive to construct than the concentrating ponds, where most of the water evaporates but no salt crystallizes. By calculating the ratio of these areas it is possible to have the brine reach the salting point approximately at the time it passes the boundary between the two areas. In this way the uneconomical situations are avoided in which (1) the expensive crystallizing area is used for concentrating the brine, and (2) salt is precipitated in the concentrating ponds, where it is unrecoverable.

The equations also may be used for calculating actual areas of crystallizing and concentrating ponds required for a given rate of salt production as well as the "recovery time" or time required for the system to reach a steady state following a change in one of the parameters.[10]

The operation of the solar salt installation of the firm Exportadora de Sal on the Pacific coast of Mexico, 400 miles south of San Diego, was described in an article.[11] Natural topography in the area permits flooding of a lagoon with sea water several times each year. Through solar evaporation a strong brine is produced; it flows through a 12-mile ditch to a crystallizing area, where the salt is harvested periodi-

[8] Chemical and Engineering News, The Netherlands Chemical Industry: Vol. 36, No. 1, Jan. 6, 1958, p. 103.
Chemical Age (London), New Dutch Salt Works Under Construction: Vol. 79, No. 2031, June 14, 1958, p. 1121.

[9] U.S. Embassy, Aden, Yemen, State Department Dispatch 145, Apr. 3, 1959, p. 9.

[10] Myers, D. M., and Bonython, C. W., The Theory of Recovering Salt From Sea Water by Solar Evaporation: Jour. Appl. Chem., vol. 8, pt. 4, April 1958, pp. 207–219.

[11] Chemical and Engineering News, vol. 36, No. 2, Jan. 13, 1958, pp. 62, 63.

cally. After a salt-water wash, the crystallized salt is dumped in a large stockpile, from which it moves by means of a 54-inch belt conveyer to a shuttle-boom-conveyer, 276 feet long. The salt drops from the boom through a telescopic chute into the holds of ships. The loading equipment, reported to be capable of delivering 2,000 tons per hour, is under remote control from an operator stationed on the ship being loaded.

Operation of the Detroit mine of the International Salt Co. was described. The mine extends over 300 acres 1,137 feet below the southwest section of the City of Detroit. Salt is mined by the room-and-pillar system; rooms are 60 feet wide and 22 feet high. After undercutting and blasting, the broken salt is loaded by electric shovels on to 20-ton trucks and hauled to a primary crusher. From this point the salt moves by conveyer to other crushers and screens for further preparation before being hoisted to the surface or stored in a large underground storage area. Preventive maintenance was stressed as being the key to optimum operating efficiency.[12]

The use of diesel-powered equipment in the Canadian salt mine, opened at Ojibway in 1955, was evaluated in an article.[13] A flat seam of high-purity halite is mined by the room-and-pillar method 975 feet below the surface. Rooms are 50 feet wide and 21 feet high. Diesel equipment includes mobile scalers and powder loaders, dump trucks, and utility vehicles. All engines are equipped with scrubbers containing water and crushed limestone through which the exhaust is passed. The scrubbers serve primarily as exhaust coolers. Experience at the mine has shown that adequate ventilation is the primary requirement in using diesel equipment safely underground; in addition, fuel must meet specifications, and the motors must be maintained at high efficiency.

The investment cost of a small plant capable of producing 35 tons per day of pure dry salt was estimated at $426,000, divided about equally between equipment and buildings. Equipment and costs were itemized as follows: (1) salt evaporator and accessories, $85,000; (2) rotary filter and accessories, $16,000; (3) salt drier, $50,000; (4) pumps, $4,000; (5) settling tanks, $8,000; (6) storage bins, $10,000; and (7) piping and miscellaneous items, $25,000. The refining costs in a plant of this capacity were estimated at $12 to $17 per ton of finished salt, exclusive of brine costs.[14]

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[12] Pfau, F. W., Preventative Maintenance for Steady Operation: Min. Cong. Jour., vol. 44, No. 3, Mar. 1, 1958, pp. 42–45.

[13] O'Day, M. F., Safety With Diesels at Ojibway Rock Salt Mine: Canadian Min. Jour., vol. 79, No. 9, September 1958, pp. 107–110.

[14] Hardy, W. L., Manufacture of Sodium Chloride: Ind. Eng. Chem., vol. 49, No. 11, November 1957, pp. 59, 60a.

Sand and Gravel

By Wallace W. Key [1] and Annie Laurie Mattila [2]

PRODUCTION of sand and gravel reached a record high in 1958. Accelerated road construction under the Federal Highway Program bolstered the market in most States.

The upward trend established over the past decade in the construction industry continued in 1958 to reach a record $49 billion. Private construction accounted for $34 billion, about the same as 1957, and public construction increased slightly.

The continued high expenditure for construction was reflected by high capacity production at many operations in the sand and gravel industry. While most construction projects utilized sand and gravel to some extent, the principal contributing factors influencing consumption were highways, airfields, commercial and industrial buildings, and public utilities.

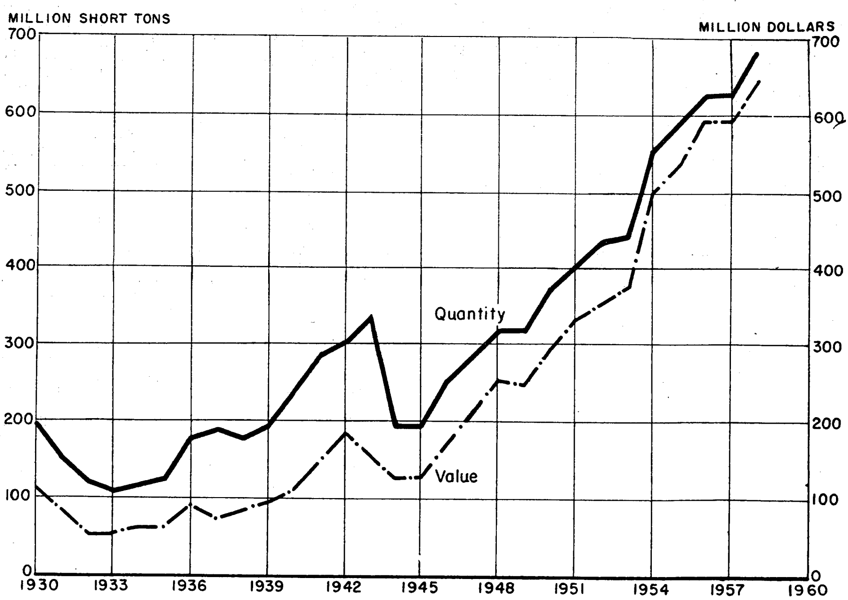

FIGURE 1.—Production and value of sand and gravel in the United States, 1930–58.

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

Economic factors influenced the development of new production techniques in order to keep pace with stricter specifications and still maintain a low-cost commodity. On the other hand, more sand and gravel producers entered the contractor field so that it was difficult to determine the primary function of some companies. Delivered price and availability of sand and gravel were factors that contributed toward increased acquisition of captive plants by heavy construction contractors to insure profitable operations.

TABLE 1.—Sand and gravel sold or used by producers in the United States,[1] by classes of operations and uses

	1957		1958	
	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)
COMMERCIAL OPERATIONS				
Sand:[2]				
Glass	[3] 6,719	[3] $19,118	5,575	$17,858
Molding	[3] 7,455	[3] 16,519	5,633	12,827
Building	[3] 100,991	[3] 100,102	98,739	99,303
Paving	[3] 64,528	[3] 59,883	69,659	66,252
Grinding and polishing[4]	1,911	5,574	1,547	5,136
Fire or furnace	585	1,274	424	952
Engine	1,286	1,797	893	1,347
Filter	391	750	659	973
Railroad ballast	764	404	381	182
Other[5]	[3] 24,646	[3] 24,729	26,674	27,724
Total commercial sand	[3] 209,276	[3] 230,150	210,184	232,554
Gravel:[6]				
Building	[3] 89,311	[3] 110,395	90,367	114,813
Paving	[3] 130,324	[3] 126,645	148,434	147,374
Railroad ballast	6,963	5,027	4,874	3,565
Other	[3] 30,385	[3] 22,733	31,182	22,023
Total commercial gravel	[3] 256,983	[3] 264,800	274,857	287,775
Total commercial sand and gravel	[3] 466,259	[3] 494,950	485,041	520,329
GOVERNMENT-AND-CONTRACTOR OPERATIONS[7]				
Sand:				
Building	[3] 2,323	[3] 1,903	1,584	1,807
Paving	24,159	12,280	28,496	15,151
Total Government-and-contractor sand	[3] 26,482	[3] 14,183	30,080	16,958
Gravel:				
Building	[3] 7,857	[3] 5,860	3,814	4,116
Paving	[3] 130,908	[3] 83,734	161,145	106,333
Total Government-and-contractor gravel	[3] 138,765	[3] 89,594	164,959	110,449
Total Government-and-contractor sand and gravel	[3] 165,247	[3] 103,777	195,039	127,407
ALL OPERATIONS				
Sand	[3] 235,758	[3] 244,333	240,264	249,512
Gravel	[3] 395,748	[3] 354,394	439,816	398,224
Grand total	[3] 631,506	[3] 598,727	680,080	647,736

[1] In addition the following reported outputs—Guam, 1957: 688 short tons valued at $1,450; 1958: 8,580 tons, $23,100; Panama Canal Zone, 1958: 41,006 tons, $34,616; Puerto Rico, 1957: 496,978 tons, $753,951; 1958: 475,752 tons, $762,546.
[2] Includes sand produced by railroads for their own use—1957: 177,471 tons valued at $62,489; 1958: 54,914 tons, $15,977.
[3] Revised figure.
[4] Includes blast sand as follows—1957: 916,231 tons valued at $3,756,695; 1958: 719,258 tons, $3,282,839.
[5] Includes ground sand as follows—1957: 798,052 tons valued at $7,472,633; 1958: 773,338 tons, $7,248,920.
[6] Includes gravel produced by railroads for their own use—1957: 2,806,745 tons valued at $1,523,924; 1958: 1,528,351 tons, $1,005,248.
[7] Approximate figures for States, counties, municipalities, and other Government agencies directly or under lease.

The cost of sand and gravel purchased or produced by the heavy construction contractor was often a deciding factor in the success or failure of his operation.

The Federal Aid Highway Act of 1958 provided for an immediate acceleration of the Federal Aid Highway Program by authorizing additional funds for interstate highway construction, primary and secondary systems, urban extensions, and public domain roads. Restrictive provisions of the 1956 Act were also corrected.[3]

DOMESTIC PRODUCTION

Production of sand and gravel increased 8 percent, continuing an upward trend for the ninth consecutive year. Most of the increased production was sold as paving gravel. The construction phase of the Federal Highway Program began to accelerate rapidly, along with residential construction during the latter part of 1958, counterbalancing reduced activity in other phases of construction.

Rates of production of sand and gravel for use in highway construction varied from State to State. Most States recovered rapidly from highway construction lags experienced in 1957. On the other hand, some States were still placing emphasis on right-of-way acquisition, and in some, construction was slow because of weather conditions and difficulties encountered in appropriating funds for their share of construction costs.

Commercial production.—In 1958 the commercial plant was still the main source of sand and gravel. It usually was better equipped to produce, process, stockpile, and blend the various sizes and grades required to meet the many and increasingly complex specifications. Many commercial producers began to operate additional portable plants to exploit deposits where construction of a permanent plant was not justified. This enabled the producer to assume jobsite production, relieving the contractor of this responsibility. The material produced was thereby diverted to the commercial classification.

Rigid State and Federal requirements for sand and gravel for use in highways made it seem likely that commercial producers would supply the major tonnage required, especially since many producers

TABLE 2.—Sand and gravel sold or used by producers in the United States[1]

Year	Sand		Gravel (including railroad ballast)		Total	
	Quantity (thousand short tons)	Value (thousands)	Quantity (thousand short tons)	Value (thousands)	Quantity (thousand short tons)	Value (thousands)
1949–53 (average)	144,462	$137,228	248,781	$183,876	393,243	$321,104
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] 235,190	[2] 246,276	[2] 391,305	[2] 349,919	[2] 626,495	[2] 596,195
1957	[2] 235,758	[2] 244,333	[2] 395,748	[2] 354,394	[2] 631,506	[2] 598,727
1958	240,264	249,512	439,816	398,224	680,080	647,736

[1] Includes possessions and other areas administered by the United States (1949–56).
[2] Revised figure.

[3] Public Law 85–767, 85th Congress, HR–12776, Aug. 27, 1958, 37 pp.

have entered the field as an on-the-job producer by utilizing high-capacity, semi-portable plants such as the California operation that produces a variety of products at the rate of 300 tons-per-hour.[4]

A manufacturer formerly purchased silica sand used in transite pipe and asbestos shingles throughout the country, but to insure an adequate supply of suitable sand, three new company-owned plants were started during the year.[5]

TABLE 3.—Sand and gravel sold or used by producers in the United States, by States

State	1957		1958	
	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)
Alabama	5,065	$4,883	4,128	$4,210
Alaska	6,096	8,799	4,255	3,871
Arizona	10,287	9,222	12,208	9,526
Arkansas	8,599	6,949	8,644	7,039
California	[1] 78,983	87,030	84,137	95,340
Colorado	16,400	13,994	20,626	17,842
Connecticut	4,777	5,042	5,019	5,479
Delaware	974	860	1,090	962
Florida	6,753	6,148	5,490	4,389
Georgia	2,127	2,096	2,634	2,717
Hawaii	286	538	438	1,112
Idaho	[1] 6,665	[1] 5,274	6,714	6,305
Illinois	30,151	32,572	29,866	33,453
Indiana	16,750	14,206	16,862	15,045
Iowa	12,042	8,927	12,411	10,965
Kansas	9,345	6,175	10,317	6,769
Kentucky	4,482	4,556	4,685	4,835
Louisiana	[1] 12,579	[1] 14,730	11,454	13,196
Maine	8,037	3,099	8,941	3,746
Maryland	8,679	11,594	7,864	10,312
Massachusetts	9,900	9,692	10,620	10,035
Michigan	41,838	35,144	39,871	34,616
Minnesota	28,493	19,385	29,634	21,680
Mississippi	5,172	4,344	6,545	6,240
Missouri	8,480	8,942	8,972	9,728
Montana	[1] 11,403	[1] 8,732	13,432	12,593
Nebraska	7,944	5,889	10,441	7,945
Nevada	5,233	5,190	5,503	5,311
New Hampshire	4,505	1,970	4,940	2,620
New Jersey	10,323	17,619	9,877	16,145
New Mexico	7,991	7,803	13,205	11,413
New York	25,640	26,480	24,730	27,541
North Carolina	6,829	5,724	7,044	5,880
North Dakota	7,048	4,967	11,464	6,605
Ohio	30,596	37,503	29,624	36,619
Oklahoma	4,960	4,507	7,232	5,859
Oregon	12,843	13,481	10,464	10,265
Pennsylvania	12,406	19,570	11,825	19,180
Rhode Island	1,058	1,060	2,038	1,883
South Carolina	2,647	2,571	2,946	2,858
South Dakota	14,758	8,001	14,705	9,179
Tennessee	5,617	6,641	5,612	6,671
Texas	23,685	23,427	32,871	30,808
Utah	26,958	15,485	25,304	14,379
Vermont	2,216	1,051	1,882	1,316
Virginia	6,298	8,854	7,158	10,834
Washington	[1] 20,415	[1] 17,510	24,389	20,086
West Virginia	5,354	9,893	5,253	11,729
Wisconsin	29,394	18,693	39,383	25,845
Wyoming	2,425	1,905	5,333	4,760
Total	[1] 631,506	[1] 598,727	680,080	647,736

[1] Revised figure.

[4] Utley, Harry F., Semi-Portable Jobsite Gravel Plant: Pit and Quarry, vol. 51, No. 6, December 1958, pp. 124–126.

[5] Trauffer, Walter E., J–M Captive Silica Operations Supply Pipe, Shingle Plant Needs: Pit and Quarry, vol. 51, No. 3, September 1958, pp. 92–95.

TABLE 4.—Sand and gravel sold or used by producers in the United States, in 1958, by States, uses, and classes of operations

[Commercial unless otherwise indicated]

State	Sand							
	Glass		Molding		Building			
					Commercial		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama			(1)	(1)	1,266,812	$1,076,332		
Alaska					83,978	143,629	10,163	$47,565
Arizona					1,022,000	1,204,400		
Arkansas	(1)	(1)	(1)	(1)	1,084,279	728,340	39,800	9,950
California	452,551	$1,917,073	(1)	(1)	15,602,007	18,061,390	8,785	14,796
Colorado					1,914,400	2,083,800		
Connecticut					1,194,636	1,182,724		
Delaware					54,098	62,371		
Florida			(1)	(1)	4,075,483	3,094,847		
Georgia	(1)	(1)	(1)	(1)	1,649,902	1,133,745		
Hawaii					126,226	261,042		
Idaho					236,723	332,582	3,640	5,096
Illinois	1,197,288	2,903,687	570,269	$1,508,650	4,936,861	4,697,648	1,400	500
Indiana	(1)	(1)	344,535	427,679	3,048,895	2,472,827		
Iowa			(1)	(1)	2,104,367	1,824,136		
Kansas	(1)	(1)	(1)	(1)	2,687,836	1,978,329	33,517	10,132
Kentucky					1,544,802	1,652,572		
Louisiana			(1)	(1)	1,562,865	1,431,016	85,129	63,847
Maine					233,023	234,176	3,940	1,684
Maryland	(1)	(1)			1,838,404	2,345,341		
Massachusetts			79,529	252,776	2,529,194	2,558,564		
Michigan	(1)	(1)	1,792,447	2,321,388	4,003,329	3,227,244	6,075	3,236
Minnesota	(1)	(1)	(1)	(1)	3,151,071	2,747,674	22,317	7,810
Mississippi			(1)	(1)	307,613	210,041	293,275	327,320
Missouri	376,161	999,707	80,773	176,865	2,513,104	2,054,492		
Montana					335,952	554,998	30,787	61,747
Nebraska					806,300	555,900		
Nevada	(1)	(1)	76,733	309,131	181,805	224,998	14,700	18,400
New Hampshire					171,162	178,408		
New Jersey	531,269	2,058,410	1,264,439	3,645,119	2,969,110	2,918,600		
New Mexico					1,019,200	1,204,400	62,500	167,600
New York			190,488	667,685	5,821,934	6,989,838	34,172	29,404
North Carolina					1,649,848	1,197,329	3,925	1,962
North Dakota					313,200	302,300	69,800	69,800
Ohio	(1)	(1)	304,858	1,041,347	5,030,323	5,835,703		
Oklahoma	(1)	(1)	(1)	(1)	1,395,508	1,073,686	66,000	27,000
Oregon			(1)	(1)	762,896	1,059,704		
Pennsylvania	(1)	(1)	151,243	457,555	3,488,941	4,931,685		
Rhode Island			(1)	(1)	261,116	271,473		
South Carolina	(1)	(1)			1,137,136	592,628		
South Dakota			500	1,500	346,100	365,800	49,400	49,400
Tennessee	(1)	(1)	(1)	(1)	1,218,132	1,489,945		
Texas	(1)	(1)	17,280	36,445	5,338,316	4,742,770	25,728	60,153
Utah			25,400	29,500	706,700	652,100		
Vermont					51,142	48,909		
Virginia	(1)	(1)	(1)	(1)	1,424,811	1,928,977		
Washington	17,900	122,330	2,331	13,654	1,890,731	1,957,251	648,625	791,751
West Virginia	(1)	(1)	(1)	(1)	936,348	1,216,678		
Wisconsin			63,036	126,685	2,432,039	2,004,833	57,886	21,899
Wyoming					278,300	205,000	12,500	15,600
Undistributed [1]	2,999,812	9,856,409	668,580	1,810,642				
Total	5,574,981	17,857,616	5,632,441	12,826,621	98,738,958	99,303,175	1,584,064	1,806,652
Guam								
Panama Canal Zone					41,006	34,616		
Puerto Rico	47,139	37,795					200,000	480,000

[1] Figure withheld to avoid disclosing individual company confidential data, included with "Undistributed."

TABLE 4.—Sand and gravel sold or used by producers in the United States, in 1958, by States, uses, and classes 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	579,599	$464,690						
Alaska	7,995	17,323	210,535	$551,549	(1)	(1)		
Arizona	297,100	230,500	604,500	378,600				
Arkansas	1,293,833	1,075,413	709,798	141,960				
California	7,621,767	7,447,912	2,747,521	2,629,848	187,128	$563,750	(1)	(1)
Colorado	174,400	182,000	47,700	50,200	(1)	(1)		
Connecticut	1,377,768	1,497,269	62,505	23,210				
Delaware	(1)	(1)						
Florida	676,452	519,506			(1)	(1)		
Georgia	353,701	280,338			(1)	(1)		
Hawaii	(1)	(1)	200	800				
Idaho	125,540	198,850	58,935	69,030				
Illinois	4,040,278	3,480,116	217,066	155,379	(1)	(1)	(1)	(1)
Indiana	3,077,750	2,489,318	61,024	39,554			(1)	(1)
Iowa	1,540,957	1,401,190	155,006	95,669	(1)	(1)		
Kansas	3,159,777	2,009,963	1,030,420	510,416	3,455	2,191		
Kentucky	828,699	796,304						
Louisiana	2,033,971	1,953,722	103,950	20,790	(1)	(1)		
Maine	105,402	46,783	469,689	164,262				
Maryland	2,183,717	2,722,566	17,042	5,965	35,892	120,626	(1)	(1)
Massachusetts	1,392,715	1,193,985	630,951	313,776	(1)	(1)		
Michigan	4,149,852	3,772,060	1,196,969	466,572	(1)	(1)		
Minnesota	1,781,253	1,379,148	519,764	206,046	(1)	(1)		
Mississippi	1,165,468	845,183	74,925	14,985				
Missouri	1,044,136	987,622	11,500	9,700	(1)	(1)		
Montana	30,454	42,005	190,600	154,835			312	$600
Nebraska	907,400	645,300	51,700	35,000				
Nevada	252,777	292,931	68,064	33,275			(1)	(1)
New Hampshire	175,384	138,762	608,146	230,405				
New Jersey	1,589,677	1,439,400	9,786	3.523	122,209	526,994	(1)	(1)
New Mexico	117,100	143,000	20,000	28,900				
New York	5,620,716	6,921,959	506,013	287,966				
North Carolina	283,885	214,492	2,278,160	1,145,908				
North Dakota	339,000	244,900	212,300	106,300				
Ohio	5,658,812	5,871,601	44,145	19,620	(1)	(1)	(1)	(1)
Oklahoma	1,166,239	941,428	1,428,025	417,649	4,186	11,511		
Oregon	252,638	335,724	15,730	20,214	(1)	(1)	12,376	3,780
Pennsylvania	1,878,762	2,809,596	161,589	78,770	(1)	(1)	102,852	346,038
Rhode Island	331,598	255,949	82,290	77,963			17,110	10,200
South Carolina	391,486	175,953	34,295	13,988	(1)	(1)	(1)	(1)
South Dakota	266,100	237,000	474,500	310,400				
Tennessee	583,737	776,077			(1)	(1)	(1)	(1)
Texas	4,830,464	3,944,014	753,572	249,829	88,732	544,061	1,500	3,000
Utah	556,100	524,000	369,400	86,900				
Vermont	237,881	145,343	185,690	115,740				
Virginia	1,077,708	1,145,371	139,596	75,589	670	737		
Washington	849,021	805,767	159,272	81,758	(1)	(1)		
West Virginia	1,028,377	1,184,291			59	186	43,095	63,457
Wisconsin	1,740,421	1,381,731	11,765,687	5,721,199	(1)	(1)		
Wyoming	56,800	65,100	7,200	7,200	2,700	3,700		
Undistributed [1]	423,899	578,592			1,101,451	3,362,021	246,820	525,002
Total	69,658,566	66,252,047	28,495,760	15,151,242	1,546,482	5,135,777	424,065	952,077
Guam			8,580	23,100				
Panama Canal Zone								
Puerto Rico	79,762	59,802	20,965	34,677				

[1] Figure withheld to avoid disclosure of individual company confidential data; included with "Undistributed."
[2] Includes 719,258 tons of blast sand valued at $3,282,839.

TABLE 4.—Sand and gravel sold or used by producers in the United States, in 1958, by States, uses, and classes 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	41,852	$27,275			(1)	(1)	(1)	(1)
Alaska	(1)	(1)						
Arizona	(1)	(1)					(1)	(1)
Arkansas			135	$175			51,342	$73,953
California	85,314	165,660	163,579	76,542	3,398	$2,270	3,881,256	3,621,550
Colorado	(1)	(1)	(1)	(1)	(1)	(1)	41,700	29,900
Connecticut			(1)	(1)	(1)	(1)	119,910	61,500
Delaware	36,806	22,083						
Florida			9,404	11,014			(1)	(1)
Georgia	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Hawaii							(1)	(1)
Idaho							52,468	15,925
Illinois	74,886	133,311	(1)	(1)	(1)	(1)	822,668	2,786,833
Indiana	79,279	75,171	2,900	4,350	4,400	2,200	(1)	(1)
Iowa	(1)	(1)	(1)	(1)	44,867	19,306	357,554	198,878
Kansas	37,536	55,548	10,405	17,056			803,739	442,793
Kentucky	(1)	(1)					(1)	(1)
Louisiana	2,603	1,742	3,518	4,063	22,393	9,797	269,006	385,314
Maine	(1)	(1)	(1)	(1)			70,593	26,646
Maryland	(1)	(1)	1,249	1,249			(1)	(1)
Massachusetts			(1)	(1)			665,245	339,720
Michigan	41,180	44,978	19,061	12,375			1,466,011	835,761
Minnesota	(1)	(1)			(1)	(1)	285,528	464,168
Mississippi	(1)	(1)	(1)	(1)			223,457	184,105
Missouri	15,271	10,153	(1)	(1)	(1)	(1)	309,853	995,874
Montana	260	500					2,758	986
Nebraska	(1)	(1)			(1)	(1)	129,200	63,900
Nevada							70,578	130,634
New Hampshire	(1)	(1)	2,500	3,750			(1)	(1)
New Jersey	(1)	(1)	53,376	137,407			801,637	1,664,093
New Mexico							3,000	2,000
New York	(1)	(1)	26,297	37,710			790,143	573,018
North Carolina			1,600	3,200	77,546	37,016	89,450	58,248
North Dakota							62,000	32,500
Ohio	(1)	(1)	71,944	117,877	16,819	12,864	699,671	1,149,787
Oklahoma	25,399	19,572	568	3,351			384,347	775,664
Oregon	(1)	(1)			464	821	144,349	131,534
Pennsylvania	53,451	110,612	(1)	(1)			208,968	863,401
Rhode Island							68,632	51,709
South Carolina	22,233	21,596	(1)	(1)	(1)	(1)	70,522	58,974
South Dakota			87,600	87,600			15,000	7,500
Tennessee	1,045	1,306					(1)	(1)
Texas	7,647	5,793	(1)	(1)	47,082	7,418	1,436,515	1,070,884
Utah	1,200	2,300					8,000,300	4,007,500
Vermont	(1)	(1)					(1)	(1)
Virginia	35,516	46,482	29,247	44,467			543,722	657,548
Washington	(1)	(1)					198,880	87,073
West Virginia	111,385	288,347					(1)	(1)
Wisconsin	(1)	(1)	(1)	(1)	19,670	6,934	1,315,897	829,309
Wyoming							34,300	24,700
Undistributed [1]	220,320	314,257	175,552	411,412	144,374	83,045	2,184,066	5,020,091
Total	893,183	1,346,686	658,935	973,598	381,013	181,671	26,674,265	27,723,973
Guam								
Panama Canal Zone								
Puerto Rico							5,850	2,700

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[3] Includes 1,634 tons of engine sand valued at $1,250, produced by railroads for their own use.
[4] Includes 47,082 tons of ballast sand valued at $7,418, produced by railroads for their own use.
[5] Includes 6,198 tons of sand valued at $7,309, used by railroads for fills and similar purposes. Also includes 773,338 tons of ground sand valued at $7,248,920. See table 11 for ground sand.

TABLE 4.—Sand and gravel sold or used by producers in the United States, in 1958, by States, uses, and classes 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	1,244,572	$1,474,867			518,927	$646,467	135,805	$138,300
Alaska	102,913	118,024	15,112	$71,898	97,004	177,548	3,483,874	2,471,061
Arizona	1,380,600	1,335,400			1,442,600	1,098,300	7,029,900	5,065,800
Arkansas	1,346,480	1,401,289			1,660,557	1,680,223	1,638,694	1,168,495
California	17,641,205	24,143,823	25,108	32,350	18,705,404	20,875,233	13,143,597	11,854,825
Colorado	2,153,900	3,040,900	242,700	209,100	3,605,700	3,268,600	12,188,100	8,762,600
Connecticut	861,526	1,199,172			914,868	1,086,940	40,400	15,501
Delaware	17,969	25,956			(1)	(1)		
Florida	185,530	194,359			201,219	348,931		
Georgia	(1)	(1)			103,000	154,500		
Hawaii	4,340	16,900			125,502	277,745	428	1,500
Idaho	396,025	530,441	49,970	68,611	2,109,068	1,541,070	3,653,145	3,523,447
Illinois	4,486,887	4,555,864	44,467	24,937	10,205,991	9,359,698	1,222,894	911,430
Indiana	2,781,639	2,994,884	47,136	18,854	4,801,644	4,834,553	419,741	200,379
Iowa	1,501,395	2,107,962	67,303	33,419	4,289,777	3,661,341	1,963,015	1,019,616
Kansas	298,354	273,000	51,624	14,980	1,216,739	963,660	919,158	427,538
Kentucky	930,766	1,083,994			483,738	497,861	217,651	182,660
Louisiana	2,443,260	3,187,976			4,346,828	5,806,407	261,625	52,887
Maine	236,447	261,736	3,020	1,380	536,097	336,403	7,028,274	2,558,779
Maryland	1,651,672	3,157,013			1,183,618	1,329,359	354,828	129,490
Massachusetts	2,012,194	2,781,126			1,393,660	1,505,647	936,539	519,315
Michigan	3,951,430	4,579,200			14,257,891	12,743,310	8,048,858	5,248,181
Minnesota	2,566,690	3,684,639	110,892	47,426	7,744,162	6,190,110	12,588,830	6,300,241
Mississippi	808,110	661,687	257,641	639,463	2,557,303	2,668,131	305,739	109,605
Missouri	1,664,461	1,739,524	14,229	8,068	1,766,439	1,603,701	665,164	425,626
Montana	531,978	707,085	69,617	122,500	805,198	850,612	11,004,731	9,853,472
Nebraska	2,970,600	2,519,900			4,882,600	3,621,000	624,700	444,200
Nevada	105,262	147,402	187,380	267,316	837,887	727,254	3,569,994	2,846,816
New Hampshire	224,326	301,132			498,852	603,704	3,098,058	1,089,742
New Jersey	1,409,067	2,497,329			839,531	984,344	43,491	22,301
New Mexico	1,094,400	1,311,600	45,600	58,800	4,628,600	3,771,700	6,050,100	4,590,500
New York	3,998,974	5,931,042	215,280	94,815	3,017,056	3,678,928	2,551,601	1,090,480
North Carolina	1,078,351	1,546,824			855,863	963,341	594,764	486,630
North Dakota	289,900	558,400			1,648,500	998,300	8,368,300	4,225,000
Ohio	5,166,683	6,417,675	5,615	16,789	9,808,025	11,747,091	137,832	113,458
Oklahoma	223,269	247,206	22,000	10,000	690,048	561,044	1,471,043	987,652
Oregon	1,142,339	1,325,732	23,146	43,232	3,213,907	3,797,305	4,130,088	2,977,418
Pennsylvania	3,258,596	4,593,614			1,707,011	2,442,856		
Rhode Island	191,685	234,310			604,697	622,052	396,720	285,625
South Carolina	(1)	(1)			(1)	(1)		
South Dakota	234,400	291,300			1,517,300	921,000	11,504,600	6,739,800
Tennessee	1,034,475	1,392,671			1,653,101	1,474,015	543,039	354,353
Texas	5,863,839	7,364,185	147,127	110,540	8,072,432	9,517,271	4,929,976	1,684,364
Utah	673,000	621,000	45,800	63,100	2,379,200	1,994,800	2,423,400	1,332,100
Vermont	62,504	108,028			434,325	471,786	809,713	351,497
Virginia	1,455,729	2,767,734	2,635	922	2,138,450	3,446,796	86,104	96,397
Washington	3,739,678	3,668,446	2,072,265	2,124,263	3,553,884	3,379,577	9,807,502	6,222,100
West Virginia	957,112	1,218,645			769,286	951,741		
Wisconsin	2,684,881	2,498,390			8,163,302	6,015,493	9,121,519	6,057,851
Wyoming	220,500	255,800	49,100	33,300	878,000	660,500	3,631,400	3,394,300
Undistributed [1]	1,087,478	1,737,859			568,943	515,828		
Total	90,367,391	114,813,045	3,814,767	4,116,058	148,433,734	147,374,076	161,144,934	106,333,332
Guam								
Panama Canal Zone								
Puerto Rico	15,950	23,440			102,354	118,056	3,732	6,076

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[6] Includes 17,175 tons of building gravel valued at $10,907, produced by railroads for their own use.
[7] Includes 15,122 tons of paving gravel valued at $8,482, produced by railroads for their own use.

TABLE 4.—Sand and gravel sold or used by producers in the United States, in 1958, by States, uses, and classes 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	66,135	$46,341	(1)	(1)	3,992,761	$4,071,708	135,805	$138,300
Alaska	203,122	253,970	37,520	$14,400	535,183	728,504	3,719,684	3,142,068
Arizona	(1)	(1)	(1)	(1)	4,573,600	4,081,700	7,634,400	5,444,400
Arkansas	8,558	3,486	623,155	297,293	6,255,711	5,719,118	2,388,292	1,320,405
California	223,480	223,343	3,587,832	3,500,354	68,211,571	80,808,010	15,925,011	14,531,819
Colorado			230,400	170,800	8,147,800	8,820,300	12,478,500	9,021,900
Connecticut			389,202	374,668	4,915,910	5,439,973	102,905	38,711
Delaware			(1)	(1)	1,089,826	961,960		
Florida			7,336	6,550	5,489,753	4,388,552		
Georgia			(1)	(1)	2,633,947	2,717,445		
Hawaii					437,867	1,109,489	628	2,300
Idaho	2,950	2,251	25,907	18,184	2,948,681	2,639,303	3,765,690	3,666,184
Illinois	537,167	352,465	1,135,730	985,406	28,379,753	32,361,243	1,485,827	1,092,246
Indiana	432,639	345,640	1,173,488	689,821	16,333,957	14,786,026	527,901	258,787
Iowa	101,304	64,936	140,679	172,995	10,225,689	9,816,628	2,185,324	1,148,704
Kansas			51,079	48,188	8,281,928	5,805,781	2,034,719	963,066
Kentucky	(1)	(1)	54,671	28,171	4,467,443	4,652,519	217,651	182,660
Louisiana	58,633	50,545	247,605	174,117	11,003,202	13,058,611	450,704	137,524
Maine	38,790	11,978	215,086	100,935	1,436,598	1,020,159	7,504,923	2,726,105
Maryland			(1)	(1)	7,492,545	10,176,397	371,870	135,455
Massachusetts	13,500	5,000	948,595	496,760	9,052,311	9,201,537	1,567,490	833,091
Michigan	158,341	169,760	353,015	231,981	30,619,300	28,897,659	9,251,902	5,717,989
Minnesota	379,477	279,918	386,345	189,506	16,392,195	15,118,268	13,241,803	6,561,523
Mississippi	74,000	39,527	462,599	516,011	5,613,585	5,148,851	931,580	1,091,373
Missouri	(1)	(1)	134,416	117,067	8,281,045	9,284,631	690,893	443,394
Montana	323,045	143,574	106,440	99,765	2,136,397	2,400,125	11,295,735	10,192,554
Nebraska			64,300	56,800	9,764,200	7,465,800	676,400	479,200
Nevada			92,903	156,889	1,662,701	2,145,387	3,840,138	3,165,807
New Hampshire	6,450	1,249	92,554	44,858	1,234,200	1,300,000	3,706,204	1,320,147
New Jersey			223,493	193,583	9,823,619	16,119,067	53,277	25,824
New Mexico	3,800	2,400	161,000	132,500	7,027,100	6,567,600	6,178,200	4,845,800
New York	(1)	(1)	1,879,968	1,185,004	21,422,535	26,038,170	3,307,066	1,502,665
North Carolina	19,417	15,230	111,043	209,763	4,167,003	4,245,443	2,876,849	1,634,500
North Dakota	103,900	44,000	56,700	23,900	2,813,200	2,204,300	8,650,400	4,401,100
Ohio	327,975	270,911	1,996,757	2,695,570	29,436,351	36,469,441	187,592	149,867
Oklahoma			68,429	34,140	4,245,083	4,416,647	2,987,068	1,442,301
Oregon	76,195	96,542	664,146	453,664	6,294,920	7,224,069	4,168,964	3,040,864
Pennsylvania	(1)	(1)	102,764	94,322	11,663,435	19,101,200	161,589	78,770
Rhode Island			(1)	(1)	1,559,460	1,519,223	479,010	363,588
South Carolina	(1)	(1)			2,912,016	2,844,164	34,295	13,988
South Dakota	181,000	151,000	28,700	16,300	2,676,700	2,079,000	12,028,500	7,099,600
Tennessee	82,306	80,000	108,745	88,717	5,068,570	6,316,572	543,039	354,353
Texas	187,407	135,255	893,580	706,851	27,014,945	28,702,686	5,856,403	2,104,886
Utah	90,700	28,500	10,032,800	5,037,200	22,465,400	12,896,900	2,838,600	1,482,100
Vermont	3,038	1,063	(1)	(1)	886,587	848,508	995,403	467,237
Virginia					6,929,893	10,661,565	228,335	172,908
Washington	153,947	70,623	1,291,608	757,253	11,701,572	10,865,756	12,687,664	9,219,872
West Virginia	(1)	(1)	(1)	(1)	5,252,586	11,729,167		
Wisconsin	390,849	270,533	1,567,700	778,481	18,437,497	14,043,719	20,945,092	11,800,949
Wyoming	132,700	66,400	29,300	28,400	1,632,600	1,309,600	3,700,200	3,450,400
Undistributed [1]	493,425	338,846	1,404,877	1,095,666				
Total	4,874,250	3,565,286	31,182,467	22,022,833	485,040,731	520,328,481	195,039,525	127,407,284
Guam							8,580	23,100
Panama Canal Zone					41,006	34,616		
Puerto Rico					251,055	241,793	224,697	520,753

[1] Figure withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[8] Includes 1,257,714 tons of ballast gravel valued at $884,814, produced by railroads for their own use.

[9] Includes 238,340 tons of gravel valued at $101,045, used by railroads for fills and similar purposes.

Government-and-Contractor Production.—Contractors continued to go into the aggregate business at an increasing rate throughout the country, mainly influenced by highway expansion. Slightly more than one-fourth of the sand and gravel produced was classified as Government-and-contractor and went into Government construction projects, including Federal, State, and local public construction programs. Some of this was direct output by Government agencies and some by private producers who sold exclusively for use on Government projects.

To be classified as Government-and-contractor, the entire output of a private producer must have been used on contract work for Government agencies. If any part of the production was sold commercially, the entire output reverted to commercial classification.

Some roadbuilders who had been able to purchase aggregates found it necessary to produce their own. One southeastern contractor reported that since 1956 his company has set up five permanent plants and more were planned.[6]

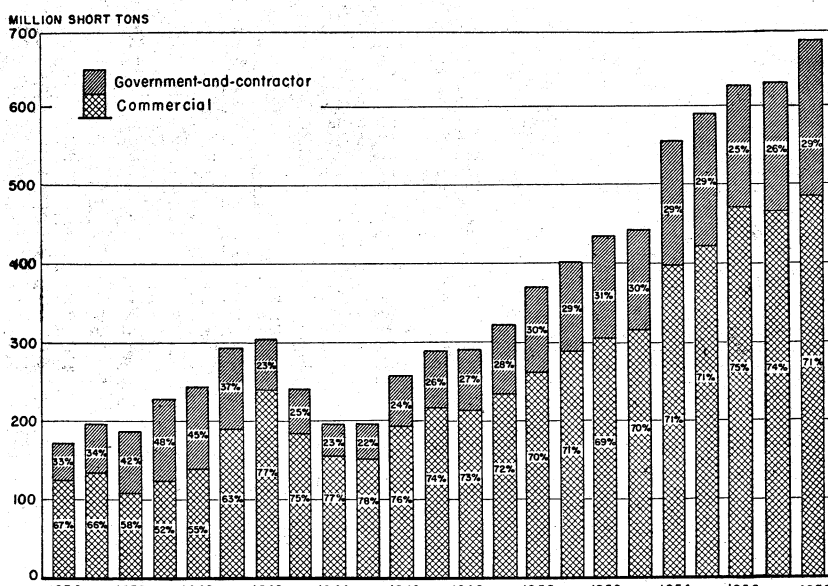

FIGURE 2.—Sand and gravel sold or used in the United States, 1936–58.

[6] Construction Methods and Equipment, Roadbuilder's Quarries Assure Ample Supply of Aggregates: Vol. 40, No. 1, January 1958, pp. 122–124, 129–131.

TABLE 5.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] by uses

Year	Sand: Building, Thousand short tons	Sand: Building, Value (thousands)	Sand: Paving, Thousand short tons	Sand: Paving, Value (thousands)	Gravel: Building, Thousand short tons	Gravel: Building, Value (thousands)	Gravel: Paving, Thousand short tons	Gravel: Paving, Value (thousands)	Total Government-and-contractor sand and gravel, Thousand short tons	Total, Value (thousands)
1949–53 (average)	1,699	$1,394	12,095	$4,808	5,724	$4,489	96,662	$42,357	116,180	$53,048
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	127,717	77,740	155,040	93,073
1957 [2]	[3] 2,323	[3] 1,903	24,159	12,280	[3] 7,857	[3] 5,860	[3] 130,908	[3] 83,734	[3] 165,247	[3] 103,777
1958 [2]	1,584	1,807	28,496	15,151	3,814	4,116	161,145	106,333	195,039	127,407

[1] Includes possessions and other areas administered by the United States (1949–56).
[2] Excludes production from Puerto Rico as follows—1957: 200,000 short tons valued at $480,000; 1958: 224,697 tons, at $520,753; and 8,580 tons at $23,100 from Guam in 1958.
[3] Revised figure.

TABLE 6.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] by types of producer

Type of producer	1949–53 (average): Thousand short tons	1949–53 (average): Value (thousands)	1954: Thousand short tons	1954: Value (thousands)	1955: Thousand short tons	1955: Value (thousands)
Construction and maintenance crews	45,423	$15,697	49,232	$18,221	46,483	$18,515
Contractors	70,757	37,351	110,372	69,547	125,594	80,169
Total	116,180	53,048	159,604	87,768	172,077	98,684
States	61,333	28,335	95,420	54,293	101,842	58,074
Counties	36,995	12,847	43,378	18,174	41,444	18,657
Municipalities	2,237	1,080	3,920	1,641	2,761	1,381
Federal agencies	15,615	10,786	16,886	13,660	26,030	20,572
Total	116,180	53,048	159,604	87,768	172,077	98,684

Type of producer	1956: Thousand short tons	1956: Value (thousands)	1957 [2]: Thousand short tons	1957 [2]: Value (thousands)	1958 [2]: Thousand short tons	1958 [2]: Value (thousands)
Construction and maintenance crews	47,592	$22,582	49,646	$24,076	49,770	$26,314
Contractors	107,448	70,491	[3] 115,601	[3] 79,701	145,269	101,093
Total	155,040	93,073	[3] 165,247	[3] 103,777	195,039	127,407
States	94,767	56,746	97,813	60,120	123,555	78,676
Counties	40,608	21,066	[3] 44,302	23,234	49,164	29,540
Municipalities	4,149	2,401	3,092	2,547	2,970	1,959
Federal agencies	15,516	12,860	[3] 20,040	[3] 17,876	19,350	17,232
Total	155,040	93,073	[3] 165,247	[3] 103,777	195,039	127,407

[1] Includes possessions and other areas administered by the United States (1949–56).
[2] Excludes the following tonnages—Guam, 1958: 8,580 short tons valued at $23,100; and Puerto Rico, 1957: 200,000 tons, at $480,000; 1958: 224,697 tons, at $520,753.
[3] Revised figure.

Degree of Preparation.—Whether large or small, the progressive producer maintained closer observation of the many variables in his market area so as to expand or modernize his facilities in accordance with the need for greater output of specification aggregates or special products.

Washed, screened, or otherwise prepared sand and gravel comprised 84 percent of commercial output. On the other hand, only 48 percent of the Government-and-contractor production was prepared. The unprepared or "bank-run" material was used principally for base courses, secondary roads, and to improve stability or drainage of subgrade. In many instances, bank-run material was definitely valuable for use in road construction; the stability achieved by compacted unwashed material was desirable.

Preparation of the materials for market became increasingly complex, requiring ore-dressing equipment on a large scale. More rigid specifications and wider use of material from inferior deposits were conditions that affected the degree of processing required.

As degree of processing added materially to the cost of the product, the average value of commercial output remained higher than that from Government-and-contractor operations, because most of the production by Government-and-contractors is used in the unprepared state.

TABLE 7.—Sand and gravel sold or used by producers in the United States, by classes of operation and degrees of preparation

	1957		1958	
	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)
Commercial operations:				
Prepared	[1] 384,784	[1] $443,616	408,014	$474,872
Unprepared	[1] 81,475	[1] 51,334	77,027	45,457
Total	[1] 466,259	[1] 494,950	485,041	520,329
Government-and-contractor operations:				
Prepared	[1] 90,251	[1] 70,415	93,615	81,167
Unprepared	74,996	33,362	101,424	46,240
Total	[1] 165,247	[1] 103,777	195,039	127,407
Grand total	[1] 631,506	[1] 598,727	680,080	647,736

[1] Revised figure.

Size of Plants.—The widespread occurrence of sand and gravel deposits and the high costs of transportation were principally responsible for increased use of semiportable and portable plants to supply local markets. The bulk of the output was contributed by large, permanent plants; however, table 8 shows that most plants were relatively small.

A growing disadvantage of the larger plant was that the wider marketing radius increased transportation charges per ton of delivered material.

The great advantage of the small portable plant was its mobility, but it often lacked the capacity to meet a variety of specifications. Designers continued to overcome many of these limitations.

The capacity of over 53 percent of all sand and gravel plants was less than 50,000 tons a year; 70 percent produced less than 100,000 tons. The number producing over 1 million tons decreased from 42 in 1957 to 38 in 1958.

TABLE 8.—Number and production of commercial sand and gravel plants by size groups[1]

Annual production (short tons)	1957				1958			
	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] 1,832	[3] 41.3	[3] 18,324	[3] 4.0	1,530	36.1	15,514	3.2
25,000 to 50,000	[3] 686	[3] 15.5	[3] 24,364	5.2	718	16.9	25,826	5.3
50,000 to 100,000	[3] 729	[3] 16.4	[3] 51,003	11.0	704	16.6	51,106	10.7
100,000 to 200,000	[3] 576	[3] 13.0	[3] 81,834	[3] 17.7	629	14.8	88,645	18.3
200,000 to 300,000	264	[3] 6.0	63,949	[3] 13.8	280	6.6	67,733	14.0
300,000 to 400,000	134	[3] 3.0	46,099	10.0	138	3.3	47,870	9.9
400,000 to 500,000	70	1.6	31,372	6.8	80	1.9	35,427	7.3
500,000 to 600,000	45	1.0	24,412	5.3	54	1.3	29,237	6.0
600,000 to 700,000	24	[3] .5	15,391	3.3	29	.7	18,856	3.9
700,000 to 800,000	16	.4	[3] 11,784	[3] 2.5	17	.4	12,694	2.6
800,000 to 900,000	17	.4	14,339	3.1	11	.3	9,044	1.9
900,000 to 1,000,000	1	(4)	[3] 988	.2	8	.2	7,629	1.6
1,000,000 and over	42	[3] .9	79,415	[3] 17.1	38	.9	73,876	15.3
Total	[3] 4,436	100.0	[3] 463,274	100.0	4,236	100.0	483,457	100.0

[1] Excludes operations by or for States, counties, municipalities, and Federal Government agencies as follows—1957: 1,639 operations with an output of 165,247,494 tons (revised figure) of sand and gravel; 1958: 2,351 operations, 195,039,525 tons. Excludes operations by or for railroads as follows—1957: 71 operations with an output of 2,984,216 tons of sand and gravel; 1958: 49 operations, 1,583,265 tons.
[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.

Methods of Transportation.—Trucks were advantageous in most instances, both because of flexibility and economy of transportation. Development continued in design of large off-the-road trucks. Adding a new dump body and four more rear axles increased the capacity of a 35-yard end dump truck to 165 tons. This unit, powered by 375 hp. diesel engines, reportedly had a full load top speed of 35 m.p.h.[7]

Transportation of sand and gravel by rail declined from 25 to 10 percent of the total production from 1949–58. Three substantial freight rate increases were granted during the past 2 years. According to Interstate Commerce Commission, sand and gravel was among the 10 most unprofitable commodities hauled by railroads. Consequently some railroad companies indicated they preferred not to haul sand and gravel. A Wisconsin producer, supported by the National Sand and Gravel Association, attempted to prove that railroad haulage of sand and gravel was profitable.[8]

[7] Engineering and Mining Journal, Dump Truck Moves 165-Ton Loads: Vol. 159, No. 9, September 1958, p. 41.
[8] Bell, Joseph N., You Can Do Something About Rising Freight Rates: Rock Products, vol. 61, No. 7, July 1958, pp. 74–77, 125, 126, 128.

TABLE 9.—Sand and gravel sold or used in the United States,[1] by method of transportation

	1956		1957		1958	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Commercial:						
Truck	[2] 342,664	55	[2] 343,865	55	380,237	56
Rail	83,737	13	87,845	14	65,753	10
Waterway	26,991	4	21,388	3	38,089	5
Unspecified	18,063	3	13,161	2	962	(3)
Total commercial	[2] 471,455	75	[2] 466,259	74	485,041	71
Government-and-contractor: Truck [4]	155,040	25	[2] 165,247	26	195,039	29
Grand total	[2] 626,495	100	[2] 631,506	100	680,080	100

[1] Includes possessions and other areas administered by the United States in 1956.
[2] Revised figure.
[3] Less than 0.05 percent.
[4] Entire output of Government-and-contractor operations assumed to be moved by truck.

Conveyors.—A 42-inch-wide conveyor belt nearly 3½ miles long was used to move a "mountain" of sand and gravel to build a Bureau of Reclamation dam on the Trinity River in northern California.[9]

Another conveyor belt system 2,500 feet long crossed a river in Ohio and brought gravel at the rate of 200 tons an hour to the processing plant from a deposit that previously had been considered virtually inaccessible.[10]

Waterway transport remained the most economical method in some areas.

More small, localized deposits were exploited by using portable equipment near the jobsite, thus reducing transportation costs.

Employment and Productivity.—A significant trend over the past decade has been the output in tons per man-shift. Automation played an increasingly important role in the sand and gravel industry as labor costs became higher. For example, a complex processing section representing a major segment of a Washington plant was operated efficiently by the rail and truck load-out operator who controlled processing from two electronic panels.[11]

Another operation in Maryland stepped up production from 250 to 700 tons-per-hour, increased the number and improved the quality of products, and reduced the number of employees from 35 to 20.[12]

The Department of Commerce published detailed contractor employment data.[13]

[9] New York Times, Rubber Road Moving A Mountain: Sept. 9, 1959, p. 49.
[10] Rock Products, Conveyor System Spans River to Connect Pit, Plant: Vol. 61, No. 2, February 1958, pp. 102–104.
[11] Rock Products, High Specification Output With Fewer Man Hours: Vol. 61, No. 2, February 1958, pp. 150–153.
[12] Trauffer, Walter E., New Sand-Gravel Plant of Campbell Sons' Corp.: Pit and Quarry, vol. 51, No. 6, December 1958, pp. 86–93.
[13] Construction Review, vol. 5, No. 4, April 1958, pp. 40–41.

TABLE 10.—Employment in the commercial sand and gravel industry and average output per man in the United States in 1958, by States [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					
				Average per man per day	Total		Per shift	Per hour	
Alabama	466	252	117, 331	8. 7	1, 019, 823	3, 543, 626	30. 2	3. 5	88. 8
Alaska	88	111	9, 767	8. 3	81, 067	535, 183	54. 8	6. 6	100. 0
Arizona	319	256	81, 641	8. 3	677, 618	4, 307, 200	52. 8	6. 4	94. 2
Arkansas	688	247	170, 172	8. 4	1, 442, 945	6, 251, 424	36. 7	4. 3	99. 9
California	3, 776	215	813, 111	8. 2	6, 667, 510	63, 754, 952	78. 4	9. 6	93. 5
Colorado	531	226	120, 223	8. 1	1, 022, 408	7, 196, 300	59. 9	7. 0	88. 3
Connecticut	261	165	43, 068	8. 4	361, 773	4, 338, 111	100. 7	12. 0	88. 2
Delaware	75	255	19, 127	8. 3	158, 751	1, 089, 826	57. 0	6. 9	100. 0
Florida	308	243	74, 810	8. 9	665, 811	5, 166, 800	69. 1	7. 8	94. 1
Georgia	252	259	65, 349	8. 5	555, 464	2, 373, 885	36. 3	4. 3	90. 1
Hawaii	120	220	26, 374	8. 4	220, 592	437, 867	16. 6	2. 0	100. 0
Idaho	236	149	35, 144	8. 3	291, 699	2, 773, 397	78. 9	9. 5	94. 1
Illinois	1, 077	244	262, 413	8. 4	2, 204, 271	16, 433, 084	62. 6	7. 5	57. 9
Indiana	593	248	147, 103	8. 3	1, 220, 958	8, 457, 204	57. 5	6. 9	51. 8
Iowa	609	208	126, 868	9. 2	1, 167, 184	6, 586, 549	51. 9	5. 6	64. 4
Kansas	511	257	131, 116	8. 7	1, 140, 707	7, 883, 538	60. 1	6. 9	95. 2
Kentucky	195	227	44, 250	9. 3	411, 521	1, 734, 443	39. 2	4. 2	38. 8
Louisiana	975	276	269, 476	9. 0	2, 425, 286	11, 003, 202	40. 8	4. 5	100. 0
Maine	221	198	43, 678	8. 7	380, 002	1, 434, 958	32. 9	3. 8	99. 9
Maryland	488	233	113, 888	8. 4	956, 659	5, 540, 945	48. 7	5. 8	74. 0
Massachusetts	479	198	94, 800	8. 3	786, 838	7, 365, 633	77. 7	9. 4	81. 4
Michigan	775	202	156, 230	8. 5	1, 327, 955	12, 022, 426	77. 0	9. 1	39. 3
Minnesota	1, 085	158	171, 419	9. 3	1, 594, 199	11, 317, 987	66. 0	7. 1	69. 0
Mississippi	429	248	106, 430	9. 4	1, 000, 440	5, 128, 372	48. 2	5. 1	91. 4
Missouri	673	230	155, 024	8. 3	1, 286, 698	8, 281, 045	53. 4	6. 4	100. 0
Montana	259	134	34, 754	8. 2	284, 981	2, 136, 397	61. 5	7. 5	100. 0
Nebraska	451	239	107, 638	9. 4	1, 011, 802	7, 600, 400	70. 6	7. 5	77. 8
Nevada	125	199	24, 836	8. 0	198, 685	1, 642, 853	66. 1	8. 3	98. 8
New Hampshire	90	140	12, 644	8. 9	112, 535	1, 227, 747	97. 1	10. 9	99. 5
New Jersey	873	248	216, 931	8. 2	1, 778, 831	8, 995, 125	41. 5	5. 1	91. 6
New Mexico	300	227	68, 074	8. 1	551, 398	3, 184, 600	46. 8	5. 8	45. 3
New York	1, 149	233	267, 867	8. 3	2, 223, 300	14, 718, 212	54. 9	6. 6	68. 7
North Carolina	326	250	81, 773	8. 8	719, 599	3, 960, 203	48. 4	5. 5	95. 0
North Dakota	108	278	20, 071	9. 2	192, 680	1, 566, 700	78. 1	8. 1	55. 7
Ohio	1, 753	229	400, 917	8. 4	3, 367, 703	23, 147, 052	57. 7	6. 9	78. 6
Oklahoma	332	244	81, 085	8. 5	689, 221	4, 245, 083	52. 4	6. 2	100. 0
Oregon	575	196	112, 511	8. 1	911, 338	6, 294, 920	55. 9	6. 9	100. 0
Pennsylvania	1, 315	221	291, 174	8. 3	2, 416, 745	11, 455, 594	39. 3	4. 7	98. 2
Rhode Island	125	218	27, 215	8. 2	223, 163	1, 552, 548	57. 0	7. 0	99. 6
South Carolina	257	237	61, 007	8 2	500, 255	2, 892, 566	47. 4	5. 8	99. 3
South Dakota	159	164	26, 102	8. 9	232, 304	1, 838, 400	70. 4	7. 9	68. 7
Tennessee	341	237	80, 708	9. 3	750, 588	3, 536, 762	43. 8	4. 7	69. 8
Texas	2, 330	267	623, 196	8. 9	5, 546, 445	27, 014, 945	43. 3	4. 9	100. 0
Utah	344	192	66, 185	8. 5	562, 574	21, 849, 900	330. 1	38. 8	97. 3
Vermont	116	207	24, 040	8. 6	206, 740	786, 201	32. 7	3. 8	88. 7
Virginia	354	256	90, 485	8. 9	805, 315	4, 590, 264	50. 7	5. 7	66. 2
Washington	737	183	134, 805	8. 0	1, 078, 441	11, 701, 572	86. 8	10. 9	100. 0
West Virginia	421	229	96, 319	8. 1	780, 182	2, 510, 411	26. 1	3. 2	47. 8
Wisconsin	751	192	143, 862	8. 7	1, 251, 598	9, 606, 452	66. 8	7. 7	52. 1
Wyoming	93	167	15, 554	7. 6	118, 208	1, 046, 300	67. 3	8. 9	64. 1
Total	28, 914	225	6, 508, 565	8. 5	55, 582, 810	384, 059, 164	59. 0	6. 9	79. 2

[1] Incomplete totals. Includes only those companies reporting employment figures and does not include plants operated by or directly for States, counties, municipalities, and Federal Government agencies.

CONSUMPTION AND USES

Construction Uses, Including Ballast.—The construction industry utilized most sand and gravel produced for buildings, paving, and related highway construction. The sand and gravel industry has more than doubled the annual tonnage and dollar volume over the past decade, paralleling expanded construction activity.

The canvass of 2,474 ready-mix concrete producers conducted by the National Ready-Mixed Concrete Association for 1957 yielded data for 1,312 operations. Results indicated that reporting companies used over 114 million tons of sand and coarse aggregate in ready-mixed concrete. Of the 64 million cubic yards of ready-mixed concrete sold by these operations, 19 million went into homebuilding, 11 million in commercial construction, 10 million in industrial construction, 8 million in streets and highways, 4 million in non-Federal public works, 3 million in Federal public works, 1 million in farm construction, and 8 million in other types of construction.[14]

The introduction of commercial jet airplanes foreshadowed increased business for construction and the aggregate industry in airport modernization.

Airport design was in a state of transition, and measures were being taken to put new plans into effect. High-speed exits, to permit jets to turn off runways at 60 to 70 miles per hour, were under construction at New York's Idlewild Airport. Washington's new $90-million Dulles International Airport reportedly will also have them. Airports within a few years reportedly will have more underpasses and cloverleafs in the runway complex—in order to make the best and fastest use of landing space.[15]

Sources of aggregates were limited in some States, nearly depleted or nonexistent in other areas, and distant from consumption centers in many sections of the country. The Bureau of Public Roads continued to insist on aggregates that insure satisfactory performance of structures and pavements, and there was a reluctance to downgrade standards in order to obtain a larger volume of materials. However, it was suggested that lower quality, locally available aggregates might be used in such applications as subbases where specifications are less critical.[16]

The Minnesota Department of Highways had a special system for controlling aggregate supplies for State projects. The Highway Department designated the source of aggregate to be used and such pits were exploited under close supervision of the project engineer for the State.[17]

Because of the possibility that the supply of aggregates in some areas may be inadequate, the Bureau of Public Roads requested its

[14] Tobin, Kenneth E., Jr., 1957 Ready Mixed Concrete Totals: Concrete, vol. 66, No. 7, July 1958, pp. 41–45.
[15] Construction Methods, Billion-Dollar Boom in Airport Construction: Vol. 40, No. 8, August 1958, p. 14.
[16] Pit and Quarry, 41st N.C.S.A. Convention Draws Record: Vol. 50, No. 10, April 1958, pp. 95–98, 105–108, 115–118.
[17] Glidden, H. K., Utilizing Pit Gravel in Highway Design and Construction: Roads and Streets, vol. 101, No. 3, March 1958, pp. 169–172.

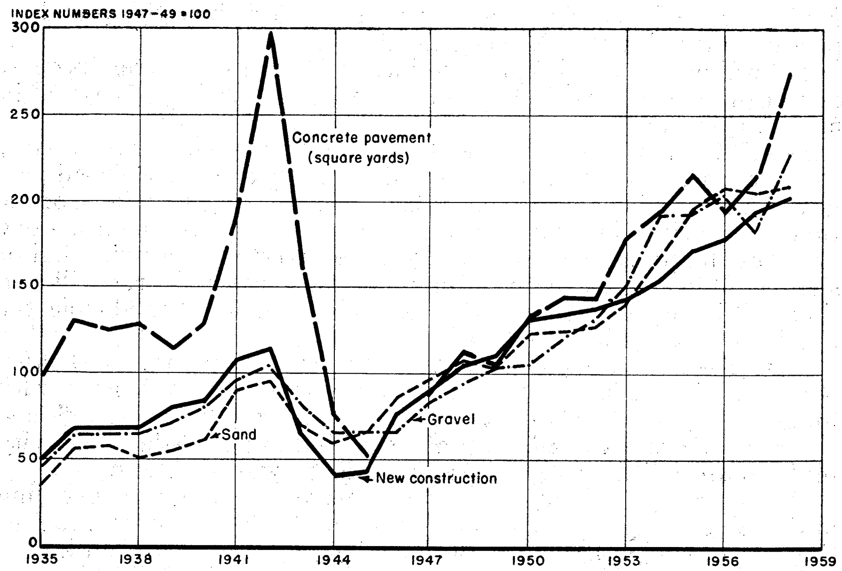

FIGURE 3.—Quantity of sand and gravel produced compared with value of total new construction, adjusted to 1947–49 prices, and total square yards of concrete pavements contracted for in the United States, 1935–58. Data on construction from Construction Review and on pavements from Survey of Current Business.

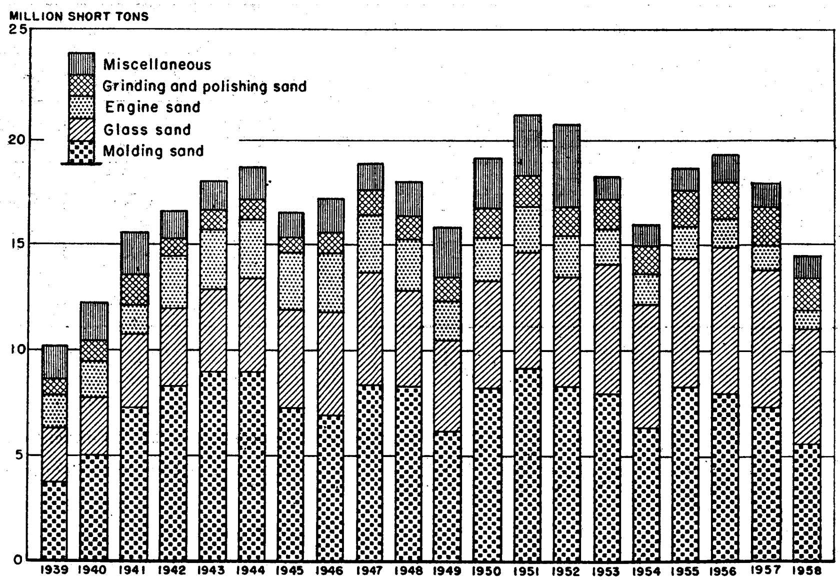

FIGURE 4.—Production of industrial sands in the United States, 1939–58.

field offices and the State highway department to investigate and report upon the situation in each State.[18]

According to an article, the engineer and road contractor in many cases can offer a lower bid if lower quality materials can be used in noncritical mixes.[19]

The Federal Highway Act of 1958 contained a number of provisions for accelerating the regular, primary, secondary, and urban road programs and provided for an emergency program. A breakdown of the funds authorized by States was published.[20] Response to an inquiry of State highway departments by a construction magazine editor showed a high degree of optimism that road contract awards will continue to increase. Some States expected to more than double the number of awards in 1958.[21]

Industrial Sands.—Sand had many important uses in the manufacturing industries. The quantity utilized in 1958 was in consonance with industrial activity. The quantity required for molding sand reflected the general cutback in the iron and steel industry. Reduced activity in the automobile industry also affected the glass sand output.

Ottawa sand was being used in about 100 paint pigment grinding mills. The new process was reported to produce pigments two to four times faster and at a third of the installation cost of pebble mills.[22]

Special Silicas.—There were several developments in chemically produced silica. Experiments were conducted on silica nose cone coatings for rockets and other applications where thermal shock resistance was necessary.[23]

TABLE 11.—Ground sand sold or used by producers in the United States,[1] by uses

Use	1957		1958	
	Short tons	Value	Short tons	Value
Abrasives	191,978	$1,716,196	184,941	$1,616,612
Enamel	25,876	263,900	29,389	282,014
Ferrosilicon				
Filler	134,163	1,196,842	85,534	682,230
Filter purposes	(2)	(2)		
Foundry uses	133,249	1,314,558	131,828	1,270,084
Glass	(2)	(2)	21,513	204,555
Pottery, porcelain, and tile	196,354	1,847,249	156,541	1,590,223
Unspecified	100,557	993,463	163,592	1,603,202
Undistributed [2]	15,875	140,425		
Total	798,052	7,472,633	773,338	7,248,920

[1] Arizona (1957 only), Arkansas (1958), California, Georgia, Illinois, Indiana (1957), Louisiana, Massachusetts, Michigan, Missouri, New Jersey, Ohio, Oklahoma, Pennsylvania, West Virginia, and Wisconsin.
[2] Figure withheld to avoid disclosure of individual company confidential data; included with "Undistributed."

[18] Trauffer, Walter E., Status of Highway Program Chief Concern at N.C.L.I. Convention: Pit and Quarry, vol. 50, No. 10, April 1958, pp. 120–122.
[19] Hudson, S. B., Practical Gradation Limits for Natural Aggregate Bituminous Concrete: Roads and Streets, vol. 101, No. 5, May 1958, pp. 115–116, 119–121, 132.
[20] American Road Builder, Digest of New Highway Law: Vol. 35, No. 5, May 1958, pp. 12–17.
[21] McKeever, Harold J., and Cronk, Duane L., Finally—A Road Building Boom: Roads and Streets, vol. 101, No. 8, August 1958, pp. 58–63, 66–67.
[22] Chemical Engineering, Sand Milling Sweeps Paint Industry: Vol. 65, No. 23, Nov. 17, 1958, p. 66.
[23] Rock Products, Quartz in Complex Shapes Can Now Be Forged to Order: Vol. 61, No. 5, May 1958, p. 11.

Silica foam developed by Pittsburgh Corning is a lightweight refractory material that resists acids. Insulation value of 1 inch of the material reportedly is equal to 18 inches of acid brick at operating temperature of 250° F.[24]

An operation began to produce silica chemically at a capacity of 7,000 to 8,000 pounds per day with a byproduct hydrogen chloride output of 3,000 tons per year. The silica was produced by combining silicon tetrachloride and hydrogen gas in a vaporizing and burning process.[25]

Hydrated silica was used as a reinforcing agent in tires as a substitute for carbon black. It was reported that silica increases treadlife about 85 percent. It was also reported that tires in various colors and hues to match the bright colors of the automobiles have already been made.[26]

Sodium silicate was another material manufactured from silica sand. It had a wide variety of applications as a sealant. Also it was perhaps the most widely used depressant in nonmetallic mineral flotation. Industry utilized 482,539 short tons of sodium silicate in 1958.[27]

PRICES

The values of the various grades of sand and gravel were computed as the value at the producer's plant. Average value of 95 cents per short ton for all types of sand and gravel remained unchanged from 1957 but the values for various uses fluctuated. The average value of sand and gravel produced by contractors remained considerably less than commercially produced material because of the degree of processing involved. In many instances, the consumer paid much more in transportation costs than the unit value of the material at the plant.

The comparative value of sand and gravel and competitive materials were reported for a number of cities.[28] Another article gave a State by State breakdown of costs for the various kinds of construction required to complete the Interstate highway system.[29]

Average wholesale prices of sand and gravel f.o.b. plant of $1.314 and $1.601, respectively, per short ton, reported for December 1958 by the Department of Commerce for selected operations were slightly higher than the corresponding period in 1957.

FOREIGN TRADE[30]

Foreign trade played a relatively small role in the sand and gravel industry. Shipments were made mostly to satisfy requirements along the borders and to provide materials for specialized uses. Examples

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[24] Chemical and Engineering News, Silica Foams, Forms Insulation: Vol. 36, No. 28, July 14, 1958, pp. 48, 51.

[25] Rock Products, Silica with Less than One-tenth of One Percent Impurities: Vol. 61, No. 8, August 1958, p. 11.

[26] Chemical and Engineering News, C-S Boosts Research: Vol. 36, No. 19, May 12, 1958, p. 25.

[27] U.S. Department of Commerce, Facts for Industry—M28A-19, Mar. 5, 1958, p. 3.

[28] Engineering News Record, vol. 161, No. 2, July 10, 1958, p. 91.

[29] Roads and Streets, How the Interstate Highway Funds Will Be Spent: Vol. 102, No. 1, January 1959, pp. 57–59, 62.

[30] 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.—Sand and gravel imported for consumption in the United States, by classes

[Bureau of the Census]

Year	Sand				Gravel		Total	
	Glass sand [1]		Sand, n.s.p.f., crude or manufactured					
	Short tons	Value [2]	Short tons	Value	Short tons	Value	Short tons	Value
1949–53 (average)	7,330	$55,011	302,084	$307,024	124,486	$20,573	433,900	$382,608
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	[3] 437,114	14,877	[3] 21,951	305,840	[3] 1,080,130
1958	6,516	223,817	317,860	485,553	7,619	7,125	331,995	716,495

[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] Data known to be not comparable with other years.

of the latter are imports of special European sands for use in glassmaking and exports of special sands for use in secondary oil recovery.

Exports to 37 countries accounted for 914,000 short tons of sand valued at $3,346,000 and 114,000 short tons of gravel valued at $198,000. Of this quantity, Canada received 737,000 short tons of sand valued at $2,368,000 and 114,000 short tons of gravel valued at $198,000.

High quality silica sand was imported from Belgium, West Germany, and Canada; lower quality imported sand was mainly from Canada.

WORLD REVIEW

Canada.—Canada imported 743,820 tons of silica sand from the United States, worth $2,407,633, in 1957.[31]

Although sand and gravel deposits are widespread in Canada, suitable material for construction and industrial applications were scarce in Saskatchewan and nearby parts of Alberta and Manitoba. The St. Lawrence Seaway continued to exert a predominating influence on aggregate production in eastern Ontario and Quebec.

TECHNOLOGY

Dense Medium Plants.—The dense medium process was first used for gravel beneficiation in 1948 by the Royal Canadian Air Force for removing shale. In 1952 Dravo Corp. opened a plant for processing Ohio River gravel. By 1958, 13 dense medium plants had been built. One such plant began operation in Illinois for removing chert from gravel during 1958.[32]

Jigs.—The first Remer jig was installed in 1954 for beneficiating gravel. Later the Baum air-operated jig was used and over 20 plants used jigs for gravel beneficiation in 1958. The operating costs of

[31] Collings, R. K., Silica in Canada, 1957: Department of Mines and Technical Surveys, Ottawa, Review 55, 8 pp.
[32] Pit and Quarry, Heavy-Media Separation Unit Installed at Illinois Quarry: Vol. 51, No. 6, December 1958, p. 26.

dense medium separation ranged between 15 to 20 cents per ton compared with 5 to 10 cents per ton for jigs.

Rising Current Classification.—The hydraulic rising current method was operated by an Ohio plant that treated up to 150 tons of gravel per hour.

Elastic Fractionation.—The elastic fractionation process developed in 1957 was being used on a commercial scale by a Michigan operation. The particles were bounced off a steel plate so that poor quality gravel with little elasticity dropped in the first compartment while the highest quality material rebounded to the third compartment.[33]

Processing equipment.—A submerged gravity separation apparatus for cleaning gravel and removing shale, coal, and similar lightweight materials was patented. It is claimed that the lightweight fraction accumulates as a layer on the gravel bed and is removed by suction.[34]

An apparatus for cleaning and separating clayey sand and gravel was patented. A mixture of water and the raw material is jetted into a rotating drum wherein blades break up and separate the materials.[35]

Design for a power driven, micro-adjustable multiple screen for sizing sand and gravel was patented. Screen clogging, or "blinding," was reportedly eliminated.[36]

A high-capacity, relatively small-sized classification mechanism for sizing sand to meet gradation requirements for concrete aggregates was patented.[37]

An operator in Wisconsin removed oversize boulders from the input conveyor by devising a set of teeth on a rotating shaft. The shaft, set at 45° to the direction of the belt, diverted the oversize into a chute.[38]

Portable Plants.—Two new simplified portable screening plants were being marketed. They consisted of single-deck buzzer screens and reciprocating plate feeders permanently mounted on a lattice frame conveyor and a hydraulic cradle.[39]

A Michigan aggregate producer grouped several portable units to produce 140 tons an hour of crushed gravel and concrete sand from a glacial deposit that contained boulders up to 15 inches in diameter.[40]

Miscellaneous Equipment.—An uneconomical bucket ladder dredge was removed and a dipper dredge installed on the same hull, thus doubling the output of sand and gravel and reducing the labor force at a dredging operation by 50 percent.[41]

A bucket drill 14 to 48 inches in diameter with a hinged bottom reportedly would allow an accurate estimate of the size, nature, and quality of the deposit. It was used to explore to a depth of 185 feet.[42]

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[33] Pit and Quarry, Cement Lightweight Aggregates, Gravel at A.I.M.E. Meeting in New York: Vol. 50, No. 10, April 1958, pp. 130–132, 152.

[34] Garland, T. F., Stratifier With Suction Separation: U.S. Patent 2,824,644, Feb. 25, 1958.

[35] Johnson, E., Gravel Separator and Scrubber: U.S. Patent 2,836,299, May 27, 1958.

[36] Edwards, F. H., Micro-Vibrating Screen: U.S. Patent 2,819,796, Jan. 14, 1958.

[37] Phipps, J. D. B., Sand Classifying Apparatus: U.S. Patent 2,840,238, June 24, 1958.

[38] Construction Methods and Equipment, Good Flow Plan Milks Profits From a Tough Pit: Vol. 40, No. 1, January 1958, pp. 96–100.

[39] Rock Products, New Machinery: Vol. 61, No. 2, February 1958, p. 198.

[40] Roads and Streets, Portable Units Do Stationary Job: Vol. 101, No. 2, February 1958, pp. 97, 126, 130, 137.

[41] Pit and Quarry, New Dipper Dredge Doubles Output of River Sand and Gravel: Vol. 50, No. 7, January 1958, pp. 138–139, 146.

[42] Heck, John J., Bucket Drill Yields Superior Data: Rock Products, vol. 61, No. 6, June 1958, pp. 103, 104, 107, 122.

A series of three comprehensive articles appraised washing and classifying equipment and discussed techniques of meeting specifications.[43]

A new silica-sand, fine grinding plant in Louisiana featured modern design, automotive control, one-man operation, specification product, and preventive maintenance.[44]

Glass.—There were many new developments in the glass industry. A new glass product was reported to have 30 percent greater resistance to thermal shock than any glass heretofore.[45]

A review of container glass compositions from 1932 to 1957 was published.[46]

Foundry.—The properties required of molding sands were reviewed, and details are given of the equipment required for sand testing together with a description of the testing techniques. Factors influencing the choice of sands are discussed.[47]

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[43] Rundquist, William A., Why Wash Aggregates: Rock Products, vol. 61, No. 8, August 1958, pp. 74–75, 125; pt. 2, vol. 61, No. 10, October 1958, pp. 92–95, 162; pt. 3, vol. 61, No. 11, November 1958, pp. 82–86, 126, 131–132.

[44] Trauffer, Walter E., J–M Captive Silica Operations Supply Pipe, Shingle Plant Needs: Pit and Quarry, vol. 51, No. 3, September 1958, pp. 92–95.

[45] Chemical and Engineering News, Glass Is More Resistant: Vol. 36, No. 25, June 23, 1958, p. 54.

[46] Lester, W. R., A Review of Container Glass Compositions: The Glass Industry, vol. 39, No. 12, December 1958, pp. 637–641, 662–664.

[47] Reparaz, J. M. Palacios, Control of Molding Sands (in Spanish): Dyna, 32, November 1957, pp. 668–669; Jour. of the Am. Ceram. Soc.—Ceramic Abstracts, vol. 41, No. 10, October 1958, p. 272.

Secondary Metals—Nonferrous

By Archie J. McDermid[1] [2]

A COMMON problem of the nonferrous secondary metals industry in 1958—as with most of the metals industry—was oversupply of primary metal, resulting from output stimulated by Federal Government inducements and higher market prices in 1957 and preceding years. Annual recoveries of all nonferrous secondary metals dropped below those of 1957. Oversupply prevailed until late in 1958 when curtailments in primary metal production began to increase the market price, and business improved for the secondary metal producers, notably those dealing in copper. The tightening of primary copper supplies was strengthened in part by labor strikes in Northern Rhodesia, Chile, and Canada, adding impetus to the demand for copper scrap. In October custom and secondary smelters and in December brass mills bought more copper scrap than in any other month. Thus the decline in copper recovery from secondary sources—5 percent below the 1957 figure—was less than in other nonferrous secondary metals.

TABLE 1.—Salient statistics of nonferrous secondary metals recovered from scrap processed in the United States

Metal	From new scrap		From old scrap		Total	
	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)
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 [1]	5,319	8,349	6,718	10,545	12,037	18,894
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 [1]		481,457		505,868		987,325
1958						
Aluminum	225,428	111,407	64,127	31,692	289,555	143,099
Antimony	2,675	1,699	16,840	10,697	19,515	12,396
Copper	386,021	203,047	411,367	216,379	797,388	419,426
Lead	58,518	13,693	343,269	80,325	401,787	94,018
Magnesium	3,933	2,773	4,774	3,366	8,707	6,139
Nickel	3,323	5,216	4,088	6,417	7,411	11,633
Tin	10,334	19,654	15,205	28,917	25,539	48,571
Zinc	160,406	32,723	69,926	14,265	230,332	46,988
Total		390,212		392,058		782,270

[1] Revised figures.

[1] Commodity specialist.

[2] The assistance of Ivy C. Roberts, statistical assistant, is acknowledged.

TABLE 2.—Secondary metals recovered as unalloyed metal, in alloys, and in chemical compounds in the United States in short tons

Metal	1949-53 (average)	1954	1955	1956	1957	1958
Aluminum	278,025	292,041	335,994	339,768	361,819	289,555
Antimony	21,863	22,358	23,702	24,106	22,565	19,515
Copper	896,865	839,907	989,004	930,664	841,887	797,388
Lead	474,120	480,925	502,051	506,755	489,229	401,787
Magnesium	10,074	8,250	10,246	10,529	10,658	8,707
Nickel	7,782	8,605	11,540	14,860	[1] 12,037	7,411
Tin	31,598	29,334	31,743	32,973	27,174	25,539
Zinc	296,664	271,774	304,775	281,355	264,104	230,332

[1] Revised figure.

Recovery of secondary lead and zinc decreased 18 and 13 percent, respectively, largely because of earlier overproduction and foreign competition. The losses in these metals were not regained, despite curtailed domestic output, as they were for copper. Import quotas in October began limiting U.S. imports to 80 percent of the yearly average for 1953–57, firming the market somewhat, but this event came too late in the year to affect the scrap-metal industry appreciably.

Recovery of secondary aluminum dropped 20 percent from 1957, reflecting in part the increased availability of primary metal and instability of the market created by Soviet offerings of this metal in the world market. Domestic primary aluminum producers manufactured considerable quantities of primary wrought and casting aluminum alloys, competing with secondary smelters and selling to aluminum rolling mills and foundries. Primary copper producers sold refined copper chiefly in unalloyed form to brass mills and foundries.

Consumption of nearly all items of nonferrous scrap declined; important exceptions were No. 2 copper scrap that increased 24 percent and low-grade scrap that increased 19 percent, both at secondary smelters.

Although copper scrap was reported to be scarce, stocks of the major kinds of nonferrous scrap increased at plants of most types of consumers. Nearly all zinc scrap items participated in a 47-percent increase in total stocks. Battery-lead-plate-scrap stocks were 87 percent higher at the end of 1958 than at the beginning, but stocks of other lead scrap, except soft lead and solder, declined. Stocks of aluminum scrap, held chiefly by secondary smelters, increased 9 percent. Stocks of copper scrap increased 3 percent, owing to activity at secondary smelters and brass mills; stocks at primary producers and foundries declined.

The prices of nonferrous scrap to consumers varied during the year according to changes in the market prices of the primary metals. Quotations for the scrap grades of lead and zinc remained comparatively unchanged throughout the year. In the New York City area heavy lead scrap averaged 8.75 cents a pound, and old zinc, 3.12 cents a pound in January 1958. In December the price of lead scrap was 8.12 cents, increasing from the low of 6.65 cents in September. The price of old zinc scrap remained stationary through September but rose to 3.62 cents in December.

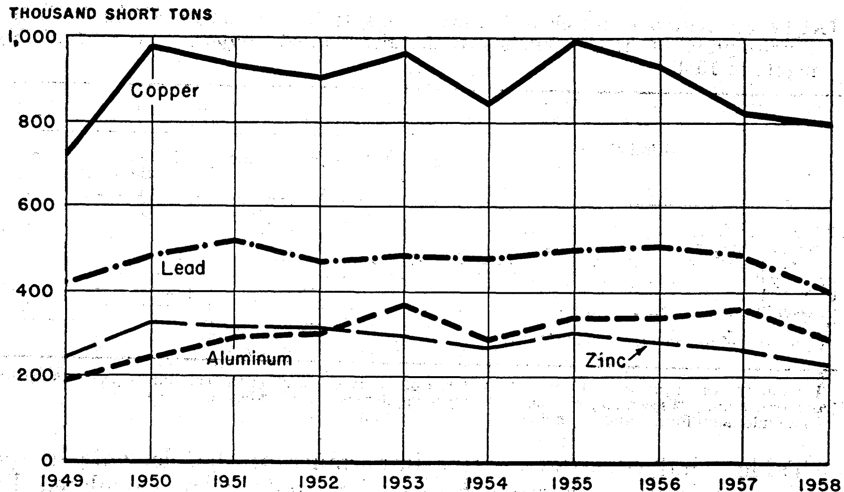

FIGURE 1.—Aluminum, copper, lead, and zinc content of total nonferrous scrap consumed in 1949–58.

Dealers bought new aluminum clippings in New York during the year at prices ranging from a high of 13.52 cents a pound in January to a low of 12.75 cents during the summer months, rising to 13.25 cents in December 1958.

Market quotations of aluminum, lead, and zinc scrap were relatively unchanged, but prices for copper scrap fluctuated more widely and frequently during the year. In January custom smelters were paying as high as 19 cents a pound for No. 2 scrap, in February, as low as 17.25 cents. The high point of the year came in October when custom smelters purchased the largest quantity (copper content) at 25 cents a pound. The price declined thereafter to about 23 cents.

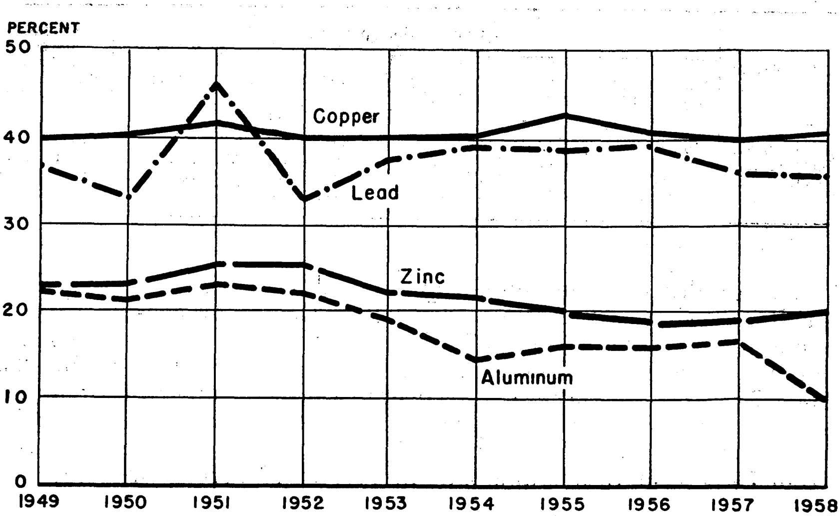

FIGURE 2.—Percentages of total consumption of aluminum, copper, lead, and zinc supplied by secondary metal, 1949–58.

TABLE 3.—Number and classification of plants in the United States reporting consumption of nonferrous scrap metals, refined copper, and copper-alloy ingots in 1958 [1]

Kind of plant	Type of material used			
	Aluminum	Copper	Lead and tin	Zinc
Primary plants	39	12	5	----
Secondary smelters	118	72	240	57
Secondary distillers	----	----	----	9
Primary distillers	----	----	----	8
Chemical plants	11	44	----	18
Brass mills	----	61	----	----
Wire mills	----	19	----	----
Foundries and miscellaneous manufacturers	[2] 135	1,744	74	44

[1] Plants indicated in each column used material of the metal heading the column in products of that base; for example, 72 secondary smelters used copper materials in copper-base products.
[2] Excludes aluminum foundries not consuming aluminum scrap.

Table 4 indicates the relative importance of the elements in the major kinds of nonferrous scrap. The data were calculated by applying composition and recovery factors to consumption totals for all items of aluminum, copper, lead, and zinc scrap reported consumed, about 100 items altogether. The largest percentage of impurities occurred in zinc scrap, principally because its residues are high in oxygen. The high percentage of impurities in lead scrap is due to the relatively low lead content of battery-plate scrap, the principal lead scrap item. Scrap items containing iron scrap and drosses and skimmings tended to increase the average impurity in copper and aluminum scrap. Although these impurities were metallurgical problems for the processors, they do not represent unrecoverable material, because the iron can often be salvaged by sweating, and the oxides that are collected as flue dust can be reprocessed.

TABLE 4.—Weighted average percentage composition of aluminum, copper, lead, and zinc scrap consumed in 1958

Kind of scrap	Composition (percent)										Total consumption, short tons
	Aluminum	Antimony	Copper	Lead	Magnesium	Nickel	Tin	Zinc	Other	Impurities	
Aluminum	76.59	----	1.92	----	0.60	0.10	----	0.78	[1] 2.51	17.50	375,976
Copper	.02	----	71.14	2.03	----	.15	0.95	9.11	----	16.60	1,109,479
Lead	----	3.73	----	72.77	----	----	1.72	----	----	21.78	520,682
Zinc	.51	----	.10	----	----	----	----	71.57	----	27.82	176,336

[1] Chiefly iron and silicon.

The grades of aluminum, copper, and lead scrap consumed by smelters, primary producers, and other classes of consumers were virtually the same as in 1957. For example, the recoverable metal content of lead scrap consumed by smelters was 78 percent in 1958 and 77 percent in 1957. The recoverable metal content of aluminum scrap consumed by primary producers was 95 percent compared with 96 percent in 1957. The grade of zinc scrap at smelters increased from 74 percent recoverable zinc in 1957 to 76 percent in 1958.

Silver

By J. P. Ryan [1] and Kathleen M. McBreen [2]

UNITED STATES mine production and consumption of silver in the arts and industries declined for the second successive year in 1958, reflecting the continued curtailment in output of silver-bearing base-metal ores and the lower level of industrial activity through much of the year. Silver imports dropped 20 percent as lend-lease returns were largely completed. The open-market price of silver remained relatively stable and fluctuated in a narrow range slightly below the fixed price of the U.S. Treasury.

Domestic mine output of silver decreased 11 percent in 1958 to 34.1 million ounces. Similarly, domestic consumption of silver dropped 11 percent to approximately 85 million ounces. Free-silver stocks rose about 75 million ounces during the year and total Treasury stocks reached 2,106 million ounces, the highest level in 10 years.

TABLE 1.—Salient silver statistics

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Mine production___thousand ounces__	38,784	36,941	37,198	[1] 38,721	38,165	34,111
Value____thousands__	$35,102	$33,434	$33,666	[1] $35,045	$34,541	$30,872
Ore (dry and siliceous) produced (thousand short tons):						
Gold ore__	2,821	2,249	2,234	2,255	2,359	2,411
Gold-silver ore__	307	46	120	245	116	107
Silver ore__	531	680	570	687	712	639
Percentage derived from—						
Dry and siliceous ores__	30	40	30	29	32	41
Base-metal ores__	70	60	70	71	68	59
Net consumption in industry and the arts____thousand ounces__	101,100	86,000	101,400	100,000	95,400	85,500
Imports [2]____do____	88,376	90,897	84,519	162,832	206,119	165,966
Exports [2]____do____	3,405	1,703	4,893	5,501	10,299	2,733
Treasury stocks (end of year) million ounces__	----------	1,935	1,930	1,981	2,014	2,106
Price, per troy ounce [3]__	$0.905+	$0.905+	$0.905+	$0.905+	$0.905+	$0.905+
World: Production____thousand ounces__	203,600	[1] 214,400	[1] 224,000	[1] 225,000	[1] 230,100	236,800

[1] Revised figure.
[2] Excludes coinage.
[3] Treasury buying price for newly mined silver.

The long-term rising trend in world production of silver continued, and estimated total output was about 4 million ounces higher than in 1957. Estimated free-world consumption in the arts and industries was 11 percent lower. The United States continued to account for

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virtually half the free-world consumption of silver (excluding coinage).

LEGISLATION AND GOVERNMENT PROGRAMS

No further action was taken on the bills introduced in the 1st session of the 85th Congress in 1957 to repeal existing silver-purchase laws. These basic laws provide for the purchase of newly mined domestic silver by the U.S. Treasury at 90½ cents an ounce and the sale of silver to domestic industry at not less than 90½ cents. A 50-percent transfer tax on profits made in trading in silver also is included in the silver-purchase law.

DOMESTIC PRODUCTION

Mine production of recoverable silver in the United States was 11 percent below 1957, again reflecting the curtailed output of base-metal ores yielding byproduct silver. A gain of 3 percent in silver output in Idaho, the leading producer, failed to offset declines in most of the other silver-producing States.

Following the pattern of 1957, about two-thirds of the domestic silver output was recovered as a byproduct of ores mined chiefly for base metals and gold. Most of the remaining one-third came from dry ores, chiefly in Idaho, in which silver was the principal product. The four leading silver-producing States, Idaho, Utah, Arizona, and Montana, again furnished more than 80 percent of the total domestic output.

Only 4 of the 25 leading silver-producing mines depended chiefly on the value of silver in the ore; at the other mines, copper, lead, and zinc, were the principal metals. The eight leading mines, each of which produced over 1 million ounces of silver, supplied 56 percent of the domestic production. The 25 leading mines together supplied 85 percent.

TABLE 2.—Silver produced in the United States according to mine and mint returns, in troy ounces of recoverable metal

	1949–53 (average)	1954	1955	1956	1957	1958
Mine	38, 784, 413	36, 941, 383	37, 197, 742	[1] 38, 721, 364	38, 164, 915	34, 111, 027
Mint	38, 947, 270	35, 584, 800	36, 469, 610	38, 739, 400	[1] 38, 720, 200	36, 800, 000

[1] Revised figure.

TABLE 3.—Mine production of silver in the United States in 1958, by months

Month	Troy ounces	Month	Troy ounces
January	2, 991, 019	August	2, 470, 745
February	2, 832, 963	September	2, 670, 967
March	2, 859, 025	October	2, 972, 226
April	2, 975, 031	November	2, 932, 297
May	2, 815, 633	December	3, 196, 501
June	2, 821, 868		
July	2, 572, 752	Total	34, 111, 027

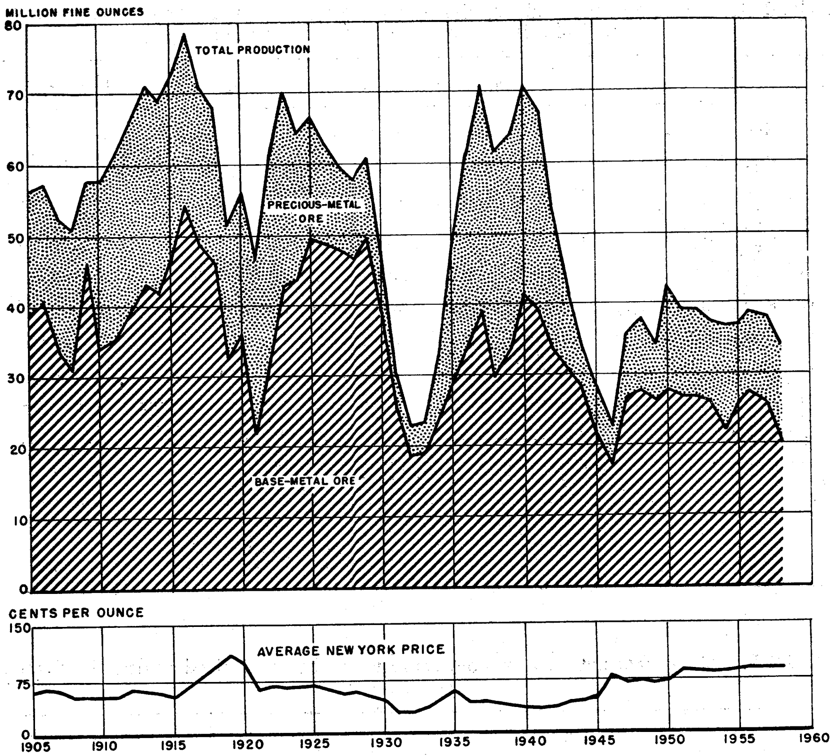

FIGURE 1.—Silver production in the United States and average price per ounce, 1905–58.

TABLE 4.—Twenty-five leading silver-producing mines in the United States in 1958, 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	Bunker Hill	Coeur d'Alene	Idaho	The Bunker Hill Co.	Lead-zinc ore.
5	United States & Lark.	West Mountain (Bingham).	Utah	U.S. Smelting, Refining, & Mining Co.	Silver, lead, lead-zinc ores.
6	Silver Summit	Coeur d'Alene	Idaho	Polaris Mining Co.	Silver ore.
7	Eagle	Red Cliff (Battle Mountain).	Colorado	The New Jersey Zinc Co.	Copper, lead-zinc ores.
8	Butte Hill Zinc Mines.	Summit Valley (Butte).	Montana	The Anaconda Co.	Do.
9	Lucky Friday	Coeur d'Alene	Idaho	Lucky Friday Silver-Lead Mines, Inc.	Lead ore.
10	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp.	Lead-zinc ore.
11	Copper Queen-Lavender Pit.	Warren	do	Phelps Dodge Corp.	Copper ore.

TABLE 4.—Twenty-five leading silver-producing mines in the United States in 1958, in order of output—Continued

Rank	Mine	District or region	State	Operator	Source of silver
12	Kelley	Summit Valley (Butte).	Montana	The Anaconda Co.	Copper ore.
13	Butte Hill Copper Mines.	do	do	do	Do.
14	Treasury Tunnel-Black-Bear-Smuggler Union.	Upper San Miguel	Colorado	Idarado Mining Co.	Copper, lead-zinc ore.
15	United Park City Mines.	Uintah	Utah	United Park Mines Co.	Lead-zinc ore.
16	Morenci	Copper Mountain	Arizona	Phelps Dodge Corp.	Gold-silver, copper ores.
17	Knob Hill	Republic	Washington	Knob Hill Mines, Inc.	Gold ore.
18	Berkeley Pit	Summit Valley (Butte).	Montana	The Anaconda Co.	Copper ore.
19	Magma	Pioneer	Arizona	Magma Copper Corp.	Do.
20	Page	Couer d'Alene	Idaho	American Smelting & Refining Co.	Lead-zinc ore.
21	New Cornelia	Ajo	Arizona	Phelps Dodge Corp.	Gold-silver, copper ores.
22	Crescent	Couer d'Alene	Idaho	The Bunker Hill Co.	Silver ore.
23	San Manuel	Old Hat	Arizona	San Manuel Copper Corp.	Copper ore.
24	Bristol	Jack Rabbit (Bristol).	Nevada	Bristol Silver Mines Co.	Do.
25	Pima	Pima	Arizona	Pima Mining Co.	Do.

TABLE 5.—Mine production of recoverable silver in the United States, by States, in troy ounces

State	1949–53 (average)	1954	1955	1956	1957	1958
Alaska	37,618	33,697	33,693	28,360	28,862	23,507
Arizona	4,893,984	4,298,811	4,634,179	5,179,185	5,279,323	4,684,580
California	1,027,409	309,575	954,181	938,139	522,288	188,260
Colorado	2,837,801	3,417,072	2,772,073	2,284,701	2,787,892	2,055,517
Idaho	14,092,041	15,867,414	13,831,458	13,471,916	15,067,420	15,952,796
Illinois	2,943	1,160	3,075	1,580		
Kentucky				31	56	99
Michigan			478,000	379,990	430,000	
Missouri	284,265	352,971	268,620	295,111	183,427	250,917
Montana	6,427,856	5,177,942	6,080,390	7,385,908	5,558,228	3,630,530
Nevada	1,191,475	560,182	845,397	[1] 993,716	958,477	932,728
New Mexico	369,466	109,132	251,072	392,967	309,385	158,758
New York	34,573	34,576	66,162	84,158	[2] 63,880	66,738
North Carolina		438	181	753	12,347	15,157
Oregon	9,655	14,335	8,815	13,542	15,924	2,728
Pennsylvania	10,237	8,415	10,379	(2)	(3)	(3)
South Dakota	132,356	151,407	154,092	136,118	134,737	152,995
Tennessee	46,651	60,759	66,619	64,878	54,407	44,592
Texas	2,239	100	126			
Utah	7,007,854	6,179,243	6,250,565	6,572,041	6,198,464	5,277,693
Vermont	37,088	48,572	50,447	[2] 47,800	36,794	5,101
Virginia	234	1,773	1,850	1,874	1,745	2,023
Washington	338,661	313,735	436,348	448,442	[3] 521,133	[3] 666,278
Wyoming	7	74	20	154	126	30
Total	38,784,413	36,941,383	37,197,742	[1] 38,721,364	38,164,915	34,111,027

[1] Revised figure.
[2] Pennsylvania and Vermont combined.
[3] Pennsylvania and Washington combined.

TABLE 6.—Ore, old tailings, etc. yielding silver, produced in the United States and average recoverable content, in troy ounces of silver per ton in 1958 [1]

State	Gold ore		Gold-Silver ore		Silver ore		Copper ore	
	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton
Alaska	40	0.925	------	------	------	------	7	14.429
Arizona	7,221	.127	69,029	0.204	51,829	0.159	56,292,640	.063
California	134,653	.343	------	------	322	17.127	4,332	[3] 27.474
Colorado	108,260	.076	3,140	1.902	477	14.751	37,621	21.364
Idaho	1,654	1.219	13	269.000	461,253	26.449	300,279	.082
Montana	14,260	2.010	3,507	9.914	28,895	4.952	10,096,767	.215
Nevada	183,423	.083	1,031	25.228	7,873	20.298	9,573,143	.042
New Mexico	4	.500	17,300	3.658	2	406.000	5,744,149	.005
Oregon	1,097	2.358	------	------	------	------	850	.089
South Dakota	1,824,436	.084	------	------	------	------	------	------
Utah	------	------	12,797	5.185	88,050	4.354	24,099,028	.089
Wyoming	3,080	.006	------	------	------	------	6	2.167
Undistributed [6]	133,306	4.625	163	1.755	171	18.684	178,832	.115
Total	2,411,434	.362	106,980	2.003	638,872	20.208	106,327,654	.087

State	Lead ore		Zinc ore		Zinc-lead, zinc-copper and zinc-lead-copper ores		Total ore	
	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton
Alaska	5	89.800	------	------	------	------	52	11.288
Arizona	6,571	8.546	14,210	0.184	367,449	[2] 2.876	56,808,949	[2] .082
California	1,643	6.282	------	------	------	------	140,950	[3] 1.284
Colorado	20,952	4.248	76	5.895	698,377	1.634	868,903	2.365
Idaho	87,874	12.682	95,462	.556	734,116	3.481	1,680,651	9.492
Montana	13,598	2.376	702,852	1.717	666	26.036	10,860,545	.334
Nevada	25,882	11.804	------	------	162	24.549	9,791,514	.093
New Mexico	10,541	.156	107,477	.268	11,844	2.956	5,891,317	.027
Oregon	------	------	------	------	------	------	1,947	1.368
South Dakota	------	------	------	------	------	------	1,824,436	.084
Utah	13,969	8.477	97,370	.110	[4] 567,754	[2,5] 4.500	[3] 24,878,968	[2,5] .212
Wyoming	------	------	------	------	------	------	3,086	.010
Undistributed [6]	111	.216	------	------	3,258,165	.045	[7] 3,570,748	[7] .221
Total	181,146	9.541	1,017,447	1.280	5,638,533	1.332	116,322,066	.291

[1] Missouri excluded.
[2] Includes silver recovered from uranium ore.
[3] Includes silver recovered from tungsten ore.
[4] Includes 70,102 tons of iron (pyrite) tailings.
[5] Includes silver recovered from iron (pyrite) tailings.
[6] Includes Kentucky, New York, North Carolina, Tennessee, Vermont, Virginia, and Washington.
[7] Excludes magnetite-pyrite-chalcopyrite ore and silver therefrom in Pennsylvania.

TABLE 7.—Mine and refinery production of silver in the United States in 1958, by States and sources, in troy ounces of recoverable metal

State	Placers	Dry ore	Copper ore	Lead ore	Zinc ore	Zinc-lead, zinc-copper, lead-copper, and zinc-lead-copper ores	Total	Refinery production [1]
Alaska	22,920	37	101	449			23,507	25,100
Arizona	10	23,248	3,545,600	56,153	2,620	[2] 1,056,949	[2] 4,684,580	5,040,300
California	7,280	51,642	[3] 119,017	10,321			[3] 188,260	217,200
Colorado	244	21,189	803,752	89,006	448	1,140,878	2,055,517	2,341,100
Idaho	213	12,205,133	24,604	1,114,409	53,064	2,555,373	15,952,796	16,130,300
Illinois								2,600
Kentucky						99	99	
Michigan								178,300
Missouri				[4] 250,917		(4)	250,917	228,000
Montana	428	206,511	2,167,491	32,310	1,206,450	17,340	3,630,530	4,528,200
Nevada	22,534	200,976	399,729	305,512		3,977	932,728	1,000,000
New Mexico		64,092	29,152	1,645	28,854	35,015	158,758	209,600
New York						66,738	66,738	66,000
North Carolina			15,157				15,157	15,800
Oregon	65	2,587	76				2,728	6,500
Pennsylvania [5]								11,560
South Dakota		152,995					152,995	152,900
Tennessee						44,592	44,592	45,510
Utah		449,687	2,143,790	118,418	10,736	[2 6] 2,555,062	[2 6] 5,277,693	6,000,000
Vermont			5,101				5,101	5,970
Virginia						2,023	2,023	2,020
Washington [7]	14	620,074	11,921	24		34,245	666,278	593,000
Wyoming		17	13				30	40
Total	53,708	13,998,188	9,265,504	1,979,164	1,302,172	7,512,291	34,111,027	36,800,000
Percent	0.2	41.0	27.2	5.8	3.8	22.0	100	

[1] U.S. Bureau of the Mint.
[2] Includes silver recovered from uranium ore.
[3] Includes silver recovered from tungsten ore.
[4] A little silver recovered from lead-copper ore from 1 mine included with that from lead ore.
[5] Included with Washington.
[6] Includes silver recovered from iron (pyrite) tailings.
[7] Includes silver recovered from magnetite-pyrite-chalcopyrite ores in Pennsylvania.

TABLE 8.—Silver produced in the United States from ore and old tailings in 1958, 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 (troy ounces)	Cyanidation (troy ounces)	Concentrates (short tons)	Troy ounces	Short tons	Troy ounces
Alaska	52	40	25		3	12	12	550
Arizona	56,808,949	56,188,380	7	27,601	1,853,529	3,882,758	620,569	774,204
California	140,950	138,725	4,512	35,012	3,103	124,416	2,225	17,040
Colorado	868,903	820,330	3,376	6,860	110,493	1,179,575	48,573	865,462
Idaho	1,680,651	1,580,909	116		192,071	15,793,742	99,742	158,725
Montana	10,860,545	10,760,621	2	955	473,606	3,414,994	99,924	214,151
Nevada	9,791,514	9,665,264	341	93,649	203,828	142,616	126,250	673,588
New Mexico	5,891,317	5,818,654	757		186,937	93,540	72,663	64,461
Oregon	1,947	1,901	35		115	2,536	46	92
South Dakota	1,824,436	1,824,436	81,034	71,961	(2)			
Utah	24,878,968	24,615,899			755,511	4,619,921	263,069	657,772
Wyoming	3,086	3,080	2		12	15	6	13
Undistributed [3]	[4] 3,570,748	[4] 3,508,375		88,667	[4] 238,787	681,312	62,373	29,995
Total	116,322,066	114,926,614	90,207	324,705	4,017,995	29,935,437	1,395,452	3,456,053

[1] Missouri excluded.
[2] Less than 1 ton.
[3] Includes Kentucky, New York, North Carolina, Pennsylvania, Tennessee, Vermont, Virginia, and Washington.
[4] Excludes magnetite-pyrite-chalcopyrite ore and concentrates therefrom in Pennsylvania

TABLE 9.—Silver produced at amalgamation and cyanidation mills in the United States and percentage of silver recoverable from all sources

Year	Bullion and precipitates recoverable (troy ounces)		Silver from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [1]	Placers
1949–53 (average)	110,639	310,203	0.3	0.8	98.7	0.2
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
1958	90,207	324,705	.3	.9	98.6	.2

[1] Both crude ores and concentrates.

TABLE 10.—Net industrial [1] consumption of silver in the United States, in thousand troy ounces

[U.S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption	Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1949–53 (average)	132,899	31,799	101,100	1956	130,000	30,000	100,000
1954	104,629	18,629	86,000	1957	133,742	38,342	95,400
1955	123,535	22,135	101,400	1958	121,500	36,000	85,500

[1] Including the arts.

CONSUMPTION AND USES

Industry and the Arts.—Domestic consumption of silver in the arts and industries declined about 10 percent in 1958 to 85.5 million ounces, according to data compiled by the U.S. Bureau of the Mint. The lower demand for industrial silver was attributed to the business recession. The United States used about 36 percent of the world output of silver.

Industrial uses accounted for about two-thirds of domestic silver consumption. The photographic industry continued to be the leading consumer, using nearly one-third of the total. Large quantities of silver solders and brazing alloys were used in the electric-appliance, air-conditioning, and automotive fields, and increasing quantities of silver brazing alloys were employed for high-temperature applications in jet aircraft and space vehicles.

The electrical industry, the third largest industrial consumer of silver, continued to expand uses of silver, especially for contacts in a wide variety of appliances. As usual, silverware and electroplating absorbed substantial quantities of silver. Other growing industrial uses for silver, which accounted for significant quantities of metal, included decorative finishes on ceramic materials, high-efficiency batteries in jet aircraft, guided missiles, and scientific instruments that require high power output with minimum size and weight.

Monetary.—A drop of 15.2 millon ounces in the quantity of silver used in U.S. coinage accounted for virtually all of the decrease in world coinage requirements, which were estimated at 63.1 million ounces [3] in 1958. The corresponding coinage consumption in 1957 was 79.2 million ounces.

TABLE 11.—U.S. monetary silver, in million ounces [1]

	1954	1955	1956	1957	1958
In Treasury:					
Securing silver certificates:					
Silver bullion	1,679.2	1,697.2	1,708.4	1,711.5	1,736.3
Silver dollars	207.0	196.1	182.8	169.4	156.8
Subsidiary coin	34.5	11.3	2.0	[2] 5.9	10.9
Free silver bullion	13.6	24.9	87.4	127.4	202.2
Total	1,934.3	1,929.5	1,980.6	[2] 2,014.2	2,106.2
Coinage in circulation:					
Silver dollars	172.5	182.0	195.1	208.3	220.8
Subsidiary coin	898.9	[2] 928.3	968.0	[2] 1,014.6	1,046.0
Total	1,071.4	[2] 1,110.3	1,163.1	[2] 1,222.9	1,266.8

[1] Compiled from circulation statements issued by the Treasury Department.
[2] Revised figure.

STOCKS

Silver stocks, comprising bullion and coin in the U.S. Treasury, increased about 4 percent to 2,106 million ounces, the highest since 1949. As in 1957, increases in bullion-securing silver certificates, subsidiary coin, and free-silver bullion rose sharply for the fourth successive year, owing principally to lend-lease returns. Silver coinage outside the Treasury continued to rise steadily. The average annual increase from 1954 to 1958 was nearly 45 million ounces.

Silver acquired by the Treasury totaled 140.3 million ounces, comprising 103.4 million ounces of lend-lease silver, 35.2 million ounces of newly mined domestic silver, 1.4 million ounces from withdrawn coins, and 0.3 million ounces from miscellaneous sources. In addition to 38.2 million ounces used in coinage, about 1.3 million ounces of silver was sold by the Treasury under the Act of July 31, 1946.

PRICES

The price paid by the U.S. Treasury for newly mined domestic silver, established in 1946 at 90.5+ cents per fine troy ounce, remained unchanged in 1958. Similarly, the official Government selling price of silver to domestic consumers also remained unchanged at 91 cents an ounce for delivery at the San Francisco Mint.

Prices on the New York silver market, continuing the trend of the past 7 years, remained relatively stable. The average open-market price declined 1.8 cents an ounce to 89 cents, fluctuating between a high of 90⅜ and a low of 88⅝ cents an ounce, 0.999 fine. The relationship of the New York open-market silver price to the fixed Treasury price and the effect of these prices on respective buying and selling policies of consumers and producers were described in the 1957 Silver chapter. As the Treasury buying price was higher than

[3] Handy & Harman, The Silver Market in 1958, p. 23.

the New York price during 1958, most of the sales by domestic producers were to the Treasury; conversely, because the price was lower at New York, consumers bought most of their silver on the New York market.

In London the market price of silver ranged from a low of 74¾ d. to a high of 78¾ d. a troy ounce, 0.999 fine, equivalent to 87.52 and 92.14 cents a troy ounce, respectively. In general, the wider price range on the London market reflected the cost of transshipping between the two principal markets, New York and London. Sales of demonetized coin by the Bank of England, aggregating about 11 million ounces also were a market price factor, as in 1957.

FOREIGN TRADE [4]

U.S. imports of silver decreased about 20 percent to 166 million ounces valued at $130 million. As in the preceding 3 years, domestic imports were largely lend-lease returns. Of the total imports about 73.5 million ounces went to industrial consumers. Western Hemisphere countries, chiefly Canada, Mexico, Peru, and Bolivia, continued to supply more than 90 percent of silver imports other than lend-lease returns.

Net imports (excess of imports over exports) excluding coin were 162.2 million ounces valued at $127.6 million, 13 percent below 1957.

Exports of silver from the United States declined sharply to 2.7 million ounces valued at $2.5 million. More than 90 percent of all exports went to Mexico and West Germany.

The reappearance of the Bank of Mexico as a buyer was a noteworthy feature of the New York market. In the London Market, the British Government continued to sell silver derived from demonetized coin.

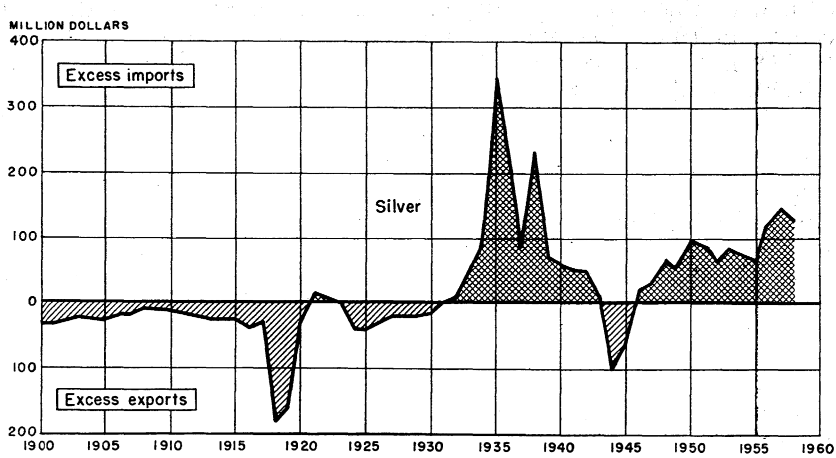

FIGURE 2.—Net imports or exports of silver, 1900–58.

[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 12.—Silver imported into the United States in 1958, by countries of origin

[Bureau of the Census]

Country of origin	In ore and base bullion		In refined bullion		United States coin value (thousand)
	Troy ounces (thousand)	Value (thousand)	Troy ounces (thousand)	Value (thousand)	
North America:					
Canada	7,258	$6,417	12,323	$10,951	[1] $1,124
Canal Zone	22	19			
Cuba	325	284			368
Dominican Republic					16
El Salvador	256	224			81
Greenland	6	5			
Guatemala	189	151			
Honduras	2,661	2,366			
Mexico	7,010	6,073	13,585	12,088	
Nicaragua	264	225			
Panama	37	34			
Total	18,028	15,798	25,908	23,039	1,589
South America:					
Argentina	248	221			
Bolivia	3,447	3,053			
Brazil	(2)	(2)			
Chile	1,472	1,310			
Columbia	954	873			
Ecuador	63	55			
Peru	10,871	9,624	4,765	4,235	
Venezuela	(2)	(2)			
Total	17,055	15,136	4,765	4,235	
Europe:					
Ireland					(2)
Malta, Gozo, and Cyprus	21	19			
Netherlands	4,331	3,080	16	14	
Portugal	50	46			
United Kingdom	78	70	329	297	14
Total	4,480	3,215	345	311	14
Asia:					
India	81,992	58,305	41	36	
Korea, Republic of	16	14			
Lebanon	116	94	35	28	
Pakistan	5,513	3,920	222	158	
Philippines	263	233			
Saudi Arabia	38	33			
Turkey	6	5			
Total	87,944	62,604	298	222	
Africa:					
Ethiopia	4,612	3,279			
Liberia					350
Rhodesia and Nyasaland, Federation of	186	166			
Union of South Africa	893	797			
Total	5,691	4,242			350
Oceania: Australia	1,452	1,291			
Grand total	134,650	102,286	31,316	27,807	1,953

[1] Includes foreign coin valued at $15,000.
[2] Less than 1,000.

TABLE 13.—Silver exported from the United States in 1958, by countries of destination

[Bureau of the Census]

Country of destination	In ore and base bullion		In refined bullion		United States coin value (thousand)	Foreign coin value (thousand)
	Troy ounces (thousand)	Value (thousand)	Troy ounces (thousand)	Value (thousand)		
North America:						
Canada	(1)	(1)	1	$1	$21	$1, 191
Cuba			16	15		3
Guatemala					1	
Mexico	1, 539	$1, 367				
Netherlands Antilles					2	
Panama						1
Total	1, 539	1, 367	17	16	24	1, 195
South America:						
Brazil			21	20		
Colombia			(1)	(1)		
Venezuela			25	24		
Total			46	44		
Europe:						
France			2	2		
Germany, West			1, 001	914		
Ireland					33	
United Kingdom	101	89	1	1		
Total	101	89	1, 004	917	33	
Asia:						
Afghanistan			3	2		
Israel			1	1		1
Turkey			22	20		
Total			26	23		1
Africa: Liberia					10	
Grand total	1, 640	1, 456	1, 093	1, 000	67	1, 196

1 Less than 1,000.

LEND-LEASE SILVER

At the end of 1958, all but 40.5 million ounces of the original 410.8 million ounces of silver supplied to foreign countries under terms of lend-lease agreements made during World War II had been repaid. Virtually all of the outstanding balance was owed by Pakistan and Saudi Arabia. The balance owed by Pakistan (18.4 million ounces), which was reported as delivered last year, has been scheduled for repayment over the next 4 years. Of the original obligation of Saudi Arabia (22.3 million ounces), 1 million ounces was reported lost in transit, leaving an outstanding balance of 21.3 million ounces at the end of 1958.

WORLD REVIEW

The rising trend in world production of silver since 1942 continued in 1958 with a 2-percent increase in output to 234 million ounces. Of the leading silver-producing countries, Canada, Bolivia, Mexico, Australia, and Japan increased output enough to more than offset lower output in Peru and the United States. Nearly two-thirds of the world output came from the Western Hemisphere.

Free-world consumption of silver in the arts and industries and for coinage was estimated at 250.5 million ounces[5]—a drop of 13 percent from 1957. In 1958, as in several preceding years, silver consumption in the free world exceeded production by a substantial margin. Decreases in silver used for industrial and artistic purposes in the United States and India and for U.S. coinage accounted for virtually all of the drop in consumption.

TABLE 14.—World production of silver, by countries,[1] in troy ounces [2] [3]

[Compiled by Augusta W. Jann and Bernice B. Mitchell]

Country	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	23,502,062	31,117,949	27,984,204	28,431,847	28,823,298	31,087,681
Central America and West Indies:						
Costa Rica [4]	303			80		
Cuba	[4] 176,523	164,235	259,440	284,202	[4] 252,728	[4] 325,278
Guatemala	312,176	283,811	343,111	533,179	528,436	320,621
Honduras	3,894,530	3,432,023	1,797,394	2,030,008	[4] 2,187,031	[4] 2,661,063
Nicaragua	204,466	218,148	268,316	258,521	230,081	304,277
Salvador	362,432	256,772	230,054	161,476	172,305	[5] 198,800
Mexico	48,124,260	39,896,467	47,957,654	43,078,040	47,149,513	47,589,528
United States [6]	38,947,270	35,584,800	36,469,610	38,739,400	38,720,000	36,800,000
Total	115,524,000	110,954,200	115,309,800	113,516,800	118,063,400	119,287,200
South America:						
Argentina	1,122,229	1,639,688	1,414,633	1,671,838	1,350,331	1,543,200
Bolivia (exports)	6,707,519	5,047,666	5,851,107	7,547,304	5,375,089	6,051,284
Brazil	58,351	126,449	140,113	171,524	348,160	326,323
Chile	1,199,416	1,489,029	1,714,535	1,821,918	1,555,903	1,775,782
Colombia	118,525	112,534	112,037	110,728	106,494	105,162
Ecuador	148,149	35,126	47,732	29,479	28,694	47,600
Peru	15,394,662	20,405,883	22,947,624	22,972,766	24,845,257	24,157,907
Total	24,748,900	28,856,400	32,227,800	34,325,600	33,610,000	34,010,000
Europe:						
Austria	5,987	5,787	3,537	1,286	1,286	
Czechoslovakia [5]	1,608,000	1,608,000	1,608,000	1,608,000	1,608,000	1,608,000
Finland	166,408	239,459	224,573	318,453	373,592	560,764
France	678,811	555,951	628,065	541,869	664,701	669,749
Germany:						
East [5]	3,600,720	4,500,000	4,500,000	4,500,000	4,500,000	4,500,000
West	1,851,188	2,346,843	2,226,375	2,197,375	2,133,973	2,112,304
Greece	42,175	85,360	77,869	79,091	93,462	96,452
Hungary [5]	11,440	64,300	64,300	64,300	64,300	64,300
Italy	825,920	887,425	862,862	1,034,129	956,420	1,334,256
Norway	153,038	131,818	70,732	54,656	64,301	[5] 64,300
Poland [5]	93,280	128,600	128,600	128,600	128,600	128,600
Portugal	60,578	55,299	58,900	57,550	62,308	[5] 50,000
Rumania [5]	598,000	643,000	643,000	643,000	643,000	643,000
Spain	748,855	1,302,491	1,473,404	1,402,801	1,345,734	1,645,000
Sweden	1,466,016	2,215,604	2,397,738	2,562,382	2,512,163	2,899,962
U.S.S.R.[5]	23,400,000	25,000,000	25,000,000	25,000,000	25,000,000	25,000,000
United Kingdom	23,715	26,497	29,706	27,878	27,337	[5] 27,000
Yugoslavia	2,592,340	2,829,394	2,983,589	2,760,013	2,589,742	3,751,702
Total [5]	37,930,000	42,600,000	43,000,000	43,000,000	42,800,000	45,200,000
Asia:						
Burma	236,891	1,278,289	1,537,895	1,500,351	1,526,810	1,961,472
China [5]	304,000	480,000	480,000	480,000	510,000	[7] 510,000
India	14,772	161,185	153,935	104,604	125,838	109,828
Japan	4,533,679	6,162,815	5,948,627	6,166,962	6,543,673	6,727,511
Korea:						
North [5]	48,000	80,000	160,000	260,000	320,000	320,000
Republic of	19,914	50,252	79,605	196,409	277,346	247,782
Philippines	394,970	527,160	502,069	541,168	479,216	497,987
Saudi Arabia	115,613	63,681				
Taiwan	23,606	39,160	63,948	53,894	82,965	52,380
Total [5]	5,691,000	8,800,000	8,900,000	9,300,000	9,900,000	10,400,000

See footnotes at end of table.

[5] Work cited in footnote 3.

TABLE 14.—World production of silver, by countries,[1] in troy ounces [2] [3]—Continued

Country	1949-53 (average)	1954	1955	1956	1957	1958
Africa:						
Algeria	25,953	57,900	61,100	[5] 60,000	[5] 60,000	[5] 55,000
Bechuanaland	176	292	189	215	35	44
Belgian Congo	4,498,686	4,550,166	4,076,457	3,791,891	3,044,868	4,533,255
Ghana (exports)	45,057	48,214	39,284	28,592	25,390	45,762
Kenya	9,218	1,325	1,770	54,689	23,051	44,146
Morocco: Southern zone	1,420,884	1,914,124	2,324,167	2,204,930	2,411,250	2,411,000
Mozambique	142	44				
Nigeria	290	182	172	111	200	[5] 200
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [7]	250,139	403,661	412,191	610,370	569,949	556,523
Southern Rhodesia	83,139	81,657	76,837	76,870	74,179	264,630
South-West Africa	875,268	779,879	1,279,213	1,632,287	1,789,323	1,719,990
Swaziland	40			14		
Tanganyika (exports)	34,295	42,156	43,292	35,020	20,520	18,552
Tunisia	62,115	106,097	91,726	86,485	113,556	135,194
Uganda (exports)	32	85	70	52	21	36
Union of South Africa	1,162,137	1,235,418	1,461,336	1,598,278	1,767,472	1,795,384
Total	8,467,600	9,221,000	9,868,000	10,180,000	9,900,000	11,600,000
Oceania:						
Australia	11,029,507	13,827,038	14,555,412	14,586,197	15,739,400	16,249,649
New Guinea	46,764	48,977	44,459	42,457	38,014	24,952
Fiji	27,505	17,794	20,421	24,302	24,946	25,375
New Zealand	138,499	33,049	27,930	950	1,279	2,339
Total	11,242,000	13,927,000	14,648,000	14,654,000	15,804,000	16,302,000
World total (estimate)	203,600,000	214,400,000	224,000,000	225,000,000	230,100,000	236,800,000

1 In addition to the countries listed, a negligible amount of silver is produced in Bulgaria, Cyprus, Hong Kong, Panama, Malaya, Sarawak, Turkey, and Sierra Leone for which no estimate has been included in the 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 Data derived in part from the Yearbook of the American Bureau of Metal Statistics and the 45th annual issue of Metallgesellschaft.
4 Imports into the United States.
5 Estimate.
6 Refinery production.
7 Data represents estimate of 1957 production; however, 1958 production was probably much larger.

Australia.—Production of silver in Australia rose for the ninth consecutive year, gaining 3 percent over 1957. As in 1957, much of the gain was attributed to expansion of production facilities at Mount Isa Mines, where output of silver-bearing base-metal ores reaching an annual rate of 1.65 million tons. The ore reserve increased about 3.5 million tons to a total of 24.2 million tons containing 5.6 ounces of silver per ton.

Canada.—Silver output in Canada increased about 11 percent in 1958 to 31.1 million ounces. Canada maintained its world rank as the third largest producer by a considerable margin. All provinces and territories except New Brunswick and the Yukon recorded increases.

More than 80 percent of Canada's silver production was recovered as a byproduct of base-metal ores and the remainder from ores mined chiefly for silver and gold. About three-fourths of the total output was supplied by British Columbia, Ontario, and the Yukon. The United Keno Hill Mines in the Yukon and the Sullivan and Torbit mines in British Columbia were again the leading producers.

Exports to the United States totaled 19.6 million ounces—more than half of Canada's output and slightly more than 90 percent of its total silver exports.

The measured and indicated reserve of silver in base-metal mines producing more than 100,000 ounces in 1957 was estimated at 450 million ounces.

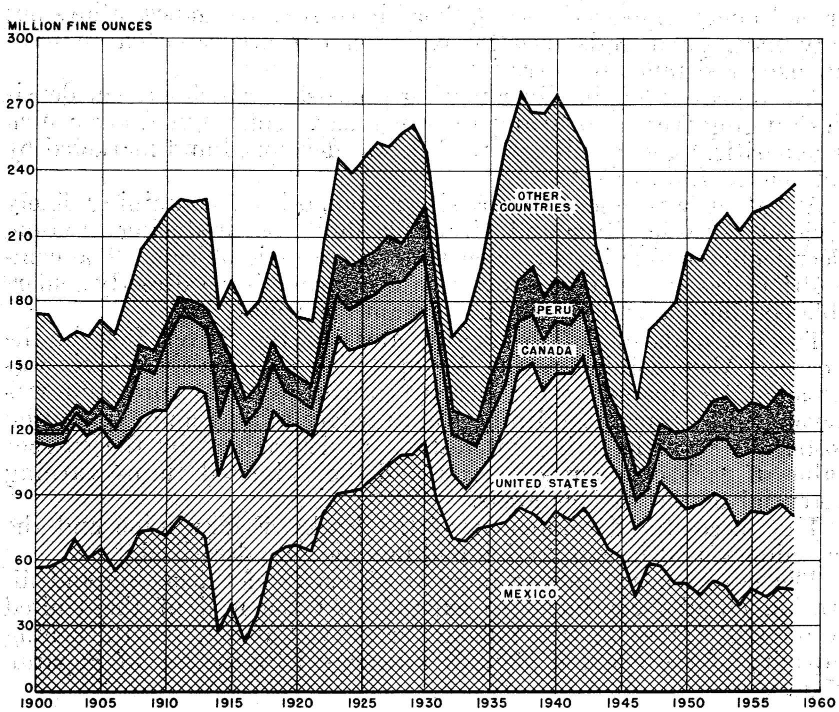

FIGURE 3.—World production of silver, 1900–58.

Mexico.—Output of silver in Mexico, the world's leading silver producer, rose slightly to 47.6 million ounces. Exports to the United States increased 20 percent to 20.6 million ounces. Industrial consumption increased 13 percent to 4.4 million ounces, but coinage requirements were 23 percent lower than in 1957. The return of the Bank of Mexico as a buyer in the New York market was significant. The operations of the bank provided a strong stabilizing influence on the silver market.

Peru.—Reversing the rising trend of the preceding 9 years, silver output in Peru dropped 3 percent. More than half of the silver was recovered as a byproduct of base-metal ores. The Cerro De Pasco Corp. continued to be the largest producer. Nearly two-thirds of Peru's silver output was exported to the United States.

TECHNOLOGY

The growing demand for brazed assemblies capable of withstanding high-temperature service conditions in rocket and jet engine parts and in many industrial applications has focused attention on new filler metals for making dependable joints in heat-resistant alloys. Recent research has developed high-silver alloys containing small quantities of lithium and copper that meet service requirements for brazing honeycomb panels of stainless steel. The adoption of these alloys has sharply reduced the rate of rejection of brazed honeycomb sections.[7] Other high-silver-manganese alloys not only have great resistance to oxidation but are reported to have superior resistance to corrosion.

An improved bright-silver-plating process, in which current densities ranging from 5 to 40 amperes per square foot are used and which is noncritical and readily controlled, was developed and marketed by Englehard Industries.[8]

A patent was issued for a silver composition containing finely divided metallic silver and vitrifiable flux[9] for producing fired-on, electrically conductive silver coatings on ceramic objects. The composition was expected to prove useful in providing a directly solderable coating on high-dielectric-constant materials.

The consolidation of productive areas of the Silver Belt in the Coeur d'Alene mining region for operation on a unitized basis was expanded to include other nearby properties. The program was developed by Sunshine Mining Co. to reduce mining and exploration costs. The participating interests were determined by the current value of each company's interest and the estimated future earning potential of the various areas.

The successful development of the Lucky Friday mine and the techniques used in exploration and mining were described.[10]

The use of flocculants to improve efficiency of thickening and filtration circuits continued to expand. At the mill of the United Keno Hill Mines in the Yukon Territory, Canada, the thickening capacity of the cyanide plant was increased by the use of Separan 2710.[11]

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[7] Industrial Laboratories, Describe Brazing Filler Metals for High-Temperature Service: Vol. 9, No. 6, June 1958, p. 74.

[8] Chemical and Engineering News, New Bright-Silver Plating Process: Vol. 36, No. 39, Sept. 29, 1958, p. 62.

[9] Short, Oliver A. (assigned to E. I. du Pont de Nemours & Co.) Vitrifiable Flux and Silver Compositions Containing Same: U.S. Patent 2,819,170, Jan. 7, 1958.

[10] Dayton, Stanley H., Lucky Friday Now Has a Bright Future: Min. World, vol. 20, No. 4, April 1958, pp. 38–42.

[11] Djingheuzian, L. E., Technical Advances in Milling and Process Metallurgy in Canada During 1958: Canadian Min. Jour., vol. 80, No. 2, February 1959, p. 178.

Slag—Iron—Blast Furnace

By Wallace W. Key [1]

SHORTAGES of iron-blast-furnace slag in 1958, resulting from cutbacks in the steel industry, caused processors to dig deeper into rapidly depleting slag banks in an attempt to meet the demand.

TABLE 1.—Iron-blast-furnace slag processed in the United States, by types

[National Slag Association]

Year	Air-cooled				Granulated		Expanded	
	Screened		Unscreened					
	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)	Thousand short tons	Value [1] (thousands)	Thousand short tons	Value (thousands)
1949–53 (average)	21, 234	$27, 049	1, 135	$663	2, 434	$849	1, 846	$4, 301
1954	22, 372	31, 228	809	537	3, 455	1, 512	2, 599	6, 199
1955	24, 901	36, 132	809	597	3, 836	1, 618	2, 892	7, 961
1956	25, 572	38, 476	2, 096	1, 280	4, 635	1, 642	2, 990	8, 496
1957	25, 414	40, 203	2, 167	1, 408	4, 318	1, 615	2, 942	8, 435
1958	20, 499	34, 027	1, 411	1, 170	3, 536	1, 373	2, 985	8, 638

[1] Excludes value of slag used for hydraulic cement manufacture.

DOMESTIC PRODUCTION

Slag production in the nation's iron furnaces declined 31 percent to 27 million short tons in 1958, following a 25 percent reduction in steel output. Processed slag for commercial applications, as reported to the National Slag Association, declined 18 percent compared with 1957. Because of shortages of slag production during the year, old slag banks were exploited, resulting in more slag for processing than the entire output of 1958. Of the States reporting production, Pennsylvania continued to lead in output. On the other hand, Pennsylvania was one of the States reported to be in short supply of aggregates.[2]

In many instances processors did not have adequate reserves of slag from previous years to supply increased demands and supple-

[1] Commodity specialist.
[2] Fish, Warren D., The Highway Aggregates Program: Rock Products, vol. 62, No. 2, February 1959, pp. 76–79.

ment reduced output in 1958. Some slag processors diverted more attention to crushed stone and sand and gravel production.

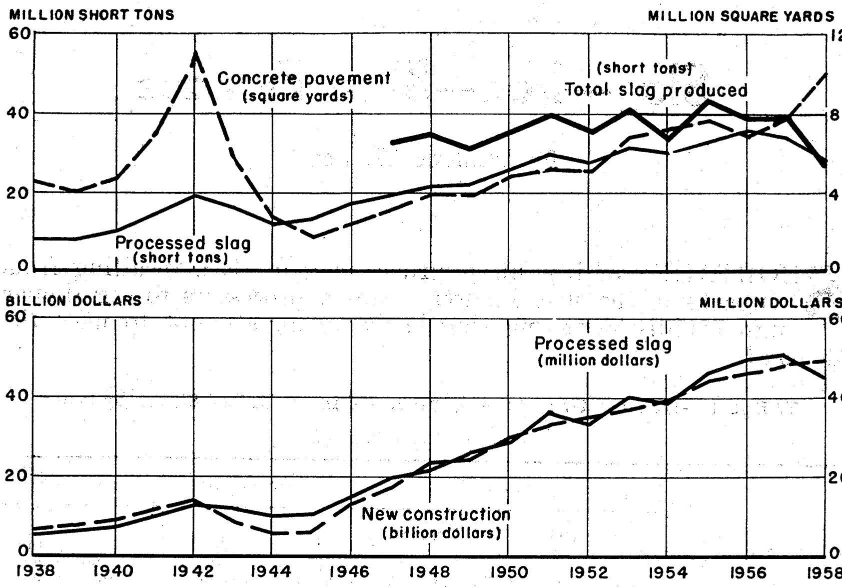

FIGURE 1.—Production of iron-blast-furnace slag compared with yards of concrete pavement (contract awards), monthly average, and value of new construction compared with value of processed slag, 1938–58.

TABLE 2.—Iron-blast-furnace slag processed in the United States, by States

[National Slag Association]

	Screened air-cooled		All types	
	Thousand Short tons	Value (thousands)	Thousand short tons	Value (thousands)
1957				
Alabama	4,068	$6,025	4,849	$7,398
Ohio	6,182	10,715	8,123	14,202
Pennsylvania	6,015	9,876	8,233	11,800
Other States [1]	9,149	13,587	13,636	18,261
Total	25,414	40,203	34,841	51,661
1958				
Alabama	3,643	5,555	4,428	6,819
Ohio	4,388	8,013	5,885	10,809
Pennsylvania	5,258	9,282	7,203	11,334
Other States [1]	7,210	11,177	10,915	16,246
Total	20,499	34,027	28,431	45,208

[1] California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia.

Because of the shortages of blast-furnace slag there was increased possibility in 1958 that open-hearth-furnace slag might be used as a substitute. Although little difficulty was found when open-hearth slag was properly applied in unconfined areas such as parking lots, its use in bituminous or portland cement concrete was not recommended until more could be learned about its properties.[3]

Forty companies operated 58 air-cooled plants, 15 granulating plants, and 23 expanded-slag plants in the United States during 1958. The quantity of slag produced per ton of iron ore continued to decline, owing largely to the use of higher grade blast-furnace feed.

Recovery of Iron.—An important function of the slag industry continued to be magnetic and hand recovery of iron for reuse in blast furnaces. In 1958, 364,000 tons of iron-slag (about 60 percent iron), representing more than 1 percent of the processed slag, was returned as furnace burden to the furnaces, a 6-percent decline compared with 1957.

Employment.—A total of 4,538,162 man-hours was expended by 2,050 plant and yard employees in producing commercial slag, compared with the 4,765,000 man-hours of 2,068 plant and yard employees in 1957. The high degree of efficiency at slag operations was indicated in 1958 by the 6.3 tons of processed slag per man-hour. This rate can be compared with 6.9 tons per man-hour in sand and gravel production.

Safety competition among slag plants, sponsored by the National Slag Association, has been conducted since 1949, but an accident analysis canvass was conducted for the first time by the Bureau of Mines for 1958. Results are shown in the Employment and Injuries in the Metal and Nonmetal Industries chapter of Volume I, Minerals Yearbook.

Methods of Transportation.—Nearly all processed slag was shipped by truck and rail in 1958, but waterway transport was important locally.

TABLE 3.—Shipments of iron-blast-furnace slag in the United States, by methods of transportation

[National Slag Association]

Method of transportation	1957		1958	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Rail	10,528	32	8,205	30
Truck	21,682	66	18,280	68
Waterway	752	2	583	2
Total shipments	32,962	100	27,068	100
Interplant handling [1]	1,879		1,363	
Total processed	34,841		28,431	

[1] Confined mainly to granulated slag used in manufacturing cement.

[3] Rock Products, Looking to Future, Slag Men Push Sales: Vol. 62, No. 1, January 1959, pp. 111, 114, 138.

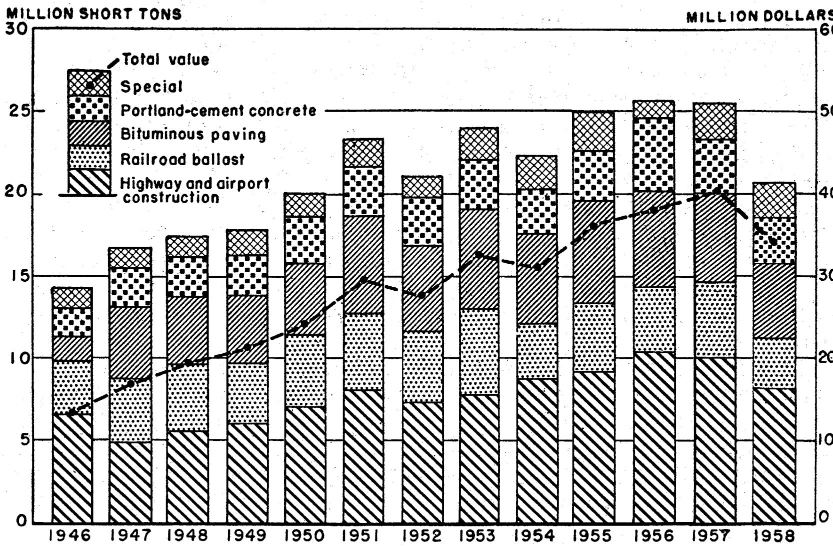

FIGURE 2.—Consumption and value of air-cooled, iron-blast-furnace slag sold or used in the United States, 1946–58.

CONSUMPTION AND USES

Blast-furnace slag was sold in three forms: Screened, air-cooled, the major product; unscreened, air-cooled; granulated; and expanded. Tables 4 and 5 show the major uses of each type.

Slag was a principal material used in concrete block production; it was also used as a trickling filter medium, for penetration macadam, for skid-proofing road surfaces, and in roofing granules.

It was used in a variety of insulation and acoustical applications. Slag used in cement manufacture and for bases in highway construction was mainly of the granulated type.

TABLE 4.—Air-cooled iron-blast-furnace slag sold or used by processors in the United States, by uses

[National Slag Association]

Use	Screened		Unscreened	
	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)
1957				
Aggregate in—				
Portland-cement concrete construction	3,267	$5,713		
Bituminous construction (all types)	5,465	9,162		
Highway and airport construction [1]	10,153	16,465	1,332	$1,175
Manufacture of concrete block	633	971		
Railroad ballast	4,566	5,244		
Mineral wool	476	765		
Roofing (cover material and granules)	422	1,136		
Sewage trickling filter medium	73	131		
Agricultural slag, lim ng	7	11		
Other uses	352	605	835	233
Total	25,414	40,203	2,167	1,408
1958				
Aggregate in—				
Portland-cement concrete construction	2,695	4,738		
Bituminous construction (all types)	4,627	8,168		
Highway and airport construction [1]	8,202	14,005	1,270	1,048
Manufacture of concrete block	598	941		
Railroad ballast	2,916	3,474		
Mineral wool	448	733		
Roofing (cover material and granules)	404	997		
Sewage trickling filter medium	29	54		
Agricultural slag, liming	6	12		
Other uses	574	905	141	122
Total	20,499	34,027	1,411	1,170

[1] Other than in portland-cement concrete and bituminous construction.

TABLE 5.—Granulated and expanded iron-blast-furnace slag sold or used by processors in the United States, by uses

[National Slag Association]

Use	1957				1958			
	Granulated		Expanded		Granulated		Expanded	
	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)	Thousand short tons	Value (thousands)
Highway construction (base and subgrade)	1,307	$931			} 1,174	$1,096		
Fill (road, etc.)	641	206						
Agricultural slag, liming	62	96			40	67		
Manufacture of hydraulic cement	1,877	(1)			1,994	(1)		
Aggregate:								
Concrete-block manufacture	169	196	2,825	$8,048	101	96	2,893	$8,320
Lightweight concrete			84	243			60	179
Other uses	262	186	33	144	227	114	32	139
Total	4,318	[2] 1,615	2,942	8,435	3,536	1,373	2,985	8,638

[1] Data not available.
[2] Excludes value of slag used for hydraulic cement manufacture.

PRICES

The comparative values of crushed slag and competitive materials in a number of cities were reported.[4]

The average unit values of processed slag in 1958 ranged from $0.50 to $4.33 per short ton. For most uses, the values increased slightly over 1957 because of increases in wages, cost of equipment, supplies, and market conditions.

TABLE 6.—Average value per short ton of iron-blast-furnace slag sold or used by processors in the United States, by uses

[National Slag Association]

Use	Air-cooled				Granulated		Expanded	
	Screened		Unscreened					
	1957	1958	1957	1958	1957	1958	1957	1958
Aggregate in—								
Portland-cement concrete construction	$1.75	$1.76					[1] $2.91	[1] $2.96
Bituminous construction (all types)	1.68	1.77						
Highway and airport construction [2]	1.62	1.71	$0.88	$0.83	[3] $0.71	[3] $0.98		
Manufacture of concrete block	1.53	1.57			1.16	.95	2.85	2.88
Railroad ballast	1.15	1.19						
Mineral wool	1.61	1.64						
Roofing (cover material and granules)	2.69	2.47						
Sewage trickling filter medium	1.80	1.84						
Agricultural slag, liming	1.70	1.82			1.55	1.66		
Fill (road, etc.)					.32	.87		
Other uses	1.72	1.58	.28	.86	.71	.50	4.38	4.33

[1] Lightweight concrete. [2] Other than in portland-cement and bituminous construction.
[3] Base and subgrade material.

TECHNOLOGY

The technologic developments in the history of iron-blast-furnace slag were outlined in an industry magazine.[5]

Aggregates.—Blast-furnace slag gained increased recognition for its value in pavements as non-skid surfaces because it resists polishing. Several articles presented recommendations for reducing hazards of slippery pavements.[6]

[4] Engineering News-Record, vol. 161, No. 2, July 10, 1958, p. 91.
[5] U.S. Steel News, vol. 23, No. 2, April 1958, pp. 1–5.
[6] Wilkes, J. H. H., Non-Skid Roads Without Tears: Surveyor (Great Britain), vol. 117, No. 3449, May 31, 1958, pp. 555–556.
White, A. M., and Thompson, H. O., Tests for Coefficients of Friction by the Skidding Car Method on Wet and Dry Surfaces: Payment Slipperiness Factors and Their Measurement, Bulletin 186, Highway Res. Board, 1958, pp. 26–34.
Clemmer, H. F., and Smith, Norman G., Supplemental Tests of Pavement Skidding Resistance With a 2-Wheel Trailer: Pavement Slipperiness Factors and Their Measurement, Bulletin 186, Highway Res. Board, 1958, pp. 48–53.
Shelburne, Tilton E., and Sheppe, R. L., Skid Resistance Measurements of Virginia Pavements: Res. Rept. 5–B, Highway Res. Board, 1958, 27 pp.
Britton, W. S. G., Seal Treatments on Bituminous Concrete Pavements: Public Works Magazine, February 1958, pp. 95–96.
Highway Research Abstracts, New Materials Used at Rumbler Stops: Vol. 28, No. 3, March 1958, p. 17.

A French article described the methods of application of crushed, granulated, and expanded slags in road construction with tables of their service life.[7]

A British slag processing plant that produced 15,000 tons per week for roadstone, concrete aggregate, and railroad ballast was described.[8]

The properties and use of blast-furnace slag and natural stone as railroad ballast were compared. Tests and phase diagrams showed the relation of strength to chemical composition.[9]

More than 10 million tons of slag is produced in Great Britain annually. To use more of the slag produced, a device called the BISRA (British Iron and Steel Research Assoc.) separator was devised and patented.[10]

Cement.—Interest in slag utilization in cement continued in foreign countries. Several articles were published on the use of slag in cement in the Japanese publication, Semento Gijutsu Nenpo. A Soviet article describes the use of slag in hydraulic cement by use of activators, such as gypsum and lime.[11] A Polish method for grinding and forced air-drying wet blast-furnace slag mixed with portland cement was described.[12]

The British standard for portland blast-furnace cement was revised in 1958. The chief changes were (1) omission of the tensile strength test and substitution of two alternative compressive strength tests made on cubes of concrete instead of a mixture of the cement and standard sand, (2) expression of fineness in terms of the specific surface and not in terms of a sieve test, (3) an increase in the time taken for mixing the paste for mortar cubes, (4) increase in the water content of pastes used in setting and soundness tests to equal the total (maximum) proportion of water needed to produce a paste of standard consistency, (5) increase in the first setting time, (6) change of test and curing temperatures to conform with international practice, and (7) revision of limitations in chemical composition and sampling.

Water permeability of mortar reportedly decreased when 30 to 50 percent by weight of the cement was replaced by slag. Fly ash was less effective in decreasing water permeability.[13]

The effects of slag content on the physical properties and heat of hydration of portland blast-furnace slag cements, prepared by separate grinding and by intergrinding, were reported. The higher the

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[7] Genet, A., Use of Materials Based on Blast-Furnace Slag for Roadmaking: Rev. Univ. mines (Liége). vol. 13, Aug. 15, 1957, pp. 445–446.
Journal of the Iron and Steel Institute Abstracts, vol. 188, pt. 3, March 1958, p. 286.

[8] Journal of American Ceramic Society, Slag Production Plant at Teesport (England): Vol. 41, No. 9, Sept. 1, 1958, p. 226.

[9] Huttemann, P., Selection and Suitability of Blast-Furnace Slag as Railroad Ballast: Stahl U. Eisen (Dusseldorf), vol. 77, Oct. 17, 1957, pp. 1436–1442.
Journal of the Iron and Steel Institute. vol. 189, pt. 1, May 1958, p. 83.

[10] Iron and Coal Trades Review (London), Density of Solid Blast-Furnace Slag Separator Being Developed at BISRA; Vol. 178, No. 4733, Feb. 6, 1959, p. 327.

[11] Bukhliskii, A. N., [Rustavi Slags and Their Use in the Cement Industry]: Cement Tsement Leningrad (USSR), vol. 23, No. 1, 1957, pp. 28, 39.
Chemical Abstracts, vol. 52, No. 18, September 1958, p. 15867.

[12] Janowski, Jan, Grinding Wet Blast-Furnace Slag With Portland Cement Clinker: Cement Wapno-Gips (Warsaw), vol. 14, No. 23, Nov. 23, 1958, pp. 97–104.
Chemical Abstracts, vol. 52, No. 18, Sept. 25, 1958, p. 15870.

[13] Kubo, Naoshi, and Suzuki, Takeo, Effect of Blast-Furnace Slag on the Water Permeability of Mortar: Semento Gijutsu Nenpo (Tokyo), vol. 2, 1957, pp. 156–162.
Journal of American Concrete Institute, vol. 30, No. 5, November 1958, p. 662.

slag content, the greater was the effect of the curing temperature (5° to 38° C.) on the decrease or increase in mortar strength.[14]

A method proposed to evaluate the latent hydraulic property of slag and determine the quantity of dissolved SiO_2 by treating slags of the same fineness with 0.2 percent solution of $Al_2(SO_4)_3$ from 5 to 60 minutes at 20° C. A relationship was observed between the quantity of SiO_2 dissolved by a 10-minute treatment and the modulus of elasticity of portland blast-furnace slag cement mortar.[15]

A new Belgian blast-furnace slag cement, which reportedly shows higher compressive strengths than required by ASTM and foreign specifications, was described in a company bulletin.[16]

The characteristics of blast-furnace slag cooling rates and critical temperature limits were studied, and a dry granulation method for producing slag to be used in cement manufacture was described.[17]

Variations permitted by the present ASTM procedure show significant deviations in the values obtained for the insoluble residue in portland and blast-furnace slag cements. It was recommended that the procedure should be specified in greater detail. The proposed revisions would bring the ASTM and Federal methods in closer agreement.[18]

Slag Wool.—In the production of mineral wool from blast-furnace slag, according to a patent, the iron content of the molten slag is lessened with carbon, aluminum, or silicon, and then about 5 percent of the silicic acid is added and the slag heated to melt the constituents and desulfurize the slag.[19]

A brief account was presented of a method of slag wool production from blast-furnace slag, which had not previously solidified. The cost was said to be only 15 percent of that when the solidified slag is remelted in a cupola.[20]

Production Methods and Equipment.—A device for pouring molten blast-furnace slag into foaming beds to produce a cellular, lightweight product was patented. The discharge side of the pouring ladle is provided with a collar, forming a broad overflow edge. When slag is discharged from the ladle it spreads over the foaming bed in a wide, flat stream and will foam uniformly.[21]

Another article described the effects of heat treatment (700° C to 1,100° C.) and addition of grinding agents on the grindability of

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[14] Arizumi, Akira, and Komatsubara, Masao, Semento Gijutsu Nenpo (Tokyo), vol. 2, 1957, pp. 125–133.
Journal of American Ceramic Society, vol. 41, No. 9, Sept. 1, 1958, p. 225.

[15] Tsumura, Soji [Reactivity of Blast-Furnace Slag]: Semento Gijutsu Nenpo (Tokyo), vol. 10, 1956, pp. 96–99.
Journal of American Ceramic Society, vol. 41, No. 9, Sept. 1, 1958, p. 225.

[16] Rock Products, vol. 61, No. 2, February 1958, p. 70.

[17] Forbath, R., [Dry Granulation of Blast-Furnace Slags:] Kohaszati Lapok (Budapest), June 1952, pp. 121–127, July, pp. 151–155.
Journal of the Iron and Steel Institute Abstracts, vol. 188, pt. 3, March 1958, p. 285.

[18] Holstead, W. J., and Chaiken, Bernard, Insoluble Residue Determination in Portland and Portland-Slag Cements: ASTM Bull. No. 229, 1958, pp. 60–65.

[19] Knüppel, H. (assigned to Dortmund-Hörder Hüttenunion Aktiengesellschaft, Dortmund, Germany), Process for Producing Slag Wool: U.S. Patent 2,829,959, Apr. 8, 1958.

[20] Brodetskii, L. V., [Plant for Production of Slag Wool From Blast-Furnace Slags:] Metallurg (Moscow), vol. 12, 1957, p. 36.
Journal of the Iron and Steel Institute Abstracts, vol. 190, pt. I, September 1958, p. 84.

[21] Vorwerk, O. K., Hüttemann, P. F., and Schmucker, E. K. (assignors to Hüttenwerke Rheinhausen Aktiengesellschaft, Rheinhausen, Germany), Device for use in Connection with the Pouring of Fiery Molten Masses: U.S. Patent 2,831,294, Apr. 22, 1958.

blast-furnace slags and on the properties of the resulting portland blast-furnace slag cements prepared by separate grinding.[22]

A retarded cement slurry was patented for cementing deep boreholes. It consists of a mixture of water and finely ground blast-furnace slag free activators. The heat in deep holes causes setting. If the borehole temperature is too low to cause setting, the slag-water slurry is heated before being pumped into the hole.[23]

A British patent was issued on a method of preparing blast-furnace slag for use in concrete. The slag is ground as a slurry and then dewatered to less than 17 percent moisture, transported to the jobsite, and mixed with portland cement, aggregate, and water.[24]

Miscellaneous.—A process was patented in Germany for producing molded parts from blast-furnace slag. The slag is treated with $FeSO_4 \cdot 7H_2O$ (pickling waste product) and 6 percent slaked lime. The mixture is pressed into blocks that reportedly solidify and have a relatively high strength at the end of 24 hours.[25]

Although the use of expanded slag aggregate in concrete block provides the major outlet for expanded slag, its use in lightweight concrete increased. Since the data available on characteristics of concrete mixes containing expanded slag were quite limited, the National Slag Association Laboratory conducted a research program to obtain more information on strength, durability, unit weight, thermal conductivity, and other characteristics over a wide range of cement and air contents and with a variety of aggregate sizes.[26]

A Soviet publication gives detailed descriptions of slag minerals, supported by chemical analyses and optical and X-ray data.[27]

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[22] Nagano, Ranzo, [Grindability of Blast-Furnace Slags:] Semento Gijutsu Nenpo (Tokyo), vol. 2, 1957, pp. 133–139.

[23] Harmsen, G. J., and Stuve, J. G. (assigned to Shell Development Co., New York, N.Y.), Cement Composition: U.S. Patent 2,822,873, Feb. 11, 1958.

[24] Rule, Tom E. (assigned to Frederick G. Mitchell): British Patent 789,737, Jan. 29, 1958.

[25] Société Anonyme des Forges et Acieries de Dilling, German Patent No. 937,759, Jan. 12, 1956.

Chemical Abstracts, Molded Parts From Blast-Furnace Slag: Vol. 52, No. 21, Nov. 10, 1958, p. 19078.

[26] Lewis, D. W., Lightweight Concrete Made With Expanded Blast-Furnace Slag: Jour. Am. Concrete Inst., vol. 30, No. 5, November 1958, pp. 619–633.

[27] Lapin, V. V., Petrology of Metallurgical Slags and Clinkers: Jour. Iron and Steel Inst. (abs.), vol. 189, pt. 1, May 1958, p. 83.

Sodium and Sodium Compounds

By Robert T. MacMillan [1] and James M. Foley [2]

DOMESTIC facilities for producing both sodium sulfate and sodium carbonate from natural deposits were enlarged in 1958, but only sodium sulfate output increased. Total production of both commodities, including that from natural and manufactured sources, was less than in 1957.

DOMESTIC PRODUCTION

Reflecting smaller demand, total sodium carbonate production decreased nearly 7 percent in 1958 while sodium carbonate from natural sources decreased only 3.7 percent. About 13 percent of the total sodium carbonate production came from natural sources in 1958; the remainder was from salt by the Solvay process used in several Eastern, North Central, and Southern States.

Natural sodium carbonate was produced in California and Wyoming. Two companies in California processed brines of Searles Lake producing soda ash and other chemicals: The American Potash and Chemical Corp. operated a plant at Trona adjoining Searles

TABLE 1.—Manufactured sodium carbonate produced [1] and natural sodium carbonates sold or used by producers in the United States

Year	Manufactured soda ash (ammonia-soda process) [2]	Natural sodium carbonates [3]	
	Short tons (thousands)	Short tons (thousands)	Value (thousands)
1949–53 (average)	4,465	[4] 329	[4] $7,706
1954	4,701	527	13,536
1955	4,907	614	15,001
1956	4,998	653	17,400
1957	[5] 4,659	653	17,792
1958	[6] 4,328	629	17,032

[1] U.S. Bureau of the Census.
[2] Includes quantities used to manufacture caustic soda, sodium bicarbonate, and finished light and dense soda ash.
[3] Soda ash and trona (sesquicarbonate).
[4] Excludes Wyoming in 1949.
[5] Revised figure.
[6] Preliminary figure.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

Lake and Stauffer Chemical Co., West End Div., operated a plant at Westend, also on the lake.

Columbia Southern Chemical Corp. produced soda ash and sodium sesquicarbonate near Bartlett on Owens Lake.

In Wyoming the Intermountain Chemical Co., subsidiary of Food Machinery and Chemical Corp., mined a large deposit of trona at Westvaco near Rock Springs in Sweetwater County. Most of the raw trona was converted to dense soda ash (sodium carbonate) in the processing plant before marketing.

Although total sodium sulfate (salt cake) output was 7.3 percent less in 1958 than it was in 1957, the part produced from natural sources was 4.8 percent greater. About 36 percent of the total sodium sulfate production was derived from natural sources in 1958.

Natural sodium sulfate was produced in three States by six companies. In California, American Potash and Chemical Corp. and Stauffer Chemical Co., West End Div., produced sodium sulfate from Searles Lake brines at Trona and Westend, respectively, and U.S. Borax and Chemical Corp. produced sodium sulfate as a coproduct in processing boric acid from a borax deposit. Sodium sulfate was produced by Ozark Mahoning Co. from subterranean brines in Texas and by Wm. E. Pratt and by the Sweetwater Chemical Co. (formerly Iowa Soda Products Co.) from natural deposits in Wyoming.

Byproduct and coproduct salt cake continued to be the leading sources of sodium sulfate in 1958. The Mannheim process and the viscose rayon industry each supplied about one-quarter of the sodium sulfate consumed by industry in 1958. Smaller quantities were contributed by manufacturers of cellophane, sodium dichromate, phenol, formic acid, lithium salts, and other chemicals.

Since 1953 the production of hydrochloric acid by the Mannheim process has declined in importance because more of the acid was recovered from organic chlorination processes—notably the chlorination of olefins, natural gas, and benzene.[3] Recovery of coproduct salt

TABLE 2.—Sodium sulfate produced and sold or used by producers in the United States

Year	Production (manufactured[1] and natural), thousand short tons			Sold or used by producers (natural only)	
	Salt cake (crude)	Glauber salt (100 percent $Na_2SO_4 \cdot 10H_2O$)	Anhydrous refined (100 percent Na_2SO_4)	Short tons (thousands)[2]	Value (thousands)
1949–53 (average)	641	189	195	224	$2,963
1954	659	147	205	250	3,890
1955	738	149	257	285	5,381
1956	763	143	248	[3] 333	[3] 6,437
1957 [3]	709	131	257	331	6,542
1958	[4] 664	[4] 107	[4] 238	347	6,716

[1] U.S. Bureau of the Census.
[2] Includes glauber salt converted to 100 percent Na_2SO_4 basis.
[3] Revised figures.
[4] Preliminary figure.

[3] Chemical Week, Sulfate Sources Shift but Supply is Ample: Vol. 82, No. 8, Feb. 22, 1958, pp. 97–100.

cake from Mannheim plants also declined, but this production loss was offset somewhat by greater output from natural sources.

Production capacity was increased at several soda ash plants in 1958. Olin Mathieson Chemical Corp. increased capacity for producing dense soda ash from salt at the Saltville, Va., plant. Columbia Southern and Intermountain Chemical Co. also increased soda ash production capacities from their respective natural deposits in California and Wyoming.

The following estimated United States soda ash production capacity by company exclusive of 1958 expansions was reported in a trade journal.[4]

Company and plant location:	*Process*	*Yearly capacity, thousand tons*
American Potash and Chemical Corp.		
Trona, Calif	Natural	150
Columbia Southern Chemical Corp.		
Barberton, Ohio	Ammonia	600
Corpus Christi, Tex	do	240
Bartlett, Calif	Natural	15
Diamond Alkali Co.		
Painesville, Ohio	Ammonia	725
The Dow Chemical Co.		
Freeport, Tex	Cell liquor	110
Intermountain Chemical Co.		
Green River, Wyo	Natural	400
Olin Mathieson Chemical Corp.		
Lake Charles, La	Ammonia	365
Saltville, Va	do	350
Solvay Process Division, Allied Chemical & Dye Corp.		
Baton Rouge, La	do	750
Detroit, Mich	do	800
Syracuse, N.Y	do	900
Stauffer Chemical Co., West End Division		
Westend, Calif	Natural	185
Wyandotte Chemicals Corp.		
Wyandotte, Mich	Ammonia	700

Coproduct salt cake from rayon manufacture declined in 1958. More widespread use of alternate fibers, such as nylon in place of rayon for tires, was one factor in decreased rayon and coproduct salt cake production.

Metallic sodium production was 110,298 short tons in 1958 according to preliminary figures of the Bureau of the Census, U.S. Department of Commerce, a 17-percent decrease from the 132,977 tons produced in 1957. An important factor in this production slump was the decrease in tetraethyl lead added to gasoline (see Technology section).

Metallic sodium was produced at four plants by the following three companies: National Distillers Chemical Co., Ashtabula, Ohio; E. I. du Pont de Nemours & Co., Inc., Niagara Falls, N.Y.; and Ethyl Corp., Baton Rouge, La., and Houston, Tex.

[4] Chemical Week, Recession Impact Soda Ash Demand Down: Vol. 82, No. 18, May 3, 1958, pp. 71–74.

CONSUMPTION AND USES

Soda ash was used chiefly in producing and processing other materials. Organic and inorganic chemicals production absorbed about 37 percent of the total sodium carbonate produced in the United States in 1958. An estimated 450,000 tons was used in producing one chemical, sodium tripolyphosphate, an ingredient of synthetic detergents.[5]

The increased use of soda ash for synthetic detergents in 1950–58 was offset largely by the diminished requirements of the soap industry, formerly an important consumer of soda ash.

Large quantities of dense soda ash were used for producing glass containers, window and plate glass, and various pressed and blown glass products. Lessened demand for plate glass in the auto industry was a factor in the decreased production of soda ash in 1958. Increased use of plastics for containers formerly made of glass also lessened the demand for soda ash.

Other uses of soda ash were in nonferrous metal refining, pulp and paper production, cleansers, water softeners, soap, and miscellaneous chemicals. The following tabulation shows the demand for the various uses of soda ash in 1958 in percentage of total production.

Use:	Percent of total
Chemicals	37
Glass	30
Nonferrous metal refining	10
Pulp and paper	7
Cleansers	3
Water softeners	2
Soap	1
Miscellaneous	10
Total	100

The Kraft paper and paperboard industry consumed about 74 percent of the total sodium sulfate production. Although more than half the woodpulp processed in 1958 was converted to Kraft paper, the demand for Kraft products lessened in 1958 contributing to the smaller output of sodium sulfate.

Sodium sulfate was also used in the glass industry, in detergents, stockfeeds, dyes, textiles, medicinals, in producing miscellaneous chemicals, and also in manufacturing television picture tubes.

The most important use of metallic sodium was in producing tetraethyl lead (TEL), an antiknock additive for motor fuels. Sodium was also used to reduce vegetable and animal oils to fatty alcohols and to reduce compounds of titanium, zirconium, columbium, beryllium, silicon, and other elements that are not readily reduced from their compounds.

The properties of sodium have become recognized in the field of heat transfer. Valves of some internal combustion engines are constructed with hollow stems and bodies into which slugs of sodium are sealed. At the operating temperature of the engine the sodium melts and, in flowing about in the cavity, aids in dissipating the heat from combustion chamber through the valve stem.

[5] Work cited in footnote 4.

The use of sodium and sodium potassium alloy as coolants in atomic power reactors increased in 1958. Several experimental and prototype atomic powerplants, designed to use sodium as a coolant were under construction.

Sodium was also used in producing sodium peroxide, hydride, amide, cyanide, and borohydride. The latter compound is an ingredient of certain high-energy fuels.

PRICES

Prices of soda ash and sodium metal were stable, about the same as in 1957. Sodium sulfate prices increased slightly in April and were steady through the remainder of the year.

Oil, Paint and Drug Reporter quoted prices for soda ash, dense, 58 percent Na_2O, carlots, works at $1.60 per hundred pounds in bulk and $1.90 in paper bags. On the same basis, light soda ash was quoted at $1.55 and $1.85. Sodium metal in tank cars, works, was quoted at $0.17 per pound in 1958; in bricks, in lots of 14,000 pounds or larger, the price was $0.19½ per pound.

According to quotations in Oil, Paint and Drug Reporter domestic salt cake, bulk, works, 100 percent Na_2SO_4 basis, sold for $28 per ton at the beginning of 1958. From April until the end of the year the price was quoted at $32 per ton. Rayon grade sodium sulfate in bags, carlots, works, sold for $34 per ton until April when the price was raised to $36. Sodium sulfate, technical, anhydrous, in bags, carlots, increased from $52 to $54 per ton in 1958.

FOREIGN TRADE [6]

Imports of sodium sulfate increased about 30 percent in 1958 and equaled 10 percent of the total United States production of the commodity. Belgium and Luxemburg, the chief sources, together with Canada supplied nearly 90 percent of the sodium sulfate imports; small quantities were imported from West Germany.

Exports of both soda ash and salt cake decreased substantially for the second consecutive year. Sodium carbonate was 40 percent and sodium sulfate 15 percent lower than in 1957. Approximately 2 percent of the total output of each commodity were exported.

TABLE 3.—Sodium sulfate imported for consumption in the United States

[Bureau of the Census]

	Crude (salt cake)		Anhydrous		Total [1]	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
1949–53 (average)	53	$730	5	$112	57	$843
1954	116	2,062	2	79	119	2,141
1955	121	2,412	4	117	124	2,530
1956	99	2,047	4	127	103	2,174
1957	73	1,450	2	61	74	1,511
1958	95	1,905	2	62	97	1,968

[1] Includes glauber salt as follows: 1949–53 (average), 11 tons valued at $230; 1958, 12 tons valued at $830.

[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 4.—Sodium carbonate and sodium sulfate exported from the United States

[Bureau of the Census]

Year	Sodium carbonate		Sodium sulfate	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
1949-53 (average)	113	$4,349	23	$661
1954	164	5,527	25	823
1955	153	4,933	25	870
1956	242	8,219	30	1,037
1957	174	6,282	24	859
1958	104	4,279	20	786

WORLD REVIEW

Brazil.—Construction of the soda ash factory of Cia Nacional de Alcalis was progressing at Cabo Frio. The new installation, part of the larger installation that includes salt pans, lime furnaces, and a powerplant, was expected to free the Brazilian glass, textile, and chemical industries from dependence on foreign soda ash.[7]

Chile.—Cristalerias de Chile, a Chilean glass company, opened a new plant near Santiago to produce various soda compounds and other inorganic chemicals including compounds of boron and phosphorus.[8]

Colombia.—The Planta Colombiana de Soda, only soda ash plant in Columbia, expanded its facilities at Zipaquira, site of the Nation's salt mines. An electrolytic caustic soda and chlorine installation also was scheduled to begin production in July 1958.[9]

Mexico.—A new chemical plant for producing caustic soda, chlorine, sodium hypochlorite, and hydrochloric acid from salt was opened at Monterrey by Sosa de Mexico, S.A. An American firm that owns a minority of the stock designed the plant.

Sosa Texcoco, S.A., producing soda ash and other compounds from natural raw materials, also increased its facilities.[10]

Netherlands.—The factory of the Nederlandse Soda Industrie, N.V., was opened at Delfzijl, June 5, 1958, by Queen Juliana. The establishment consists of a soda ash plant, a salt electrolysis plant producing chlorine and caustic soda and a salt plant. The new installation was expected to produce 170,000 tons of soda, 23,000 tons of chloride, and 300,000 tons of salt, annually.[11]

Poland.—The soda ash works at Janikow was opened with a production capacity of 900 tons per day. The plant was designed and built with Russian technical assistance. An appreciable part of the output was expected to be exported to eastern Europe and the Scandinavian countries.[12]

[7] Chemical Age (London), Brazilian Soda Ash Plant Opened: Vol. 79, No. 2014, Feb. 25, 1958, p. 321.
[8] Chemical Age (London), New Chemical Plant for Chile: Vol. 80, No. 2049, Oct. 25, 1958, p. 690.
[9] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 1, July 1958, p. 36.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 6, December 1958, p. 41.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 1, January 1959, p. 34.
[12] Chemical Trade Journal and Chemical Engineer (London), Polish Soda Ash for Export: Vol. 141, No. 3677, Nov. 22, 1957, p. 1267.

TECHNOLOGY

The soda ash and sodium sesquicarbonate plant at Bartlett, Calif., was replaced by a new unit reportedly three times the capacity of the older plant. Raw material for the plant is liquor from Owens Lake, containing principally sodium carbonate, sodium chloride, sodium sulfate, and borax.

The saturated liquor is drawn from shallow wells penetrating the crust on the surface of the lake and carbonated to produce a slurry of sodium sesquicarbonate, some of which is washed, dried, and sold as a crude product. The remainder is further refined and calcined to produce high-density soda ash.[13]

Improvements in mining and processing sodium sulfate from natural deposits in Saskatchewan were described in an article.[14] Mining and washing natural glauber salt crystals as they occur in natural crystal beds have been replaced by a procedure known as brine pumping, which produces a purer product and is adapted to the climate of the area.

During the summer the warmer temperatures increase the solubility of sodium sulfate; the dense brine is then pumped from the shallow lake into deeper reservoirs, where gradual cooling causes crystallization of glauber salt during the fall. The residual brine is drained before the advent of freezing temperatures in winter, when the crystal bed becomes solid enough to support harvesting equipment.

The refining step is largely dehydration of the crystals which normally have the formula $Na_2SO_4.10H_2O$. Several types of equipment for removing the water of crystallization are used in the different refineries. Among these are rotary kilns, special evaporators, and submerged combustion units.

Because of the inverse temperature-solubility relation of sodium sulfate above 91° F., evaporators used to dehydrate glauber salt usually are adapted to combat the tendency for sodium sulfate to form a hard scale on heat transfer surfaces. One type is known as a convection evaporator in which the solution is caused to flow rapidly past the heating tubes. In submerged combustion oil or gas is mixed with air and burned beneath the surface of the liquid, thus eliminating solid surfaces to transfer heat.

An experimental sodium-cooled, graphite-moderated nuclear reactor operating at Santa Susana, Calif., produced heat that was converted to 6,000 electric kilowatts by Southern California Edison Co. This installation was the first nonmilitary nuclear reactor to produce electric power for commercial distribution.[15]

North American Aviation began constructing a 75,000 kilowatt-capacity sodium-graphite reactor at Hallam, Nebr., for the Atomic Energy Commission; when completed in 1960, the installation will be operated by Consumers Public Power District of Nebraska.

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[13] Chemical and Engineering News. New Plant, More Soda Ash: Vol. 36. No. 45, Nov. 10, 1958. pp. 28–29.

[14] Miller. G. F., Manufacture and Uses of Saskatchewan Salt Cake: Canadian Min. and Met. Bull., vol. 51, No. 559. November 1958, pp. 698–703.

[15] Atomic Industrial Forum, The Atomic Industry 1958 Progress Report: February 1959, 12 pp.

Tetraethyl lead, produced commercially by reacting a lead, sodium alloy with ethyl chloride, is the most important consumer of metallic sodium in the United States. As a motor fuel additive tetraethyl lead was used in 99 percent of the gasoline consumed as aviation and motor fuel in 1958.

Although still a major consumer of sodium metal, production of tetraethyl lead dropped substantially because the concentration of tetraethyl lead in regular grade gasoline was reduced from 2.2 milliliters per gallon in 1956 to 1.5 milliliters per gallon in 1958. Installation of catalytic reforming equipment in oil refineries was held chiefly responsible for the reduction. This equipment increases the base octane rating of gasoline before blending with tetraethyl lead thus obtaining the desired antiknock quality with a smaller than usual addition of tetraethyl lead.

No further reduction of tetraethyl lead content of gasoline fuels was anticipated because the maximum quantity that can profitably be processed through catalytic reformers has been reached at approximately 20 percent of the crude capacity of the industry. As a result the consumption of metallic sodium in producing tetraethyl lead was not expected to decline below the 1958 quantity.

Stone

By Wallace W. Key [1] and Nan C. Jensen [2]

DESPITE reduced activity in many industries that required stone, the bolstering effect of highway construction created a record demand for stone products in 1958. Construction lagged during most of the year, but its rapid recovery in the last quarter resulted in record sales of stone in many areas.

Slate, formerly reported separately, is included in this chapter.

TABLE 1.—Salient statistics of the stone industry in the United States [1]

	1949–53 (average)	1954	1955	1956	1957	1958
Dimension stone:						
Short tons (thousands)	1,986	2,534	2,674	[2] 2,640	2,456	2,522
Value (thousands)	$63,874	$73,446	$82,575	[2] $83,473	$83,688	$80,254
Crushed stone:						
Short tons (thousands)	272,698	410,287	468,577	[2] 504,871	[2] 530,967	532,818
Value (thousands)	$372,467	$554,049	$638,634	[2] $694,972	[2] $741,714	$745,955
Total sold or used by producers:						
Short tons (thousands)	274,684	412,821	471,251	[2] 507,511	[2] 533,423	535,340
Value (thousands)	$436,341	$627,495	$721,209	[2] $778,445	[2] $825,402	$826,209
Imported for consumption: [3] Value (thousands)	$3,703	$5,361	$5,728	$7,857	$8,792	$8,312
Exported: Value (thousands)	[4] $984	$4,514	$5,491	$5,602	[2] $6,013	$6,756

[1] Includes slate. 1949–56 includes Territories of the United States, possessions, and other areas administered by the United States. 1957–58 includes Alaska and Hawaii.
[2] Revised figure.
[3] Includes whiting.
[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] by States

State	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Alabama	[2] 9,519	[2] $11,972	[2] 11,080	[2] $17,068
Alaska	528	1,953	615	2,065
Arizona	2,101	2,982	1,528	2,731
Arkansas	[2] 7,278	[2] 8,378	8,461	10,178
California	[2] 41,351	[2] 53,591	32,423	48,345
Colorado	2,438	4,168	2,930	4,943
Connecticut	6,199	10,040	4,223	6,863
Delaware	(3)	(3)	(3)	(3)
Florida	21,786	30,467	[2] 23,549	[2] 30,983
Georgia	[2] 9,065	[2] 15,833	12,129	31,108
Hawaii	2,585	4,632	2,377	4,446
Idaho	1,542	2,759	1,122	1,710
Illinois	31,861	41,835	35,016	44,245
Indiana	14,460	33,094	15,394	31,974
Iowa	15,214	18,768	21,045	26,138
Kansas	[2] 10,412	[2] 11,926	[2] 12,424	[2] 15,036
Kentucky	12,718	16,714	12,597	17,360
Louisiana	4,383	7,152	5,453	9,532
Maine	[2] 889	[2] 3,076	880	2,760
Maryland	6,140	13,392	6,721	14,387
Massachusetts	4,877	13,165	4,649	12,354
Michigan	34,495	34,176	27,188	26,846
Minnesota	[2] 2,968	[2] 8,175	3,519	9,560
Mississippi	[2] 60	[2] 54	[2] 102	[2] 92
Missouri	22,098	29,836	24,276	32,878
Montana	2,567	3,654	1,545	2,214
Nebraska	3,065	3,749	3,555	4,747
Nevada	925	1,585	813	1,335
New Hampshire	(3)	(3)	(3)	(3)
New Jersey	8,792	21,222	8,229	19,193
New Mexico	1,348	1,618	1,730	1,507
New York	24,324	44,237	22,598	38,219
North Carolina	[2] 9,455	[2] 12,839	12,385	19,132
North Dakota	29	52	23	35
Ohio	[2] 37,451	[2] 61,847	29,122	49,782
Oklahoma	12,016	14,064	10,794	12,232
Oregon	[4] 10,583	[4] 11,745	15,004	15,483
Pennsylvania	43,397	77,095	40,049	69,694
Rhode Island	[2] 4	[2] 14	[2] 3	[2] 8
South Carolina	[2] 3,413	[2] 4,581	[2] 3,637	[2] 5,229
South Dakota	1,718	5,068	1,395	4,095
Tennessee	[2] 15,354	[2] 24,155	[2] 16,850	[2] 26,814
Texas	[4] 31,249	[4] 36,154	36,076	40,912
Utah	7,854	8,540	13,126	13,949
Vermont	[2] 557	[2] 11,404	808	15,789
Virginia	[2] 14,244	[2] 21,158	15,413	27,504
Washington	[4] 8,897	[4] 11,645	7,837	9,991
West Virginia	6,989	11,934	[2] 5,599	[2] 9,990
Wisconsin	12,434	22,455	13,722	23,334
Wyoming	1,291	2,266	1,099	1,472
Undistributed	10,500	34,183	4,227	9,947
Total	[4] 533,423	[4] 825,402	535,340	826,209
American Samoa	34	37	30	59
Guam	1,034	1,132	684	751
Midway Island	3,875	6,700	175	476
Panama Canal Zone	59	99	140	237
Puerto Rico	2,452	3,505	1,986	2,768
Virgin Islands	11	31	25	81
Wake Island	5	6	10	37

[1] Includes slate.
[2] 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.
[3] Figures withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[4] Revised figure.

TABLE 3.—Stone sold or used by producers in the United States, by kinds [1]

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone and dolomite		Shell	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
1949-53 (average)	20, 986	$49, 862	26, 709	$40, 138	291	$11, 389	198, 475	$277, 832	(2)	(2)
1954	23, 450	56, 705	30, 808	49, 593	538	13, 794	[3] 316, 500	[3] 423, 622	12, 358	$15, 320
1955	26, 079	59, 581	35, 851	56, 141	1, 092	19, 786	[3] 361, 524	[3] 489, 002	15, 131	22, 630
1956	[4] 29, 640	[4] 65, 995	38, 052	63, 021	947	18, 380	[3] [4] 381, 001	[3] [4] 516, 687	19, 852	28, 368
1957	41, 636	75, 985	[4] 43, 798	[4] 72, 869	1, 423	23, 707	383, 022	532, 863	[4] 19, 098	[4] 27, 563
1958	31, 913	69, 474	44, 067	69, 037	1, 405	27, 656	391, 447	535, 522	18, 916	31, 876

Year	Calcareous marl		Sandstone		Slate		Other stone [5]		Total	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
1949-53 (average)	(6)	(6)	8, 431	$24, 390	786	$13, 418	19, 006	$19, 312	274, 684	$436, 341
1954	(6)	(6)	12, 119	35, 321	761	12, 961	16, 287	20, 179	412, 821	627, 495
1955	(6)	(6)	13, 108	38, 624	760	12, 914	17, 706	22, 531	471, 251	721, 209
1956	(6)	(6)	[4] 13, 447	[4] 46, 389	645	11, 666	23, 927	27, 939	[4] 507, 511	[4] 778, 445
1957	1, 916	$1, 804	16, 294	49, 102	632	11, 029	25, 604	30, 480	[4] 533, 423	[4] 825, 402
1958	1, 803	1, 660	24, 973	53, 677	638	11, 459	20, 178	25, 848	535, 340	826, 209

[1] 1949-56 includes Territories of the United States, possessions, and other areas administered by the United States. 1957-58 includes Alaska and Hawaii.
[2] Data not available.
[3] Includes calcareous marl used in making cement.
[4] Revised figure.
[5] Includes mica schist, conglomerate, argillite, various light-colored volcanic rocks, serpentine not used as marble, soapstone sold as dimension stone, etc.
[6] Calcareous marl for agricultural use not included in stone; marl used in making cement, 1954-56, included with limestone.

DIMENSION STONE

Sales of dimension stone increased in 1958, despite competition from manufactured products and reduced activity in certain types of building construction, but the unit value declined compared with 1957.

Preparation of dimension stone involved the ordinary processes of sawing, splitting, surface dressing, carving, and polishing. The stone was used principally for constructing masonry walls and memorials.

Total sales of dimension stone (including slate) increased 3 percent in tonnage but declined 4 percent in value compared with 1957.

Quarries producing dimension stone were operated in 42 States including Hawaii. The leading States, in order of value, were Indiana, Vermont, Georgia, Ohio, Minnesota, Tennessee, and Massachusetts.

As stone normally cost more than substitutes, it was used chiefly for high-class buildings where permanence and architectural dignity are important attributes. Use of stone veneer in residential construction has increased in recent years.

Building stone remained the principal form in which dimension stone was sold, although concrete and steel have replaced it to a considerable extent. Prefabricated factory-assembled units, wall sections, and a variety of stone veneers were available, but transportation

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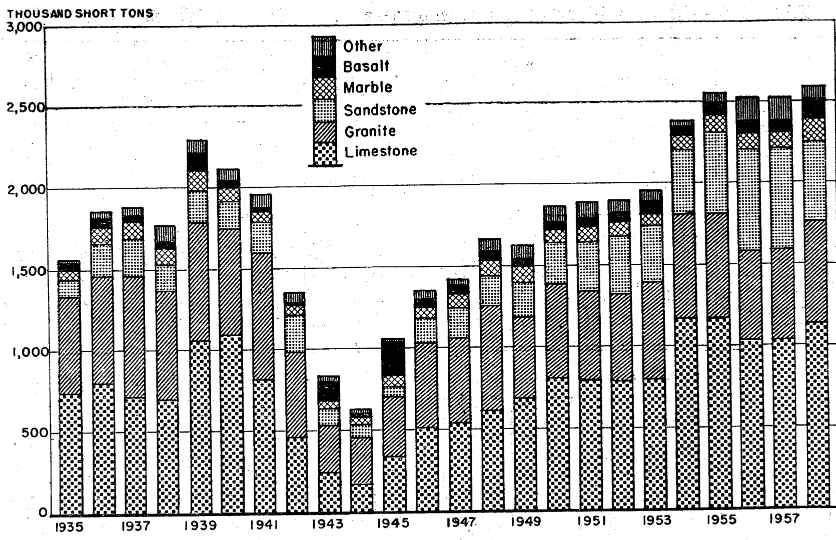

FIGURE 1.—Sales of dimension stone, except slate, in the United States and Puerto Rico, by kinds, 1935–58.

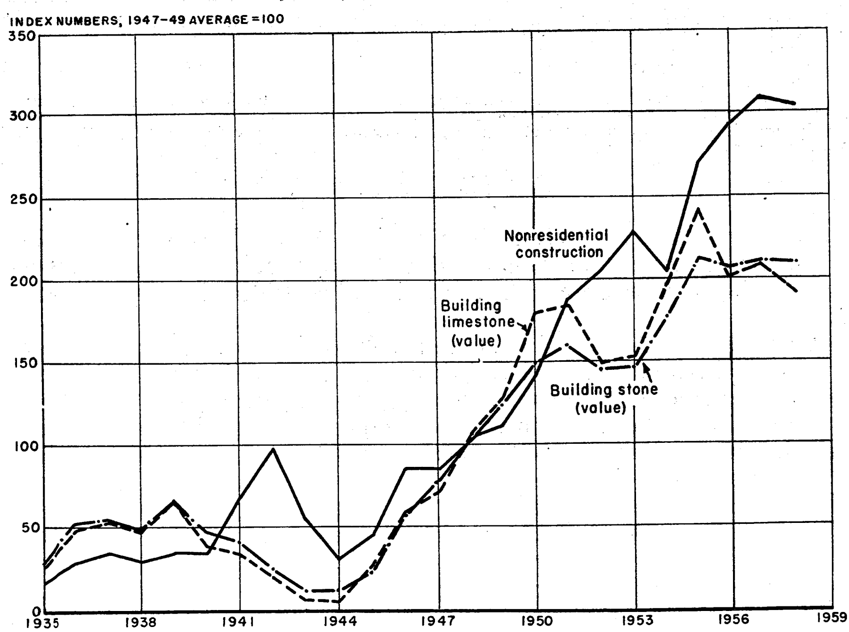

FIGURE 2.—Sales of all building stone, compared with sales of building limestone and value of all nonresidential construction, 1935–58.

(Data on nonresidential-building construction from Survey of Current Business, U.S. Department of Commerce.)

TABLE 4.—Dimension stone sold or used by producers in the United States, by uses

Use	1957			1958		
	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)
Building:						
Rough:						
Construction	219	----------	$1,766	353	----------	$2,048
Architectural [1]	405	5,440	7,537	396	5,283	6,615
Dressed:						
Sawed [1]	618	8,136	20,455	604	7,889	20,226
Cut	213	2,768	21,227	198	2,527	21,170
Rubble	352	----------	1,592	303	----------	1,139
Roofing (slate)	33	----------	2,003	33	----------	2,020
Millstock (slate)	23	----------	3,227	24	----------	3,113
Monumental (rough and dressed)	247	2,986	18,942	236	2,843	17,257
Paving blocks	4	----------	84	[2] 101	----------	[2] 475
Curbing	122	1,486	3,575	128	1,555	3,095
Flagging [3]	220	2,722	3,280	146	1,760	3,096
Total	2,456	----------	83,688	2,522	----------	80,254

[1] Includes stone for refractory use to avoid disclosing individual company confidential data.
[2] Includes 100,000 tons of blocks for other uses, valued at $454,000.
[3] Includes small quantity of slate for miscellaneous uses.

costs and mass-production methods favored substitute building materials, because various synthetic products were manufactured and assembled close to centers of consumption, whereas many stone-producing centers were remote from markets.

Because of the weight of dimension stone, transportation added greatly to delivered prices, and freight rates were important in competitive marketing. Nevertheless, stone was shipped long distances to satisfy architectural demands for certain textures and colors. Competition from imported stone was relatively insignificant in 1958, despite the downward trend in tariff rates.

Precision surface plates made from granite and basalt continued to be in demand for use in industrial plants where a hard, durable, nonwarping, and corrosion-proof surface was required. Marble and other ornamental stones were in greater demand for making tabletops, lamp bases, and novelties.

Waste blocks, "roughbacks" (end 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. Slate had special uses, such as in electrical insulation, not common to other stone types.

GRANITE

Total sales of granite as slabs and blocks increased 15 percent over 1957, but the value was lower. A large quantity of special blocks that sold for a relatively low unit value contributed to the overall reduction in value per ton. Building-stone production increased, but monumental-stone sales declined. Suitability of granite as dimension stone was governed mainly by physical properties and structural features. The American Society for Testing Materials approved a tentative specification for structural granite (C-422-58T) in 1958.

In the stone industry, the term "granite" was used broadly to refer to intrusive igneous rocks with ganitic texture and even metamorphic rocks with gneissic texture. Commercial granites included such rocks as syenite, granite, granodiorite, quartz monzonite, diorite, and gabbro. Ordinarily, gabbro, termed "black granite," would be included under the heading Basalt and Related Rocks.

A comparatively new use for granite was as surface plates for precision tools and instruments that required a polished, flat surface. Stone used for this purpose combined the qualities of low absorption, low compressibility, and low coefficient of thermal expansion.

TABLE 5.—Granite (dimension stone) sold or used by producers in the United States, by uses

Use	1957			1958		
	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)
Building:						
Rough:						
Construction	37		$395	48		$315
Architectural	15	178	659	15	181	588
Dressed:						
Construction	36	433	1, 819	36	434	1, 531
Architectural	32	393	4, 633	32	382	4, 129
Rubble	73		178	50		166
Monumental:						
Rough	175	2, 122	8, 931	168	2, 036	8, 350
Dressed	48	573	6, 312	46	556	5, 539
Paving blocks	4		84	[1] 101		[1] 475
Curbing and flagging	119	1, 439	3, 431	125	1, 512	2, 966
Total	539		26, 442	621		24, 059

[1] Includes 100,000 tons of blocks for other uses, valued at $454,000.

TABLE 6.—Granite (dimension stone) sold or used by producers in the United States in 1958, by States

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
California	9	6, 405	$455, 029	Pennsylvania	2	4, 982	$39, 159
Colorado	6	1, 537	63, 160	South Carolina	3	11, 925	343, 854
Georgia	26	137, 694	3, 211, 397	South Dakota	10	18, 696	2, 097, 262
Minnesota	24	34, 555	3, 473, 042	Texas	4	113, 202	1, 157, 369
Missouri	1	3, 165	258, 765	Washington	6	1, 313	22, 767
Montana	1	8	210	Wisconsin	8	7, 629	1, 362, 686
New Jersey	1	140	175	Other States [1]	43	272, 857	11, 022, 763
Oklahoma	6	6, 419	549, 178				
Oregon	1	10	1, 875	Total	151	620, 537	24, 058, 691

[1] Includes Connecticut and Maine, 5 plants each; Maryland, 4 plants; Massachusetts, 7 plants; New Hampshire, 1 plant; North Carolina, 15 plants; and Vermont, 6 plants.

Granite was quarried as dimension stone in (1) the Appalachian district of the eastern United States from Maine to Georgia; (2) the Middle Western States, particularly South Dakota, Minnesota, Wisconsin, and Oklahoma; (3) the Rocky Mountain States, where deposits have not been developed extensively; and (4) the Pacific Coast States, particularly California. Granite was also produced outside these four main territories.

BASALT AND RELATED ROCKS (TRAPROCK)

Basalt and related rocks were not used extensively as building stone because of their dark color. Output of rough construction stone totaled 120,000 tons, valued at $271,000, an increase over 1957. Use as dressed architectural stone and precision surface plates accounted for 2,000 tons valued at $300,000. The number of plants reporting output increased from seven to nine. The production of most States cannot be shown; but Pennsylvania with five plants led in production, followed by New Jersey, Oregon, California, and Connecticut with one plant each.

Some basalt and related dark rocks were used for memorials and usually classed in the trade as "black granite." Two Pennsylvania companies produced "black granite" precision surface plates for bases of precision instruments.

MARBLE

The total value of marble increased 11 percent a ton. The average value of marble sold for memorials was $13.39 a cubic foot, compared with $12.68 in 1957. The value of marble sold for buildings increased $2.34 a cubic foot in 1958 to $9.12.

The Bureau of Mines published an information circular on marble, giving its properties, uses, and geographic distribution and discussing recent advances in technology.[3]

A new sealant was introduced for protecting marble surfaces.[4] A new adhesive also was developed for mending, filling, and bonding marble. Reportedly it will allow scrap marble to be reclaimed and can be honed and polished.[5]

TABLE 7.—Marble (dimension stone) sold or used by producers in the United States [1]

Use	1957			1958		
	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)
Building: [2]						
Rough: Architectural	15	176	$641	21	251	$895
Dressed:						
Sawed	77	946	2,743	54	633	3,085
Cut	33	409	6,989	39	461	8,283
Monumental (rough and finished)	24	292	3,699	22	251	3,368
Total	149	----------	14,072	136	----------	15,631

[1] Produced by the following States in 1958 in order of value and with number of plants: Vermont, 5; Georgia, 2; Tennessee, 13; Missouri, 4; Alabama, 2; North Carolina, 1; Colorado, 4; Arkansas, 1; Maryland, 1; and California, 2.

[2] Includes: 1957—1,029,000 cubic feet of building stone, valued at $4,220,000, for exterior use, and 502,000 cubic feet, $6,153,000, for interior use; 1958—755,000 cubic feet, $5,567,000, for exterior use, and 590,000 cubic feet, $6,696,000, for interior use.

[3] Bowles, Oliver, Marble: Bureau of Mines, Inf. Circ. 7829, 1958, 31 pp.
[4] Stone, New Sealant Protects Marble From Stain: Vol. 78, No. 7, July 1958, p. 23.
[5] Stone, New Adhesive for Marble and Stone: Vol. 78, No. 5, May 1958, p. 18.

LIMESTONE

Limestone blocks, cut to definite shapes and sizes, were used mainly for building purposes. Small quantities were used for curbing and flagging and for memorials. The number of plants producing dimention limestone increased slightly, and sales increased 26,000 tons compared with 1957. The average value declined $2.86 a ton from $22.02 a ton in 1957, but the largest drop was in the quantity and value of finished building stone. Limestone used in rough form for buildings increased considerably in tonnage but declined in unit value. The rustic appearance offered by rough stone in residential construction gained favor in many sections of the country.

The Bedford-Bloomington (Ind.) area continued to produce most of the rough blocks and finished dimension limestone in the United States, contributing 73 percent of the total. Sales by firms operating quarries in the district also include a small quantity of crushed-stone byproducts. Many dimension-limestone producers used the scrap from block and slab production to supply local crushed-stone markets.

TABLE 8.—Limestone (dimension stone) sold or used by producers in the United States, by uses

Use	1957			1958		
	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)
Building:						
Rough:						
Construction	29	----------	$166	102	----------	$263
Architectural	246	3,381	3,505	256	3,510	3,456
Dressed:						
Sawed	329	4,445	7,957	331	4,452	7,682
Cut	111	1,487	8,492	86	1,154	6,582
Rubble	195	----------	535	184	----------	520
Curbing and flagging	43	572	326	20	260	254
Total	953	----------	20,981	979	----------	18,757

TABLE 9.—Limestone (dimension stone) sold or used by producers in the United States in 1958, by States

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
California	2	3,629	$16,314	Nebraska	3	2,603	$10,068
Colorado	1	650	6,500	Ohio	1	4,033	12,101
Hawaii	2	2,300	5,742	Oklahoma	3	2,608	21,448
Illinois	5	2,557	105,597	Texas	8	59,387	1,071,720
Indiana	17	557,756	12,853,871	Wisconsin	30	75,438	1,281,568
Iowa	6	9,773	82,220	Wyoming	1	92	4,600
Kansas	11	51,019	530,345	Other States [1]	12	68,817	1,011,222
Michigan	5	50,965	120,361				
Minnesota	6	42,482	1,384,631	Total	124	979,154	18,757,358
Missouri	11	45,045	239,050	Puerto Rico	6	148,146	281,058

[1] Includes Alabama, Connecticut, and New Jersey, 1 plant each; Pennsylvania, 2 plants; Tennessee, 3; and Florida, 4.

The potentially profitable use and possible strategic importance of worked-out underground limestone mines continued to be stressed in the trade journals.[6]

TABLE 10.—Limestone sold by producers in the Indiana oolitic limestone district, by classes

Year	Construction					
	Rough blocks		Sawed and semifinished		Cut	
	Cubic feet (thousands)	Value (thousands)	Cubic feet (thousands)	Value (thousands)	Cubic feet (thousands)	Value (thousands)
1949–53 (average)	2,196	$2,288	2,908	$4,321	863	$4,523
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
1958	2,941	2,967	3,007	5,104	725	4,273

Year	Construction—Continued			Other uses		Total	
	Total						
	Cubic feet (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
1949–53 (average)	5,967	432	$11,132	163	$297	595	$11,429
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
1958	6,673	484	12,344	168	449	652	12,793

SANDSTONE

Sandstone used as dimension stone decreased 12 percent in tonnage and 5 percent in value compared with 1957. The value of $23.15 a ton in 1958 was $1.78 higher than that in 1957.

Nine more dimension-sandstone producers reported than in 1957. The leading quarry was in the Amherst area of northern Ohio.

[6] Trauffer, Walter E., Limestone Mines as Warehouses and Shelters: Pit and Quarry, vol. 50, No. 11, May 1958, p. 10.

TABLE 11.—Sandstone (dimension stone) sold or used by producers in the United States, by uses

Use	1957			1958		
	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)	Short tons (thousands)	Cubic feet (thousands)	Value (thousands)
Building:						
Rough:						
Construction	92		$725	81		$899
Architectural [1]	129	1,705	2,732	104	1,341	1,676
Dressed:						
Sawed [1]	138	1,870	5,370	139	1,852	4,686
Cut	37	479	1,113	41	530	2,176
Rubble	48		290	59		303
Curbing	3	47	144	3	43	129
Flagging	108	1,326	1,490	62	769	1,444
Total	555		11,864	489		11,313

[1] Includes stone for refractory use to avoid disclosing individual company confidential data.

TABLE 12.—Sandstone (dimension stone) sold or used by producers in the United States in 1958, by States

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
Arizona	11	34,147	$542,146	New York	10	33,291	$1,276,870
Arkansas	16	28,600	360,530	North Carolina	2	400	1,342
California	5	16,517	47,427	Pennsylvania	23	71,094	617,701
Colorado	15	9,641	168,512	Tennessee	14	68,574	1,248,377
Georgia	3	2,029	36,848	Texas	1	250	1,250
Kentucky	4	2,182	36,970	Utah	3	1,477	33,914
Massachusetts	1	290	29,016	Virginia	2	437	5,215
Michigan	3	18,776	132,981	West Virginia	1	480	12,000
Nevada	3	1,717	41,775	Wisconsin	8	4,496	49,640
New Mexico	2	533	11,750	Other States [1]	31	193,840	6,659,161
				Total	158	488,771	11,313,425

[1] Includes Kansas, 1 plant; Alabama, Ohio, and Washington, 2 plants each; Missouri, 4; Indiana, 5; and Ohio, 15.

SLATE

Production of dimension slate declined for the fourth consecutive year. Four States—Pennsylvania, Vermont, Virginia, and New York—produced over 95 percent of the total quantity and 93 percent of the total value. The average value increased from $54.99 to $55.75 a ton.

The average value of roofing slate dropped from $23.54 to $23.51 a square in 1958. Roofing slates are overlapped like shingles, and a square of slate is the amount that will cover 100 square feet of exposed roof. Although slate roofs were more durable than competitive materials, their comparatively high installation cost and limited color range contributed toward reduced sales in residential construction.

The average value of millstock a square foot declined to 84 cents. Electrical slate rose in value a square foot from $1.62 in 1957 to $2.41 in 1958 and structural and sanitary products from 77 to 80 cents a square foot; blackboards and bulletin boards decreased from 83 to 79 cents a square foot; and billiard tabletops decreased from 81 cents a square foot in 1957 to 77 cents in 1958.

TABLE 13.—Slate (dimension stone) sold or used by producers in the United States [1]

Use	1957 Quantity: Unit of measurement (thousands)	1957 Quantity: Approximate short tons (thousands)	1957 Value (thousands)	1958 Quantity: Unit of measurement (thousands)	1958 Quantity: Approximate short tons (thousands)	1958 Value (thousands)
Roofing slate	*Squares* 85	33	$2,003	*Squares* 86	33	$2,020
Millstock:						
Electrical, structural, and sanitary slate [2]	*Sq. ft.* 2,310	19	2,148	*Sq. ft.* 2,325	20	2,024
Blackboards and bulletin boards [3]	1,223	3	1,014	1,323	3	1,042
Billiard tabletops	81	1	65	60	1	47
Total millstock	3,614	23	3,227	3,708	24	3,113
Flagstones [4]	10,814	62	1,286	9,982	55	1,190
Miscellaneous uses [5]	----------	2	104	----------	3	108
Grand total	----------	120	6,620	----------	115	6,431

[1] Produced by the following States in 1958 in order of value of output and with number of plants: Pennsylvania, 13; Vermont, 17; Virginia, 3; New York, 9; Maine, 1; North Carolina, 3; and California, 1.
[2] Includes a small quantity of slate used for grave vaults and covers.
[3] Includes a small quantity of school slates.
[4] Includes slate used for walkways and steppingstones.
[5] Includes slate for aquarium bottoms, buildings, fireplaces, flooring, headstones, shims, and unspecified uses.

MISCELLANEOUS STONE

The principal types of stone in this classification are mica schist, argillite, light-color volcanic rocks (such as rhyolite), soapstone, and greenstone. The quantity sold decreased, but the unit value increased substantially compared with 1957.

TABLE 14.—Miscellaneous varieties of dimension stone sold or used by producers in the United States [1]

Use	1957 Short tons (thousands)	1957 Cubic feet (thousands)	1957 Value (thousands)	1958 Short tons (thousands)	1958 Cubic feet (thousands)	1958 Value (thousands)
Building:						
Sawed [2]	38	442	$2,566	44	518	$3,242
Rubble	36	----------	589	10	----------	150
Flagging	5	60	74	6	71	100
Total	79	----------	3,229	60	----------	3,492

[1] Produced by the following States in 1958 in order of value of output and with number of plants: Virginia, 2; California, 20; Oregon, 4; Maryland, 1; Pennsylvania, 4; New York, 1; Colorado, 1; and Nevada, 1.
[2] Includes rough and cut stone and stone for refractory use to avoid disclosing individual company confidential data.

FOREIGN TRADE [7]

Imports of building and ornamental stone decreased, but the quantity of the various types used fluctuated compared with 1957. Marble from Italy, Spain, France, Belgium, Portugal, and England was the main stone type imported, but granite used for memorials was imported from Finland, Sweden, and Canada. Onyx marble was imported from Mexico and travertine from Italy.

Exports of building and monumental stone decreased 6 percent in quantity but increased 7 percent in value compared with 1957.

Tariff.—Duties on the various types of imported stone have declined consistently from the rates established by the Tariff Act of 1930 through numerous concessions made under the General Agreement on Tariffs and Trade (GATT). The duty on all marble and breccia, in blocks rough or squared only, was reduced from 29 cents per cubic foot in 1957 to 27½ cents per cubic foot in 1958. The duty on manufactured marble was reduced from 22½ percent ad valorem in 1957 to 21 percent in 1958; on unmanufactured travertine from 11 cents per cubic foot in 1957 to 10½ cents in 1958; and on hewn, dressed, or otherwise manufactured marble (including travertine) from 22½ percent ad valorem in 1957 to 21 percent in 1958. Duties on sawed or dressed marble over 2 inches thick, slabs and paving tiles, and mosaic cubes remained unchanged in 1958. The import duty on unmanufactured granite dropped from 9 cents per cubic foot in 1957 to 8 cents in 1958, and that on manufactured granite from 13½ percent ad valorem in 1957 to 12½ percent in 1958. The duty on slate (excluding roofing) was reduced from 11 percent ad valorem in 1957 to 10½ percent in 1958.

Tables on export and import of the various stone types are given under Foreign Trade heading in the Crushed Stone section of this chapter.

WORLD REVIEW

North America

Canada.—Production of building and ornamental stone increased 14 percent in value in 1957 and reached an alltime high of $7,354,000. The increase was attributed mainly to a rise in prices rather than volume. The value of granite and sandstone output increased 25 and 18 percent, respectively, whereas that of limestone and marble was about the same as in 1956. Sandstone production increased in value in 1957 but declined 20 percent in quantity.[8]

Cuba.—Limestone produced in Cuba during 1957 totaled 4.5 million short tons, of which 1.5 million was used for cement and the remainder for other purposes.

According to industry sources, the production of building and monumental marble in slabs ⅞ inch thick totaled 57,000 square yards. Reportedly, the quantity of blocks produced was minor, although potential annual production is 6,300 cubic yards.

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[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.

[8] Hanes, F. E., Building and Ornamental Stone in Canada, 1957: Canadian Mineral Industry—1957, Review 34, May 1958, p. 1.

Crushed, ground, or broken marble production, consisting mostly of chips used in manufacturing "Cuban terrazzo tiles," totaled 36,000 tons.[9]

South America

Argentina.—Production of marble in blocks was estimated at 29,000 short tons in 1956, compared with 95,000 tons in 1955; production of marble as rubble was estimated at 20,000 tons. Crystallized limestone production was estimated at 1,100 tons; travertine, 6,000 tons; onyx, 900 tons; and serpentine, 2,900 tons in 1956.

Exports of marble from Argentina were estimated at 250 tons in 1956 and 275 tons in 1955; limestone 350 tons in 1956 and 450 tons in 1955; granite blocks, 4 tons in 1956 and 2 tons in 1955; and travertine, 20 tons in 1956.[10]

Producers reported exporting slate items valued at $309,115, an increase of 9 percent over 1957. Granules, flour, blackboards, flagstones, and other products were shipped to Canada. Exports in smaller quantities went to Latin American countries.

Asia

Ceylon.—Production of limestone totaled 111,000 short tons in 1957, compared with 100,000 tons in 1956, an increase of 11 percent.[13]

Jordan.—Production of marble totaled 13,000 square yards in 1956, compared with estimated outputs of 11,000 square yards in 1955 and 7,000 square yards in 1954.

Production by a new marble company, organized in 1955 to quarry, cut, and polish Jordan marble, was small in the early half of 1956.[11]

Israel.—A modern limestone quarry near Haifa was described.[12]

TECHNOLOGY

A machine was patented for straight or circular cutting of dimension stone.[14]

An improved method and apparatus for wire sawing dimension stone from marble, limestone, and granite was patented. Pressure is level during sawing, and maximum grinding length is obtained.[15]

A pocket reference was available on the use of abrasive grains and powders for cutting, polishing, and sandblasting operations in the stone industries.[16]

Two marble polishes, a paste and liquid both containing silicone, were developed. These polishes reportedly impart a hard, protective finish.[17]

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[9] U.S. Embassy, Havana, Cuba, State Department Foreign Service Dispatch 896, May 2, 1958.
[10] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 3, March 1958, p. 38.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 1, January 1958, pp. 27–28.
[12] Arnon, J., Stone Aggregate Production in Israel: Mine and Quarry Eng., vol. 24, No. 4, April 1958, pp. 153–157.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, p. 40.
[14] Rovis, M., Marble Cutting and Finishing Machine: U.S. Patent 2,838,041, June 10, 1958.
[15] Wallin, S., Method and Device for Sawing Stone Blocks: U.S. Patent 2,830,573, Apr. 15, 1958.
[16] Stone, Abrasive Grains and Powders: Vol. 78, No. 8, August 1958, p. 22.
[17] Stone, Two Marble Polishes: Vol. 78, No. 3, March 1958, p. 19.

A new tentative ASTM standard specification for dimension granite used in building, based on physical tests rather than source as previously used, was accepted by the Society.[18]

Increased production of manufactured industrial diamonds and a reduction in price per carat from $5.10 to $3.48 encouraged their wider use in dimension-stone sawing and finishing processes.

An improved saw blade for dressing dimension stone was patented.[19]

Details were given of an underground slate mining operation in Wales that extended downward 1,000 feet and had over 35 miles of underground roadways connecting hundreds of slate workings on 31 levels.[20]

A new low-cost wire saw that has several improved features was placed in operation at southern granite and marble plants.[21]

A design for a portable, ultrasonic vibrating tool adapted to cutting stone in large blocks was patented.[22]

Some dimension-stone quarries modernized their operations. A sandstone quarry switched from the traditional guy derrick for handling quarry blocks to a mobile crane.[23]

A machine was patented for sawing marble, granite, or other types of dimension stone with endless, flexible wire strands, with or without feeding an abrasive to the saw. The cutting run of the sawing wire passes through a tubular member which may serve as a tracer or stylus coacting with the fixed pattern.[24]

CRUSHED AND BROKEN STONE

Total sales of nearly 533 million tons of crushed and broken stone (including slate) by more than 2,500 producers increased slightly in 1958 over the record year 1957.

Crushed and broken stone applications may be grouped under two broad categories: (1) Physical uses, in which the stone is crushed, pulverized, or otherwise changed in form without changing its chemical characteristics, and (2) chemical uses, in which the original composition of the rock has been changed, such as in manufacturing cement and lime.

The bulk of stone production went into construction projects. Most chemical and metallurgical uses for stone declined, but requirements for stone in cement manufacture increased.

The Federal Highway Act of 1958 contains numerous provisions for accelerating the road program. A breakdown of the funds authorized by States was published.[25]

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[18] American Society for Testing Materials, Bull. 235: January 1959, p. 10.

[19] Blum, H. T. (assigned to Briar Hill Stone Co., Glenmont, Ohio), Slanted Tooth Saw Blade for Cutting Stone: U.S. Patent 2,829,632, Apr. 8, 1958.

[20] Mine and Quarry Engineering, The Oakeley Slate Mine: Vol. 24, No. 9, September 1958, pp. 380–387.

[21] Stone, New Wire Saw: Vol. 78, No. 8, August 1958, p. 20.

[22] Skowronski, R. F., Ultrasonic Stone Cutting Device: U.S. Patent 2,831,668, Apr. 22, 1958.

[23] Stone, Largest Sandstone Quarry Modernizes to Cut Costs: Vol. 78, No. 12, December 1958, pp. 18–19.

[24] Dessureua, J. T., and Dessureua, J. B., Abrasive Wire Shape-Cutting Stone Saw Machine: U.S. Patent 2,866,448, Dec. 30, 1958.

[25] Public Law 85–767, 85th Cong., HR 12776, Aug. 27, 1958, 37 pp.

Although some companies seemed to retrench in 1958, others continued to increase production facilities. One company opened its 24th plant and operated two shifts at near capacity.[26]

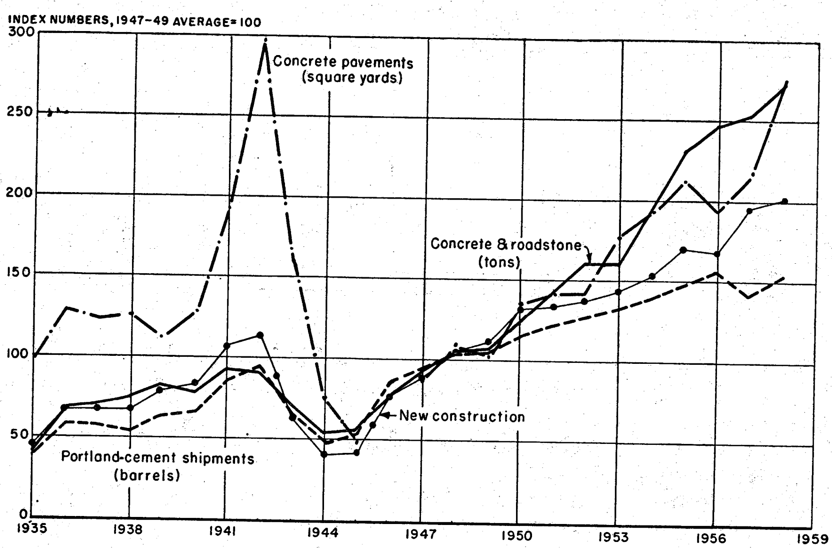

FIGURE 3.—Crushed-stone aggregates (concrete and roadstone) sold or used in the United States compared with shipments of portland cement, total new construction (value), and concrete pavements (contract awards, square yards), 1935–58.

(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.)

TABLE 15.—Crushed and broken stone sold or used by producers in the United States, by uses

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Agriculture	19,727	$32,290	20,545	$34,551
Cement	78,697	83,062	80,757	85,748
Concrete and roadstone	[1] 298,049	[1] 405,659	322,109	427,190
Fill	8,354	7,659	14,415	13,762
Filtration	172	442	178	404
Flux	39,890	57,390	26,045	37,491
Glass	1,425	4,118	1,178	3,443
Lime	[1] 17,862	[1] 26,571	15,708	24,043
Mineral food	460	2,758	635	3,664
Poultry grit	592	3,301	767	7,117
Railroad ballast	16,582	18,020	10,567	11,809
Refractory	1,720	11,894	920	7,810
Riprap	[1] 15,132	[1] 19,007	15,374	18,887
Roofing granules, aggregates, and chips	1,635	9,509	1,775	10,583
Stone sand	3,296	3,643	2,619	3,215
Terrazzo	385	4,650	370	4,588
Other uses [2] and unspecified	[1] 26,989	[1] 51,741	18,856	51,650
Total	[1] 530,967	[1] 741,714	532,818	745,955

[1] Revised figure.
[2] Includes some uses listed separately in the limestone and sandstone sections.

[26] Meschter, Elwood, Stone Plant Sets New Standards for Sizing: Rock Products, vol. 61, No. 2, February 1958, pp. 106–109, 172.

TABLE 16.—Crushed stone sold or used by noncommercial producers in the United States, by uses (included in total production)

(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)

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Concrete and roadstone	34,369	$38,114	39,510	$40,433
Riprap	[1] 7,372	[1] 7,552	7,960	8,991
Agricultural (limestone)	346	498	456	656
Other uses	9,038	5,119	1,572	1,466
Total	[1] 51,125	[1] 51,283	49,498	51,546

[1] Revised figure.

The largest producer of crushed stone in New England furnished 2 million tons of crushed traprock for the 77-mile Connecticut turnpike.[27]

Some States expected to more than double the 1957 number of contract awards in 1958.[28]

An Arkansas contractor established a $1-million crushed-stone plant that was reportedly one of the most efficient and flexible operations in the State.[29]

Trends in Use.—Highway construction induced many contractors throughout the country to enter the aggregate field. Some contractors used the rock from road cuts for aggregate. One producer used a portable crusher along the road-construction site. This cost-saving scheme allowed a lower bid for the overall construction work.[30] However, rigid State and federal requirements for crushed stone used in highways made it probable that commercial producers would supply most of the required tonnage. To retain their lead, many producers continued to enter the field as on-the-job producers, using high-capacity, portable and semiportable plants.

Some roadbuilders who had normally purchased aggregates found it necessary to produce their own. One southeastern contractor reported that since 1956 his company has set up five permanent plants and more were planned.[31]

A Massachusetts firm that for many years had purchased crushed stone on its jobs, opened its own 250-ton-per-hour crushed-stone plant and 200-ton-per-hour asphalt plant, exemplifying the trend toward contractor-produced aggregate.[32]

The Bureau of Public Roads continued to insist on aggregates that insure satisfactory structures and pavements, but it was suggested

[27] Jamieson, Syd., New England's Largest Stone Producer: Excavating Eng., vol. 52, No. 8, August 1958, pp. 16–21, 53–54.

[28] McKeever, Harold J., and Cronk, Duane L., Finally—a Road Building Boom: Roads and Streets, vol. 101, No. 8, August 1958, pp. 58–63, 66–67.

[29] Day, Ray, Stone Plant Meets Twin Needs—Handles Both Highway and Industrial Requirements: Rock Products, vol. 61, No. 7, July 1958, pp. 90–92.

[30] Roads and Streets, This Contractor Used a Special Ripper and Crushed Material Out of His Cuts: Vol. 101, No. 8, August 1958, pp. 76–77.

[31] Construction Methods and Equipment, Roadbuilder's Quarries Assure Ample Supply of Aggregates: Vol. 40, No. 1, January 1957, pp. 122–124, 129–131.

[32] Trauffer, Walter E., Eastern Contractor Builds Permanent Crushed Stone and Agbit Plants: Pit and Quarry, vol. 51, No. 2, August 1958, pp. 88–90.

TABLE 17.—Crushed stone for concrete and roadstone sold or used by producers in the United States, by States

State	1957		1958	
	Short tons	Value	Short tons	Value
Alabama	[1] 2,625,195	[1] $3,298,696	4,934,529	$6,218,586
Alaska	349,452	1,543,873	290,999	1,100,399
Arizona	[1] 567,300	[1] 325,700	97,231	107,873
Arkansas	[1] 2,283,374	[1] 2,455,710	[1] 4,817,300	[1] 5,943,235
California	15,467,253	17,786,122	9,204,846	11,481,260
Colorado	344,600	425,000	796,800	1,426,800
Connecticut	[1] 5,424,197	[1] 8,259,183	[1] 3,567,395	[1] 5,240,448
Florida	[1] 16,620,456	[1] 22,549,865	19,806,047	25,147,629
Georgia	[1] 7,114,501	[1] 10,126,784	[1] 7,940,721	[1] 12,716,689
Hawaii	2,468,364	4,509,175	2,185,992	4,120,396
Idaho	[1] 1,043,467	[1] 1,805,157	[1] 759,059	[1] 989,823
Illinois	23,081,191	31,056,816	26,314,679	33,358,831
Indiana	9,062,663	11,383,874	9,915,528	12,559,314
Iowa	11,415,716	13,946,187	15,562,603	18,973,904
Kansas	[1] 5,924,724	[1] 7,403,101	[1] 7,909,338	[1] 9,999,601
Kentucky	10,285,302	13,669,894	10,419,609	14,530,797
Louisiana	(2)	(2)	4,048,313	7,539,563
Maine	[1] 187,929	[1] 459,050	[1] 42,000	[1] 120,000
Maryland	4,142,452	6,884,044	[1] 4,353,224	[1] 7,211,301
Massachusetts	[1] 3,770,725	[1] 6,310,634	[1] 3,266,993	[1] 5,442,559
Michigan	4,970,530	6,131,587	6,220,260	6,980,800
Minnesota	[1] 1,974,302	[1] 2,396,866	[1] 2,524,187	[1] 3,019,889
Missouri	11,443,418	15,008,613	13,872,461	18,186,027
Montana	[1] 415,863	[1] 986,176	629,194	858,923
Nebraska	820,900	1,221,200	1,470,600	2,173,900
Nevada	28,763	36,930	90,248	111,360
New Jersey	[1] 7,283,291	[1] 16,564,323	6,987,442	15,052,815
New Mexico	1,116,900	1,328,200	1,633,977	1,366,927
New York	16,671,556	31,262,387	15,300,339	25,219,867
North Carolina	[1] 8,910,827	[1] 12,208,913	[1] 11,804,554	[1] 16,797,898
Ohio	16,955,497	21,548,070	[1] 13,332,065	[1] 17,462,523
Oklahoma	9,502,936	10,498,530	8,690,694	8,938,215
Oregon	[1] 5,067,817	[1] 6,360,665	11,720,506	12,241,492
Pennsylvania	[1] 16,407,684	[1] 24,734,958	18,537,260	28,025,216
Rhode Island	[1] 4,200	[1] 14,154	[1] 2,641	[1] 7,923
South Carolina	[1] 2,957,570	[1] 4,254,876	[1] 2,922,265	[1] 4,229,973
South Dakota	[1] 931,900	[1] 1,460,700	831,900	1,274,800
Tennessee	[1] 11,304,989	[1] 13,870,606	[1] 13,153,136	[1] 16,805,879
Texas	[1 3] 19,849,837	[1 3] 20,696,430	[1] 23,832,761	[1] 23,023,560
Utah	130,900	80,600	[1] 78,900	[1] 78,900
Virginia	8,443,328	12,165,178	[1] 9,311,588	[1] 13,745,473
Washington	5,852,114	6,144,899	[1] 5,694,531	[1] 6,617,739
West Virginia	[1] 1,719,360	[1] 2,939,972	[1] 1,717,434	[1] 3,053,291
Wisconsin	8,723,893	8,617,756	[1] 10,064,498	[1] 10,095,449
Wyoming	[1] 7,200	[1] 6,400	246,600	154,500
Undistributed [4]	14,374,250	20,922,049	5,205,627	7,438,621
Total	[3] 298,048,686	[3] 405,659,903	322,108,874	427,190,968

[1] To avoid disclosing confidential information, total is somewhat incomplete; the part not included is combined with "Undistributed."
[2] Included with "Undistributed."
[3] Revised figure.
[4] Includes data indicated by footnote 2 and Delaware, New Hampshire, and Vermont.

that lower quality, locally available materials might be used as subbases where specifications are less critical.[33] This agency requested its field offices and the State highway departments to investigate and report upon the supply of aggregates in each State.[34]

The aggregate industry has increased its labor-productivity rate by 264 percent since 1939. The average size of quarries and mines, based on tonnage, increased by about 75 percent in the same period,

[33] Pit and Quarry, 41st N.C.S.A. Convention Draws Record: Vol. 50, No. 10, April 1958, pp. 95–98, 105–108, 115–118.
[34] Trauffer, Walter E., Status of Highway Program Chief Concern at N.C.L.I. Convention: Pit and Quarry, vol. 50, No. 10, April 1958, pp. 120–122.

average number of employees dropped more than one-fourth, and production per man-year increased over 150 percent.[35]

Prices.—The comparative value of crushed stone and competitive materials was reported for a number of cities.[36]

SIZE OF PLANTS

The plant arrangement and size usually were tailored to meet the requirements of the deposit, extent of the market, and specifications for the product. Modifications of the plant flowsheet and capacity to meet changing market conditions were made at many operations. Plants ranged from simple portable frameworks supporting a crusher and one or two screens to elaborate structures housing complicated arrangements of various processing equipment. Some of the largest mineral-producing plants in the country were crushed-stone operations. However, the trend appeared to favor plant design rather than volume output to meet rigid specifications at lower costs. Highly efficient portable plants, mounted on pneumatic-tired wheels, became more popular in certain regions. These plants were used where freight rates on stone produced at permanently established plants made its costs prohibitive.

TABLE 18.—Number and production of commercial crushed-stone plants in the United States, by size groups

Annual production (short tons)	1957				1958			
	Number of plants	Production		Cumulative total, short tons (thousands)	Number of plants	Production		Cumulative total, short tons (thousands)
		Short tons (thousands)	Percent of total			Short tons (thousands)	Percent of total	
Less than 1,000	79	34	0.01	34	101	47	0.01	47
1,000 to 25,000	616	6,037	1.26	6,071	656	6,585	1.36	6,632
25,000 to 50,000	276	9,937	2.07	16,008	307	11,811	2.44	18,443
50,000 to 75,000	221	13,653	2.85	29,661	205	12,795	2.65	31,238
75,000 to 100,000	176	15,227	3.17	44,888	162	14,348	2.97	45,586
100,000 to 200,000	407	57,434	11.97	102,322	424	60,976	12.62	106,562
200,000 to 300,000	205	49,962	10.41	152,284	200	48,569	10.05	155,131
300,000 to 400,000	125	43,557	9.08	195,841	142	48,903	10.12	204,034
400,000 to 500,000	97	43,376	9.04	239,217	104	46,805	9.68	250,839
500,000 to 600,000	[1] 62	[1] 33,593	7.00	272,810	55	30,189	6.25	281,028
600,000 to 700,000	42	26,735	5.57	299,545	49	30,747	6.36	311,775
700,000 to 800,000	30	22,645	4.72	322,190	24	17,984	3.72	329,759
800,000 to 900,000	24	20,399	4.25	342,589	21	17,871	3.70	347,630
900,000 and over	74	137,253	28.60	479,842	79	135,690	28.07	483,320
Total	[1] 2,434	[1] 479,842	100.00	[1] 479,842	2,529	483,320	100.00	483,320

[1] Revised figure.

[35] Rock Products, Efficiency is the Keynote as Aggregate Producers Battle Rising Costs: Vol. 61, No. 9, September 1958, pp. 92–97, 114.

[36] Engineering News-Record, vol. 161, No. 2, July 10, 1958, p. 91.

TRANSPORTATION

The trend toward increased use of trucks for transporting crushed stone continued. The quantity hauled by rail again declined, reaching a new low of 15 percent of the total. Freight-rate increases over the past 2 years contributed to this decline. Waterways provided relatively minor but locally important transportation facilities.

Use of larger trucks in quarrying operations proved more economical, because higher productivity more than offset higher costs.[37] More attention was given by the trucking industry to roadbuilding and maintenance in 1958. Expanding roadbuilding programs increased demand for trucks; and the new roads, which usually provided more direct routes, gave the trucks a further competitive advantage over rail haulage. On the other hand, greater use of portable plants near the job site shortened the haul and thus decreased the number of trucks required.

TABLE 19.—Crushed stone sold or used in the United States in 1958, by method of transportation

Method of transportation	Commercial operations		Commercial and noncommercial [1] operations	
	Short tons (thousands)	Percent of total	Short tons (thousands)	Percent of total
Truck	295,360	61	344,858	65
Rail	81,716	17	81,716	15
Waterway	56,984	12	56,984	11
Unspecified	49,260	10	49,260	9
Total	483,320	100	532,818	100

[1] Entire output of noncommercial operations assumed to be moved by truck.

The "piggyback" method of hauling loaded trailer trucks by rail was not used extensively in shipments of crushed-stone products. However, the method was considered to be potentially advantageous for transporting higher valued crushed-stone products in some instances.

GRANITE

The quantity and value of crushed-granite production decreased despite a relatively large amount of construction in the producing States. Other types of stone and sand and gravel competed in most of these States in the major markets. Value per ton increased 24 cents to $1.45. Georgia and North Carolina were the leading producing States.

[37] Rock Products, Those Trends Are Cutting Rock Plant Costs: Vol. 61, No. 9, September 1958, p. 101.

TABLE 20.—Granite (crushed and broken stone) sold or used by producers in the United States, by uses

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Concrete and roadstone	27,944	$39,061	26,269	$39,002
Railroad ballast	1,830	1,947	1,876	2,154
Riprap	1,257	2,038	1,023	2,067
Fill	1,104	872	916	614
Stone sand	838	393	1,128	844
Poultry grit	25	292	50	611
Other uses [1]	8,099	4,940	30	123
Total	41,097	49,543	31,292	45,415

[1] Includes stone used for agriculture, roofing granules, and unspecified uses.

TABLE 21.—Granite (crushed and broken stone) sold or used by producers in the United States in 1958, by States

State	Short tons	Value	State	Short tons	Value
Alaska	189,878	$370,990	Oklahoma	24,932	$20,100
Arkansas	11,176	5,588	South Carolina	3,624,789	4,884,841
California	3,642,985	4,892,650	Tennessee	50,000	75,000
Colorado	9,300	18,900	Texas	3,430	6,350
Georgia	8,753,500	13,336,130	Utah	77,300	146,100
Idaho	15,600	24,000	Virginia	2,815,440	4,298,385
Massachusetts	764,712	1,408,317	Washington	367,096	246,300
Minnesota	431,339	773,491	Wisconsin	357,700	114,425
Missouri	483	898	Wyoming	265,300	185,000
New Jersey	562,252	1,136,873	Other States [1]	1,091,310	1,471,649
New Mexico	26,100	24,500			
North Carolina	8,184,281	11,939,403	Total	31,291,703	45,415,190
North Dakota	22,800	35,300			

[1] Includes Arizona, Connecticut, Delaware, Maine, Montana, Nevada, New Hampshire, Oregon, Rhode Island, and Vermont.

Methods used in producing a million tons of crushed granite annually at a large quarry near Greenville, S.C., were described in a Bureau of Mines report. One of a series published by the Bureau on practices in mining and preparing crushed stone for market, the report contains sections on exploration and estimation of reserves, development and mining, processing, maintenance, auxiliary operations and labor and power distribution.[38]

BASALT AND RELATED ROCKS (TRAPROCK)

Commercial traprock includes basalt, gabbro, diorite, and other dark igneous rocks widely used for concrete and roadstone, railroad ballast, and riprap. Sales of crushed and broken traprock were slightly larger than in 1957, but their value decreased 5 percent. Sales as concrete and roadstone increased 11 percent, offsetting the lower output for most other uses. Oregon again led, followed by New Jersey.

[38] Alfred, Robert, and Schroeder, H. J., Methods and Practices for Producing Crushed Granite, Campbell Limestone Co., Pickens County, S. C.: Bureau of Mines Inf. Circ. 7857, 1958, 24 pp.

TABLE 22.—Basalt (crushed and broken stone) sold or used by producers in the United States, by uses

Use	1957 Short tons (thousands)	1957 Value (thousands)	1958 Short tons (thousands)	1958 Value (thousands)
Concrete and roadstone	35,299	$59,178	39,187	$59,665
Railroad ballast	2,247	3,345	1,421	2,169
Riprap	[1] 5,350	[1] 6,480	2,177	3,002
Fill	164	93	433	267
Stone sand	98	142	22	60
Other uses [2]	579	3,151	705	3,303
Total	[1] 43,737	[1] 72,389	43,945	68,466

[1] Revised figure.
[2] Includes stone used for filter rock, mineral filler, roofing granules, and unspecified uses.

TABLE 23.—Basalt and related rocks (traprock) (crushed and broken stone) sold or used by producers in the United States in 1958, by States

State	Short tons	Value	State	Short tons	Value
Alaska	122,406	$529,974	Oregon	9,830,573	$10,591,400
California	1,498,262	1,736,720	Pennsylvania	3,210,806	6,565,561
Connecticut	3,697,311	5,393,211	Virginia	1,149,643	1,900,508
Hawaii	1,958,500	3,850,887	Washington	5,883,588	6,901,636
Idaho	743,459	965,823	Wisconsin	254,467	1,282,127
Maine	42,000	120,000	Other States [1]	3,544,771	6,235,743
Massachusetts	3,078,310	4,873,374			
Michigan	30,652	34,000	Total	43,944,775	68,466,401
Nevada	84,500	103,800			
New Jersey	6,972,730	15,094,985	American Samoa	23,080	53,946
New Mexico	9,075	9,000	Panama Canal Zone	89,544	178,048
North Carolina	1,833,722	2,277,652	Virgin Islands	25,296	80,586

[1] Includes Arizona, Maryland, Minnesota, Montana, New York, and Texas.

MARBLE

Substantial quantities of waste material, comprising defective blocks or cuttings and spalls from marble-dressing operations, accumulate in quarrying and processing marble blocks. This byproduct material was marketed for a variety of uses. Moreover, several plants produce marble exclusively for industrial use, as marble consists of relatively pure calcium carbonate and therefore is interchangeable with high-calcium limestone for various uses. The average value varies from one area to another owing to the diversity of its use. In some States marble, as terrazzo or marble flooring, was marketed as a high-priced product, whereas in other States it was sold at a relatively low price as roadstone or concrete aggregate. The average unit value for crushed and broken marble increased from $7.56 to $9.48 per ton.

TABLE 24.—Marble (crushed and broken stone) sold or used by producers in the United States [1]

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Terrazzo	377	$4,543	359	$4,487
Other uses [2]	897	5,092	910	7,538
Total	1,274	9,635	1,269	12,025

[1] Produced by the following States in 1958, in order of tonnage: Georgia, Alabama, Vermont, New York, Tennessee, Texas, Maryland, Virginia, Washington, California, New Jersey, Arizona, Nevada, North Carolina, Colorado, and New Mexico.
[2] Includes stone used for agriculture, asphalt filler, concrete and roadstone, poultry grit, roofing, stone sand, stucco, whiting (excluding marble whiting made by companies that purchase marble), and unspecified uses.

LIMESTONE

Record production of crushed and broken limestone was established again, despite reduced activity in the steel, glass, and other industries where limestone is an essential raw material. The accelerated highway program was a major factor in bolstering sales.

Limestone was the most widely used type of stone in the United States, comprising 75 percent of all crushed and broken stone sold. Fortunately, limestone occurs in every State in some form, and 46 States reported sales to the Bureau of Mines. Because of its wide occurrence, limestone is the most convenient stone for highway or building construction and railroad ballast in many areas. The overall cost of quarrying and crushing limestone was usually lower than that of the harder rocks.

According to the Atomic Energy Commission, limestone added to acid soils in proper proportion reduces the effect of radioactivity fallout material, such as strontium 90, as the plants absorb calcium and thereby lower intake of the deadly material.

A plant began producing high-quality limestone in an area in Florida that formerly imported most of its needs.[39]

Mining a Florida limestone deposit by combining a tractor-mounted ripper and bulldozer blade resulted in reduced costs and increased production.[40]

Dolomite was to be used as the raw material in producing magnesium at a $3-million plant.[41]

Shortages of sand became more acute in several sections of the country. To relieve shortages in the eastern Tennessee area, a dolomite operation began to crush and screen sand-size material.[42]

[39] Trauffer, Walter E., Southwest Florida Stone Plant Has Unusual Washing Facilities: Pit and Quarry, vol. 51, No. 2, August 1958, pp. 82–83, 110.
[40] Pit and Quarry, Ripping Stone Pays Off for Florida Lime Producer: Vol. 50, No. 11, May 1958, pp. 185–188.
[41] Skillings' Mining Review, Calumet & Hecla Has Magnesium Interests: Vol. 47, No. 35, Nov. 29, 1958, p. 14.
[42] Meschter, Elwood, Here, Crushing Dolomite Eases a Sand Shortage: Rock Products, vol. 61, No. 10, October 1958, pp. 96–97, 150, 155.

Public interest in quarrying was shown at a limestone operation that recorded 41,000 visitors from 41 States, the District of Columbia, and 14 foreign countries during the summer of 1958.[43]

Dolomite had a variety of uses, some quite distinct from those of high-calcium limestone. Dead-burned dolomite was used as refractory lining for metallurgical furnaces; statistical data on the product are given in the Lime and Magnesium Compounds chapters of this volume. Raw dolomite was used as a refractory, particularly for patching furnace floors, and as a source of magnesium metal.

Mining methods using mobile equipment, loading and hauling practices, and processing techniques in producing dead-burned dolomite and commercial crushed stone at a new Utah dolomitic-limestone plant were described.[44]

Shell.—In areas where the supply of limestone was limited, shell was substituted for limestone in many instances. Oystershell is nearly pure calcium carbonate, and contaminants are removed more readily than impurities in limestone deposits. Some material classified as coquina is included in the shell category. Twenty-five million pearl-growing oysters, trapped in wire cages in Japanese waters, reportedly required tiny bits of Mississippi oystershell to produce lustrous cultured pearls that were indistinguishable from the natural variety.[45]

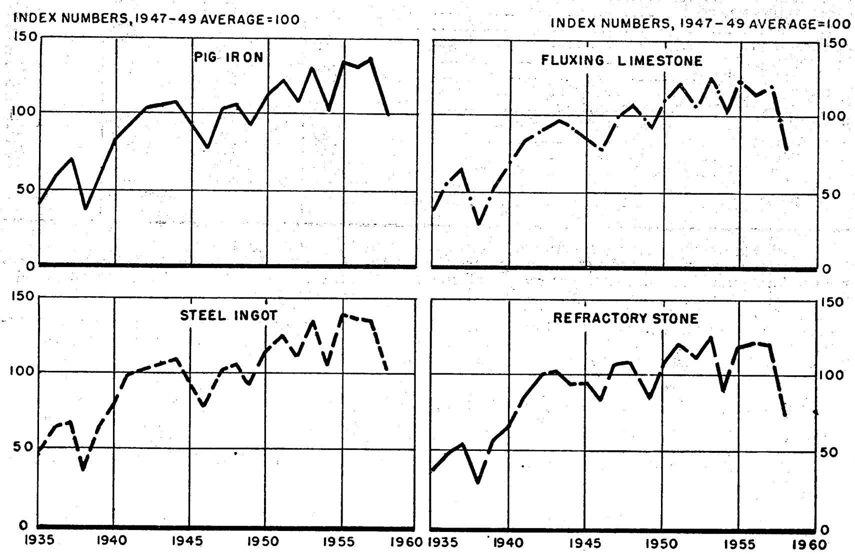

FIGURE 4.—Sales (tons) of fluxing limestone and refractory stone (including that used in making dead-burned dolomite), compared with production of steel ingot and pig iron, 1935–58.

(Statistics of steel-ingot production compiled by American Iron and Steel Institute.)

[43] Pit and Quarry, Michigan Limestone Div. Reports 41,000 Visitors at World's Largest Quarry: Vol. 51, No. 5, November 1958, p. 26.

[44] Utley, Harry F., Marblehead's New Utah Plant for Western Steel Markets Producing Dead-Burned Dolomite: Pit and Quarry, vol. 51, No. 5, November 1958, pp. 122–125.

[45] Oganesoff, Igor, How Yankee Oysters and a Farm Girl Hike Japan's Pearl Output: Wall Street Jour., vol. 152, No. 76, Oct. 16, 1958, pp. 1, 10.

The Game and Fish Commission of Texas using a special electronic device, conducted a survey of shell deposits in the numerous bays along the gulf coast.

TABLE 25.—Limestone and dolomite (crushed and broken stone) sold or used by producers in the United States, by uses

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Concrete and roadstone	201,631	$264,727	226,693	$288,956
Flux	39,384	56,113	25,616	36,537
Agriculture	18,929	31,362	19,922	33,901
Railroad ballast	8,365	9,966	4,307	5,290
Riprap	5,357	5,886	4,763	5,131
Alkali manufacture	4,899	4,551	5,420	7,811
Calcium carbide manufacture	857	839	742	727
Cement-portland and natural	72,103	75,677	73,976	78,240
Coal-mine dusting	565	2,231	479	1,921
Filler (not whiting substitute):				
Asphalt	2,054	5,343	2,333	5,672
Fertilizer	345	718	424	895
Other	541	2,162	384	590
Fill material	17	67	1,500	1,500
Filtration	120	234	125	217
Glass manufacture	1,204	3,589	964	2,864
Lime and dead-burned dolomite	17,146	25,764	14,508	22,093
Limestone sand	2,311	3,054	1,431	2,272
Limestone whiting [1]	809	6,019	712	6,379
Magnesia [2]	143	406	136	376
Mineral food	453	2,657	623	3,551
Mineral (rock) wool	7	8	3	6
Paper manufacture	504	1,356	417	1,210
Poultry grit	129	825	180	906
Refractory (dolomite)	524	1,127	369	558
Road base	130	130		
Sugar refining	780	1,866	850	2,004
Other uses [3]	1,747	3,717	1,989	5,405
Use unspecified	1,015	1,488	1,602	1,753
Total	382,069	511,882	390,468	516,765

[1] 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.
[2] Includes stone for refractory magnesia.
[3] Includes stone for acid neutralization, carbon dioxide, chemicals (unspecified), concrete products, disinfectants and animal sanitation, dyes, electrical products, oil-well drilling, patching plaster, rayons, rice milling, roofing granules, stucco, terrazzo, artificial stone, and water treatment.

Calcareous Marl.—Unconsolidated material that is mainly a mixture of calcium carbonate and clay is included in this category. More indurated materials, such as cement rock, normally are included under limestone.

In some States, marl deposits supply calcareous material for cement and agriculture. Marl is dredged from ponds and marshes or excavated from evaporite, caliche-type deposits. As dredged, marl has a 25- to 50-percent moisture content, but when dry it is light and porous.

Shell marls along the east coast comprise mixtures of fossil shells, shell fragments, and clay and sand accumulations, in flat-lying beds as much as 20 feet thick with a thin overburden. Most of the material was dredged and transported by barge in 1958. Clay was added for use in manufacturing cement.

TABLE 26.—Limestone (crushed and broken stone) sold or used by producers in the United States in 1958, 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)	1,340,816	$2,087,899	4,381,270	$5,665,327	(1)	(1)	516,258	$787,832	4,562,429	$4,575,777	10,857,220	$13,203,076
Arizona			110,100	159,300	(1)	(1)					(1)	(1)	1,122,800	1,399,540
Arkansas			596,460	631,258	2,626,346	3,189,925	55,842	$70,919	159,131	238,983	(1)	(1)	(1)	(1)
California	19,195	$25,601	(1)	(1)	872,643	866,076			(1)	(1)	11,761,031	19,152,784	12,987,917	21,048,997
Colorado	(1)	(1)	147,100	243,700	621,300	1,099,200					(1)	(1)	2,701,100	3,998,000
Florida					18,737,561	23,664,933			467,955	1,361,774	3,227,576	3,892,564	22,433,092	28,919,271
Georgia					389,425	702,465	3,796	5,505	(1)	(1)	(1)	(1)	1,153,324	1,974,676
Hawaii			19	76	386,374	524,839			4,539	7,844	16,169	23,404	407,101	556,163
Illinois	266,428	356,683	331,509	624,958	26,314,679	33,358,831	504,167	704,446	3,370,542	4,725,754	4,225,558	4,358,745	35,012,883	44,130,417
Indiana	51,010	86,584	(1)	(1)	9,915,528	12,559,314	232,644	286,183	2,304,446	3,047,291	(1)	(1)	14,702,249	18,169,552
Iowa	315,658	389,344	41,104	64,470	15,562,603	18,973,904	7,469	10,933	1,630,122	2,223,126	3,478,307	4,393,966	21,035,263	26,055,743
Kansas	(1)	(1)			7,553,413	9,822,255	(1)	(1)	288,213	430,584	2,982,128	3,365,335	11,443,991	14,122,037
Kentucky	10,685	11,750	(1)	(1)	10,413,322	14,517,280	397,377	416,781	1,113,251	1,477,520	(1)	(1)	12,588,331	17,309,461
Louisiana					282,660	282,660							282,660	282,660
Maryland	(1)	(1)	(1)	(1)	4,228,224	6,961,301	(1)	(1)	(1)	(1)	1,280,507	3,227,439	5,738,009	10,598,330
Massachusetts			(1)	(1)	(1)	(1)			117,528	351,529	(1)	(1)	633,940	1,796,364
Michigan	(1)	(1)	8,821,169	9,064,220	6,189,608	6,946,800	(1)	(1)	486,653	694,633	11,325,117	9,676,721	26,856,586	26,427,815
Minnesota	24,478	14,684	200	700	2,385,183	2,753,898	(1)	(1)	477,077	772,375	(1)	(1)	2,929,534	3,750,701
Mississippi									102,000	91,800			102,000	91,800
Missouri	1,314,145	1,194,498	(1)	(1)	13,510,751	17,912,835	(1)	(1)	2,407,630	3,561,620	6,071,209	7,803,116	23,342,462	30,534,609
Montana	1,573	472	(1)	(1)	(1)	(1)	640	832			696,115	1,088,850	926,573	1,372,081
Nebraska	1,139,700	1,187,100			1,469,400	2,172,700			80,100	136,800	861,100	1,236,700	3,550,300	4,733,300
New Mexico			12,300	19,900	745,177	720,787					37,600	60,800	795,077	801,487
New York	117,026	173,384	57,227	92,524	13,075,451	21,128,411	381,375	613,244	358,163	2,224,365	6,056,883	7,266,530	20,046,125	31,498,458
North Carolina					2,230,465	3,147,185	18,257	22,456	759	1,498			2,249,481	3,171,139
Ohio	48,863	50,172	3,845,022	5,411,753	13,332,065	17,462,523	668,752	751,672	1,678,488	2,650,683	8,703,898	14,665,781	28,277,088	40,992,584
Oklahoma	113,094	150,073			7,955,413	8,538,656	(1)	(1)	117,273	132,817	(1)	(1)	9,380,878	10,811,433
Oregon	(1)	(1)	(1)	(1)					(1)	(1)	(1)	(1)	1,170,267	1,470,910
Pennsylvania	(1)	(1)	5,443,191	9,806,835	14,977,438	22,176,754	(1)	(1)	776,764	2,497,005	13,874,524	18,135,214	35,272,875	52,899,061
South Dakota	2,000	2,400			527,700	703,500	14,300	16,800			334,500	509,700	878,500	1,232,400
Tennessee	7,014	7,108	(1)	(1)	13,076,145	16,701,133	368,215	436,717	651,283	928,568	(1)	(1)	16,656,170	21,701,726
Texas	183,861	296,785	495,695	526,511	17,053,036	14,416,380	613,605	512,931	170,325	187,839	6,893,670	7,781,617	25,410,192	23,722,063
Utah	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)			2,380,600	2,934,700	2,958,000	3,648,900
Vermont	(1)	(1)	(1)	(1)	(1)	(1)			(1)	(1)	(1)	(1)	252,674	1,755,642
Virginia	(1)	(1)	(1)	(1)	5,446,882	7,703,025	252,742	318,875	648,735	1,309,775	3,909,878	6,155,923	10,781,572	16,363,269
Washington			(1)	(1)	32,569	20,067			(1)	(1)	1,019,865	1,603,877	1,114,444	1,723,662
West Virginia	(1)	(1)	2,403,790	4,346,862	1,717,434	3,053,291	(1)	(1)	(1)	(1)	1,240,796	2,190,226	5,596,570	9,977,040
Wisconsin	99,752	77,636	(1)	(1)	9,706,798	9,981,024	(1)	(1)	1,240,677	1,687,095	263,557	349,341	11,395,918	12,214,355
Wyoming	149,700	151,000	(1)	(1)	202,400	114,700	169,400	240,000			(1)	(1)	788,200	1,206,600
Undistributed [2]	898,804	956,218	1,969,915	3,455,998	773,748	1,114,306	618,302	880,317	754,273	2,372,346	13,964,434	22,499,653	6,636,767	11,099,249
Total	4,762,986	5,131,492	25,615,617	36,536,964	226,693,011	288,956,285	4,306,883	5,289,611	19,922,185	33,901,456	109,167,451	146,948,763	390,468,133	516,764,571
Puerto Rico	250	750			438,867	987,150			11,473	34,419	1,327,066	1,329,194	1,777,656	2,351,516

[1] Included with "Undistributed" to avoid disclosing individual company confidential data.

[2] Includes data indicated by footnote 1 and Connecticut, Idaho, Maine Nevada, New Jersey, Rhode Island and South Carolina.

TABLE 27.—Sales of fluxing limestone, by uses

Year	Blast furnace		Open-hearth plants		Other smelters [1]		Other metallurgical [2]		Total	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
1949–53 (average)	28,996	$32,541	6,467	$8,202	780	$955	245	$298	36,488	$41,996
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
1958	19,427	28,153	4,777	6,641	866	975	546	768	25,616	36,537

[1] Includes flux for copper, gold, lead, zinc, and unspecified smelters.
[2] Includes flux for foundries and for cupola and electric furnaces.

TABLE 28.—Shell sold or used by producers in the United States, by uses

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Concrete and roadstone	[1] 11,922	[1] $17,516	11,216	$17,094
Cement	4,701	5,234	5,058	5,609
Lime	716	807	1,200	1,950
Poultry grit	438	2,184	537	5,600
Mineral food	7	101	12	113
Other uses [2]	1,314	1,721	893	1,510
Total	[1] 19,098	[1] 27,563	18,916	31,876

[1] Revised figure.
[2] Includes agriculture, alkali, asphalt filler, chemicals, filter beds, magnesium metal, paper, railroad ballast, road base, road fill, and unspecified uses.

TABLE 29.—Shell sold or used by producers in the United States in 1958

State	Short tons	Value	State	Short tons	Value
Florida	1,116,401	$2,063,676	Washington	844	$14,958
Louisiana	5,170,754	9,248,873	Other States [1]	3,571,698	7,696,055
New Jersey	1,755	29,125			
Texas	9,035,410	12,684,194	Total	18,916,489	31,876,302
Virginia	19,627	139,421			

[1] Includes Alabama, California, Maryland, and Pennsylvania.

TABLE 30.—Calcareous marl sold or used by producers in the United States [1]

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Agriculture	265	$159	316	$224
Cement	1,651	1,645	1,487	1,436
Total	1,916	1,804	1,803	1,660

[1] Produced by the following States in 1958, in order of tonnage: Mississippi, South Carolina, Virginia, Michigan, Ohio, Indiana, Wisconsin, Nevada, West Virginia, Minnesota, and Washington.

SANDSTONE, QUARTZ, AND QUARTZITE

Sales of crushed and broken sandstone, quartz, and quartzite increased both in quantity and value.

Because of its durability, quartzite was selected to replace railroad ballast on 10,000 miles of mainland railroad track.[46]

A continuous method was developed for drawing quartz into vitreous silica fibers 20 microns thick. The fibers reportedly had a higher tensile strength than steel, could be metal-coated, and had many potential uses (such as in electronics, as insulation, and in clothing).[47]

Another novel product is a foamed silica. It is reportedly resistant to most acids, lightweight, impermeable, and a good thermal insulator.[48]

The Silicon Metals Co. of California completed the installation of an electric furnace for smelting a high-grade quartz to silicon metal.

TABLE 31.—Sandstone, quartz, and quartzite (crushed and broken stone) [1] sold or used by producers in the United States, by uses

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Concrete and roadstone	9,351	$12,165	8,862	$11,820
Railroad ballast	416	565	706	796
Riprap	2,208	3,363	1,657	2,606
Refractory stone (ganister)	1,196	10,767	551	7,252
Abrasives	77	387	50	270
Ferrosilicon	133	503	115	455
Filtration	32	92	45	113
Flux	505	1,276	429	954
Foundry	562	1,307	293	691
Glass	221	529	214	579
Other use [2]	1,038	6,284	11,562	16,828
Total	15,739	37,238	24,484	42,364

[1] Includes ground sandstone, quartz, and quartzite. Friable sandstone is reported in the chapter on Sand and Gravel.
[2] Includes cement, fill, filler, pottery, porcelain, tile, roofing granules, stone, sand, and unspecified uses.

TABLE 32.—Sandstone, quartz, and quartzite (crushed and broken stone) sold or used by producers in the United States in 1958, by States

State	Short tons	Value	State	Short tons	Value
Arizona	288,600	$652,600	Oklahoma	274,958	$262,474
Arkansas	1,445,754	1,886,817	Pennsylvania	1,164,632	4,951,990
California	3,916,728	5,640,557	South Dakota	424,400	692,000
Colorado	28,000	173,900	Texas	996,871	849,889
Connecticut	25,000	222,000	Utah	10,089,400	10,119,500
Illinois	889	8,890	Virginia	238,951	510,777
Kentucky	6,287	13,517	Wisconsin	1,618,662	7,022,725
Michigan	570	250	Wyoming	3,400	5,900
Montana	102,599	109,441	Other States [1]	2,952,786	8,536,658
Nebraska	2,400	3,800			
Nevada	3,912	42,061	Total	24,484,299	42,363,786
New Mexico	899,500	658,040			

[1] Includes Alabama, Georgia, Idaho, Indiana, Kansas, Maine, Maryland, Minnesota, New Hampshire, New York, North Carolina, Ohio, Oregon, Tennessee, Washington, and West Virginia.

[46] Meschter, Elwood, Quartzite—Tough and Expensive But Hard to Beat for Railroad Ballast: Rock Products, vol. 61, No. 11, November 1958, pp. 78–81.
[47] Research, New Use for Quartz: Vol. 36, No. 15, Apr. 14, 1958, p. 41.
[48] Chemical Engineering, Foamed Silica—Hard-to-Beat Properties: Vol. 65, No. 17, Aug. 25, 1958, pp. 142, 144.

CRUSHED AND BROKEN SLATE

Waste slate from the Pennsylvania district was used for expanded aggregate by crushing it to minus-½-inch, mixing it with 6 percent coal, and feeding it to a 30- by 5½-foot traveling-grate sintering furnace fired by 12 burners using fuel oil. After 2¼ minutes the temperature of about 2,200° F. produced an expanded clinker with a bulk density of 24 to 41 pounds a cubic foot, depending on the size to which it was crushed.[49]

Another article was published on slate in Pennsylvania.[50]

A paper on the use of Pennsylvania slate for expanded aggregate was presented at a meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers.[51]

TABLE 33.—Slate (crushed and broken) sold or used by producers in the United States [1]

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Granules [2]	376	$3,711	388	$4,289
Flour	121	679	127	703
Other uses [3]	15	19	8	36
Total	512	4,409	523	5,028

[1] Produced by the following States in 1958 in order of tonnage: Georgia, Vermont, Pennsylvania, Arkansas, Virginia, New York, and California.
[2] Includes crushed slate used for lightweight aggregate.
[3] Includes asphalt filler and unspecified uses.

MISCELLANEOUS STONE

Stone types that do not conform to the five principal varieties already discussed are grouped statistically as miscellaneous stone. These include light-color volcanic rocks, schists, boulders from riverbeds, serpentine, chats, and flint. The output of miscellaneous stone decreased 21 percent in quantity and 18 percent in value compared with 1957. The average unit value increased 4 cents to $1.11 a ton.

TABLE 34.—Miscellaneous stone (crushed and broken) sold or used by producers in the United States, by uses

Use	1957		1958	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
Concrete and roadstone	11,902	$13,012	9,882	$10,653
Railroad ballast	3,724	2,197	2,257	1,400
Riprap	960	1,240	5,754	6,081
Fill	7,065	6,624	1,069	857
Other uses [1]	1,874	4,178	1,156	3,365
Total	25 525	27,251	20,118	22,356

[1] Includes stone used for filler, filtration, flux, roofing granules, stone sand, and unspecified uses.

[49] Pit and Quarry, Expanded Slate: Vol. 50, No. 10, April 1958, p. 132.
[50] Hoyt, F. D., Proximity to Market and Low Production Cost Make Expanded Slate a Commodity With a Future: Min. Eng., vol. 10, No. 8, August 1958, pp. 874–876.
[51] Hoyt, F. D., The Utilization of Pennsylvania Slate for Expanded Aggregates: Soc. Min. Eng. AIME, Preprint 5819P12, February 1958, 4 pp.

TABLE 35.—Miscellaneous varieties of stone (crushed and broken stone) sold or used by producers in the United States in 1958, by States

State	Short tons	Value	State	Short tons	Value
Alaska	302, 926	$1, 164, 015	Utah	200	$200
Arizona	2, 331	3, 833	Washington	386, 241	357, 274
California	8, 890, 800	12, 169, 019	Wyoming	42, 200	69, 600
Hawaii	9, 172	33, 277	Other States [1]	7, 132, 671	6, 045, 359
Kansas	928, 874	383, 175			
Maryland	125, 060	250, 034	Total	20, 117, 998	22, 356, 215
Massachusetts	52, 992	485, 407			
Missouri	870, 879	465, 054	American Samoa	7, 150	5, 250
Montana	8, 100	10, 530	Guam	425, 048	571, 365
Nevada	75, 621	104, 181	Midway Island	175, 300	475, 840
Oklahoma	1, 104, 419	565, 489	Panama Canal Zone	50, 000	58, 000
Pennsylvania	109, 271	168, 245	Puerto Rico	60, 000	135, 000
Rhode Island	2, 641	7, 923	Wake Island	9, 560	36, 786
South Dakota	73, 600	73, 600			

[1] Includes Arkansas, Colorado, New Jersey, New York, Oregon, Texas, and Virginia.

Roofing Granules.—Minnesota Mining & Manufacturing Co. began exploration to establish another roofing-granule plant near San Andreas, Calif. The company had three other plants in operation. In producing roofing granules the company crushed the rock to desired size and applied a permanent colorfast ceramic coating by firing the granules in rotary kilns.[52] Besides being colorful, the granules improved the durability of the roofs by protecting the asphalt base from the harmful effects of sun and weather.

Shipments of asphalt roofing declined considerably early in 1958 compared with 1957.[53]

A treatment of roofing granules to improve their adhesion to asphalt coating was patented.[54]

The Flintcoke Co., East Rutherford, N.J., and its subsidiaries reportedly achieved the highest sales record in company history in 1957, with a total volume of $116 million compared with $114 million in 1956.[55]

TABLE 36.—Roofing granules [1] sold or used in the United States, by kinds

Year	Natural		Artificially colored [2]		Total	
	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)	Short tons (thousands)	Value (thousands)
1949–53 (average)	394	$3, 531	1, 205	$21, 529	1, 599	$25, 060
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
1958	389	3, 797	1, 361	33, 307	1, 750	37, 104

[1] Manufactured from stone, slate, slag, and brick.
[2] A small quantity of brick granules is included with artificially colored granules.

[52] California Mining Journal, Minnesota Mining & Mfg. Testing Calaveras Rock for Roofing Granule: Vol. 27, No. 11, July 1958, p. 15.
[53] Bureau of the Census, Facts for Industry: Asphalt and Tar Roofing and Siding Products, Series M29A–28, Apr. 11, 1958, p. 1.
[54] Keene, H. B., Anderson, D. A., and Aldrich, P. H. (assigned to Minnesota Mining & Mfg. Co.), Canadian Patent 565,176, Oct. 28, 1958.
[55] Pit and Quarry, Flintkote Co. Sets Record for Sales Total in 1957: Vol. 50, No. 11, May 1958, p. 30.

Crushed-stone aggregates entered the field of roofing materials, both as prefabricated products and built-up, natural and artificially colored roofing.

FOREIGN TRADE [56]

Little crushed and broken stone was exported or imported because of its low unit value and high weight. Quartzite from Canada and chalk or whiting and terrazzo from Europe accounted for most of the imports. Exports were virtually limited to border shipments.

TABLE 37.—Stone and whiting imported for consumption in the United States, by classes

[Bureau of the Census]

Class	1957 Quantity	1957 Value	1958 Quantity	1958 Value
Marble, breccia, and onyx:				
Sawed or dressed, over 2 inches thick...cubic feet..	2,305	$7,432	525	$5,037
In blocks, rough, etc...do....	216,461	1,210,567	172,136	988,345
Slabs or paving tiles...superficial feet..	2,029,529	[1] 1,537,328	2,419,163	1,859,966
All other manufactures		[1] 2,430,440		2,198,397
Total		[1] 5,185,767		5,051,745
Granite:				
Dressed...cubic feet..	101,965	[1] 1,071,233	63,323	680,203
Rough...do....	64,350	293,916	68,598	331,254
Paving blocks, wholly or partly manufactured number..	46,671	53,499	2,408	56,330
Total		[1] 1,418,648		1,067,787
Quartzite...short tons..	[2] 254,895	782,791	24,203	291,636
Slate		288,379		299,179
Travertine stone (unmanufactured)...cubic feet..	92,687	268,098	99,661	323,137
Stone (other):				
Dressed: Travertine, sandstone, limestone, etc. cubic feet..	22,777	[1] 73,528	149,328	94,269
Rough (monumental or building stone)...do....	5,255	14,956	11,771	12,817
Rough (other)...short tons..	[2] 104,036	[1] 265,390	298,884	382,669
Marble chip or granito...do....	[2] 23,195	[1 2] 228,755	29,223	313,417
Crushed or ground, n.s.p.f.		44,395		277,118
Total		[1 2] 627,024		1,080,290
Whiting:				
Chalk or whiting, precipitated...short tons..	1,266	76,649	856	45,371
Whiting, dry, ground, or bolted...do....	8,595	[1] 144,766	9,046	152,865
Total		[1] 221,415		198,236
Grand total		[1 2] 8,792,122		8,312,010

[1] Data known to be not comparable with 1958.
[2] Revised figure.

[56] Work cited in footnote 7.

TABLE 38.—Stone exported from the United States

[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	
1949–53 (average)	254,655	$619,323	(1)	(1)	(1)	(1)	$365,113
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	[2] 1,088,004	[2] 1,649,697	129,559	2,699,023	506,180
1958	349,366	1,236,205	767,757	1,390,365	173,340	3,696,951	432,072

[1] Not separately classified before Jan. 1, 1952. Exports 1952: Limestone 803,029 short tons ($789,733); other 126,123 short tons ($1,631,358). 1953: Limestone 691,811 short tons ($703,833); other 153,105 short tons ($2,204,139).
[2] Revised figure.

TABLE 39.—Slate exported from the United States, by uses [1]

(Included in stone exports)

Use	1949–53 (average)	1954	1955	1956	1957	1958
Roofing	$11,542	$17,129	$12,801	$6,747	$6,168	$12,026
School slate [2]	6,556	(3)				
Electrical	14,374	9,085	107,566	135,516		84,629
Blackboards	75,182	[3] 91,257			276,177	
Billiard tables	73,228	71,961				
Structural (including floors and walkways) and granules and flour	300,541	231,312	271,268	189,050		212,460
Total	481,423	420,744	391,635	331,313	282,345	309,115

[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

North America

Canada.—Output of limestone reached a record of 29 million short tons valued at $39 million in 1957, an increase of 5 million tons over 1956. In all, 389 limestone operations were reported active in 1956.[57] The 18,000 tons of whiting valued at $184,000, manufactured from limestone in 1957 represented a slight increase over 1956. Detailed breakdown of uses were given.[58]

Silica production totaled 2,114,000 short tons in 1957. It was used mainly in manufacturing silicon and ferrosilicon brick, as a fluxing material in metallurgical industries, and as an ingredient in portland cement. Most of the high-purity silica sand used for making glass, silicon carbide, and chemicals was supplied by the United States.[59]

[57] Ross, J. S., Limestone, General: Canadian Mineral Industry—1957, Review 45, June 1958, 4 pp.
[58] Woodrooffe, H. M., Whiting in Canada, 1957: Canadian Mineral Industry—1957, Review 59, June 1958, 3 pp.
[59] Collings, R. K., Silica in Canada, 1957: Canadian Mineral Industry—1957, Review 55, April 1958, 8 pp.

Roofing-granule consumption in 1957 totaled 111,000 tons, 17 percent below 1956. Seventy-eight percent was artificially colored slate, basalt, and pink rhyolite.[60]

Europe

Germany, West.—Synthetic basalt or "smolten basalt" was used extensively in West Germany for lining conveyors, separators, and chutes where an abrasive-resistant material is needed.[62]

Norway.—Production of dolomite totaled 100,000 short tons, 22,000 tons less than in 1956, and 280,000 tons of quartz, 11,000 tons more than 1956.[61]

Asia

India.—India is favored with many raw materials; however, limestone, which is needed for smelting and to supply the growing chemical industry, was reported to be scarce.[63]

Africa

Egypt.—Production of basalt totaled about 1.5 million tons in 1956, compared with 900,000 in 1955 and 550,000 in 1954.

Granite production totaled about 27,000 tons in 1955 and 26,000 in 1954. Production figures for 1956 were not available.

Limestone production totaled approximately 4.5 million short tons in 1956, compared with 3 million in 1954. Production figures for 1955 were not available.[64]

Union of South Africa.—A new crushed-dolomite plant installed near Pretoria was reportedly one of the largest materials-handling installations in the country.[65]

TECHNOLOGY

Trends in technology of crushed-stone production were toward wider use of portable plants, down-the-hole drilling, more powerful wagon drills, larger quarrying and transporting equipment, and conveyors for loading and transporting products. Public relations and land rehabilitation were of increasing concern. More emphasis was placed on upgrading deposits by removing deleterious material.

Drilling and Blasting.—Two more reports were published in the Bureau of Mines series on the performance of diamond-drill bits in rocks of different types. One report discusses bit performance in cherty limestone and cherty dolomite and the other, performance in quartzite.[66]

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[60] Hanes, F. E., Roofing Granules in Canada, 1957: Canadian Mineral Industry—1957, Review 52, April 1958, 5 pp.

[61] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 3, September 1958, p. 40.

[62] Ramlu, M. Anant, Basalt in Mining: Indian Min. Jour., vol. 6, No. 3, March 1958, p. 17.

[63] Knibbs, N. Y. S., India's Lime and Limestone Industry: Pit and Quarry, vol. 51, No. 5, November 1958, pp. 86–89.

[64] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, p. 34.

[65] Cordes, Theodor, Largest South African Plant Goes Into Production: Pit and Quarry, vol. 50, No. 12, pp. 86–88, 90.

[66] Long, Albert E., and Johnson, George H., Diamond-Bit Performance in Cherty Limestone and Cherty Dolomite: Bureau of Mines Rept. of Investigations 5403, 1958, 23 pp.

Rambosek, A. J., and Long, Albert E., Diamond-Bit Performance in Quartzite: Bureau of Mines Rept. of Investigations 5402, 1958, 23 pp.

An oil-well-drilling engine that operates at the bottom of the hole was expected to double or quadruple drilling speeds through the hardest rocks.[67]

The drilling and blasting procedure at a 215-foot-high granite-quarry face was outlined.[68]

An aqueous slurry of ammonium nitrate and TNT (trinitrotoluene) was used in open-pit blasting at an iron mine. The explosive's high strength and efficient loading characteristics were expected to make it suitable for breaking hard rock.[69]

Current technology, applied to drilling and blasting practices at a New York limestone quarry, was described.[70]

Cost data on prilled ammonium nitrate fuel-oil explosives indicated a savings of more than 75 percent, a reduction from 14–18 cents to 2.5 cents per cubic yard of rock, depending upon the choice of a primer. However, drawbacks limited their use in 1958. The Bureau of Mines did not consider these explosives suitable for underground operations because they produce excessive gas. Moreover, they could not be used effectively in a wet hole.[71]

A British article described a blasting technique that reportedly overcame problems arising from the proximity of a quarry to a townsite.[72]

Blasting with short-period delay firing and vibration studies at a Georgia limestone quarry proved effective in reducing noise and excessive vibration.[73]

The Atomic Energy Commission stated that the use of atomic blasting had possibilities in crushed-stone production.[74] One underground atomic blast crushed about 500,000 tons of bedded tuffs to sand and broke at least 200,000 tons by caving.[75]

Based on these results, it was concluded that the future peacetime applications at atomic energy might include quarry blasting as a "one-shot proposition."[76]

Quarrying and processing techniques, featuring an extensive dust-control system and a unique stockpile system, were described at a large Canadian operation.[77]

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[67] Rock Products, Power Drill for Hard Formations: Vol. 61, No. 2, February 1958, p. 198.

[68] May, W. M., Blasting in a North Carolina Granite Quarry: Explosives Eng., vol. 36, No. 3, May–June 1958, pp. 81–86.

[69] Chemical and Engineering News, New Explosive Under Test: Vol 36, No. 46, Nov. 17, 1958, p. 43.

[70] Dintruff, Carl P., Quarrying Limestone at Oriskany Falls, New York: Explosives Eng., vol. 36, No. 1, January–February 1958, pp. 17–22.

[71] Corrigan, Frank W., Blasting Agent Slashes Powder Costs by 75%: Construction Methods and Equipment, vol. 40, No. 30, March 1958, pp. 130, 134–136, 138, 140.

[72] Mine and Quarry Engineering (London), Bowne and Shaw Quarries: Vol. 24, No. 10, October 1958, pp. 428–437.

[73] Loviza, John W., Blasting With Short-Period Delay Detonators in Georgia Limestone: Explosives Eng., vol. 36, No. 6, November–December 1958, pp. 179–184.

[74] Rock Products, Crushing Rock Inside a Mountain by Atom Blasting: Vol. 61, No. 6, June 1958, p. 11.

[75] Johnson, Gerald W., Rainier Blast Opens New Horizons: Eng. Min. Jour., vol. 159, No. 4, April 1958, pp. 21–23.

[76] Crawford, John, Nuclear Blast in Your Mine or Quarry?—It's Possible: Pit and Quarry, vol. 51, No. 3, September 1958, pp. 122–125.

[77] Trauffer, Walter E., 1,200 t.p.h. Canadian Crushed Stone Plant: Pit and Quarry, vol. 51, No. 3, September 1958, pp. 126–133.

Underground Operations.—Operations were described at a California mine that had employed block caving for nearly a quarter of a century in producing more than 7 million tons of limestone.[78]

Another publication described a method of determining the strength of a limestone mine roof in place.[79]

Ten million tons of metallurgical limestone, developed in a steeply dipping stratum on the lower level of a Pennsylvania limestone mine, was scheduled to be mined by sublevel stoping, crushed underground, and transported to the surface by inclined belt conveyors working in conjunction with a conventional skip hoist.[80]

The method of producing high-quality silica from an underground operation in the St. Peter sandstone was described.[81]

Processing.—The changing situation in dam construction over the years, has resulted in improved technology in crushed-stone and sand-and-gravel processing. Dense-medium separation of low-quality materials and aggregate cooling techniques gained increased recognition in 1958.[82] More than three-fourths million tons of aggregates reportedly will be processed by dense-medium separation to produce a quality concrete in the Glen Canyon (Colo.) dam.[83]

The Bureau of Mines conducted mining methods and costs studies at the operation that supplied aggregates for the Lucin railroad cutoff across Great Salt Lake. One blast of 2,138,000 pounds of nitrocarbonitrate dynamite reduced a cliff face 300 feet high and 1,300 feet across to 3.7 million cubic yards or rock fill.[84]

Processing innovations at an Arkansas quartzitic-sandstone deposit resulted in an efficient and flexible aggregates operation.[85]

Quarrying, including removal by dragline of broken cemented shell and subsequent crushing and screening procedures, were described at a new plant in the Everglades area of southern Florida.[86]

Dust-control systems for the crushing, grinding, and screening sections of crushed-rock plants, including various types of equipment and their uses, were discussed.[87]

At a 300-tons-per-hour New York traprock plant, flexibility of plant design included an efficient system of dust control at processing operations.[88]

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[78] Long, Albert E., and Obert, Leonard, Block Caving in Limestone at the Crestmore Mine, Riverside Cement Co., Riverside, Calif.: Bureau of Mines Inf. Circ. 7838, 1958, 21 pp.

[79] Merrill, Robert H., and Morgan, Thomas A., Method of Determining the Strength of a Mine Roof: Bureau of Mines Rept. of Investigations 5406, 1958, 22 pp.

[80] Meschter, Elwood, Waiting—10,000,000 tons of Limestone: Rock Products, vol. 61, No. 1, January 1958, pp. 132–134, 137–138.

[81] Meschter, Elwood, Going Underground for a Pure White Silica: Rock Products, vol. 61, No. 6, June 1958, pp. 78–81, 110, 112.

[82] Lenhart, Walter B., More Dams Abuilding, More Rock Markets Opening: Rock Products, vol. 61, No. 6, June 1958, pp. 84–86, 119.

[83] Engineering News-Record, Mighty Construction Plant Faces Unique Rock Problem: Vol. 161, No. 5, July 31, 1958, pp. 28–31.

[84] Rock Products, What's Happening in Other Fields of Interest to the Rock Products Industry: Vol. 61, No. 3, March 1958, p. 12.

[85] Day, Ray, Stone Plant Meets Twin Needs: Rock Products, vol. 61, No. 7, July 1958, pp. 90–92, 142.

[86] Pit and Quarry, Plant in Everglades Area Supplies Crushed Stone for Road, Concrete Work: Vol. 51, No. 3, September 1958, pp. 136–137.

[87] Vedder, W. O., Disciplining Dust: Pit and Quarry, vol. 51, No. 4, October 1958, pp. 112–115.

[88] Trauffer, Walter E., New York Trap Rock's 4-Star Plant at West Nyack: Pit and Quarry, vol. 51, No. 4, October 1958, pp. 128–134.

A French equipment manufacturer claimed that his 43-square-foot jaw crusher was the largest in the world.[89]

Another crusher was patented that reportedly lessened the direct work required and wear on equipment.[90]

Miscellaneous.—Observation indicated that precoated aggregates used in bituminous-road surface treatment resulted in denser and better appearing pavement.[91]

The ages of granitic rocks in California were determined by potassium-argon radiogenic measurements.[92]

Output at an English granite property was increased by improved mechanization, drilling, and blasting techniques and by installing a new crushing and screening plant.[93]

One portable plant moved back and forth among six separate quarries, supplying their demand for crushed limestone.[94]

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[89] Walter, Leo, Is This Jaw Crusher the World's Largest?: Rock Products, vol. 61, No. 12, December 1958, pp. 79, 125.

[90] Dening, R. D., and Garlinghouse, L. H. (assigned to Garlinghouse Brothers, Los Angeles, Calif.), Continuous Crusher With Fracturing Disc Obliquely Overlying a Material Filled Container: U.S. Patent 2,856,133, Oct. 14, 1958.

[91] Bixby, Howard M., Bituminous Pretreated Aggregates for Bituminous Surface Treatment: Crushed Stone Jour., vol. 33, No. 2, June 1958, pp. 12–14.

[92] California Dept. of Natural Resources, Age of Granite Measured: Mineral Information Service, vol. 11, No. 10, Oct. 1, 1958, p. 12.

[93] Grindrod, J., New British Crushed Stone Plant: Pit and Quarry, vol. 50, No. 8, February 1958, pp. 125–128.

[94] Nordyke, Lewis, Portable Plant Crushes Limestone in Six Kansas Quarries: Explosives Eng., vol. 36, No. 3, May–June 1958, pp. 71–76, 92.

Strontium

By Albert E. Schreck[1] and James M. Foley[2]

THE DOMESTIC strontium-mining industry was inactive during 1958 and manufacturers of strontium chemicals again relied on imports for their raw materials.

DOMESTIC PRODUCTION

The celestite deposits of San Diego County, Calif., and Skagit County, Wash., were idle throughout 1958. As a result, for the first time since 1953, no domestic production of strontium minerals was reported. A small quantity of celestite was, however, sold by Mineral Products Corp. of Seattle, Wash., from stocks on hand. A historical record of domestic strontium minerals sold or used is presented in table 1. In 1958, celestite was converted to various strontium compounds by 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 small quantity of strontium metal was produced by King Laboratories, Inc., Syracuse, N.Y.

A historical resume of domestic strontium production follows:

The year 1916 is considered the start of the domestic strontium-mining industry, although some celestite had been mined and shipped earlier. In 1840, about 40 tons of celestite was mined in Ohio and in 1904, 17 tons in Texas. Output for both years was exported to Germany for experimental purposes.

TABLE 1.—Strontium minerals sold or used in the United States, 1916–58

Year	Short tons	Value	Year	Short tons	Value
1916	250	$3,650	1945	2,784	$27,840
1917	4,035	82,597	1946	243	3,726
1918	400	20,000	1947–52	----	----
1919–39	----	----	1953	50	1,000
1940	2,343	41,442	1954	12	300
1941	4,724	69,054	1955	177	4,4[illegible]5
1942	4,041	55,529	1956	4,040	77,160
1943	7,566	114,526	1957–58	(1)	(1)
1944	3,005	48,165			

1 Figure withheld to avoid disclosing individual company confidential data.

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1 Commodity specialist.
2 Supervisory statistical assistant.

Output of the domestic strontium mining industry always has been small, sporadic, and usually only when imports of strontium minerals were curtailed. Before 1916 requirements for strontium compounds were small, and the demand was satisfied by importing finished strontium compounds from Germany. World War I cut off German supplies and the United States began processing imported celestite. An embargo in 1916 on strontium ore and compound exports from England resulted in domestic strontium chemicals producers looking to U.S. deposits for raw material supplies. During 1916–18, deposits in California, Texas, Arizona, and Washington supplied some of the requirements. The end of hostilities in 1918, the decreased demand for strontium compounds, and the renewed availability of European material forced domestic mines to close and to remain idle until 1940 when raw material supplies were threatened. From 1940 to 1946 domestic celestite partly supplied the needs of the chemical industry and also substituted for barite in drilling muds. Domestic celestite mining ended after World War II when foreign supplies became readily available and drilling-mud requirements could be supplied by the barite industry.

Small-scale mining of celestite for local consumption was resumed in California and Washington in 1953.

CONSUMPTION AND USES

The bulk of the strontium minerals consumed was converted to various strontium compounds. These compounds impart a characteristic red color to a flame; this property was used in several pyrotechnical applications such as manufacturing tracer bullets, marine distress signal rockets and flares, tactical military signal flares, highway and railroad warning fusees, fireworks, and other pyrotechnic devices. The principal compound used for these purposes was nitrate.

Strontium carbonate was used in ceramics and zinc refining and other strontium compounds were used in greases, corrosion inhibitors, depilatories, medicines, plastics, and luminous paints.

Small quantities of strontium metal were used as a getter, to remove traces of gas from vacuum tubes.

PRICES

Oil, Paint and Drug Reporter quoted the following prices on various strontium compounds during 1958: Strontium sulfate, air-floated, 90 percent, 325-mesh, bags, works, \$56.70–66.15 per short ton. This price remained unchanged since 1952. Strontium carbonate, pure, drums, 5-ton lots or more, works, 35 cents per pound; drums, 1-ton lots, works, 37 cents per pound; Technical grade, drums, works, 19 cents per pound. Strontium nitrate, bags, carlots, works, \$11 per 100 pounds; less than carlots, works, \$12 per 100 pounds.

FOREIGN TRADE [3]

Imports of strontium minerals were about 100 tons greater than in 1957. The United Kingdom supplied 65 percent of the total and Mexico, the remainder.

A total of 11,023 pounds of strontium carbonate valued at $1,350 was imported from Italy in 1958. No imports of strontium nitrate were reported.

TABLE 2.—Strontium minerals [1] imported for consumption in the United States, 1957–58, by countries, in short tons

[Bureau of the Census]

Country	1957		1958	
	Short tons	Value	Short tons	Value
Italy	5	$1,321	----------	----------
Mexico	1,896	22,911	2,297	$38,901
United Kingdom	4,624	106,499	4,350	102,108
Total	6,525	130,731	6,647	141,009

[1] Strontium or mineral strontium carbonate and celestite or mineral strontium sulfate.

WORLD REVIEW

Strontium minerals are produced in about a dozen countries throughout the world, but the United Kingdom and Mexico are the principal producers.

TABLE 3.—World production of strontium minerals, by countries,[1] 1954–58, in short tons

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

Country [1]	1954	1955	1956	1957	1958
Argentina	----------	----------	401	(2)	(2)
Italy	----------	77	234	1,226	[3] 1,200
Mexico [4]	1,906	2,072	2,313	1,896	2,297
Morocco: Southern Zone	----------	----------	----------	661	1,124
Pakistan	391	486	246	956	[3] 950
United Kingdom	2,352	5,320	10,304	7,728	[3] 7,500
United States	12	177	4,022	(5)	----------
World total [1]	4,661	8,132	17,520	[3] 13,000	[3] 13,100

[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] Data not available; estimate by author of chapter included in total.
[3] Estimate.
[4] United States imports.
[5] Production included in total; Bureau of Mines not at liberty to publish.

[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.

TECHNOLOGY

A spectrochemical method for quantitative determination of strontium in mineral and rock samples was described in an article.[4] The sample to be analyzed is fused with sodium carbonate and then dissolved in hydrochloric acid. This solution is then analyzed spectrochemically, using a high voltage spark. Results of tests for strontium in certain igneous rocks compare well with results of other techniques. A quantity as small as 0.005 percent strontium can be measured reliably.

[4] Grabowski, R. J., and Unice, R. C., Quantitative Spectrochemical Determination of Barium and Strontium: Analytical Chemistry, vol. 30, No. 8, August 1958, pp. 1374–1379.

Sulfur and Pyrites

By Leonard P. Larson [1] and James M. Foley [2]

SEVERE competition, lower prices, and ample supply characterized the sulfur industry in 1958. Exports of sulfur from the United States remained high despite the increased competition from French, Mexican, and other producers in world markets.

TABLE 1.—Salient statistics of the sulfur industry, in long tons of sulfur content

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Native-sulfur production	5,141,784	5,578,973	5,799,880	6,484,285	5,578,525	4,645,577
Production (all forms)	6,020,556	6,675,200	7,026,778	7,818,112	7,003,888	6,141,169
Imports (pyrites and sulfur)	101,205	[1] 135,114	[1] 206,127	[1] 387,429	[1] 668,501	754,987
Producers' stocks (Frasch and recovered sulfur)	[2] 2,976,923	3,337,086	3,301,465	4,055,896	4,579,623	4,619,028
Exports (sulfur)	1,372,154	1,675,130	1,635,652	1,675,331	[1] 1,592,979	1,598,928
Apparent domestic consumption (all forms)	4,756,480	4,912,600	5,625,400	5,744,300	[1] 5,553,700	5,266,000
World production:						
Sulfur (native)	5,715,000	6,300,000	7,000,000	8,000,000	7,300,000	6,500,000
Pyrites	5,334,000	[1] 6,300,000	[1] 6,900,000	[1] 7,400,000	[1] 7,500,000	7,400,000

[1] Revised figure.
[2] Frasch sulfur only before 1952.

DOMESTIC PRODUCTION

United States production of sulfur declined for the second consecutive year as a result of lower consumption, increased imports, and a large reduction in the rate of stockpile accumulation by Frasch sulfur producers.

Output of sulfur in all forms totaled 6.1 million tons, 12 percent below 1957. Of this, approximately 76 percent was native sulfur, 10 percent recovered sulfur, 7 percent sulfur contained in pyrites, 6 percent sulfur in smelter acid, and 1 percent sulfur in other forms.

NATIVE SULFUR

Output of native sulfur from the salt domes of Louisiana and Texas and from surface deposits in California and Nevada reached an 11-year low, declining to 4.6 million tons.

Frasch Sulfur.—Twelve Frasch-process mines were in operation—7 in Texas and 5 in Louisiana. All except two mines in Texas and Louisiana reported lower production.

[1] Commodity specialist.
[2] Supervisory statistical assistant.

TABLE 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States, in long tons

	1949–53 (average)		1954		1955		1956		1957		1958	
	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, 132, 787	5, 132, 787	5, 514, 640	5, 514, 640	5, 738, 978	5, 738, 978	6, 423, 883	6, 423, 883	5, 491, 212	5, 491, 212	4, 643, 243	4, 643, 243
From other mines [1]	34, 661	8, 997	214, 157	64, 333	199, 899	60, 902	212, 476	60, 402	276, 868	87, 313	6, 292	2, 334
Total native sulfur	----------	5, 141, 784	----------	5, 578, 973	----------	5, 799, 880	----------	6, 484, 285	----------	5, 578, 525	----------	4, 645, 577
Recovered elemental sulfur:												
Brimstone	193, 775	193, 071	361, 107	359, 135	400, 754	398, 601	466, 848	464, 629	511, 936	510, 307	641, 890	640, 096
Paste	4, 620	2, 154	284	136	380	179	287	129	452	204	----------	----------
Total recovered elemental sulfur	----------	195, 225	----------	359, 271	----------	398, 780	----------	464, 758	----------	510, 511	----------	640, 096
Pyrites (including coal brasses)	950, 862	400, 349	908, 715	405, 310	1, 006, 943	409, 826	1, 069, 904	431, 687	1, 067, 396	436, 012	974, 114	403, 373
Byproduct sulfuric acid (basis 100 percent) produced at Cu, Zn, and Pb plants	691, 860	225, 960	791, 049	258, 600	992, 903	324, 580	1, 064, 406	347, 954	1, 194, 230	390, 394	1, 101, 754	359, 723
Other byproduct sulfur compounds [2]	66, 339	57, 238	85, 255	73, 046	106, 129	93, 712	102, 300	89, 428	102, 157	88, 446	106, 527	92, 400
Total equivalent sulfur	----------	6, 020, 556	----------	6, 675, 200	----------	7, 026, 778	----------	7, 818, 112	----------	7, 003, 888	----------	6, 141, 169

[1] Sulfur content estimated for 1949–52.
[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.

According to monthly reports submitted to the Bureau of Mines by producers, production of Frasch sulfur was lower in each of the 12 months of 1958 than in corresponding months of 1957. Declines in output ranged from a low of 3.3 percent in May to a high of 24.7 percent in October and averaged 15.4 percent. The greatest decline occurred during the last 6 months of the year, when it averaged 22.3 percent.

Texas Gulf Sulphur Co., the largest domestic producer, operated mines at Boling, Moss Bluff, Spindletop, and Fannett domes in Texas. Fannett dome, which began operating in May, was designed to produce about 500,000 tons annually. Sulfur recovered from this dome was to be shipped molten to the company's facilities at Spindletop.

Freeport Sulphur Co., the country's second largest producer, operated mines in Louisiana at Grande Ecaille, Bay Ste. Elaine, Chacahoula, and Garden Island Bay. Two new salt-dome plants were under construction at Grand Isle and Lake Pelto. The largest deposit is at Grand Isle, where the company completed major construction of the steel island designed to support offshore mining. Production at this property was expected to begin in 1960.

Jefferson Lake Sulphur Co., the third largest domestic producer, operated mines at Starks dome in Louisiana and Clemens and Long Point domes in Texas.

Duval Sulphur & Potash Co. continued its operations at Orchard dome in 1958.

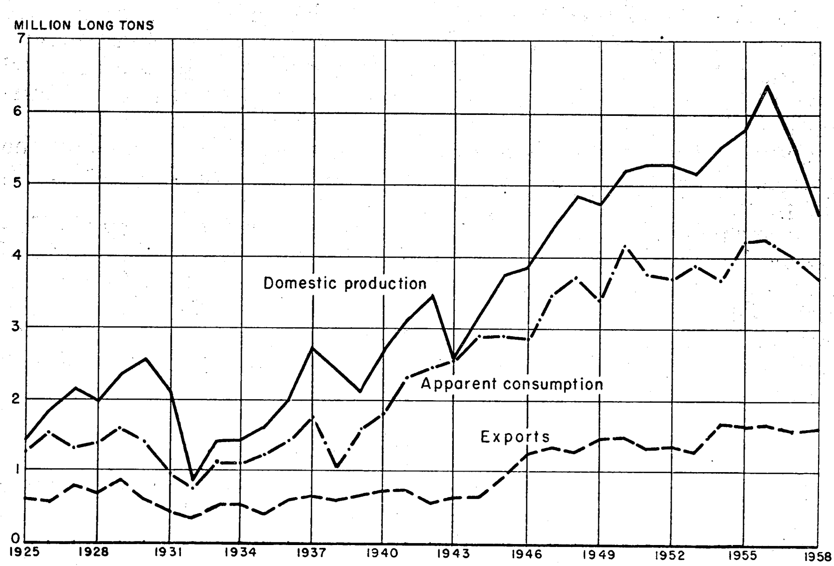

FIGURE 1.—Domestic production apparent consumption, and exports of native sulfur, 1925–58.

TABLE 3.—Sulfur produced and shipped from Frasch mines in the United States

Year	Produced (long tons)			Shipped	
	Texas	Louisiana	Total	Long tons	Approximate value
1949-53 (average)	3,765,263	1,367,524	5,132,787	5,129,544	$109,895,800
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
1958	2,587,760	2,055,483	4,643,243	4,644,021	109,272,000

TABLE 4.—Sulfur ore (10–70 percent S) produced and shipped in the United States, in long tons[1]

Year	Produced (long tons)	Shipped		Year	Produced (long tons)	Shipped	
		Long tons	Value			Long tons	Value
1949-53 (average)	34,661	33,949	$219,633	1956	212,476	185,532	1,577,857
1954	214,157	185,085	1,507,429	1957	276,868	172,169	1,521,425
1955	199,899	199,899	1,697,052	1958	6,292	153,574	1,504,849

[1] California, Colorado (1949 only), Nevada (except 1954), Utah (1952 only), and Wyoming (except 1953–57).

RECOVERED ELEMENTAL SULFUR

Six new plants to obtain sulfur from the purification of natural and other industrial gases were completed or under construction. Of the total added capacity (112,000 long tons), 96,000 tons or 86 percent was at oil refineries and 16,000 tons or 14 percent at natural-gas-cleaning plants.

Output of recovered elemental sulfur rose steadily throughout the year to 62,280 tons in December, 29.5 percent above December 1957, the previous peak.

Recovered-sulfur capacity at refineries was augmented by the following installations: American Oil Co., Yorktown, Va.; Anlin Co. of New Jersey, Perth Amboy, N.J.; Magnolia Petroleum Co., Beaumont, Tex., and Socony Mobil Oil Co., Paulsboro, N.J. New installations for recovering elemental sulfur from sour natural gas included the plants of J. L. Parker, Andrews County, Tex., and Pan American Petroleum Co., Cottonwood Creek, Wyo.

PYRITES

Production of pyrites (ores and concentrates) was approximately 9 percent less than in 1957. The sulfur content of the pyrites averaged 41 percent in both 1957 and 1958.

The quantity of pyrites sold or consumed by producing companies in 1958 totaled 954,711 tons. Of this total, 11,282 tons having a sulfur content of 55,558 tons and a value of $800,547 was sold and 838,429 tons having a sulfur content of 339,815 tons and a value of $7,086,392 was consumed. Compared with 1957, consumption dropped 10 percent.

TABLE 5.—Pyrites (ores and concentrates) produced in the United States, in long tons

Year	Quantity		Value	Year	Quantity		Value
	Gross weight	Sulfur content			Gross weight	Sulfur content	
1949–53 (average)	950,862	400,349	$4,514,600	1956	1,069,904	431,687	[1]$9,743,000
1954	908,715	405,310	7,159,000	1957	1,067,396	436,012	9,087,000
1955	1,006,9[illegible]3	409,826	8,391,000	1958	974,000	403,000	7,987,000

[1] Revised figure.

Tennessee was the largest pyrites-producing State, followed by Virginia, California, Colorado, Montana, Arizona, and Pennsylvania. The Tennessee Copper Co. recovered pyrites flotation concentrate in Polk County, Tenn., as a coproduct of copper. The concentrate was roasted, and the recovered gases were used in manufacturing sulfuric acid. General Chemical Division, Allied Chemical & Dye Corp., produced a substantial quantity of pyrites at the Cliffview mine in Carroll County, Va. Bethlehem Steel Corp. recovered pyrites in Lebanon, Pa. Appalachian Sulphides, Inc., discontinued operations at the South Strafford mine, Orange County, Vt.

In the Western States considerable pyrite was produced by the Mountain Copper Co., Ltd., at the Hornet mine in Shasta County, Calif. In Colorado pyrites was recovered by Rico Argentine Mining Co. at the Mountain Springs mine, Dolores County; by the Empire Zinc Division, New Jersey Zinc Co., Eagle County; and by Climax Molybdenum Co. from its operations in Lake County. The Ana-

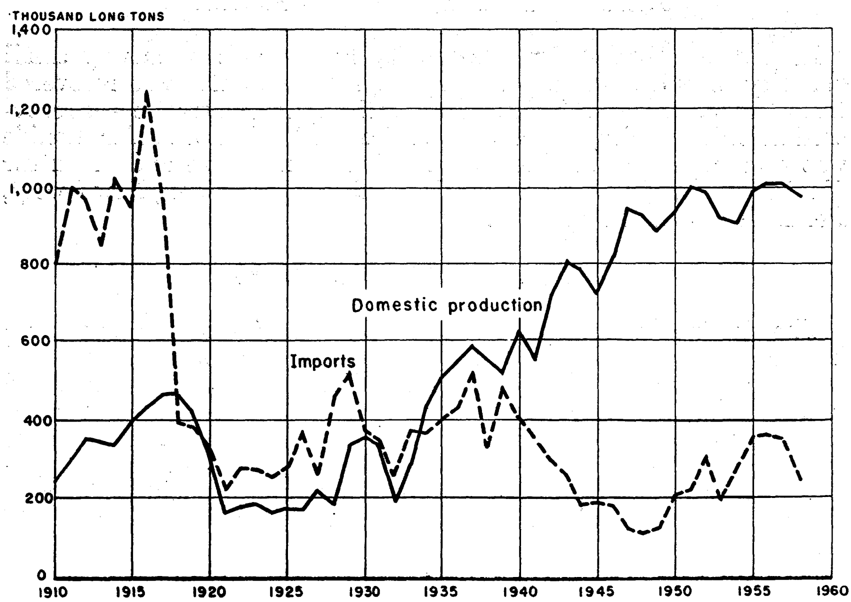

FIGURE 2.—Domestic production and imports of pyrites, 1910–58.

conda Co. produced pyrites from its mines at Butte, Mont. In Arizona, Ray Mines Division, Kennicott Copper Corp., produced pyrite from its mine in Pinal County.

BYPRODUCT SULFURIC ACID

Output of byproduct sulfuric acid (100 percent H_2SO_4) at copper, lead, and zinc smelters in the United States decreased 8 percent—from 1.3 million short tons in 1957 to 1.2 million tons. Of this total, 738,385 tons (60 percent) was recovered at zinc plants and the balance at copper and lead smelters. Production of acid at copper and lead plants increased 3 percent during the year, continuing the uninterrupted upward trend begun in 1949. The 14-percent reduction in acid output at zinc smelters reflected the substantial reduction in production of primary zinc.

TABLE 6.—Byproduct sulfuric acid [1] (basis, 100 percent) produced at copper, zinc, and lead plants in the United States, in short tons

	1949–53 (average)	1954	1955	1956	1957	1958
Copper plants [2]	170,077	273,725	329,114	384,659	482,181	495,576
Zinc plants [3]	604,806	612,250	782,938	807,477	855,357	738,385
Total	774,883	885,975	1,112,052	1,192,136	1,337,538	1,233,961

[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.

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. Virtually all of the hydrogen sulfide was recovered at oil refineries, whereas the entire production of sulfur dioxide was obtained from smelter gases. Hydrogen sulfide and/or sulfur dioxide was produced in California, Louisiana, Michigan, New Jersey, Pennsylvania, and Tennessee.

CONSUMPTION AND USES

The decline in business activity in such major sulfur-consuming industries as steel, rubber, and textiles resulted in consumption of all forms of sulfur falling 5 percent below the 5.6 million tons consumed in 1957. This decline would have been more severe except for the relatively good year experienced by the phosphate fertilizer industry and part of chemical industry, two of the largest consumers. A general increase in the demand for sulfuric acid and nonacid sulfur near the end of 1958 was insufficient to bring the annual rate to the 1957 level.

TABLE 7.—Production of new sulfuric acid[1] (100 percent H_2SO_4) by geographic divisions and States, in short tons

[U. S. Department of Commerce]

Division and State	1954	1955	1956	1957	1958
New England[2]	169, 880	183, 698	201, 758	183, 092	174, 531
Middle Atlantic:					
Pennsylvania	713, 074	855, 913	815, 016	795, 929	647, 972
New York and New Jersey	1, 441, 943	1, 547, 113	1, 577, 476	[3] 1, 541, 278	1, 458, 124
Total Middle Atlantic	2, 155, 017	2, 403, 026	2, 392, 492	[3] 2, 337, 207	2, 106, 096
North Central:					
Illinois	1, 257, 759	1, 305, 576	1, 272, 453	1, 241, 474	1, 219, 517
Indiana	440, 166	562, 315	519, 853	493, 151	468, 993
Michigan	217, 888	261, 493	220, 604	241, 587	298, 946
Ohio	656, 226	745, 051	714, 454	713, 201	607, 791
Other[4]	536, 234	720, 435	789, 369	760, 127	697, 879
Total North Central	3, 108, 273	3, 594, 870	3, 516, 733	3, 449, 540	3, 293, 126
South:					
Alabama	269, 576	243, 024	251, 314	314, 669	243, 899
Florida	1, 185, 883	1, 233, 281	1, 497, 155	1, 738, 945	1, 830, 104
Georgia	212, 732	256, 075	339, 751	318, 325	302, 195
North Carolina	142, 048	152, 159	137, 127	120, 207	119, 613
South Carolina	163, 373	160, 711	146, 046	131, 933	133, 748
Virginia	463, 897	537, 095	527, 257	488, 707	469, 182
Kentucky and Tennessee	944, 404	974, 827	1, 035, 739	995, 277	893, 530
Texas	1, 212, 530	1, 477, 179	1, 552, 202	1, 605, 445	1, 600, 683
Delaware and Maryland	1, 203, 399	1, 353, 567	1, 325, 004	1, 094, 275	1, 081, 210
Louisiana	730, 021	788, 311	782, 330	727, 144	653, 573
Other[5]	467, 898	459, 035	402. 121	428, 682	496, 206
Total South	6, 995, 761	7, 635, 264	7, 996, 046	7, 963, 609	7, 823, 943
West[6]	1, 127, 560	1, 502, 502	1, 630, 319	1, 834, 777	1, 882, 727
Total United States	13, 556, 491	15, 319, 360	15, 737, 348	[3] 15, 768, 225	15, 280, 423

[1] Includes information for Government-owned and privately operated plants.
[2] Includes data for plants in Maine, Rhode Island, Massachusetts, and Connecticut.
[3] Revised figure.
[4] Includes data for plants in Missouri, Wisconsin, Iowa, and Kansas.
[5] Includes data for plants in West Virginia, Mississippi, Arkansas, and Oklahoma.
[6] Includes data for plants in Arizona, California, Colorado, Idaho, Nevada (1956–58), New Mexico (1956–58), Montana, Utah, Washington, and Wyoming.

TABLE 8.—Apparent consumption of native sulfur in the United States, in long tons

	1949–53 (average)	1954	1955	1956	1957	1958
Apparent sales to consumers[1]	5, 173, 292	[2] 5, 373, 439	[2] 5, 846, 702	[2] 5, 730, 800	[2] 5, 090, 660	4, 663, 625
Imports	1, 705	1, 214	34, 627	212, 229	[3] 499, 401	590, 687
Total	5, 174, 997	5, 374, 653	5, 881, 329	5, 943, 029	[3] 5, 590, 061	5, 254, 312
Exports:						
Crude	1, 341, 075	1, 645, 000	1, 600, 951	1, 651, 307	[3] 1, 578, 359	1, 570, 979
Refined	31, 079	30, 130	34, 701	24, 024	[3] 14, 620	27, 949
Total	1, 372, 154	1, 675, 130	1, 635, 652	1, 675, 331	[3] 1, 592, 979	1, 598, 928
Apparent consumption	3, 802, 843	3, 699, 523	4, 245, 677	4, 267, 698	[3] 3, 997, 082	3, 655, 384

[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, in long tons[1]

	1949-53 (average)	1954	1955	1956	1957	1958
Native sulfur[2]	3,802,840	3,699,500	4,245,700	4,267,700	[3] 3,997,100	3,655,400
Recovered sulfur shipments	170,600	342,300	380,100	432,300	472,700	590,800
Pyrites:						
Domestic production	400,340	405,300	409,800	431,700	436,000	403,400
Imports	99,500	133,900	171,500	175,200	169,100	164,300
Total pyrites	499,840	539,200	581,300	606,900	605,100	567,700
Smelter-acid production	225,960	258,600	324,600	348,000	390,400	359,700
Other production[4]	57,240	73,000	93,700	89,400	88,400	92,400
Total	4,756,480	4,912,600	5,625,400	5,744,300	[3] 5,553,700	5,266,000

[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] In 1949, hydrogen sulfide; 1950-58, 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.

STOCKS

Major changes occurred in stockpile trends in the Frasch sulfur industry. Producers' stocks of Frasch sulfur increased only about 19,000 long tons in 1958, whereas they increased 488,000 tons in 1957 and 753,000 tons in 1956. On December 31, 1958, 4,037,960 tons was held at the mines and 403,797 tons elsewhere, for a total of 4,441,757 tons. Stocks of recovered sulfur were 177,271 tons at the end of 1958 compared with 157,075 at the end of 1957—a net gain of approximately 13 percent. Inventory statistics on pyrites are not available.

PRICES

No changes were reported in the price of Frasch sulfur. Throughout 1958 domestic 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, $24 to $25 per long ton; and for foreign buyers, f.o.b. vessel, Galveston, $25 to $28 per long ton. Prices of Mexican dark sulfur, f.o.b. mines, were $22.40 to $31.60 for internal use and for export, f.o.b. vessel, $22 to $24, depending on grade. Oil, Paint and Drug Reporter quoted crude domestic sulfur, bright, bulk, f.o.b. car, mines, at $23.50 per long ton and crude, bulk, domestic and Canadian, f.o.b. vessel, gulf ports, at $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, mines, at $5 per long ton.

FOREIGN TRADE [3]

Imports.—The United States was a large importer of elemental Frasch sulfur, owing to increased shipments from Mexico. Imports of pyrites from Canada totaled 343,060 long tons valued at $1,193,973.

Exports.—Despite increased competition from foreign sources, world demand for United States Frasch sulfur remained high, indicating that the trend continued in foreign markets toward the use of sulfur as opposed to pyrites in acid manufacture. As evidence of this trend a near record quantity of Frasch sulfur was shipped overseas. Three factors contributing to the increase in exports were the low prices of American Frasch sulfur, lower ocean freight rates, and confidence in continuing availability of low-cost elemental sulfur from the Frasch industries of the United States.

In mid-1958 the four United States Frasch sulfur producers established the Sulfur Export Corp. under terms of the Webb-Pomerene Act, which permits the formation of a single corporation within an industry to transact business overseas. A company of the same name with only two members, Texas Gulf Sulphur Co. and Freeport Sulphur Co., operated from 1922 to 1952, when it was disbanded. The corporation was organized to meet competition from foreign sources and deal more effectively with buying combines.

WORLD REVIEW

NORTH AMERICA

Canada.—The production of sulfur in all forms in Canada totaled 820,300 long tons in 1957, an increase of approximately 24 percent above the 663,500 tons produced in 1956. Of this total, 509,100 tons

TABLE 10.—United States sulfur imports (for consumption) and exports

[Bureau of the Census]

Year	Imports				Exports			
	Ore		In any form, n.e.s.		Crude		Crushed, ground, refined, sublimed, and flowers	
	Long tons	Value (thousand)	Long tons	Value (thousand)	Long tons	Value (thousand)	Long tons	Value (thousand)
1949–53 (average)	1,447	$42	258	$23	1,341,075	$32,254	31,079	$2,070
1954	110	2	1,104	[1] 56	1,645,000	50,362	30,130	2,162
1955	24,152	595	10,475	264	1,600,951	48,708	34,701	2,454
1956	14,750	359	197,479	4,975	1,651,307	48,305	24,024	1,777
1957	14,454	350	[2] 484,947	[1] 11,882	[2] 1,578,359	[2] 43,940	[2] 14,620	[2] 1,458
1958	18,906	445	571,781	13,106	1,570,979	39,317	27,949	2,050

[1] Data known to be not comparable with other years.
[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 11.—Sulfur exported from the United States, by countries of destination

[Bureau of the Census]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1957		1958		1957		1958	
	Long tons	Value (thousand)	Long tons	Value (thousand)	Pounds	Value (thousand)	Pounds	Value (thousand)
North America:								
Canada	[1]364,234	[1]$10,461	332,262	$8,663	6,072,121	$283	5,469,872	$258
Central America			167	7	889,759	34	851,956	37
Mexico	27	1			331,145	37	410,383	55
West Indies	19,591	529	16,750	417	473,062	17	215,565	15
Total	[1]383,852	[1]10,991	349,179	9,087	7,766,087	371	6,947,776	365
South America:								
Argentina	[1]44,979	[1]1,277	33,959	855	129,775	22	8,603,584	162
Bolivia	19	1			50,000	2		
Brazil	[1]102,440	[1]2,779	96,045	2,421	[1]3,347,220	[1]139	1,011,495	85
Chile					2,200	(2)	20,000	3
Colombia					717,549	42	671,656	38
Paraguay	97	3	29	(2)			26,213	1
Peru	976	32	2,991	95	485,596	17	345,700	11
Uruguay	4,420	124	6,133	154	136,289	5	224,702	7
Venezuela	1,784	60	2,080	67	1,127,047	58	657,753	47
Total	[1]154,715	[1]4,276	141,237	3,592	[1]5,995,676	[1]285	11,561,103	354
Europe:								
Austria	19,350	636	25,717	665				
Belgium-Luxembourg	84,620	2,564	100,180	2,483	85,992	3	60,700	6
Finland	32,088	862	41,567	1,021				
France	132,092	3,647	99,065	2,474	43,592	1		
Germany, West	[1]67,735	[1]1,915	63,869	1,594	416,950	81	493,400	95
Greece			999	25	213,887	6	15,829,183	360
Netherlands	[1]6,300	[1]161	10,400	255			25,500	5
Norway					174,500	7	240,000	6
Portugal					81,400	13	26,400	4
Sweden	11,610	318			91,150	19	10,000	2
Switzerland	[1]33,775	[1]925	40,905	1,023	113,450	23	71,923	13
United Kingdom	[1]246,285	[1]6,459	279,053	6,587				
Yugoslavia	2,000	85	2,000	61			6,953,516	155
Other Europe	3,000	75	7,421	167	64,000	13	79,700	15
Total	[1]638,855	[1]17,647	671,176	16,355	1,284,921	166	23,790,322	661
Asia:								
India	102,590	2,791	114,028	2,859	7,429,766	210	11,487,515	319
Indonesia	1,781	46	7,800	191	2,649,585	86	3,199,865	96
Iran	14,972	537	6,000	215				
Israel			7,500	184	237,036	9	223,818	21
Japan	49	2			76,620	16	66,200	14
Korea, Republic of	596	21	1,844	61	3,632,174	104	2,052,573	42
Lebanon	1,300	33	2,499	62	218,460	5	23,976	1
Pakistan	1,986	67	3,065	100				
Philippines	[1]4,651	[1]136	1,944	50	856,707	44	626,529	31
Turkey							3,950	(2)
United Arab Republic (Syria)[3]					407,340	10	326,690	8
Other Asia	2,197	67	561	17	774,672	25	301,428	8
Total	[1]130,122	[1]3,700	145,241	3,739	16,282,360	509	18,312,544	540
Africa:								
Algeria	16,111	428	23,560	589				
Belgian Congo							925,872	22
Morocco	7,000	196	7,700	193				
Tunisia	12,743	331						
Union of South Africa	80,350	2,219	65,900	1,655	685,135	34	220,480	19
United Arab Republic (Egypt)[3]	2,617	101					113,695	7
Other Africa	7,949	204	4,428	111			4,000	1
Total	126,770	3,479	101,588	2,548	685,135	34	1,264,047	49

See footnotes at end of table.

TABLE 11.—Sulfur exported from the United States, by countries of destination—Continued

[Bureau of the Census]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1957		1958		1957		1958	
	Long tons	Value (thousand)	Long tons	Value (thousand)	Pounds	Value (thousand)	Pounds	Value (thousand)
Oceania:								
Australia	80,185	$2,119	122,704	$3,000	299,300	$56	267,450	$53
New Zealand	63,860	1,728	39,854	996	435,191	37	463,502	28
Total	144,045	3,847	162,558	3,996	734,491	93	730,952	81
Grand total	[1]1,578,359	[1]43,940	1,570,979	39,317	[1]32,748,670	[1]1,458	62,606,744	2,050

[1] Revised figure. [2] Less than $1,000. [3] Effective July 1, 1958.

was sulfur contained in pyrites, 219,900 tons sulfur in smelter gases, and 91,200 tons elemental sulfur recovered from natural gas.[4] Canadian imports of Frasch sulfur from the United States were reduced by 51,100 tons in 1957 as a result of increased output of recovered sulfur. Imports of elemental sulfur, all from sources in the United States, totaled 372,300 tons, 12 percent below 1956. The value of exports of sulfur and pyrites increased 13 percent.

Five projects or expansions to existing facilities were underway or completed in Canada in 1958. The largest new project was the addition of a 225-long-ton-per-day sulfur-recovery unit to the British American Oil Co., Ltd., recovery plant at Pincher Creek, Alberta. Although productive capacity was doubled from 225 to 450 tons per day with the addition of the new plant, actual output was only about 400 tons owing to the limited amount of gas being treated. Construction of a third unit that will increase plant capacity to 675 long tons per day was planned for 1959.

Jefferson Lake Petrochemicals of Canada, Ltd., began producing elemental sulfur from sour natural gas at its sulfur recovery plant in the Fort St. John area of British Columbia early in 1958. Plant capacity was reported to be 300 long tons per day. Shipments from this plant were restricted because transportation facilities were not available in the area until near the end of the year.

Laurentide Chemical & Sulphur, Ltd., began producing liquid elemental sulfur in March at a $2.5-million plant in Montreal East. The sulfur was recovered by the modified Claus process from H_2S gas collected from five oil refineries. Nominal capacity of the plant was reported to be 100 long tons per day or approximately 30,000 tons per year.

[4] Bartley, C. M., Sulphur in Canada, 1957: Min. Res. Div., Dept. Min. and Tech. Surveys, Ottawa, Canada, May 1958, 9 pp.

TABLE 12.—Pyrites, containing more than 25 percent sulfur, imported for consumption in the United States, by customs districts, in long tons

[Bureau of the Census]

Customs district	1949–53 (average)	1954	1955	1956	1957	1958
Buffalo	200,965	[1] 30,594	[1] 38,954	[1] 30,214	[1] [2] 40,842	296,002
Chicago	7					
Connecticut				18	(3)	
Duluth and Superior	9					
Michigan	1	260	[1] 24,348	25,188	20,744	16,768
New York	54					217
Philadelphia	2,815					
Pittsburgh			682	763	54	
Rochester	10				208	
St. Lawrence	570	7,115	8,973	10,032		13,373
Vermont	3,111	[1] 8,680	[1] 7,348	7,063	[1] 8,766	16,523
Washington				18	18	177
Total: Long tons	207,542	[1] 46,649	[1] 80,305	[1] 73,296	[1] 70,632	343,060
Value	$533,285	[1] $292,025	[1] $519,756	[1] $479,950	[1] $408,342	$1,193,973

[1] In addition to data shown, an estimated 232,920 long tons ($627,620) was imported through the Buffalo customs district in 1954; 277,020 long tons ($706,840) through the Buffalo customs district and 840 long tons ($4,900) through the Michigan customs district in 1955; 292,520 long tons ($865,020) through the Buffalo customs district in 1956; and 282,400 long tons ($889,100) through the Buffalo customs district in 1957.
[2] Revised figure.
[3] Revised to none.

TABLE 13.—World production of native sulfur, by countries,[1] in long tons [2]

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

Country [1]	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Mexico	9,212	52,407	475,487	758,415	1,007,915	1,236,929
United States	5,141,783	5,578,973	5,799,880	6,484,285	5,578,525	4,645,577
South America:						
Argentina	11,345	17,000	17,651	27,298	28,788	[3] 30,000
Bolivia (exports)	5,444	2,565	3,975	3,418	783	392
Chile	27,090	43,100	56,338	37,272	18,492	24,015
Colombia	2,073	5,118	5,413	4,921	[3] 5,000	6,693
Ecuador	549	64	1,550			21,200
Peru	2,886					
Europe:						
France (content of ore)	10,016					
Greece (content of ore)	240	2,507	3,600	1,322	2,826	[3] 3,000
Italy (crude)[4]	212,348	194,064	181,629	170,094	171,730	158,665
Spain [3]	5,680	5,400	6,500	6,200	3,410	3,700
Asia:						
Japan	131,209	184,745	199,676	243,312	253,548	177,175
Philippines	218	761	[3] 3,700		[3] 1,300	[3] 1,300
Ryukyu Islands				254	1,003	(5)
Taiwan	2,835	5,873	4,854	7,864	9,433	6,178
Turkey	6,818	9,862	11,318	13,681	12,893	12,622
Total (estimate)[1] [2]	5,715,000	6,300,000	7,000,000	8,000,000	7,300,000	6,500,000

[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 exactly 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: 1949–53 (average), 19,107 tons; 1954, 22,803 tons; 1955, 21,560 tons; 1956, 22,219 tons; 1957, 19,904 tons; 1958, 18,656 tons.
[5] Negligible.

Steelman Gas, Ltd., completed work on its 7.5-long-ton-per-day, 3,000-ton-per-year, sulfur-recovery plant in southeastern Saskatchewan. The sulfur will be recovered as a byproduct in processing 25 million cubic feet of natural gas per day.[5]

Under agreement with Shell Oil of Canada, Ltd., Texas Gulf Sulphur Co. and Devan-Palmer Oils, Ltd., were constructing a new-sour gas recovery plant at Okotoks, near Calgary, Alberta. The new plant, scheduled for completion by the summer of 1959, was designed to produce 100,000 tons of elemental sulfur annually.[6]

Mexico.—Production of all forms of sulfur in Mexico totaled 1,264,776 long tons in 1958, 24 percent more than in 1957. Of this total, 1,201,483 tons or 95 percent was produced at three Frasch mines, 35,446 tons or 2.8 percent from volcanic sulfur deposits (Las Cerritas of San Luis Patose), and 27,641 tons or 2.2 percent from oilfield gases at the Permex gas-separation plant, Poga Rica State, Vera Cruz. Stocks of Frasch sulfur on hand December 31, 1958, totaled 774,325 tons, 17 percent above the 660,000 tons on hand on December 31, 1957.[7]

Pan American Sulfur Co., the world's third largest sulfur producer, mined 822,000 long tons of Frasch sulfur at the Jaltipan dome in 1958, 99,000 tons (14 percent) more than in 1957. Output of Frasch sulfur from the Jaltipan dome was 65 percent of the total production of sulfur in all forms and 68 percent of Frasch production. Shipments totaled 807,000 long tons, 129,000 tons (19 percent) more than the 678,000 tons shipped in 1957. Year-end stocks were 552,000 tons, an increase of 14,000 tons during the year.[8]

Cía. de Azufre Veracruz, S.A., an operating subsidiary of the Gulf Sulphur Corp., produced 265,000 tons of Frasch sulfur from the Las Salinas dome, an increase of 85,000 tons or 47 percent over the 1957 production. Shipments totaled 270,000 tons, of which all but 1,000 tons was exported. Stocks were reduced to approximately 60,000 tons, as shipments exceeded production by 5,000 tons.[9]

Central Minera, S.A., the operating Mexican subsidiary of Texas International Sulphur Corp., encountered delays in completing its Frasch plant and field installations. As a result the steaming of the plant, originally scheduled for the spring of 1958, was delayed. When completed, the plant is scheduled to operate at a daily rate of 500 tons.[10]

Cía. Exploradora dil Istmo, an operating subsidiary of Texas Gulf Sulphur Co., produced approximately 115,000 tons of Frasch sulfur at the Napalapa dome, all of which was placed in inventory. No shipments have been made by the company since operations were begun on February 7, 1957; as a result stock held at the mine site totaled about 230,000 tons.[11]

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[5] Haw, V. A., Industrial Minerals—1958: Canadian Min. Jour., vol. 80, No. 2, February 1959, pp. 151–152.
[6] Texas Gulf Sulphur Co., Annual Report, 1958, pp. 2, 3.
[7] U.S. Embassy, Mexico City, D.F., Mexico, State Department Dispatch 960: Apr. 9, 1959, p. 3, incl. 1.
[8] Sulphur, Sulphur in Mexico: British Sulphur Corp. (London), Quart. Bull. 24, April 1959, pp. 18–22.
[9] Work cited in footnote 7.
[10] Work cited in footnote 7.
[11] Texas Gulf Sulphur Co., Annual Report 1958, p. 5. Sulphur, Sulphur in Mexico: British Sulphur Corp. (London), Quart. Bull. No. 24, April 1959, pp. 18–22.

TABLE 14.—World production of pyrites (including cupreous pyrites), by countries,[1] in thousand long tons [2]

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

Country [1]	1949–53 (average) gross weight	1954		1955		1956		1957		1958	
		Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
North America:											
Canada (sales)	352	614	278	784	361	935	423	1,041	460	1,664	800
Cuba	[3] [4] 30	118	57	130	63	65	32	36	17	25	12
United States	951	909	405	1,007	410	1,070	432	1,067	436	974	403
South America: Venezuela	----	----	----	----	----	59	14	15	4	14	4
Europe:											
Austria	9	----	----	----	----	----	----	----	----	----	----
Finland	212	246	[3] 104	294	[3] 125	289	128	292	[3] 126	251	105
France	262	295	135	301	133	299	126	319	124	370	[3] 163
Germany:											
East	[3] 83	128	[3] 46	141	[3] 48	[3] 152	[3] 53	[3] 148	[3] 49	[3] 148	[3] 50
West	484	556	194	580	206	634	253	596	237	557	224
Greece	141	207	[3] 90	229	[3] 100	237	104	231	102	148	65
Italy	992	1,231	563	1,296	592	1,349	634	1,445	[3] 679	1,490	676
Norway	718	782	344	730	362	840	363	830	360	775	335
Poland	102	151	[3] 60	139	56	152	61	207	76	[3] 207	[3] 76
Portugal	678	642	259	725	297	659	297	656	302	589	271
Rumania	(5)	190	76	179	72	178	71	174	70	[3] 174	[3] 70
Spain	1,673	1,864	904	2,290	1,110	2,259	1,084	2,182	1,047	1,738	283
Sweden	402	393	194	388	191	486	239	494	245	329	162
United Kingdom	13	7	3	6	2	4	2	4	1	[3] 4	[3] 1
Yugoslavia	171	160	[3] 72	223	116	252	131	308	123	326	130
Asia:											
Cyprus	948	1,103	[3] 530	1,318	[3] 633	1,603	[3] 770	1,080	524	1,006	485
Japan	2,105	2,636	1,106	2,693	1,131	3,049	1,296	3,324	1,404	3,143	1,329
Philippines	[4] 1	5	2	30	14	----	----	18	8	19	8
Taiwan	13	24	10	29	11	29	11	33	12	32	12
Turkey	[4] 21	34	17	16	[3] 8	19	[3] 9	48	23	80	39
Africa:											
Algeria	28	33	15	21	10	6	3	19	8	24	11
Morocco: Southern zone	2	2	1	1	1	2	(6)	6	2	18	6
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	23	36	15	21	10	19	8	20	8	58	24
Union of South Africa	45	226	87	352	138	430	[3] 163	388	160	493	205

Oceania: Australia	146	207	98	223	106	187	88	227	108	229	109
World total (estimate)[1] [2]	12,700	15,000	6,300	16,500	6,900	17,700	7,400	17,800	7,500	17,650	7,400

[1] In addition to countries listed, China, Czechoslovakia, North Korea, and U.S.S.R. produce or have produced pyrites, but production data are not available; estimates by senior author of chapter included in total. Negligible quantities are produced in Brazil, India, Kenya, Republic of Korea, and Tunisia.

[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] Estimate.

[4] Average for 1952–53.

[5] Data not available; estimate by senior author of chapter included in total.

[6] Less than 500 tons.

Assets of Cía. Azufrera Mexicana, S.A., the Mexican operating subsidiary of the Mexican Gulf Sulphur Co., were sold under foreclosure to National Financiera, S.A., an agency of the Mexican Government for $2.5 million. The assets, purchased with promissory notes payable over 15 years, include the Frasch sulfur plant at San Cristobal on the Isthmus of Tehuantepec, the marine equipment, and other property. Credits amounting to $5 million had been extended to Azufrera Mexicana by the Export-Import Bank between 1951 and 1955. Foreclosure became necessary when reserves became exhausted. The company had been unsuccessful in its search for other good deposits near San Cristobal.

SOUTH AMERICA

Peru.—"Sulfur, crude, in any form, and in any quantity lots," imported through the port of Callao and destined for preparing sulfur powder for agricultural insecticides and fungicides and for manufacturing calcium superphosphates, was exempted from import duty and customs surcharges by a Supreme Resolution effective March 20, 1958. The exemption was to remain in effect until domestic production of crude sulfur became sufficient to meet demand.[12]

EUROPE

France.—Production of sulfur at the sour-gas treatment and desulfurization plant at Lacq, operated by the Société Nationale des Pétroles d'Aquitaine, totaled 126,518 long tons, of which 47,433 tons was exported—18,825 tons to West Germany, 15,039 to the United Kingdom, 2,700 tons to Sweden, 2,276 tons to Israel, 5,576 tons to Belgium, 3,002 tons to Austria, and 23 tons to Switzerland. After completion of the first stage of the gas-purification plant at Lacq in 1957 and the second stage in the latter half of 1958, annual production capacity totaled 345,000 tons. Construction work was in progress to bring an additional 345,000 tons of sulfur capacity into production by mid-1959.[13] The plant was expected to have a total annual capacity of 1.3 million tons when completed in 1961, which would make France one of the world's leading producers.[14]

Poland.—Work neared completion on a modern chemical combine for processing sulfur ore from Tarnobrzeg-Peaseczno sulfur deposits. The Tarnobrzeg-Peaseczno area has been completely drilled, and an open-pit mine opened at Peaseczno. The ore from the mine will be concentrated by flotation to produce a product containing 80 to 85 percent sulfur and having a recovery factor of 90 percent. The concentrate will be melted and filtered to 99.95-percent sulfur.

United Kingdom.—Production of sulfur in all forms in the United Kingdom totaled about 577,000 long tons, slightly more than in 1957. Of the total, approximately 352,000 tons (61 percent) was sulfur in

[12] Foreign Commerce Weekly, vol. 59, No. 17, Apr. 28, 1958, p. 8.
[13] Sulphur, Sulphur in France: British Sulphur Corp. (London), Quart. Bull. No. 24, April 1959, pp. 22–23.
[14] Fertiliser and Feeding Stuffs Journal, Lacq Sulphur: Vol. 49, No. 12, Dec. 3, 1958, pp. 514–515.

anhydrite used for making sulfuric acid, 116,000 tons (20 percent) sulfur in spent oxide, 50,000 tons (9 percent) sulfur recovered at oil refineries, 46,000 tons (8 percent) sulfur in smelter gases (zinc), 12,000 tons (2 percent) sulfur in hydrogen sulfide, and 1,000 tons sulfur in pyrites.

Imports of elemental sulfur totaled 328,439 tons—2.5 percent greater than in 1957. Of the total, approximately 77 percent was from the United States, 19 percent from Mexico, and the remaining 4 percent from France. Imports of pyrite declined approximately 31 percent from about 357,000 tons in 1957 to 245,123 tons in 1958. Cyprus accounted for 55 percent of the pyrites imports. Imports from Spain showed a marked reduction, representing only 20 percent of the total. Other countries supplying pyrites include Canada 30,000 tons, Sweden 16,000 tons, Portugal 10,000 tons, and Eire (St. Patrick's Copper Mines) 1,000 tons.

ASIA

Iraq.—Ralph M. Parsons & Co. of Los Angeles, Calif., was awarded a contract to build a 300-ton-per-day elementary-sulfur recovery plant at the Kirkuk oilfield by the Iraq Development Board. The new plant will process 80 million cubic feet of natural gas a day.[15]

Japan.—Production of elemental sulfur in Japan totaled approximately 177,200 long tons, 30 percent less than in 1957. Of this total, 48,200 tons was produced by the Matsuo Mining Co., 28,600 tons by Hokkaido Sulphur Co., 17,700 tons by the Teikaku Sulphur Industry Co., 16,700 tons by the Akan Sulphur Mining Co., and 66,000 tons by other producers.

Exports of elemental sulfur from Japan to various Far Eastern countries totaled about 3,700 tons.

Prices for elemental sulfur were considerably reduced in 1958 owing to the decline in demand.[16]

TABLE 15.—Exports of sulfur (Frasch) from Mexico, by countries of destination, in long tons[1]

[Compiled by Corra A. Barry]

Country	1957	1958	Country	1957	1958
North America:			Asia:		
Canada	----------	1,009	India	----------	----------
United States	489,455	607,381	Indonesia	----------	----------
South America: Brazil	----------	----------	Israel	24,036	27,224
Europe:			Africa: Union of South Africa	29,719	52,530
Belgium	5,783	----------	Oceania:		
France	105,267	144,696	Australia	58,066	72,592
Germany, West	10,723	----------	New Zealand	30,261	3,768
Netherlands	29,040	34,197	Other countries	----------	132
Sweden	----------	3,150			
Switzerland	----------	----------			
United Kingdom	80,997	58,822	Total	863,347	1,005,501

[1] Compiled from Customs Returns of Mexico.

[15] Sulphur, Sulphur from Natural Gas at Kirkuk: British Sulphur Corp. (London), Quart. Bull. 21, June 1958, p. 45.

[16] Sulphur, Elemental Sulphur in Japan: British Sulphur Corp. (London), Quart. Bull. No. 24, April 1959, pp. 23–24.

AFRICA

United Arab Republic (Egypt).—About 3,000 long tons of sulfur a year, recovered from petroleum refineries was used for domestic consumption. An estimated output of 7,000 tons of sulfur a year by the end of 1958 was expected as Egypt's refinery capacity increases. Production of sulfur (nonpetroleum) totaled 101 tons in 1956, compared with 615 tons in 1955.

Imports of sulfur into Egypt during 1956 were 9,282 tons, of which 3,201 tons came from the United States.

Sulfur deposits at Gemsa, in the Eastern Desert near the Red Sea coast, were to be developed by the Egyptian Fertilizer & Chemical Industries Co. The company planned to use the sulfur in producing sulfate of ammonia at the company's Suez plant, which had been producing only calcium nitrate. The estimated size of the deposits was not disclosed, but reportedly half of the sulfur-deposit area will serve the plant for about 20 years.[17]

Union of South Africa.—Standard-Vacuum Refining Co. has begun constructing a new sulfur recovery plant at South Africa's only major oil refinery at Wentworth near Durban. The plant will have a capacity of 20 tons per day and was scheduled for production by mid-1959.[18]

TECHNOLOGY

An article in the trade press discussed the purification of dark sulfur at Jaltipan dome in Mexico. The treatment of contaminated sulfur by activated clay and the purification of crude sulfur by sulfuric acid were described.[19]

Research scientists and engineers employed by the International Nickel Co. of Canada, Ltd., developed a new process for the electrorefining of nickel. The main feature of the process is the direct electrolysis of nickel matte and artificial sulfide. The new process eliminates high-temperature oxidation and reduction reactions with the attendant loss of metal, sulfur, and selenium and permits commercial recovery of elemental sulfur and selenium in addition to the cobalt and precious metals normally recovered.[20]

The Chemical Research Laboratory of the United Kingdom Ministry of Works developed a process for producing sulfur from raw sewage sludge to which calcium sulfate has been added. Installation of a 100,000-gallon plant for full-scale development trials[21] was being considered.

Details of the Blaw-Knox-Ruthner pilot-plant program for recovering waste pickle liquor were presented in a paper. Advantages claimed for the Blaw-Knox-Ruthner process include:

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[17] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 4, April 1958, p. 35.

[18] Chemical Age (London), Africa's First Sulphur Plant: Vol. 79, No. 2031, June 14, 1958, p. 1121.

[19] Sulphur, Dark Sulphur Purification at Jaltipan Dome: British Sulphur Corp. (London), Quart. Bull. 23, December 1958, pp. 34–36.

[20] Sulphur, Elemental Sulphur from New Nickel Refining Process: British Sulphur Corp. (London), Quart. Bull. 20, March 1958, pp. 45, 46.

[21] Chemical Trade Journal and Chemical Engineer (London), Sulfur from Sewage: Vol. 142, No. 3701, May 9, 1958, p. 1117.

1. The entire sulfate equivalent of the waste pickle liquor is recovered as a reusable sulfuric acid without using a contact sulfuric acid plant.

2. The only byproduct obtained is iron oxide, which is of high quality and can be recharged to the blast furnace when sintered. The iron oxide may find use as paint pigment or as a base material for making powdered iron.

3. The process is capable of handling high-acid-strength waste pickle liquor.[22]

A new coal-gas desulfurizing and sulfur-recovery process was developed by Appleby-Frodingham Steel Co., a branch of United Steel Co., Ltd. The first full-scale plant was being installed at Appleby-Frodingham works at Scunthorpe and was scheduled for completion by mid–1959. The plant consists essentially of a fluidized, hot iron oxide absorber and regenerator, capable of removing virtually all of the hydrogen sulfide and organic sulfurs. Heat requirements of the plant are met by combustion of the sulfur, which once begun is exothermic.[23]

An article discussed the reactions and mechanisms involved in oxidizing pyrite in aqueous suspension by molecular oxygen at temperatures of 100° to 130° C. The overall rate of oxidation is proportional to the surface area of the pyrite and the partial pressure of the oxygen. High temperatures and low acidities favor the formation of sulfuric acid, whereas the opposite conditions are conducive to production of elemental sulfur.[24]

An article discussed the use of calcium sulfate seed crystals in disposing of industrial waste from solutions of sulfuric acid. The conclusions drawn from the experiments were that the deposition of calcium sulfate on the native-gypsum seed improves sludge settling and composition. More calcium sulfate is deposited on native-gypsum than on precipitated-gypsum seed particles, and continuous return of sludge initially seeded with the native form is more effective than with the precipitated form. Calcium habit and particle size are factors governing settling and composition characteristics.[25]

The construction details of a Peterson-tower sulfuric acid plant were described in an article. The plant was designed to produce 110 long tons of sulfuric acid per 24 hours (calculated as monohydrate), at a strength of 78 percent H_2SO_4, from flash-roaster gases containing 10 percent sulfur dioxide and at a temperature of 300° to 350° C. The designers guarantee a sulfur efficiency of 98.5 percent in terms of sulfur burned, exit-gas acidity not in excess of 0.64 grain per cubic foot (1.5 gr./m.^{3}) calculated as sulfur trioxide, and nitric acid consumption less than 2.3 percent niter on sulfur burned (10 kg. HNO_3 36° B. per 1,000 kg. of monohydrate).[26]

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[22] Strassburger, J. H., Evaluation of the Blaw-Knox-Ruthner Pilot Plant Program: Reprint of paper presented at General Meeting, Am. Iron and Steel Inst., New York, N.Y., May 21, 1958.

[23] Chemical Age (London), New Combined Desulphurising and Sulphuric Acid Plant: Vol. 79, No. 2027, May 17, 1958, p. 912.

[24] McKay, D. R., and Halpern, J., A Kenetic Study of the Oxidation of Pyrite in Aqueous Suspension: Trans. AIME, vol. 212, No. 3, June 1958, pp. 301–309.

[25] Faust, S. D., and Orford, H. E., New Jersey Agricultural Exp. Sta., New Brunswick, N.J., Reducing Sludge Volume with Crystal Seeding in Disposal of Sulfuric Acid Waste: Ind. Eng. Chem., vol. 50, No. 10, October 1958, pp. 1537–1538.

[26] Macdonald, J. P. A., Construction Details of a Peterson Tower Sulphuric Acid Plant: Chem. and Ind. (London), No. 12, Mar. 22, 1958, pp. 338–345.

An article compared the spray-burning and indirect-combustion methods of recovering sulfuric acid of commercial grade from spent acid and waste sludge from oil refineries. Composition of the waste or acid sludge is given as the main factor in selecting one of the two methods. The choice may also be influenced by the value of the byproduct coke, cooling water, temperature, and desired plant capacity.[27]

Construction and operating details of a Kachkaroff-type sulfuric acid plant were described. The process is a modification of the lead-chamber process, nitrous oxides being used for oxidizing sulfur dioxide. It differs from other intensive processes in that the mass relationship between nitrogen trioxide and sulfur dioxide in the system is unusually high. Thus, the method has two distinct advantages: (1) Reaction time is reduced to a minimum, and (2) retention of a relatively large mass of nitrogen trioxide in the system gives flexibility. In the Kachkaroff process, gases containing sulfur dioxide and oxygen are passed through packed towers in which is circulated a solution of nitrogen oxides in concentrated sulfuric acid. Subsidiary circuits are used for denitrating the acid produced; concentrating the denitrated acid; and arresting traces of sulfur dioxide, nitric oxide, and vesicular acid that may be carried by gases leaving the reaction tower.[28]

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[27] Harris, T. R., Disposal of Refinery Sulfuric Acid: Ind. Eng. Chem., vol. 50, No. 12, December 1958, pp. 81A–82A.

[28] Snelling, F. C., A Kachkaroff Sulphuric Acid Plant: Chem. and Ind. (London), No. 11, Mar. 15, 1958, pp. 300–306.

Talc, Soapstone, and Pyrophyllite

By Donald R. Irving [1] and Betty Ann Brett [2]

ALTHOUGH mine production of talc, soapstone,[3] and pyrophyllite in 1958 approached the record high of 1956, sales of these commodities were only slightly greater than in 1957. Imports increased during the year, and exports reached an alltime high.

TABLE 1.—Salient statistics of the talc, soapstone, and pyrophyllite industries

(In thousand short tons and thousand dollars)

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Mine production:						
Quantity	590	619	726	739	684	737
Value [1]	[2] $3,524	$3,493	$4,517	$4,859	$4,796	$4,818
Sold by producers:						
Quantity	584	600	719	735	692	694
Value	$10,439	$12,634	$15,225	$15,026	$14,411	$14,206
Imports for consumption:						
Quantity	21	22	29	23	20	23
Value	$681	$678	$986	$749	$701	$785
Exports: [3]						
Quantity	21	24	35	42	40	59
Value	$638	$855	$961	$1,083	$1,265	$1,451
World: Production (estimated): Quantity	1,550	1,620	1,790	1,930	2,030	2,000

[1] Partly estimated.
[2] 1953 only.
[3] Excludes powders—talcum (in package), face, and compact.

DOMESTIC PRODUCTION

New York, California, and North Carolina ranked first, second, and third, respectively, in the quantity of talc, soapstone, and pyrophyllite produced, an order maintained since 1951. North Carolina continued as the major pyrophyllite-producing State, followed by Pennsylvania (sericite schist) and California.

Talc operations in Hudspeth County, Tex., were described.[4] Talc production in Texas has increased steadily since its beginning in 1952. About 95 percent of the output was used in wall-tile bodies; about 30 percent was exported to Mexico.

Pennsylvania became a soapstone-producing State.

[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.
[4] Flawn, P. T., Texas Miners Boast Talc Output: Eng. Min. Jour., vol. 159, No. 1, January 1958, pp. 104–105.

TABLE 2.—Talc, soapstone, and pyrophyllite sold by producers in the United States, by classes

Year	Crude			Sawed and manufactured		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1949-53 (average)	18,431	$191,370	$10.38	890	$321,148	$360.84
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
1958	61,287	349,471	5.70	801	400,453	499.94

Year	Ground [1]			Total		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1949-53 (average)	564,826	$9,926,418	$17.57	584,147	$10,438,936	$17.87
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
1958	631,804	13,455,650	21.30	693,892	14,205,574	20.47

[1] Includes some crushed material.

TABLE 3.—Pyrophyllite [1] produced and sold by producers in the United States

Year	Production (short tons)	Sales					
		Crude		Ground		Total	
		Short tons	Value	Short tons	Value	Short tons	Value
1949-53 (average)	115,341	4,653	$26,146	109,655	$1,478,067	114,308	$1,504,213
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
1958	174,644	20,732	135,790	122,419	1,886,531	143,151	2,022,321

[1] Includes sericite schist, 1953-58.
[2] Includes a small quantity of sawed material.

TABLE 4.—Crude talc, soapstone, and pyrophyllite produced in the United States

State	1957		1958	
	Short tons	Value [1] (thousands)	Short tons	Value [1] (thousands)
Alabama	1,600	$3	(2)	(2)
California	133,915	1,526	148,806	$1,439
Georgia	49,372	106	(2)	(2)
Maryland and Virginia	24,690	100	26,674	115
Nevada	7,467	57	5,391	41
North Carolina	120,905	558	126,158	614
Texas	47,780	199	60,827	168
Washington	4,065	25	4,000	21
Other States [3]	294,659	2,222	365,477	2,420
Total	684,453	4,796	737,333	4,818

[1] Partly estimated.
[2] Included with "Other States."
[3] Includes States indicated by footnote 2 and Arkansas, Montana, New York, Pennsylvania, and Vermont.

CONSUMPTION AND USES

Ceramics, paints, insecticides, roofing, rubber, asphalt filler, and paper consumed 80 percent of the talc and soapstone sold by producers, compared with 83 percent in 1957. Percentage increases were reported for ceramics and roofing; decreases were reported for paint, insecticides, rubber, and asphalt filler. Insecticides and ceramics consumed 55 percent of the pyrophyllite sold by producers, compared with 47 percent in 1957.

TABLE 5.—Talc, soapstone, and pyrophyllite sold or used by producers in the United States, by uses

Use	Talc and soapstone		Pyrophyllite	
	1957	1958	1957	1958
	Short tons	Short tons	Short tons	Short tons
Asphalt filler	19,073	18,493	(1)	(1)
Ceramics	170,326	187,668	33,722	36,273
Crayons	712	701		
Foundry facings	7,352	4,823		
Insecticides	45,184	37,888	42,166	42,285
Paint	119,848	102,058	6,223	5,480
Paper	15,980	18,302		
Plaster products			4,766	4,399
Rice polishing	1,785	2,666		
Roofing	39,124	53,044		64
Rubber	28,532	24,431	(1)	12,458
Textile	7,393	8,556		
Toilet preparations	10,390	9,541		
Other	[2] 64,443	[2] 82,570	[3] 74,905	[3] 42,192
Total	530,142	550,741	161,782	143,151

[1] Included with "Other" to avoid disclosing individual company confidential data.
[2] Includes adhesive, cement admixtures, composition floor and wall tile, export, fertilizer, instrument wire and cable, joint cement, plaster, plastics, refractories, stucco, and vault manufacturing.
[3] Includes uses indicated by footnote 1 and exports, heavy clay products, joint cement, refractories, 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, based on a wide range of specifications.

TABLE 6.—Prices quoted on ground talc, in bags, carlots, 1958, per short ton

[Oil, Paint and Drug Reporter]

Grade	1958
Domestic, f.o.b. works:	
Ordinary:	
California	$33.00–$39.50
Vermont	19.40
Fibrous (New York):	
Offcolor	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 7.—Prices quoted on talc, carlots, 1958, per short ton, f.o.b. works

[E&MJ Metal and Mineral Markets]

Grade [1]	1958
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 [5]

A 26-percent increase in imports of ground talc from Italy more than offset declining imports from other major suppliers. The value of imports of manufactures, n.s.p.f. (not specifically provided for), except toilet preparations was $19,141, distributed as follows: West Germany, $13,688; Mexico, $3,921; and Canada, $1,532.

Shipments to Mexico and Canada comprised more than 70 percent of talc, soapstone, and pyrophyllite exports. Shipments to Mexico doubled, furnishing the rise in exports to a new high.

[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 8.—Talc, steatite or soapstone, and French chalk imported for consumption in the United States, by classes and by countries

[Bureau of the Census]

Country	Crude and unground		Ground, washed, powdered, or pulverized, except toilet preparations		Cut and sawed		Total unmanufactured	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1949–53 (average)	163	$25,765	20,908	$619,463	119	$36,054	21,190	$681,282
1954	36	6,230	22,076	[1] 653,850	45	18,149	22,157	[1] 678,229
1955	125	20,300	28,882	[1] 936,312	72	29,363	29,079	[1] 985,975
1956	117	17,555	23,128	[1] 684,954	106	46,761	23,351	[1] 749,270
1957								
Canada			2,119	27,322			2,119	27,322
France			3,325	74,618	2	615	3,327	75,233
India	277	42,265	755	20,732			1,032	62,997
Italy			13,572	495,078	3	828	13,575	495,906
Japan					73	33,486	73	33,486
Mexico			261	4,722			261	4,722
Other countries					8	1,687	8	1,687
Total	277	42,265	20,032	[1] 622,472	86	36,616	20,395	[1] 701,353
1958								
Canada			1,556	23,465			1,556	23,465
France			3,008	65,370	1	401	3,009	65,771
India	29	5,935	929	25,333			958	31,268
Italy	2	105	17,069	619,516	9	2,715	17,080	622,336
Japan					89	37,998	89	37,998
Mexico			198	3,900			198	3,900
Total	31	6,040	22,760	737,584	99	41,114	22,890	784,738

[1] Data known to be not comparable with other years.

TABLE 9.—Talc, pyrophyllite, and talcum powders exported from the United States

[Bureau of the Census]

Year	Talc, steatite, soapstone, and pyrophyllite				Powders—talcum (in packages), face, and compact (value, thousands)
	Crude and ground		Manufactures, n.e.c.		
	Short tons	Value (thousands)	Short tons	Value (thousands)	
1949–53 (average)	21,073	$573	116	$65	$1,375
1954	23,348	745	259	110	1,076
1955	35,230	859	135	102	1,246
1956	42,333	1,009	69	74	1,371
1957	39,985	1,127	291	138	1,322
1958	58,647	1,358	212	93	1,341

WORLD REVIEW

Estimated world production of talc, soapstone, and pyrophyllite reached 2 million tons for the second successive year; quantity increases, principally in the United States and Italy, offset the decrease in Japan.

TABLE 10.—World production of talc, soapstone, and pyrophyllite, by countries,[1] in short tons [2]

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

Country [1]	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Canada (shipments)	27,362	28,143	27,160	29,326	34,725	33,494
United States	589,785	618,994	725,708	739,039	684,453	737,333
Total	617,147	647,137	752,868	768,365	719,178	770,827
South America:						
Argentina	19,741	50,376	25,211	24,920	26,239	[3] 26,500
Brazil	18,184	21,967	27,190	30,684	23,023	[3] 22,000
Chile	61					
Paraguay	[4] 99	132	[3] 110	[3] 110	[3] 110	[3] 110
Peru	[5] 96	131	3,708	4,031	2,689	[3] 2,750
Uruguay	853	1,167	1,249	1,580	1,566	1,990
Total	39,034	73,773	57,468	61,325	53,627	[3] 53,350
Europe:						
Austria	63,839	68,310	77,905	72,813	80,915	78,074
Finland	3,305	8,197	5,265	8,146	9,259	7,330
France	112,404	132,154	132,683	126,840	156,528	155,205
Germany, West (marketable)	30,375	36,170	38,889	39,463	[3] 33,000	[3] 33,000
Greece	1,769	1,275	2,315	2,205	2,205	[3] 2,200
Italy	81,398	94,440	110,292	105,005	102,065	120,101
Norway	70,660	80,771	88,598	82,154	72,752	63,383
Portugal	7	6	11	95		
Spain	20,816	22,896	25,168	30,405	32,064	32,131
Sweden	12,239	14,689	13,695	14,492	13,918	15,242
United Kingdom	2,980	4,447	5,641	4,270	4,256	[3] 4,400
Yugoslavia			2,922			
Total [1] [3]	420,000	485,000	525,000	510,000	530,000	535,000
Asia:						
Afghanistan	560	1,200	700	899	[3] 770	[3] 770
India	29,173	47,405	47,476	52,478	49,253	51,520
Japan	351,325	246,197	251,479	345,846	469,109	381,378
Korea, Republic of	11,363	20,965	12,092	15,719	12,434	17,581
Taiwan	1,265	7,791	5,807	6,758	5,938	3,677
Total [1] [3]	450,000	390,000	430,000	565,000	705,000	620,000
Africa:						
Egypt	4,395	2,822	6,878	7,706	6,031	[3] 6,000
Kenya	365	111				
Union of South Africa	6,820	7,974	1,581	1,968	2,314	765
Total	11,580	10,907	8,459	9,674	8,345	[3] 6,765
Oceania: Australia	10,968	14,699	14,075	14,979	16,484	14,018
World total (estimate) [1] [2]	1,550,000	1,620,000	1,790,000	1,930,000	2,030,000	2,000,000

[1] In addition to countries listed, talc or pyrophyllite was reported in China, Rumania, and U.S.S.R., but data were 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 exactly to totals shown because of rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Average for 1 year only as 1953 was first year of commercial production.
[5] Average for 1951-53.

Canada.—Canada Talc Industries, Ltd., furnished the following prices of ground talc per short ton, f.o.b. Madoc, Ontario: Roofing grade, \$10 to \$13.75; Filler grade, \$11.50 to \$15; Ceramic grade, \$17.50 to \$26; and Cosmetic grade, \$26 to 50.[6]

[6] Reeves, J. E., Talc and Soapstone; Pyrophyllite, Canada, 1957: Review 58, Canada Dept. Mines and Tech. Surveys, Ottawa, June 1958, p. 6.

Newfoundland Minerals, Ltd., subsidiary of American Encaustic Tile Co., Lansdale, Pa., planned to build a 100-ton-per-day grinding plant at its pyrophyllite deposit at Manuels, Newfoundland.

The Canadian talc and soapstone industry in 1957 was described as follows:[7]

During 1957 the Canadian producers of talc, soapstone, pyrophyllite and steatite shipped 34,725 short tons valued at $427,673 compared with 29,326 tons valued at $365,226 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. 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 77 to whom $222,287 were paid as salaries. Fuel cost $7,692 and 1,380,150 kwh. of electricity were purchased for $27,735. Containers and process supplies cost $107.298.

Imports of talc and soapstone in 1957 amounted to 14,949 tons valued at $536,189. Exported were 2,353 tons worth $29,848.

TABLE 11.—Talc and soapstone exported from selected countries, by countries of destination, in short tons[1 2]

[Compiled by Corra A. Barry]

Country of destination	Exporting countries					
	Austria		France		Italy	
	1957	1958	1956	1957	1957	1958
Algeria			2,006	1,953		
Austria					632	(3)
Belgium-Luxembourg	2,419	2,339	3,607	3,831	285	(3)
Canada					1,670	(3)
Denmark	76	131				
France	957	1,366			3,917	4,061
Germany:						
East	1,431	1,424				
West	17,576	17,326	4,942	5,528	6,813	6,744
Hungary	2,003	1,980				
Italy	2,241	1,498				
Morocco: Southern Zone			867	582		
Netherlands	1,048	878	1,099	918	411	(3)
Philippines	109					
Poland	25,082	26,124				
Portugal					220	(3)
Saar	89	123				
Sweden	50	88		633		
Switzerland	2,716	2,797	7,016	9,081	1,231	(3)
Union of South Africa					708	(3)
United Kingdom	563	634	5,718	6,449	9,802	10,107
United States			4,160	3,121	14,071	18,016
Yugoslavia	28	116				
Other countries	3	40	3,125	3,520	4,947	10,687
Total	56,391	56,864	32,540	35,616	44,707	49,615

[1] Computed from customs returns of exporting countries.
[2] This table incorporates a number of revisions of data published in the preceding Talc, Soapstone, and Pyrophyllite chapter.
[3] Data not separately recorded.

[7] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, The Talc and Soapstone Industry, 1957: Ind. Merchandising Div., Mineral Statistics Section, Ottawa, 1957, 5 pp.

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Japan.—Suspension of trade relations between Japan and Communist China eliminated the major source of talc used by Japanese manufacturers of toilet preparations and porcelain products.[8] Some talc for these uses was imported from the Republic of Korea. Local production of talc, suitable principally for use in insecticides, was enough to meet Japan's needs for lower grade material.

For manufacturing porcelain products, consumers required talc containing 60 to 63 percent SiO_2, 30 to 33 percent MgO, not more than 0.7 percent Al_2O_3, 0.5 percent Fe_2O_3, and 0.5 percent CaO. For toilet preparations, consumers required 59 to 63 percent SiO_2, 30 to 34 percent MgO, and not more than 0.9 percent Al_2O_3, 0.7 percent Fe_2O_3, and 0.7 percent CaO.

Principal producers of ground talc were Asada Seifun, K.K., 1 Honmachi-dori 2-chome, Nakano-ku, Tokyo; Kunimine Koka Kogyo, K.K., 7 Shinkawa 1-chome, Chuo-ku, Tokyo; Nihon Talc, K.K., 1 Okajima-cho, Taisho-ku, Osaka; and Shin Nihon Kasei Kogyo, K.K., 59 Shikanjima Motomiya-cho, Konohana-ku, Osaka.

Korea, Republic of.—Pyrophyllite production in 1957 was 5,159 short tons; talc production was 7,275 short tons.[9]

Principal pyrophyllite deposits are the Okmaison and Sungsan mines, Kasa Island, Cholla Namdo; and the Milyang mine, Kyongsang Namdo. A typical analysis of the pyrophyllite shows 38.7 percent Al_2O_3, 39.2 percent SiO_2, 1.1 percent Fe_2O_3, and 14.0 percent ignition loss. Principal talc deposits are the Tongyang Talc and Chosun Talc mines, Chungchong Pukdo; and the Sinbo Talc mine, Cholla Pukdo. The material ranges from 30 to 33 percent MgO, 61 to 62 percent SiO_2, and up to 0.42 percent Fe_2O_3.

Pyrophyllite resources exceed 1 million tons; talc resources exceed 600,000 tons.

Peru.—Pyrophyllite production in 1957 was 2,554 short tons; talc production was 134 short tons.[10]

TECHNOLOGY

Insulators made from phosphate-bonded steatite talc were determined to be equal to insulators made from natural block steatite talc in evaluation tests completed in 1958 by two power-tube manufacturers. Phosphate-bonded talc was somewhat more difficult to fabricate, and manufacturing losses were 2 or 3 percent greater, but its use required no changes in tube-manufacturing procedures. The tests were conducted under the sponsorship of the U.S. Army Signal Supply Agency. Successful conclusion of the tests eliminated strategic dependency of the United States on foreign sources of block steatite talc.

A survey was made of alunite, pyrophyllite, and clay deposits in the Cerro La Tiza area, Puerto Rico.[11] A resource-use study of North

[8] Bureau of Mines, Mineral Trade Notes: Vol. 49, No. 1, July 1959, pp. 53–55.
[9] U.S. Embassy, Seoul, Korea, State Department Dispatch 70: Aug. 9, 1958, p. 2.
[10] U.S. Embassy, Lima, Peru, State Department Dispatch 766: Apr. 15, 1958, p. 6.
[11] Hildebrand, F. A., and Smith, R. J., Occurrences of Alunite, Pyrophyllite, and Clays in the Cerro La Tiza area, Puerto Rico: Geol. Survey Open File Rept., Nov. 10, 1958, 82 pp.

Carolina pyrophyllite was reported,[12] and the characteristics of California and Montana talcs were compared.[13]

Substantial reduction in thermal expansion and increased thermal shock resistance in pyrophyllite refractories were obtained in laboratory tests by adding talc to the pyrophyllite-clay mixture.[14] Studies were made of talc used in steatite ceramics,[15] the effect of pyrophyllite on the quality of saggers,[16] and the properties of ceramic talc used in the U.S.S.R.[17]

A booklet on steatite manufacturing standards was compiled.[18]

Patents were issued during 1958 for a water-dispersible talc pigment[19] and a flameproof mastic, using talc as an ingredient.[20] New processes were patented for grinding[21] and pelletizing[22] talc and other materials with similar grinding and agglomerating characteristics.

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[12] Stuckey, J. L., Resources and Utilization of North Carolina Pyrophyllite: Min. Eng., vol. 10, No. 1, January 1958, pp. 97–99.

[13] Stafford, Ray, and Felton, Ernest, A Comparative Study of California and Montana Talcs: Bull. Am. Ceram. Soc., vol. 37, No. 6, June 1958, pp. 274–279.

[14] Kenan, W. M., Control of Reversible Thermal Expansion of Pyrophyllite Refractories by Talc Additions: North Carolina State Coll., Bull. 68, April 1958, 19 pp.

[15] Santos, Persio de Souza, and Santini, Pedro [Characteristics of Talc for the Manufacture of Steatite Ceramics of Low Dielectric Loss]: Cerâmica (São Paulo), vol. 4, No. 14, 1958, pp. 2–14.

[16] Romankevich, I. P., and Gerasimova, N. A. [The Influence of Additions of Pyrophyllite on the Quality of Saggers]: Steklo i Keramika (Moscow), vol. 15, No. 6, June 1958, p. 40.

[17] Ajetikov, V. G., Belinskaia, G. V., and Zin'ko, E. I. [Properties of Tales Used in Ceramic Industry of U.S.S.R.]: Trudy Gosudarstvennyi Issledovtel'skii Elektrokeramicheskii Institut (Moscow), No. 2, 1957, pp. 15–22; Monthly Index of Russian Accessions vol. 11, No. 7, October 1958, p. 2253, The Library of Congress, Washington, 1958.

[18] Steatite Manufacturing Association, Standards of the Steatite Manufacturing Association, 1958: Bull. Am. Ceram. Soc., vol. 37, No. 5, May 1958, p. 253.

[19] Lamar, R. S. (assigned to Sierra Talc and Clay Co.), Water Dispersible Talc Pigment Composition: U.S. Patent 2,844,486, July 22, 1958.

[20] Ellis, W. P., Smith, L. I., and Steltz, I. J. (assigned to Benjamin Foster Co.), Flameproof Mastic Composition Containing Isobutylene Polymer: U.S. Patent 2,861,967, Nov. 25, 1958.

[21] Work, L. T. (assigned to Texaco Development Corp.), Fluid Energy Grinding: U.S. Patent 2,846,150, Aug. 5, 1958.

[22] Jordan, M. E. (assigned to Godfrey L. Cabot, Inc.), Process of Pelletizing Metal Silicates: U.S. Patent 2,844,444, July 22, 1958.

Thorium

By James Paone[1]

MANUFACTURE of lightweight, heat-resistant magnesium-thorium alloys in supersonic aircraft and guided missiles was the major nonenergy use for thorium. Use as a refractory material grew, and increased consumption in chemical processing was significant. No outstanding developments were reported in the nuclear use of thorium.

Information on the geology, processing, refining, and use of thorium was presented at the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, at Geneva, Switzerland, in September.

LEGISLATION AND GOVERNMENT PROGRAMS

The Office of Minerals Exploration (OME), which succeeded the Defense Minerals Exploration Administration (DMEA) July 1, 1958, included thorium in the list of minerals eligible for financial assistance. Under the DMEA program, seven contracts were approved in 1958, involving a total of $145,327 in Government assistance. Loans for exploration for thorium under the OME program will be at a rate of 50 percent of the total allowable cost of the exploration work specified by the terms of the contract. The Atomic Energy Commission (AEC) procurement program for thorium was being met through contracts negotiated in previous years.

DOMESTIC PRODUCTION

Mine Production.—Domestic shipments totaled 2,021 tons valued at $286,000 and included monazite, bastnaesite, and thorite. About 650 tons of thorite valued at $35,000 was produced in Colorado. Domestic bastnaesite does not contain commercial quantities of thoria. Firms producing monazite on a greatly reduced scale during the year included Rutile Mining Company of Florida, in Duval County, Fla.; and Marine Minerals Inc., in Aiken County, S.C. Porter Brothers Corp. continued dredging operations near Bear Valley, Idaho, for euxenite from which Mallinckrodt Chemical Works, St. Louis, Mo., recovered a thorium residue, which was shipped to the General Services Adminis-

[1] Commodity specialist.

tration stockpile. Idaho-Canadian Dredging Co., Boise, Idaho, shipped some monazite during the year, and small quantities of thorium concentrate were produced by Northwest Prospecting and Development Co., Spokane, Wash., from thorite mined on Hall Mountain, north of Bonners Ferry, Idaho; by Calico Mining Co., in the Wet Mountain (Colo.) area; and by Cotter Corp. at Canon City, Colo. Trail Mines, Inc., Colorado Springs, Colo., curtailed operations. Salmon River Uranium Development, Inc., near Salmon, Idaho, was constructing a 100-ton-per-day mill for concentrating thorium ore in the area. Exploration and development activities for thorium deposits in the Lemhi Pass area of Lemhi County, Idaho, were noted.

Refinery Production.—Principal commercial processors of thorium-bearing ores included Lindsay Chemical Div. of American Potash & Chemical Corp., West Chicago, Ill.; Davison Chemical Div. of W. R. Grace & Co., Pompton Plains, N.J., and Curtis Bay, Md.; and Heavy Minerals Co., Chattanooga, Tenn. Mallinckrodt Chemical Works, St. Louis, Mo., continued to recover thorium residues from Idaho euxenite concentrate. Wah Chang Corp., New York, N.Y., concentrated thorite ores at its Boulder (Colo.) mill for shipment to the Davison Chemical Division, Curtis Bay (Md.) plant for further refining.

The principal producer of refined thorium compounds, formerly Lindsay Chemical Co., merged with American Potash & Chemical Corp. during the year. Under the new organizational setup Lindsay is known as the Lindsay Chemical Division of American Potash & Chemical Corp.

Westinghouse Electric Corp., Lamp Division, Bloomfield, N.J., fabricated thorium products and thorium sheet for use in electrical and electronic equipment. M&C Nuclear, Inc., Attleboro, Mass., fabricated thorium products, and Nuclear Materials & Equipment Corp., Apollo, Pa., produced thorium alloys for nuclear experiments. Dow Chemical Co. continued to make magnesium-thorium alloys at the Madison and the Midland and Bay City Divisions. Davison Chemical Division, Erwin, Tenn., offered, on a commercial basis, thorium hardener, an agent for introducing thorium into magnesium alloys.

Reactor-grade (high-purity) thorium oxide was produced by Davison Chemical Division and by Lindsay.

CONSUMPTION AND USES

Nonenergy Uses.—Domestic consumption of thorium increased nearly 20 percent over that in 1957. Significant increases were noted in the use of thorium in refractories and in chemical processing. Magnesium-thorium alloys and the production of gas mantles continued to be the significant outlets for thorium. Thorium was also used in chemical reagents, refractories, electrical equipment, sand castings, and research.

Dow Chemical Co., Midland, Mich., principal producer of magnesium-thorium alloys, indicated a major breakthrough for the lightweight alloys with the successful firings of the U.S. Air Force Bomarc Interceptor missile, the first large-scale use of the alloy HK31. Magnesium-thorium alloys also were used in the Navy Vanguard rocket, forming the section of the missile from the base of the nose cone to

TABLE 1.—Thorium consumption for nonenergy purposes, in pounds of contained ThO_2

Use	1953	1954	1955	1956 [1]	1957 [1]	1958 [1]
Magnesium alloys	3,600	4,647	23,944	50,000	100,000	120,000
Gas-mantle manufacture	8,707	9,765	44,566	40,000	40,000	40,000
Refractories and polishing compounds	236	24	105	200		5,000
Chemical and medical products	5,179	3,738	3,898	4,000	4,000	6,000
Electronic products	1,222	2,016	926	1,000	1,000	1,000
Total	18,944	20,190	73,439	95,200	145,000	172,000

[1] Estimate.

the top of the second stage tankage; this section encountered temperatures of about 600° F.

Consumption of thorium in producing of incandescent gas mantles, particularly abroad, remained about the same as in 1957. Thorium applications in refractories reached an alltime high.

Energy Uses.—Thorium retained its long-term importance as a potential source of fissionable material. Its nuclear uses in 1958 were limited to breeder reactors, either as a fuel constituent or as a blanket so that the thorium would be transmuted into fissionable uranium 233 by neutron capture.[2] The quantity of thorium used for nuclear energy was estimated to approximate 10 tons in 1958, chiefly in oxide form.

The AEC indicated that it required 30 kilograms of uranium 233 in 1958 and that 80 kilograms would be needed in 1960 to fulfill the thorium-reactor development plan.[3]

It was disclosed that thorium was one of the materials that held promise as a propellant for an ion-stream rocket.[4]

PRICES

Price quotations for monazite listed in E&MJ Metal and Mineral Markets were unchanged from 1957 as follows:

Type and grade, rare-earth oxide including thoria, percent:	*Price per pound, c.i.f. U.S. ports*
Massive; 55	$0.13
Sand; 55	.15
Sand; 66	.18
Sand; 68	.20

Payments for thorite-type ores were negotiated between buyer and seller; however, some producers quoted prices ranging from 70 cents a pound of contained ThO_2 for ore averaging 2 percent ThO_2 up to about $1.25 for 10-percent ore. The price for 10-percent thorium concentrate from thorite ores remained about $1.75 per pound of ThO_2 content.

Principal thorium compounds were quoted by a leading producer in 1958 for 100-pound lots or more as follows:

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[2] Atomic Energy Commission, Atomic Industrial Progress and Second World Conferences: July–December 1958, p. 11.
[3] Nucleonics, vol. 16, No. 8, August 1958, p. 92.
[4] American Metal Market, vol. 65, No. 234, Dec. 6, 1958, p. 8.

	ThO_2, percent	Price per pound
Thorium compound:		
Carbonate	80–85	[1] $6.25–8.00
Chloride	50	7.00
Fluoride	80	5.50
Nitrate (mantle grade)	46	3.00
Oxide	97–99	5.75–9.25
Other forms:		
Metal (nuclear grade) [2]	-------	19.55
Thorium hardner (for alloying)	20–40	12.50–15.00

[1] Variable, depending on rare-earth content.
[2] F.o.b. AEC, Feed Materials Production Center, Fernald, Ohio.

The following prices per pound for Nuclear-grade thorium metal remained in effect in 1958:

	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

In December the AEC announced that uranium 233 (thorium) would be leased at $15 per gram.

FOREIGN TRADE

Import-export data for thorium ore and concentrate, thorium compounds, and thorium metal were not available for publication. The Union of South Africa and Australia provided monazite, and India and Brazil retained their embargo on the export of source materials.

WORLD REVIEW

Free world production of monazite containing 5 to 6 percent thoria was about 14,000 tons in 1958, principally from the massive monazite deposit in South Africa. Canada's large potential source of thorium as a byproduct of Blind River-area uranium approached realization.

NORTH AMERICA

Canada.—Dow Chemical Co. of Canada, Ltd., and the Rio Tinto Mining Co. of Canada, Ltd., formed a new company, Rio Tinto-Dow, Ltd., to produce thorium as a byproduct of uranium in the Blind River area of Ontario. The new firm began constructing a $1 million plant adjacent to the Quirke Lake uranium-concentrating plant of Algom Uranium Mines near Elliot Lake. The plant was designed to produce crude thorium concentrate and refined Metallurgical-grade thorium sulfate and oxide from solutions that were being discarded from the uranium-recovery process. The projected annual output rate of 100–200 tons was expected to be reached by mid-1959.[5]

Dominion Magnesium, Ltd., produced about 10,000 pounds of thorium metal monthly. The product, as sintered pellets, as powder, or as a master alloy was alloyed with magnesium by the company or sold for alloying purposes.[6]

[5] Northern Miner (Toronto), vol. 44, No. 14, June 26, 1958, p. 17.
[6] Northern Miner (Toronto), vol. 43, No. 43, Jan. 16, 1958, pp. 1, 5.

SOUTH AMERICA

Brazil.—Exports of thorium continued to be restricted. The Brazilian National Commission for Nuclear Energy embarked on a program to stimulate production of fissile and fertile nuclear material in Brazil. Under the program the Government would purchase thorium and uranium oxides produced by private industry and would provide financial assistance for the production of pure metal from the oxides.[7]

EUROPE

France.—Pure thorium salts were processed at Le Bouchet plant from uranothorianite ore mined in Madagascar; the plant had a capacity of 330 tons a year of thorium in the form of nitrate. The processing and manufacture of thorium nitrate in France were described at the Geneva Conference.[8]

Spain.—Determination of thorium in low-grade ores found in Spain was described at the Geneva Conference.[9]

United Kingdom.—Research on production of high-purity thorium suitable for nuclear use was continued by the Atomic Energy Authority (AEA). The AEA plant at Sheffield for production of thorium metal closed.[10]

ASIA

India.—Thorium nitrate was produced at the Government-owned thorium-uranium processing plant at Trombay, near Bombay, at a rate of about 15 to 17 tons of thoria annually. Production from the Trombay plant, one of the largest in the world, supplied the requirements of the gas-mantle industry in Asia. Part of the thorium was stockpiled for use in the atomic energy program. Results of systematic and detailed surveys for atomic minerals indicated that the placer deposits of monazite contained about half a million tons of thorium. Detailed evaluation of beach placers, particularly those of the southwestern coast of India, was presented at the Geneva Conference.[11]

Korea, Republic of.—Thorium production from monazite deposits mined during the year was unknown. Residual black-sand deposits in Korea have been a minor source of thorium.

Thailand.—Exploration for thorium deposits continued. A Japanese company was reported to have made preparations to begin mining a monazite deposit with a significant thorium content.[12]

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[7] Chemical Trade Journal and Chemical Engineer (London), vol. 143, No. 3721, Sept. 26, 1958, p. 722.

[8] Braun, C., and others, Manufacture of Thorium Nitrate at Le Bouchet Plant: Proc. 2d United Nations International Conf. on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1–13, 1958, United Nations, Geneva, Switzerland, vol. 4, 1958, pp. 202–207.

[9] Suner, Antonio A., Determination of Thorium in Low-Grade Ores: Proc. 2d United Nations International Conf. on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1–13, 1958, United Nations, Geneva, Switzerland, vol. 3, 1958, pp. 580–588.

[10] Metal Bulletin (London), No. 4310, July 11, 1958, p. 26.

[11] The following references are from Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1–13, 1958, vol. 2, 1958:

Mahadevan, V., and others, Prospecting and Evaluation of Beach Placers Along the Coastal Belt of India: Pp. 103–106.

Bhola, K. L., and others, A Survey of Uranium and Thorium Occurrences in India: Pp. 100–102.

Shirke, V. G., and Chatterji, B. D., Monazite Sands of Bihar and West Bengal: Pp. 713–715.

[12] E&MJ Metal and Mineral Markets, vol. 29, No. 15, Apr. 10, 1958.

AFRICA

Egypt.—Processing of Egyptian monazite sands for the recovery of thorium and rare earths was described at the Geneva Conference.[13] The process, suitable for large-scale separations, is described in the Technology section. Black-sand deposits along the northern beaches of the Nile Delta were described in detail at the Geneva Conference. The monazite, comprising ½ to 1 percent of the black sands, contains about 5 percent thoria.

Madagascar.—Thorium-uranium ores mined in the southern part of Madagascar were concentrated locally by gravity methods. The resultant thorium concentrate, containing about 60 percent thorium and 12 percent uranium, was shipped to the Bouchet plant in France for processing.

Union of South Africa.—Thorium-bearing minerals in the Union of South Africa were described in detail at the Geneva Conference.[14]

The monazite-lode deposit on Steenkampskraal, Van Rhynsdorp, met the major requirements of the free world for thorium; however, the mine was expected to shut down early in 1959 because the market in the United States had been curtailed.

OCEANIA

Australia.—Shipments were made of monazite from the beach-sand deposits of heavy minerals. The Commonwealth Scientific and Industrial Research Organization described a process for high-purity thorium production at the Geneva Conference.[15]

WORLD RESERVES

Information revealed at the Geneva Conference indicated a significant increase in the world reserve of thorium. Largest gains were noted in India, Canada, and Brazil.

TABLE 2.—World reserves of thorium

Country	ThO_2, short tons	Average grade (percent ThO_2)	Country	ThO_2, short tons	Average grade (percent ThO_2)
India	500,000	8.5	Union of South Africa	15,000	6.0
Canada	210,000	.05	Egypt	10,000	----------
Brazil	200,000	6.0	Rhodesia and Nyasaland, Federation of	10,000	----------
United States	50,000	4.5–6.0			
Australia	50,000	----------			

[13] Higazy, R. A., and Naguib, A. G., A Study of the Egyptian Monazite-Bearing Black Sands: Proc. 2d United Nations International Conf. on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1–13, 1958, United Nations, Geneva, Switzerland, vol. 2, 1958, pp. 658–662.

[14] Cannon, R. S., and others, Radiogenic Lead in Nonradioactive Minerals: A Clue in the Search for Uranium and Thorium: Proc. 2d United Nations International Conf. on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1–13, 1958, United Nations, Geneva, Switzerland, vol. 2, 1958, pp. 91–96.

[15] Scaife, D. E., and Wylie, A. W., A Carbide-Iiodide Process for High-purity Thorium: Proc. 2d United Nations International Conf. on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1–13, 1958, United Nations, Geneva, Switzerland, vol. 4, 1958, pp. 215, 236.

TECHNOLOGY

Research on the recovery of thorium from monazite, by the Institute for Atomic Research and Department of Chemical Engineering, Iowa State College, Ames, Iowa, indicated that very pure thorium, uranium, cerium, and rare-earth products could be obtained in high yield. The process consisted of digesting 65-mesh monazite concentrate in 93-percent sulfuric acid at 210° C. for 4 hours, diluting with water, and removing the sludge and undigested sand. After adjusting the solution to pH 1.5, thorium and rare-earth elements were precipitated as oxalates, and the uranium was recovered from the filtrate on a strongly basic anion-exchange resin. The oxalate cake was digested in hot caustic to free the oxalate for recycle and convert the rare-earth metals and thorium to hydroxides. The hydroxides were calcined to eliminate residual oxalate ions and oxidize the cerium to the tetravalent state. The residue was dissolved in nitrate acid, and the cerium and thorium were separated from the other rare-earth elements by extraction with tributyl phosphate (TBP). Thorium was removed from the TBP by a separate water strip and then precipitated with oxalic acid.[16] The Ames process permitted recovery of almost all the thorium, about 98 percent of the cerium, and about 90 percent of the uranium in monazite.

Federal Bureau of Mines investigations on refining methods indicated that arc-melting thorium into a water-cooled cup would not affect its purity. Research in the U.S.S.R. on electrolytic and calcium-thermic methods of refining thorium, powder metallurgy of thorium, and uses and applications of the element were described.[17]

Methods of producing nuclear-grade thorium nitrate and metal were presented at the Geneva Conference.[18]

The AEC made tests to determine the feasibility of using uranium 233 produced in a reactor by neutron bombardment of thorium 232 as a fuel by operating the Materials Testing Reactor with a full set of U^{233} fuel elements. The U.S.S.R. also did research on the thorium cycle.

The aqueous homogeneous reactor concept, using a dispersion of slurry of UO_2 and ThO_2, under study by Pennsylvania Power & Light Co. and Westinghouse Electric Corp. at Philadelphia, was terminated because it did not appear feasible under current technology. Large-scale power-reactor projects under development by Consolidated Edison Co. at Indian Point, N.Y., and by Power Reactor Development Co. near Detroit, Mich., would utilize thorium.

Advantages of the thorium-uranium 233 fuel cycle in nuclear reactors included a high neutron yield, good radiation stability, and good

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[16] Barghusen, John, Jr., and Smutz, Morton, Processing Monazite Sands: Ind. and Eng. Chem., vol. 50, No. 12, December 1958, pp. 1754–1755.

[17] Meyerson, G. A., and Islankina, A. F. (Metallic Thorium): Atomnaya Energiya (Moscow), vol. 5, No. 2, August 1958, pp. 155–165.

Kaplan, G. Ye., Zarembo, Yu. I., and Uspenskaya, T. A., (Thorium): Atomnaya Energiya (Moscow), vol. 5, No. 2, August 1958, pp. 147–154.

[18] The following references are from Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, Sept. 1–13, 1958, vol. 4, 1958:

Fareeduddin, S., and others, Production of Nuclear-grade Thorium Nitrate: Pp. 208–214.

Gibson, A. R., and others, Thorium Metal Production by a Chlorination Process: Pp. 237–242.

adaptability to power systems with large conversion ratios. Disadvantages were a small fast-fission factor, a small delayed-neutron yield, the long half-life of the intermediate nuclide protactinium 233 (27.4 days), and the radiation problems in recycling the fuel.[19]

At the Seventh International Cancer Congress in London in July, it was reported that some cancers had resulted from radioactive medication containing thorium given to some persons in the late 1920's. The medicine, Thorotrast, was given by injection to help in taking diagnostic X-rays of the liver and spleen.

[19] Manowitz, Bernard, Thorium: Nucleonics, vol. 16, No. 8, August 1958, pp. 91–95.

Tin

By J. W. Pennington [1] and John B. Umhau [2]

THE INTERNATIONAL Tin Agreement continued as the predominant factor in the tin industry during 1958. Export restrictions imposed on participating tin-producing countries under the agreement were chiefly responsible for a 24-percent drop in world mine production of tin. World consumption of tin also decreased, but it still exceeded production.

In the United States total tin consumption dropped 12 percent to 72,600 long tons; imports of tin declined for the sixth consecutive year; the Texas City tin smelter began small-scale operations; and plans were announced for Government acquisition of 10,000 tons of tin by agricultural surplus barter transactions.

TABLE 1.—Salient tin statistics

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Production:						
From domestic mines [1] long tons	81.04	204.68	99.24	----------	----------	----------
From domestic smelters [1] do	32,234	27,407	22,329	17,631	1,564	(2)
From secondary sources do	28,211	26,190	28,340	29,440	24,260	22,810
Imports for consumption:						
Metal do	65,286	65,599	64,815	62,590	[3] 56,158	41,149
Ore (tin content) do	31,271	22,140	20,112	16,688	94	5,440
Exports (domestic and foreign) do	610	822	1,107	890	1,531	1,341
Consumption:						
Primary do	54,904	54,427	59,828	60,470	54,429	47,998
Secondary do	30,916	28,464	30,655	29,854	28,078	24,587
Monthly price of Straits tin at New York:						
Highest cents per pound	138.70	101.00	110.00	113.75	103.00	99.625
Lowest do	87.18	84.25	85.75	92.88	87.13	85.50
Average do	107.88	91.81	94.73	101.26	96.17	95.09
World:						
Mine production long tons	179,200	188,800	197,200	199,300	200,100	152,400
Smelter production do	182,600	196,700	198,200	200,300	194,900	159,700

[1] Includes tin content of alloys made directly from ores.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Revised figure.

LEGISLATION AND GOVERNMENT PROGRAMS

The Export Control Act of 1949, extended to June 30, 1960, governed shipments of tin by destinations. Exports were under general license to the free world.

[1] Assistant chief, Branch of Base Metals.
[2] Commodity-industry analyst.

Regulations administered by the Office of Export Supply, U.S. Department of Commerce, required a license for exports of tinplate and terneplate scrap and old tin cans.

The foreign assets control regulations of the U.S. 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 that it might be of Chinese origin. Entrance of alloys that might include Chinese and/or Soviet tin also was prohibited.

Under new regulations of the U.S. Department of the Interior, effective December 17, 1958, the Office of Minerals Exploration, successor to Defense Minerals Exploration Administration, may grant loans up to 50 percent of total allowable costs for exploration of eligible domestic tin deposits.

A November 14 announcement of the U.S. Department of Agriculture returned tin (dropped in 1955) to the list of materials eligible for acquisition for the supplemental stockpile through barter or exchange transactions.

DOMESTIC PRODUCTION

MINE OUTPUT

No tin ore or concentrate of marketable grade was produced in the United States in 1958. A small quantity of tin concentrate recovered from molybdenum ore during 1956, 1957, and 1958 was unsold.

Operation of the Lost River tin mine and mill on Seward Peninsula, Alaska, was described in a report.[3] A bulletin was published[4] on the geology of the Majuba Hill copper-tin deposits, Pershing County, Nev.

SMELTER OUTPUT

The Wah Chang Corp. began tin smelting on a small scale at Texas City, Tex., in 1958. During 1958 the production-payment provision of the contract of sale was administered by the Federal Facilities Corp., General Services Administration. According to the General Accounting Office:[5]

> The sales price under the contract of sale was $1,350.000. In addition, the contract required the purchaser to make additional payments not to exceed a total of $2,000,000 under a formula geared to anuual production of tin metal, tin alloys, and tungsten over certain minimum amounts, but the purchaser was not required to produce any particular quantities of such materials.
>
> In January 1958, the purchaser requested that the production payment provision of the contract relating to tin metal be modified to enable a successful negotiation for the smelting, on a toll basis of a large quantity of tin concentrates. This would permit operations to commence at the tin smelter which had been shut down since February 1957. Accordingly, the Corporation in February 1958 modified the sales contract to provide for lower production payments on tin metal for a period of 1 year from the date of the purchaser's

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[3] Lorain, S. H., Wells, R. R., Mihelich, Miro, Mulligan, J. J., Thorne, R. L., and Herdlick, J. A., Lode-Tin Mining at Lost River, Seward Peninsula, Alaska: Bureau of Mines Inf. Circ. 7871, 1958, 76 pp.

[4] Trites, Albert F., Jr., and Thurston, Ralph H., Geology of Majuba Hill, Pershing County, Nevada: Geol. Survey Bull. 1046–I, 1958, pp. 183–203.

[5] U.S. General Accounting Office, Report on Audit of Federal Facilities Corp., General Services Administration, Fiscal Year 1958: 85th Cong., 2d sess., p. 5.

first production of tin metal, but the total contingent payment of $2,000,000 was not reduced. Tin smelting began during April 1958. Based upon the purchaser's estimated production, the Corporation expects to receive production payment of $5 a ton on approximately 3,000 tons of tin metal in fiscal year 1959. There were no production payments due the Corporation in fiscal year 1958.

SECONDARY TIN [6]

Secondary tin production was 22,800 long tons in 1958, compared with 24,300 tons in 1957. In 1958 nearly half returned in the form of bronze and brass, which dropped 830 tons compared with 1957. Tin reclaimed in solder, second in rank, decreased 13 percent. Tin in old scrap and from scrap in babbitt was the smallest recorded.

The tonnage of tinplate clippings treated at detinning plants increased for the sixth successive year to a new high. Material treated totaled 659,920 long tons, compared with the previous peak of 648,340 tons in 1957. The average quantity of tin recovered per long ton of tinplate scrap treated was 11.15 pounds in 1958, against 11.45 pounds in 1957. The lower recovery (for the 12th consecutive year) continued to reflect treatment of a larger proportion of electrolytic tinplate carrying a thinner coating of tin.

TABLE 2.—Secondary tin recovered in the United States, in long tons

Year	Tin recovered at detinning plants			Tin recovered from all sources			
	As metal	In chemicals	Total	As metal	In alloys and chemicals	Total: Long tons	Total: Value
1949–53 (average)	2,918	432	3,350	3,159	25,052	28,211	$68,511,328
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
1958	2,820	490	3,310	3,470	19,340	22,810	48,571,100

TABLE 3.—Tin recovered from scrap processed in the United States, by kind of scrap and form of recovery, in long tons

Kind of scrap	1957	1958	Form of recovery	1957	1958
New scrap:			As metal:		
Tinplate	3,310	3,290	At detinning plants	3,100	3,010
Tin-base	1,260	1,105	At other plants	440	460
Lead-base	2,800	2,805			
Copper-base	2,150	2,030			
Total	9,520	9,230	Total	3,540	3,470
Old scrap:					
Tin cans	30	20	In solder	5,170	4,520
Tin-base	1,110	970	In tin babbitt	280	230
Lead-base	5,200	5,200	In chemical compounds	560	590
Copper-base	8,400	7,390	In lead-base alloys	3,480	3,600
			In brass and bronze	11,230	10,400
Total	14,740	13,580	Total	20,720	19,340
Grand total	24,260	22,810	Grand total	24,260	22,810

[6] The assistance of Archie J. McDermid and Edith E. den Hartog is acknowledged.

TABLE 4.—Secondary tin recovered from scrap processed at detinning plants in the United States

	1957	1958
Scrap treated:		
Clean tinplate clippings.....long tons..	648,343	659,924
Old tin-coated containers.....do....	4,056	2,997
Total.....do....	652,399	662,921
Tin recovered:		
From new tinplate clippings.....do....	3,310	3,290
From old tin-coated containers.....do....	30	20
Total.....do....	3,340	3,310
Form of recovery:		
As metal.....do....	2,840	2,820
In compounds.....do....	500	490
Total [1].....do....	3,340	3,310
Weight of tin compounds produced.....do....	1,020	945
Average quantity of tin recovered per long ton of clean tinplate scrap used pounds..	11.45	11.15
Average quantity of tin recovered per long ton of old tin-coated containers used pounds..	15.58	16.25
Average delivered cost of clean tinplate scrap.....per long ton..	$39.20	$29.56
Average delivered cost of old tin-coated containers.....do....	$42.41	$28.25

[1] Recovery from tinplate clippings and old containers only. In addition, detinners recovered 315 tons of tin as metal and in compounds from tin-base scrap and residues in 1957, and 290 from these sources in 1958.

TABLE 5.—Stocks and consumption of new and old tin scrap in the United States, in 1958, gross weight in long tons

Class of consumer and type of scrap	Stocks, beginning of year [1]	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks, end of year
Smelters and refiners:						
Block-tin pipe, scrap, and foil	21	414	------	418	418	17
No. 1 pewter	21	50	------	50	50	21
High-tin babbitt	127	485	------	569	569	43
Drosses and residues	406	1,932	1,758	------	1,758	580
Total	575	2,881	1,758	1,037	2,795	661
Foundries and other manufacturers:						
Block-tin pipe, scrap, and foil	10	28	------	36	36	2
High-tin babbitt	1	3	------	1	1	3
No. 1 pewter	1	------	------	1	1	------
Total	12	31	------	38	38	5
Grand total:						
Block-tin pipe, scrap, and foil	31	442	------	454	454	19
No. 1 pewter	22	50	------	51	51	21
High-tin babbitt	128	488	------	570	570	46
Drosses and residues	406	1,932	1,758	------	1,758	580
Total	587	2,912	1,758	1,075	2,833	666

[1] Revised figures.

CONSUMPTION

Total tin consumption in the United States declined 12 percent in 1958. Three items—tinplate, solder, and bronze and brass—consumed more than 80 percent of the tin in 1958. Consumption of tin in tinplate (the leading use of primary, which took about 60 percent of the annual totals for 1952–58) dropped slightly from 1957. Almost 90 percent of the reduction was due to decreased output of hot-dipped tinplate.

Electrolytic tinplate production in 1958 was the second largest on record, being exceeded only by 1957. Of the total output of tinplate in 1958, electrolytic accounted for 90 percent, compared with 87 percent in 1957, and the hot-dipped type for only 10 percent, compared with 13 percent in 1957. Hot-dipped-tinplate production was the smallest since 1902.

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 for making cans, about 60 percent was used for food packing and 40 percent for nonfood products.

The first aluminum cans to be produced in commercial quantities in the United States for packing processed food were for sardines in 1958.

According to the 1958 annual report of the American Can Company, tinplate makes up 60 to 65 percent of the cost of a can.

A significant quantity of tin is used in the form of platings, solders, alloys, and chemical compounds in the automotive and aircraft industries.[7] On the average from 1 to 3 pounds of tin is used in each passenger car, truck, or bus, distributed as follows: Body solder, 0.120 pound; tin plate, 0.030 pound; bearing alloys, 0.100 pound; radiator solders, 0.700 pound; fuel tank coating, 0.002 pound; and heater solder, 0.300 pound. Many uses of tin for automobile manufacture also apply to aircraft manufacture. In addition, other important aircraft applications include tin-coated wire, phosphor-bronze alloys, zinc-tin coatings for hydraulic brake parts and landing gear equipment, cadmium-tin alloy for plating reciprocating engine parts; and a thin tin oxide transparent film on glass which, upon passage of a low electrical current, generates heat to cause deicing of the windshield.

Receipts of tin for industrial consumption totaled 72,800 long tons (18 percent less than 1957), of which 64 percent was primary tin. "Straits" brand comprised 56 percent of the primary receipts in 1958.

[7] Shearer, Andrew W., Automotive and Aircraft Uses of Tin: Automotive Industries: vol. 119, No. 2, July 15, 1958, pp. 54–58.

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TABLE 6.—Consumption of primary and secondary tin in the United States, in long tons

	1949–53 (average)	1954	1955	1956	1957	1958
Stocks on hand Jan. 1 [1]	25,483	24,525	23,326	27,757	28,446	32,030
Net receipts during year:						
Primary	56,540	52,673	64,544	62,099	59,215	46,553
Secondary	2,834	2,351	2,191	2,185	2,868	2,524
Terne	657	[2] 226	------	------	------	------
Scrap	28,936	28,601	30,262	28,999	26,758	23,680
Total receipts	88,967	83,851	96,997	93,283	88,841	72,757
Available	114,450	108,376	120,323	121,040	117,287	104,787
Stocks on hand Dec. 31 [1]	24,974	23,326	27,757	28,446	32,030	30,003
Total processed during year	89,476	85,050	92,566	92,594	85,257	74,784
Intercompany transactions in scrap	2,405	2,159	2,083	2,270	2,750	2,199
Tin consumed in manufactured products	[3] 87,071	82,891	90,483	90,324	82,507	72,585
Primary	54,904	54,427	59,828	60,470	54,429	47,998
Secondary	30,916	28,464	30,655	29,854	28,078	24,587

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1954, 240 tons; 1955, 1,340 tons; 1956, 2,005 tons; 1957, 1,815 tons; 1958, 1,310 tons; and 1959, 1,940 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.

TABLE 7.—Tin content of tinplate produced in the United States

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)
1949–53 (average)	4,507,782	30,832	15.4	1,546,759	17,819	25.7	2,720,086	11,629	9.6	240,937	1,384	13.0
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	------	------
1958	5,367,098	29,136	12.2	476,697	5,793	27.2	4,489,275	23,343	11.7	401,126	------	------

[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

TABLE 8.—Consumption of tin in the United States, by finished products, in long tons of contained tin

Product	1957 Primary	1957 Secondary[1]	1957 Total	1958 Primary	1958 Secondary[1]	1958 Total
Tinplate[2]	32,046		32,046	29,136		29,136
Terne metal	181	181	362	138	281	419
Solder	8,987	9,917	18,904	7,412	8,912	16,324
Babbitt	2,440	2,031	4,471	1,993	1,519	3,512
Bronze and brass	4,274	12,883	17,157	3,135	11,104	14,239
Collapsible tubes and foil	765	53	818	751	84	835
Tinning	2,091	53	2,144	1,890	36	1,926
Pipe and tubing	100	24	124	108	20	128
Type metal	85	1,464	1,549	91	1,252	1,343
Bar tin	1,070	162	1,232	855	226	1,081
Miscellaneous alloys	271	145	416	263	99	362
White metal	1,400	140	1,540	1,552	139	1,691
Chemicals including tin oxide	594	966	1,560	546	816	1,362
Miscellaneous	125	59	184	128	99	227
Total	54,429	28,078	82,507	47,998	24,587	72,585

[1] Includes 3,100 long tons of tin contained in imported tin-base alloys in 1957; and 2,300 in 1958.
[2] Includes small tonnage of secondary pig tin and tin acquired in chemicals.

TABLE 9.—Consumer receipts of primary tin, by brands, in long tons

Year	Banka	English	Katanga	Longhorn	Straits	Others	Total
1949–53 (average)	3,373	(1)	4,619	10,833	29,457	8,258	56,540
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
1958	8,785	4,779	2,143		25,999	4,847	46,553

[1] Included with "Others," not separately reported.

STOCKS

Tinplate mills, holding nearly 80 percent of plant stocks of pig tin in the United States, decreased inventories 2,860 long tons. At the end of the year, however, pig-tin stocks at other industrial plants increased 860 tons.

TABLE 10.—Industry tin stocks in the United States, in long tons

	1949–53 (average)	1954	1955	1956	1957	1958
At plants:						
Pig tin—virgin	13,978	12,162	16,205	16,290	20,126	18,173
In process[1]	10,996	11,164	11,552	12,156	11,904	11,830
Total	24,974	23,326	27,757	28,446	32,030	30,003
Other pig tin:						
In transit in United States	630	1,340	2,005	1,815	1,310	1,940
Jobbers-Importers	310	1,200	260	620	660	1,050
Afloat to United States	4,179	5,200	5,340	5,500	1,735	1,660
Total	5,119	7,740	7,605	7,935	3,705	4,650
Grand total industry	30,093	31,066	35,362	36,381	35,735	34,653

[1] Includes secondary pig tin (long tons) as follows: 1949–53 (average), 287; 1954, 277; 1955, 246; 1956, 304; 1957, 327; and 1958, 281 tons.

PRICES

The tin market was influenced mainly by U.S.S.R. tin exports and international buffer-stock activity in 1958. The average price of Straits tin for prompt delivery in New York was 95.09 cents a pound in 1958—about 1 cent below 1957. A gradual upward trend was abruptly interrupted on September 18 by a sharp drop to 86.5 cents, the low for the year. The market rebounded and reached 99.625 cents on November 10, the high for the year.

On the London market the cash price averaged £734.9 per long ton in 1958 against £754.8 in 1957. The quotation fluctuated around the floor of £730 until it slumped to the low of £640 on September 18, when buffer-stock buying suddenly ceased and the London Metal Exchange temporarily suspended tin trading. Upon resumption of trading, the market quickly recovered. On October 3 the unsustained price rose above £730 on a steadily climbing market. The high for the year was £765 on November 10. Prices of 3 months and of cash tin averaged virtually the same in 1958. However, after November 11 a premium on forward tin prevailed, indicating restoration of firmer confidence in the market outlook.

On the Singapore market the price of Straits tin ex-works was £724.7 for 1958 (£731.5 for 1957). The lowest quotation for 1958 was £676 on September 19 and the highest, £761, on December 27.

TABLE 11.—Monthly prices of Straits tin for prompt delivery in New York, in cents per pound [1]

Month	1957			1958		
	High	Low	Average	High	Low	Average
January	103.000	99.250	101.35	93.750	90.625	92.68
February	102.500	97.875	100.22	95.250	92.750	93.75
March	101.875	98.250	99.48	95.875	93.000	94.33
April	100.250	98.375	99.30	94.250	92.500	92.98
May	99.125	97.750	98.32	95.250	94.000	94.49
June	98.500	97.125	98.02	95.000	94.250	94.62
July	97.875	95.625	96.46	96.500	93.875	94.89
August	95.375	92.875	94.15	95.750	94.000	94.94
September	93.875	92.750	93.31	95.625	86.500	94.01
October	93.125	90.625	91.84	97.750	95.000	96.47
November	91.000	87.125	89.23	99.625	97.625	98.96
December	93.375	90.375	92.32	99.125	98.250	98.97
Total	103.000	87.125	96.17	99.625	86.500	95.09

[1] Compiled from quotations published in the American Metal Market.

FOREIGN TRADE [8]

The principal tin items in the foreign trade of the United States in 1958 were imports of metallic tin, 94-percent tin alloys, and tin concentrate 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

[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.

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 1958 for the sixth successive year and fell 27 percent below 1957. This was the longest period recorded of continuous downtrend in metallic tin imports. Of the total imports, about 57 percent came from Malaya, the principal source; however, the quantity of tin received from Malaya was the smallest since 1951.

Receipts of tin concentrates for smelting, chiefly from Indonesia, were consigned to the tin smelter at Texas City, Tex.

In addition, 3,200 long tons of alloys, with the chief value in tin, was imported, mainly from Denmark in 94-percent tin alloys.

Exports of metallic tin in 1958 were 1,340 long tons (1,530 in 1957); the United Kingdom, Mexico and Canada were the principal destinations. The gross weight of tin-alloy scrap exported (mostly to the United Kingdom) was 2,120 long tons in 1958 compared with 9,400 tons in 1957.

The principal tin export item of the United States, as usual, was tinplate. Tinplate exports declined 47 percent compared with 1957 and were the smallest since 1939. Of the total tonnage exported in 1958, 69 percent was electrolytic tinplate, 28 percent hot-dipped, and 3 percent embossed or lacquered tinplate and terneplate.

Tinplate scrap imports, mainly from Canada, were 32,820 long tons in 1958, compared with 31,400 in 1957. Beginning January 1, 1958, the Bureau of the Census discontinued tabulating separate figures on exports of tinplate scrap and included it among other steel scrap. Tinplate scrap exported was 3,630 long tons in 1957.

TABLE 12.—Foreign trade of the United States in tin concentrate and tin

[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 (thousand)	Long tons	Value (thousand)	Long tons	Value (thousand)	Long tons	Value (thousand)
1949–53 (average)	31,271	$71,160	65,286	$150,554	211	$483	399	$1,093
1954	22,140	41,725	65,599	133,186	271	467	551	1,125
1955	20,112	[1] 36,773	64,815	131,606	254	504	853	1,748
1956	16,688	32,317	62,590	136,412	439	821	451	1,018
1957	94	118	[2] 56,158	[2] 120,739	1,112	1,526	419	919
1958	5,440	11,244	41,149	84,624	917	1,336	424	899

[1] Data known to be not comparable to other years.
[2] Revised figure.

TABLE 13.—Tin concentrate (tin content) imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957		1958	
	Long tons	Value	Long tons	Value
Argentina	(1)	$384	1	$623
Bolivia	11	5,839	81	147,942
Canada			14	21,500
Indonesia			5,105	10,675,775
Japan			(1)	312
Mexico	9	11,921	45	15,750
Nigeria	34	79,927		
Thailand	40	20,345	194	382,410
Total	94	118,416	5,440	11,244,312

[1] Less than 1 ton.

TABLE 14.—Tin [1] imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957 [2]		1958	
	Long tons	Value (thousand)	Long tons	Value (thousand)
South America: Bolivia	214	$408	148	$285
Europe:				
Belgium-Luxembourg	3,730	8,134	3,005	6,269
Germany, West	263	562	43	88
Netherlands	[3] 7,992	[3] 17,455	7,292	15,279
Portugal	20	43	482	1,003
United Kingdom	4,913	10,406	6,290	12,973
Total	[3] 16,918	[3] 36,600	17,112	35,612
Asia:				
Malaya, Federation of	[3] 39,026	[3] 83,731	20,610	42,272
Singapore, Colony of			2,715	5,380
Total	[3] 39,026	[3] 83,731	23,325	47,652
Africa: Belgium Congo			564	1,075
Grand total	[3] 56,158	[3] 120,739	41,149	84,624

[1] Bars, blocks, pigs, grain, or granulated.
[2] Minerals Yearbook 1957, p. 1167, table 16, Indonesia revised to none.
[3] Revised figure.

TABLE 15.—Foreign trade of the United States in tinplate, taggers tin, and terneplate in various forms, 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
1949-53 (average)	3,819	[1] 517,415	8,877	103	43,047	2,027
1954	127	635,969	11,831		29,214	944
1955	40	747,682	14,798		28,721	144
1956	586	648,517	21,858	10	29,137	3,377
1957	40	[2] 625,666	19,531		31,431	3,628
1958	51	331,813	15,728	(3)	32,824	(3)

[1] Owing to changes in classifications, data for 1949-51 not strictly comparable.
[2] Revised figure.
[3] Beginning Jan. 1, 1958, not separately classified.

TABLE 16.—Foreign trade of the United States in miscellaneous tin, tin manufactures, and tin compounds

[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) (thousand)	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) (thousand)	Imports (long tons)	Exports (long tons)
		Long tons	Value (thousand)	Long tons	Value (thousand)			
1949-53 (average)	$365	3,955	$6,764	32,934	$12,904	[1] $2,005	17	50
1954	[2] 785	5,878	9,358	23,878	11,022	3,341	1	153
1955	[2] 559	6,117	[2] 10,383	26,490	11,517	2,441	5	139
1956	[2] 605	5,073	[2] 9,430	30,502	13,245	2,324	10	167
1957	[2] 561	[3] 5,077	[3] 9,485	30,166	14,309	3,911	10	218
1958	610	3,208	5,771	35,849	18,322	992	11	([4])

[1] Owing to changes in classifications data for 1949-51 not strictly comparable to later years.
[2] Data known to be not comparable with other years.
[3] Revised figure.
[4] Beginning Jan. 1, 1958, not separately classified.

WORLD REVIEW

INTERNATIONAL TIN AGREEMENT

Tin control continued under the International Tin Agreement for the second full year in 1958. The agreement passed through an extremely critical period. Several adverse factors affected its status. Among these were the selling of an unexpected large tonnage of tin by the U.S.S.R. on Western European markets; protracted recovery of domestic tin consumption; and the slow-to-dwindle flow of supplies from prior unrestricted production. Major changes in the statistical position necessitated drastic cutbacks in export quotas. Percentages and votes of participating countries were reallocated. Producing countries completed contributions to the buffer stock, and Malaya provided a special fund not bound by the agreement in efforts to sustain the floor price. Nevertheless, apparently due to lack of funds, support of the cash price of £730 per long ton (91¼ cents a pound) was withdrawn September 18. All metal offered as a result of U.S.S.R. exports presumably could not be absorbed. It has been estimated that the buffer stock stood at 30,000 long tons, including about 5,000 tons acquired with the special fund.

The U.S.S.R., invited to become a producer-participant in the agreement, in turn requested observer membership, which was not permitted. Effective August 30, emergency restrictions limiting U.S.S.R. tin imports were imposed by the United Kingdom, followed by similar action by other consumer-participants—Australia, Canada, Denmark, France, and Netherlands.

The International Tin Council met eight times in 1958. Authority was extended to March 31, 1959, for the buffer-stock manager to operate on the market should the price reach the middle range at £780 per long ton (97½ cents a pound). The buffer stock held 15,300 long tons of tin on December 31, 1957.

At the first meeting of the year in January the first control period was extended to March 31, 1958, instead of March 14, with the export amount for the longer period remaining at 27,000 long tons. This represented an overall reduction of about 40 percent instead of 28½ percent in exports from the participating producing countries. A second control period from April 1 to June 30, 1958, was agreed to with the export amount fixed at 23,000 tons. Producing country delegates agreed to recommend to their governments to consider creating a special fund to be put at the disposal of the buffer-stock manager.

At a March meeting permissible export amounts were reconsidered but no change was made. The buffer stock totaled 22,440 tons of tin on March 31, 1958.

At an April meeting approval was given to new percentages for the producing countries and to a third control period, July 1 to September 30, 1958, with the total permissible export amount unchanged at 23,000 long tons. On April 22 announcement was made that the special fund contributions had been received by the buffer-stock manager.

At a June meeting in Paris approval was given to a fourth control period—October 1 to December 31, 1958. The deposit of the instrument of ratification of the International Tin Agreement by the government of the Republic of Korea was welcomed. A redistribution of the votes of the participating countries was made. The council agreed to formally invite the U.S.S.R. to become a producer-participant in the agreement. The buffer stock held 23,305 long tons of tin June 30, 1958.

At a July meeting the total permissible export quantity for the fourth control period, October 1 to December 31, 1958, was fixed at 20,000 long tons. This was a reduction of 48 percent from the base export rate, as compared with 40-percent reduction in previous periods.

At a meeting on September 25 (previously scheduled for October 14) full confidence in the agreement and the will of its members to support it was affirmed. On September 26 the chairman announced that operation of the special fund of the buffer-stock manager was not bound by price limitations of the agreement. The amount of the special fund and its tin holdings have not been disclosed. The buffer stock held 23,350 long tons on September 30, 1958.

At a November meeting approval was given to a fifth control period, January 1 to March 31, 1959, with the total permissible export amount unchanged at 20,000 long tons. Provisions of the agreement would not permit the Council to accede to a request by the U.S.S.R. to become an observer member.

At the 16th meeting, December 16–19, the Council approved arrangements whereby 10,000 tons of tin held in producing countries might be transferred through barter transactions to the United States. The permitted stocks in producing countries would be reduced by like amounts. These transfers would not come out of the total permissible export amounts. This action followed the U.S. Department of Agriculture barter program announcement of November 14 in which tin was included among the materials. The resignation of W. A. Davey, buffer-stock manager, was accepted effective at the end of April, 1959. The council has appointed as his successor J. B. M. Lochtenberg, the present deputy buffer-stock manager.

TABLE 17.—International Tin Agreement export control

Producing country	Percentages			Vote	Export amount (by control periods), long tons				
	(1)	(2)	(3)	(4)	First [5]	Second [6]	Third [3]	Fourth [7]	Fifth [8]
Belgian Congo and Ruanda-Urundi	8.72	8.95	8.92	92	2,416	2,058	2,052	1,784	1,784
Bolivia	21.50	20.43	19.92	198	5,516	4,699	4,582	3,984	3,984
Indonesia	21.50	20.43	19.41	193	5,516	4,699	4,464	3,882	3,882
Malaya	36.61	37.50	37.50	369	10,125	8,625	8,625	7,500	7,500
Nigeria	5.38	5.34	5.90	62	1,442	1,228	1,357	1,180	1,180
Thailand	6.29	7.35	8.35	86	1,985	1,691	1,920	1,670	1,670
Total	100.00	100.00	100.00	1,000	27,000	23,000	23,000	20,000	20,000

[1] Established in text of 1953 International Tin Agreement, Geneva, Nov. 16–Dec. 9, 1953.
[2] Established at sixth meeting Oct. 23, 1957.
[3] July 1–Sept. 30, 1958. Fixed at 11th meeting Apr. 29–May 1, 1958.
[4] Reallocated 12th meeting, June 17–18, 1958.
[5] Dec. 15, 1957–Mar. 31, 1958. Fixed at eighth meeting Dec. 4–5, 1957; and ninth, Jan. 22–24, 1958.
[6] Apr. 1–June 30, 1958. Fixed at ninth meeting Jan. 22–24, 1958.
[7] Oct. 1–Dec. 31, 1958. Fixed at 13th meeting July 22–24, 1958.
[8] Jan. 1–Mar. 31, 1959. Fixed at 15th meeting Nov. 5–6, 1958.

TABLE 18.—International Tin Agreement voting power of consuming countries

Country	At 8th meeting [1]	At 12th meeting [2]
Australia	29	29
Austria	13	13
Belgium	38	40
Canada	71	66
Denmark	86	83
Ecuador	(3)	(3)
France	168	164
India	75	68
Israel	7	7
Italy	58	57
Korea [2]		7
Netherlands	53	51
Spain	13	12
Turkey	17	15
United Kingdom	372	388
Total	1,000	1,000

[1] Dec. 4–5, 1957
[2] June 17–20, 1958.
[3] Withdrew, November 1957.

WORLD MINE PRODUCTION

World mine production of tin decreased 47,700 long tons (24 percent) in 1958. Six countries operating under the International Tin Agreement as producers, representing about 69 percent of the total, decreased their output to 104,500 tons in 1958 compared with 152,200 tons in 1957. Among these the tinfields of Malaya supplied 25 percent of the world total; Indonesia, 15 percent; Bolivia, 12 percent; Belgian Congo, 8 percent; Thailand, 5 percent; and Nigeria, 4 percent.

TABLE 19.—World mine production of tin (content of ore), by countries, in long tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	234	149	220	338	317	321
Mexico	411	349	605	500	473	544
United States	81	205	99			
Total	726	703	924	838	790	865
South America:						
Argentina	237	95	89	85	182	[2] 47
Bolivia (exports)	33,049	28,824	27,921	26,843	27,794	17,731
Brazil	228	167	146	175	293	[2] 180
Total	33,514	29,086	28,156	27,103	28,269	17,958
Europe:						
Czechoslovakia [3]	200	200	200	200	200	200
France	205	525	450	433	445	4
Germany, East	313	669	669	[2] 660	[2] 670	[2] 720
Portugal	1,205	1,283	1,445	1,169	1,144	1,245
Spain	809	1,020	822	550	491	[2] 240
U.S.S.R. [4] [5]	8,400	9,800	10,300	11,800	13,000	13,500
United Kingdom	927	940	1,034	1,044	1,028	1,087
Total [2] [5]	12,100	14,400	14,900	15,900	17,000	17,000
Asia:						
Burma	1,540	950	1,130	1,050	931	[2] 1,200
China [4]	7,000	9,400	18,000	20,000	23,000	23,000
Indonesia	32,176	35,861	33,368	30,053	27,723	23,201
Japan	463	715	896	926	949	1,104
Laos	120	110	253	254	275	301
Malaya	56,541	60,690	61,244	62,295	59,293	38,458
Thailand	9,457	9,776	11,023	12,481	13,531	7,728
Total [2] [5]	107,300	117,500	125,900	127,100	125,700	95,000
Africa:						
Belgian Congo [6]	13,996	15,084	15,028	14,764	14,281	11,163
French Cameroon	77	82	85	85	71	73
French West Africa	70	73	47	56	50	59
Morocco: Southern Zone	7	5	14	5	8	6
Nigeria	8,431	7,926	8,158	9,067	9,534	6,200
Rhodesia and Nyasaland, Federation of	53	15	208	354	283	534
South-West Africa	122	412	357	475	636	161
Swaziland	35	34	27	29	25	22
Tanganyika (exports)	73	37	41	15	14	19
Uganda (exports)	128	83	68	33	40	35
Union of South Africa	834	1,315	1,283	1,442	1,463	1,416
Total	23,826	25,066	25,316	26,300	26,405	19,688
Oceania: Australia	1,693	2,075	2,017	2,078	1,952	1,914
World total (estimate)	179,200	188,800	197,200	199,300	200,100	152,400

1 This table incorporates a number of revisions of data published in previous Tin chapters. Data do not add exactly to totals shown because of 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 Estimate, according to the 45th annual issue of Metal Statistics (Metallgesellschaft) through 1957.
4 Estimated smelter production.
5 Output from U.S.S.R. in Asia included with U.S.S.R. in Europe.
6 Including Ruanda-Urundi.

WORLD SMELTER PRODUCTION

World smelter production of tin in 1958 decreased 18 percent. Smelting on a small scale began at Texas City, Tex., by private industry. Malaya smelter output decreased 36 percent but represented 28 percent (37 percent in 1957) of the total. Next in rank were United Kingdom, China, Netherlands, U.S.S.R., and Belgium. These six countries furnished 88 percent of the world tin smelter production in 1958.

TABLE 20.—World smelter production of tin, by countries, in long tons [1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Mexico	273	224	357	218	207	[2] 371
United States	32,234	27,407	22,329	17,631	1,564	(3)
Total	32,507	27,631	22,686	17,849	1,771	(3)
South America:						
Argentina	202	60	99	61	39	(4)
Bolivia (exports)	253	196	107	421	328	659
Brazil	215	1,850	1,184	1,544	1,401	(4)
Total	670	2,106	1,390	2,026	1,768	(4)
Europe:						
Belgium	9,298	11,377	10,432	9,716	9,869	8,723
Germany:						
East	341	600	605	[2] 600	[2] 600	[2] 600
West	550	----------	280	683	955	[2] 701
Netherlands	23,223	28,442	26,566	28,197	29,259	17,098
Portugal	310	664	1,018	1,127	982	1,267
Spain	803	676	608	576	783	[2] 459
U.S.S.R. [2] [5]	8,400	9,800	10,300	11,800	13,000	13,500
United Kingdom	28,583	27,475	27,241	26,434	34,174	32,551
Total [2] [5]	71,500	79,000	77,100	79,100	89,600	74,900
Asia:						
China [2]	7,000	9,400	18,000	20,000	23,000	23,000
Indonesia	323	1,351	1,572	[2] 1,500	[2] 600	[2] 600
Japan	539	813	1,030	1,105	1,261	1,307
Malaya	64,527	71,166	70,632	73,263	71,289	45,336
Total [2] [5]	72,400	82,700	91,200	95,900	96,200	70,200
Africa:						
Belgian Congo	2,995	2,459	3,034	2,772	2,651	2,644
Morocco: Southern Zone	3	8	8	[2] 12	[2] 12	[2] 12
Rhodesia and Nyasaland, Federation of	56	19	22	12	253	503
Union of South Africa	786	752	779	756	825	900
Total	3,840	3,238	3,843	3,552	3,741	4,059
Oceania: Australia	1,714	2,063	2,004	1,850	1,806	2,220
World total (estimate)	182,600	196,700	198,200	200,300	194,900	159,700

[1] This table incorporates a number of revisions of data published in previous Tin chapters. Data do not add exactly to totals shown because of 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] U.S. production included in world total; Bureau of Mines not at liberty to publish separately.
[4] Data not available; estimate by author included in the world total.
[5] Output from U.S.S.R. in Asia included with U.S.S.R. in Europe.

REVIEW BY COUNTRIES

South America

Bolivia.—Tin in concentrate and ore exported from Bolivia was 17,730 long tons valued at $36.1 million, a decline of about 36 percent in quantity and value compared with 1957. The 1958 tonnage was the lowest since 1933. The reduced rate reflected quotas established by the International Tin Council. Exports were less than the permissible amount by 70 long tons during the first four control periods (from December 15, 1957, to December 31, 1958). Arrangements were approved by the Council whereby a limited tonnage of tin, which would not come out of the permissible export amount, might be shipped by Bolivia through barter transactions to the United States.

TABLE 21.—Tin production in Bolivia by nationalized mines, in long tons of contained tin

Mine	1953 [1]	1954 [1]	1955 [2]	1956 [2]	1957 [2]	1958 [2]
Carocoles	789	447	351	340	561	417
Catavi	10,707	8,588	7,381	8,109	7,620	6,702
Chorolque	981	844	890	561	640	312
Colavi	330	218	191	171	172	81
Colquechaca	----------	----------	51	60	67	11
Colquiri	4,618	4,240	4,775	4,440	4,083	3,447
Huanuni	5,236	4,308	3,637	3,431	2,874	2,638
Japo	28	65	47	63	110	85
Monserrat	14	4	----------	----------	----------	----------
Morococala	219	168	185	194	238	230
Ocuri	----------	----------	29	----------	----------	----------
Oploca-Santa Ana	659	657	707	526	351	67
San Jose	1,741	1,787	1,644	1,502	1,352	1,023
Santa Fe	608	379	405	441	712	548
Tasna	1,192	664	810	693	748	321
Unificada	2,683	2,300	1,937	1,897	1,602	1,086
Viloco	214	94	75	81	174	139
Others	89	13	----------	125	3	3
Total	30,108	24,776	23,115	22,634	21,307	17,110

[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.

TABLE 22.—Tin exports from Bolivia by groups, in long tons of contained tin

[Departmento de Estadistica, Ministeno de Mines y Petroleo]

Group	1953	1954	1955	1956	1957	1958
Corporation Minera de Bolivia [1]	30,108	24,776	23,417	22,478	22,032	13,852
Banco Minero:						
Medium mines	1,782	1,686	1,957	3,914 (medium and small mines)	5,435	3,173
Small mines	2,761	2,166	2,440			
Oruro smelter (tin metal)	174	196	107	449	329	705
Total	34,825	28,824	27,921	26,841	27,796	17,730

[1] Decree of Oct. 31, 1952, nationalized the major producers of tin, namely, Patino Mines & Enterprises, Inc., Compagnie Aramayo de Mines en Bolivie, and Mauricio Hochschild, S.A.M.I., included in this group.

TABLE 23.—Tin exports from Bolivia by destinations, in long tons of contained tin

[Departmento de Estadistica, Ministeno de Mines y Petroleo]

Destination	1953	1954	1955	1956	1957	1958
Argentina	137	196	77	48	15	533
Brazil				304	254	
Chile	24	31	30	33		
Germany, West			401	517	1,034	602
Netherlands				119	456	81
United Kingdom	19,188	16,368	15,828	17,860	25,035	15,874
United States	15,476	12,229	11,585	7,960	1,002	640
Total	34,825	28,824	27,921	26,841	27,796	17,730

Europe

United Kingdom.—Mine production of about 1,100 long tons of tin was derived principally from 690 long tons of black tin (65 percent) produced by Geevor Tin Mines, Ltd., and 740 tons by South Crofty, Ltd.

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 decreased 5 percent. Most of the concentrate treated was from Bolivia and Nigeria. Primary tin consumption was 20,000 long tons (21,500 in 1957), of which about half was for making tinplate. Tinplate production gained for the sixth consecutive year and totaled 1 million long tons, 1 percent more than 1957 (986,800 long tons revised) and the largest on record. For the first time in the United Kingdom the annual production of electrolytic tinplate exceeded that of hot-dipped. Of the 1958 output, 56 percent was electrolytic and 44 percent hot-dipped. About 41 percent of the tinplate or 414,100 long tons was exported in 1958. Tinplate exports gained except for the sharp falling-off of shipments to Australia and New Zealand, the principal foreign markets.

Imports of tin metal, mainly from the U.S.S.R. and Malaya, were 13,200 long tons (9,830 in 1957), the highest since 1937. Effective August 30, imports of tin and tin alloys originating from the U.S.S.R. were confined to 750 tons per 3 months; and such imports from Sino-Soviet Bloc were subject to individual licensing. Tin metal exports totaling 10,400 long tons (7,600 in 1957) went mostly to the United States.

Pig-tin stocks, the bulk under control of the buffer-stock manager, stood at 19,050 tons at the end (14,380 at beginning) of 1958. Stocks of tin-in-concentrates was 3,870 tons at beginning compared with 2,300 at end of 1958. Metal afloat decreased from 2,680 tons at beginning to 200 tons at end of 1958. Yearend stocks of tin-in-concentrate afloat were 1,885 tons (2,689 at beginning of year).

Asia

Indonesia.—The tin output—23,201 long tons—was 16 percent less than in 1957 and the lowest since 1947. The islands of Banka, Billiton, and Singkep furnished 70, 25, and 5 percent, respectively, of the total.

Exports of tin-in-concentrate were 18,185 long tons; 2,571 tons went to the Netherlands; 5,596 to the United States; and, beginning in April, 10,018 were shipped "London option" (to London unconsigned for possible future sale). Trade channels indicated the latter actually moved to the Netherlands for processing.

The Gemeenschappelijke Mijnbouwmaatschappij Billiton (Billiton Joint Mining Co.) was dissolved March 1, 1958. Afterward, operations were conducted directly by the Indonesian Government.

Malaya.—Mine tin production in Malaya was reduced 35 percent to 38,460 long tons in 1958. Of the total, 61 percent came from European mines (mostly by dredges) and 39 percent from Asian mines (mostly by gravel pumps), including 2 percent from dulang washing. European mines produced 23,330 long tons (33,800 in 1957), and Asian, 15,130 tons (25,500 in 1957). By methods of mining, the largest declines in tin production were 10,380 tons by gravel pumps and 8,230 tons by dredges. Gains over 1957 were shown for hydraulicking (Asian) and small workings (European). The federal revenues received M$29.6 million in export duty on tin in 1958, against M$54.5 million in 1957.

Active mines totaled 738 at the beginning compared with 417 at the end of 1958; dredges decreased from 76 to 34; and gravel pump units dropped from 597 to 333. The labor force was 23,153 on December 31, 1958, against 36,585 on December 31, 1957. Many of the workers were on a part-time basis. Tin-in-concentrates produced for mine stocks helped retain some workers in employment.

Permitted exports of tin under the International Tin Agreement were 34,875 tons during the first four control periods, December 15, 1957 to December 31, 1958. The quantity allowed was about half the domestic "annual assessment" established at 68,000 tons. Tin-in-concentrates delivered to smelters was 34,866 tons. Quota distribution was European 59 percent, and Asiatic 41 percent, including dulang washing. Buffer stock contributions from producers were collected at the rate of M$12 a picul of concentrate for January and February and at M$21 for the remainder of 1958. Malaya provided the buffer stock manager with an undisclosed amount for a special fund not bound by price limitations of the tin agreement.

The principal world source of tin 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 Butterworth, Province Wellesley. Concentrate treated was derived mostly from Malaya and Thailand. Total smelter production was 45,340 long tons (71,290 in 1957). A labor strike which began November 13, 1957, at the Penang smelter was settled on January 19, 1958.

Of the total tonnage exported from Malaya in 1958, Penang accounted for 84 percent (71 percent in 1957), and Singapore 16 percent (29 percent in 1957). Shipments to the United States decreased 16,450 tons; the flow was small in December. Destinations showing increases represented about 30 percent of the 1958 total; together, their tonnage was 7 percent higher than 1957.

Stocks of tin metal decreased from 2,830 long tons at the beginning to 2,324 at the end of 1958. However, tin-in-concentrates (including mine stocks) increased from 6,960 tons at the beginning to 9,159 at the end—the highest recorded.

TABLE 24.—Tin-metal exports from Malaya in long tons [1]

Destination	1957	1958	Destination	1957	1958
Argentina	2,813	773	Netherlands	1,762	707
Australia-New Zealand	1,483	1,466	Union of South Africa	753	671
Canada	1,720	842	United Kingdom	6,531	3,579
France	2,202	1,768	United States	36,117	19,686
India	4,223	4,427	Other countries	3,730	2,585
Italy	2,520	2,305			
Japan	6,745	7,004	Total	70,599	45,813

[1] Federation of Malaya, Department of Statistics, Monthly Statistical Bulletin: January 1959, p. 54.

TABLE 25.—Imports of tin-in-concentrate into Malaya, in long tons

Country of origin	1957	1958	Country of origin	1957	1958
Burma	806	1,306	Other	91	26
Laos and Viet-Nam	384	455			
Thailand	12,862	6,440	Total	14,143	8,227

Thailand.—Thailand ranked seventh among the world tin-producing countries in 1958.

Tin-in-concentrate passed by the Customs Department of Thailand for payment of royalty was 7,283 tons (December 15, 1957 to December 31, 1958). Exports by destinations were 5,319 tons in 1958. About 1,200 tons of tin-in-concentrate was afloat to the United States at the end of 1958.

Bartering tin for United States surplus agricultural products was being considered.

TABLE 26.—Exports of tin-in-concentrate from Thailand, in long tons

Destination	1957	1958	Destination	1957	1958
Belgium	42		Portugal	73	
Brazil	292		United States	1	261
Germany, West		7	Other		7
Japan	243	22			
Malaya	12,696	5,022	Total	13,347	5,319

U.S.S.R.—Tin from U.S.S.R. was an important factor in world trade in 1957 and 1958. Exports of tin to free Europe were 11,000 long tons in 1957 and 18,000 tons in 1958. In September 1958 the flow reached a monthly peak of almost 3,100 long tons. Sales were from either reexported Chinese tin (some of which was further refined) or exports of U.S.S.R. tin made possible by large arrivals from China. Some of the tin was from Poland, of otherwise unknown origin. U.S.S.R. imports from China were 16,633 long tons in 1955, 15,452 in 1956, 21,653 in 1957 and 18,000 (estimated) in 1958. Tin acquired from free world sources was 225 tons in 1957 and 57 in 1958. Sino-Soviet imports of tin by free Europe were 7,200 long tons in 1957 and 21,100 in 1958. Tin from Sino-Soviet Bloc, totaling about 2,600 long tons in 1957 and 3,100 tons in 1958, moved in transit through Belgium, Netherlands, and West Germany.

TABLE 27.—Tin metal shipments from Sino-Soviet Bloc, in long tons[1]

Source and destination	1957	1958
From U.S.S.R. into:		
Finland	----------	268
France	----------	788
Germany, West	674	1,983
Netherlands	3,799	7,434
Sweden	15	----------
Switzerland	85	466
United Kingdom	2,209	6,522
Total	6,782	17,461
From China into:		
France	----------	145
Germany, West	50	264
Hong Kong	14	934
Netherlands	98	497
Switzerland	192	92
United Kingdom	----------	560
Total	354	2,492
From Poland into:		
France	----------	127
Germany, West	----------	397
Netherlands	----------	416
United Kingdom	----------	235
Total	----------	1,175
From Czechoslovakia into:		
Denmark	30	----------
Grand total	7,166	21,128

[1] Statistical Bulletin of the International Tin Council.

Africa

Belgian Congo.—Mine production of tin in Belgian Congo, including Ruanda-Urundi was 11,163 long tons—a 22-percent decrease from 1957. Smelting in Belgian Congo remained virtually unchanged from 1957. Exports of tin-in-concentrate and metal were mostly to Belgium. Permissible exports under the International Tin Agreement for the first four control periods were 8,310 long tons, whereas actual exports were 8,263 tons (reported for purposes of control at a point inland where delivery was made to a carrier near the mines).

Nigeria.—In 1958 Nigeria produced 8,423 long tons of tin ore (13,151 in 1957) averaging about 73.6 percent tin. The entire tin-in-concentrate exports, totaling 5,627 tons (10,006 in 1957), went to the United Kingdom. In accordance with definitions in the Tin Agreement, during the first four control periods Nigeria exported 5,196 tons of tin, against the permitted amount of 5,207 tons. Columbium was produced as a byproduct or coproduct of tin mining in Nigeria.

In the year ended March 31, 1958, Nigeria's largest tin producer—Amalgamated Tin Mines of Nigeria, Ltd.—reported treating 13.1 million cubic yards compared with 14.3 in the preceding year. The value of the ground worked increased from 0.62 pound to 0.67 pound of cassiterite per yard.

The output (in long tons) was obtained by the following methods:

	Cassiterite	*Columbite*
Gravel pumps	1,781	182
Draglines with washing plants	1,061	132
Dredge	107	16
Jig plants	228	53
Elevators, hand paddocks, tribute, and contract	757	58
Mill tailing	149	64
	4,083	505

Rhodesia and Nyasaland, Federation of.—Tin production in Southern Rhodesia, although small, almost doubled and was the highest recorded. The principal producer was the Kamativi Tin Mines, Ltd.

(N. V. Billiton Maatschappij), near Dett, Bulawayo District. Mill production was smelted on the mine to produce refined tin, solder, and white metal by the Kamativi Smelting and Refining Co., Ltd., which also treated concentrate purchased from other small operators in the area. Slag was shipped to the Netherlands. The Bulawayo smelting works established in 1940 was closed.

Oceania

Australia.—Mine production of tin in Australia remained virtually unchanged, whereas smelter production increased 23 percent compared with 1957. Imports of tin were necessary to meet expanded needs, mostly for making tinplate. Tin consumption was 2,630 long tons, against 2,220 in 1957; tinplate required 1,050 tons in 1958 and 230 tons in 1957. The Port Kembla mill produced 68,000 long tons of tinplate (14,800 in 1957), and attained a capacity output of 6,520 tons in November.

Tableland Tin Dredging, N.L., North Queensland, the leading tin producer, recovered 629 tons (544 in 1957) of tin concentrate. Mount Lyell Mining and Railway Co., Ltd., acquired an interest in Renisson Associated Tin Mines, N.L., developing extensive low-grade pyritic tin deposits in Tasmania. The Commonwealth Government was assisting United Uranium, N.L., by diamond drilling the Maranboy tin field, Northern Territory, the cost thereof to be defrayed if the field reaches the productive stage.

TECHNOLOGY

A study [9] of the economic geology of the Irish Creek tin deposits, Rockbridge County, Va., showed the presence of 46 minerals in the deposits. Although cassiterite was identified in the district as early as 1846, little interest has been shown in the mineral deposits. Major rock types of the Irish Creek district are gneisses and schists, intruded by granodiorite. The mineral deposits are fissure veins consisting largely of quartz veins bordered by greisen and enriched by recurrent deposition. Minerals identified included beryl, cassiterite, fluorite, rutile, zircon, arsenopyrite, chalcopyrite, galena, pyrite, and pyrrhotite. Arsenopyrite, the most abundant sulfide, was reported to contain appreciable amounts of gold and silver.

Research on organotin compounds, their technological application, and production were publicized widely during the year. One report[10] described the history of the recent surge of interest in organotin compounds, the development of industrial uses, and recent research. Organotin compounds uses include fungicides in paper manufacture and paint, wood preservation, rotproofing and insectproofing textiles, treatment of bacterial slimes in industrial waters, and agriculture crop protection.

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[9] Glass, Jewell J., Koschmann, A. H., and Vhay, J. S., Minerals of the Cassiterite-Bearing Veins at Irish Creek, Virginia, and Their Paragenetic Relations: Econ. Geol., vol. 53, No. 1, January–February 1958, pp. 65–84.

[10] Review of Speeches on Organotin Compounds: Chem. and Ind. (London), No. 21, May 24, 1958, pp. 609–611.

The method of preparing organotin compounds at Metal and Thermit Corp.'s new plant at Carrollton, Ky., was described.[11] Although organotin compounds are manufactured for various applications, a leading use is as a stabilizer for polyvinyl chloride plastics to help prevent heat and light from discoloring or making the plastic brittle.

The technology of tin plating, developments and new plants, and general description of the process including hot-rolled band, cold reduction, automatic gage control, annealing, electrolytic and hot-dip tinning, quality control, and future outlook were discussed in a report.[12]

Upon comparing the coulometric method for determination of tin and tin-iron alloy on tinplate—described by Kunze and Willey in 1952—it was learned that determinations agree with those obtained by chemical dissolution and weight loss methods, provided that a de-aerated electrolyte is used for precise work. In addition, the method is rapid and ideal for analysis of differentially coated tinplate.[13]

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[11] Chemical and Engineering News, Organotin Compounds Get Boost: Vol. 36, No. 15, Apr. 14, 1958, pp. 25–26.

[12] Hoare, W. E., Some Advances in Tinplate Technology: Metal Prog., vol. 73, No. 1, January 1958, pp. 91–96.

[13] Cooke, F., and Shanahan, C. E. A., The Determination of Tin and Tin-Iron Alloy Weights on Tinplate Using the Kunze-Willey Method: Metallurgia, vol. 57, No. 344. June 1958, pp. 321–326.

Titanium

By John W. Stamper [1]

SIGNIFICANT reductions in United States production and consumption of titanium sponge metal coupled with termination of purchases under Government contracts with producers resulted in a close balance between supply and demand for the metal at the end of 1958.

Domestic shipments of titanium dioxide pigments increased 4 percent over 1957 but all other segments of the titanium industry declined.

Ilmenite production and consumption was 26 and 13 percent, respectively, below 1957, but output of titanium pigments, which uses virtually all of the ilmenite, was down only 10 percent.

Owing chiefly to the decreased use of rutile for making titanium metal, rutile consumption dropped 59 percent below 1957 and shipments were 1,900 short tons, the lowest reported since 1940. Decreased demand for rutile in the United States was also reflected by a marked decline in world production particularly in Australia, the principal source.

All five producers of titanium pigments in the United States expanded capacity or were constructing additional producing facilities.

LEGISLATION AND GOVERNMENT PROGRAMS

On January 14, 1958, the Business and Defense Services Administration, United States Department of Commerce, revoked its Order M–107, which provided for scheduling 75 percent of the output of titanium mill products for defense use. The order had become unnecessary because the capacity for the production of titanium mill products was more than adequate to meet defense and civilian requirements. The Titanium Advisory Committee, established in 1954 by the Office of Defense Mobilization to develop recommendations with regard to the Government program on titanium expansion, was abolished on June 11, 1958.

The Defense Minerals Exploration Administration (DMEA) established in 1951 to provide assistance to industry in exploration for certain strategic minerals, including rutile, expired on June 30, 1958, and in September was succeeded by the Office of Minerals Exploration (OME). Under OME, the Government could loan up to 50 percent (limited to $250,000 for any one contract) of the costs of exploration for rutile.

[1] Commodity specialist.

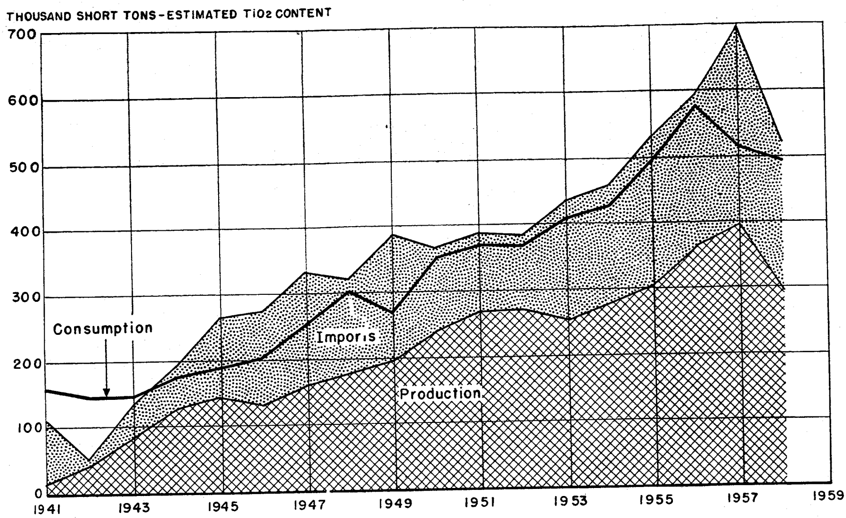

FIGURE 1.—Domestic production, imports, and consumption of ilmenite (includes titanium slag and a mixed product), 1941–58, in short tons.

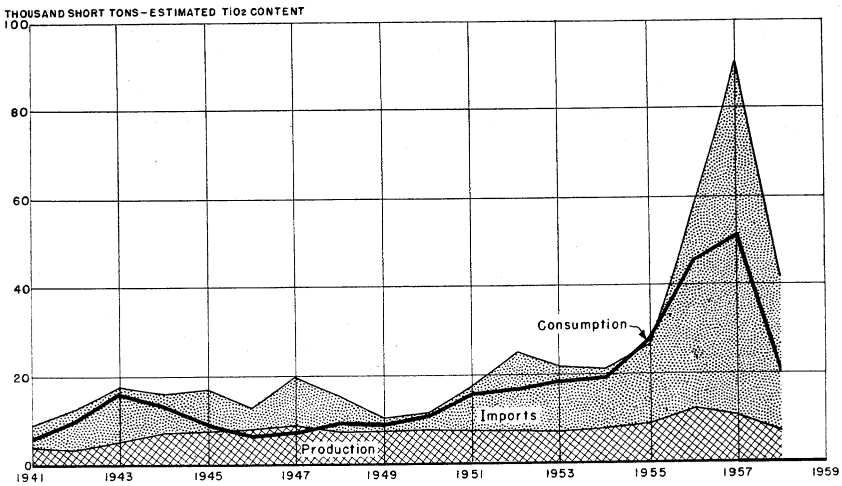

FIGURE 2.—Domestic production, imports, and consumption of rutile, 1941–58, in short tons.

TABLE 1.—Salient titanium statistics

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Ilmenite concentrate: [1]						
Mine shipments____short tons__	478,423	531,895	573,192	735,388	782,975	565,164
Value__________(thousands)__	$6,977	$7,375	$10,268	$14,199	$21,802	$11,155
Imports [2]__________short tons__	240,070	275,005	353,351	359,281	460,353	348,144
Consumption [2]__________do____	703,955	780,728	876,403	1,027,645	957,184	849,005
Rutile:						
Mine shipments________do____	7,305	7,305	9,182	12,065	10,644	1,863
Value__________(thousands)__	$536	$870	$1,122	$1,749	$1,544	$210
Imports__________short tons__	11,141	15,060	19,526	48,906	84,837	36,563
Consumption__________do____	15,419	20,663	28,762	46,853	53,393	21,677
Sponge metal:						
Production__________do____	78	5,370	7,398	14,595	17,249	4,585
Imports for consumption do____	[3] 26	193	567	2,048	3,532	2,073
Consumption__________do____	(4)	2,500	3,979	10,936	8,221	4,147
Price Grade A-1, Dec. 31 per pound__	$5.00	$4.50	$3.45	$2.75	$2.25	$1.82
World:						
Ilmenite concentrate: Production [1]__________short tons__	966,900	1,234,950	1,405,150	1,791,550	1,972,050	1,710,900
Rutile concentrate: Production short tons__	39,400	57,700	75,740	122,200	156,200	102,750
Sponge Metal: Production short tons__	----------	7,700	10,500	19,100	22,300	7,700

[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite.
[2] Beginning in 1950 includes titanium slag.
[3] 1951 to 1953 only.
[4] Data not available.

DOMESTIC PRODUCTION

Concentrates.—Owing chiefly to the low demand for titanium dioxide pigments, ilmenite output was 563,000 tons, 26 percent below the 1957 peak. Oversupply of rutile and decreased demand for rutile for making titanium metal resulted in a 31 percent decline in production below that of 1957 to 7,400 tons. Rutile shipments were 1,900 tons, the lowest reported since 1940.

Production of ilmenite was reported from the following companies: American Cynamid Co., Piney River, Va.; E. I. du Pont de Nemours & Co., Inc., Starke and Lawtey, Fla.; Marine Minerals Division of Heavy Minerals Co., Bath, S.C.; Metal and Thermit Corp., Beaver Dam, Va.; National Lead Co., Tahawus, N.Y.; Rutile Mining Co. of Florida, Jacksonville, Fla.; and The Florida Minerals Co., Wabasso, Fla. A small quantity of ilmenite, which accumulated during monazite dredging and processing operations from 1951 to 1955, was shipped from stockpiles at Boise, Idaho.

Rutile producers were as follows: Marine Minerals Division of Heavy Minerals Co., Bath, S.C.; Metal and Thermit Corp., Beaver Dam, Va.; Rutile Mining Co. of Florida, Jacksonville Fla.; and The Florida Minerals Co., Wabasso, Fla.

In March 1958 it was announced that the mining operations of the Marine Minerals Division of Heavy Minerals Co. at Bath, S.C., was closed.

TABLE 2.—Production and mine shipments of titanium concentrates from domestic ores in the United States, in short tons

Year	Production (gross weight)	Shipments		
		Gross weight	TiO_2 content	Value
ILMENITE [1]				
1949-53 (average)	490,751	478,423	241,481	$6,976,963
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	[2] 21,801,548
1958	563,338	565,164	297,021	11,154,854
RUTILE				
1949-53 (average)	7,136	7,305	6,806	535,592
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
1958	7,406	1,863	1,804	209,872

[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite. In 1949, 4,980 short tons of the mixed product was listed under rutile prior to 1957.
[2] Revised figure.

Metal.—Following the cutback in military requirements for titanium metal in mid-1957, production of titanium sponge dropped steadily to about 10 percent of the industry's capacity by mid-1958. Output began to increase during the third quarter 1958 and total production for the year was 4,600 short tons or about one-fourth of the 1957 peak output of 17,200 short tons. Delivery of 2,642 short tons of titanium sponge metal in 1958 to the General Services Administration completed all Government purchase contracts with producers.

Commercial producers of titanium sponge in 1958 were as follows: Cramet, Inc., Chattanooga, Tenn.; Union Carbide Metals Co., Division of Union Carbide & Carbon Corp., Ashtabula, Ohio; E. I. du Pont de Nemours & Co., Inc., Newport, Del.; Mallory-Sharon Metals Corp., Ashtabula, Ohio; and Titanium Metals Corp. of America (TMCA), Henderson, Nev. Cramet, Inc., E. I. du Pont de Nemours & Co., Inc., and TMCA used magnesium to reduce titanium tetrachloride to titanium metal and Mallory-Sharon Metals Corp. and Union Carbide Metals Co. used sodium.

TABLE 3.—Titanium-metal data, in short tons

	1954	1955	1956	1957	1958
Sponge metal:					
Production	5,370	7,398	14,595	17,249	4,585
Imports for consumption	193	567	2,048	3,532	2,073
Industry stocks	(1)	854	3,000	2,800	1,000
Government stocks	2,894	6,647	[2] 9,316	19,821	22,463
Consumption	[3] 2,500	3,979	10,936	8,221	4,147
Scrap metal consumption	(1)	1,353	2,033	1,743	1,336
Ingot: [4]					
Production	[3] 3,000	4,573	11,688	10,009	5,408
Consumption	[3] 2,900	4,442	10,860	10,428	4,971
Mill shape production	[5] 1,299	1,898	5,166	5,658	2,594

[1] Data not available.
[2] Revised figure.
[3] Estimate.
[4] Includes alloying constituents.
[5] Shipments.

Owing to the reduced demand for titanium metal, Cramet, Inc., stopped production at its plant at Chattanooga, Tenn., in April 1958 and exercised its contractual right to turn the plant over to the Government. The GSA offered the plant, raw materials, and miscellaneous products for sale or lease to private companies. One million pounds of titanium tetrachloride and about 325 tons of offgrade titanium sponge metal were sold by GSA during the year. The titanium metal plant had not been sold by the end of 1958.

On April 8, 1958, the Stauffer Chemical Co., a producer of titanium tetrachloride, announced that its two pilot plants for studying the production of titanium metal had been closed. Stauffer discontinued manufacturing titanium tetrachloride at its Niagara Falls, N.Y., plant early in 1958 and later sold its titanium tetrachloride plant at Ashtabula, Ohio, to Mallory-Sharon Metals Corp., a titanium metal producer.

In July TMCA announced the formation of a new titanium company with Deutsche Edelstahlwerke (DEW), Germany's leading producer of specialty steels. The new company, known as Continental Titanium Metals Corp. (Contimet), is jointly-owned by TMCA and DEW, had main offices in Luxembourg and planned to produce titanium mill products at the DEW steel plant in Krefeld, West Germany.

The New Jersey Zinc Co., a titanium pigment producer, continued to develop its fused salt electrolytic process for producing titanium metal from titanium tetrachloride. The company had completed pilot plant studies in 1957 on the production of titanium tetrachloride from either ilmenite or titanium slag.

Plans of the Allied-Kennecott Titanium Corp. to produce titanium metal commercially were deferred in 1958. The company announced it had developed its process through the pilot-plant stage and could start commercial production whenever demand warranted.

Titanium melters were: Harvey Aluminum, Inc., Torrance, Calif.; Mallory-Sharon Metals Corp., Niles, Ohio; Oregon Metallurgical Corp., Albany, Oreg.; Crucible Steel Co., Midland, Pa.; Republic Steel Corp., Massillon and Canton, Ohio; and TMCA, 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 bars. Harvey Aluminum, Inc., produced titanium castings in addition to other mill products. The Ladish Co., Cudahy, Wis., processed ingots into forged products.

Pigments.—For the second consecutive year production of titanium dioxide pigments declined and, based on gross weight, was 10 percent below 1957. Nevertheless shipments increased 4 percent over 1957.

Titanium pigments were produced by the following companies: American Cyanamid Co., Piney River, Va., and Savannah, Ga.; Glidden Co., St. Helena and Hawkins Point, Baltimore, Md.; E. I. du Pont de Nemours & Co., Inc., Edge Moor, Del., and Baltimore, Md.; National Lead Co., St. Louis, Mo., and Sayreville, N.J.; and The New Jersey Zinc Co., Gloucester City, N.J.

The American Cyanamid Co. doubled the capacity of its Savannah, Ga., titanium dioxide plant, bringing it to 72,000 tons annually.

The E. I. du Pont de Nemours & Co., Inc., new titanium dioxide plant at New Johnsonville, Tenn., was virtually completed and was expected to go on stream in 1959. This is the first major plant designed to produce titanium dioxide by the chloride process.

In March, The Glidden Co. discontinued production of titanium dioxide at its St. Helena plant in Baltimore, Md., and during the year expanded capacity of its Hawkins Point plant, which is also in Baltimore.

The capacity of the National Lead Co. titanium dioxide plant at St. Louis, Mo., was increased. The company also acquired a controlling interest in Société Chimique des Derives du Titane, S.A., a Belgian producer of titanium pigments.

The New Jersey Zinc Co. continued the expansion of its titanium dioxide plant at Gloucester City, N.J., which was expected to approximately double its annual capacity of about 25,000 tons by 1960.

Estimated titanium dioxide capacity of each plant of the five titanium pigment producers was given in a report and the expansion program at each plant was discussed.[2] Annual titanium pigment capacity as of January 1, 1958, was estimated at 504,000 tons and after January 1, 1960, at 635,000 tons.

Welding-Rod Coatings.—A total of 210,500 tons of welding rods containing titaniferous material in their coatings was produced in 1958. This quantity was 21 percent below the tonnage of welding rods similarly coated in the preceding year.

Of the total welding rods produced, 37 percent contained rutile only; 24 percent, ilmenite only; 13 percent, a mixture of rutile and manufactured titanium dioxide only; 14 percent, manufactured titanium dioxide only; and 12 percent, slag only.

CONSUMPTION AND USES

Concentrates.—Consumption of ilmenite, used principally for making titanium pigment, decreased 13 percent but consumption of titanium slag, which also was used for titanium pigments, increased 1 percent. The decline in ilmenite consumption was reflected by a drop in production of pigment of 10 percent. A decline of nearly 60 percent in rutile consumption was due primarily to the decreasing use of rutile for making titanium metal. Of the 22,000 tons of rutile used in 1958, 36 percent was used in making metal, 51 percent was used in welding-rod coatings, and the remainder went into alloys, carbides, ceramics, fiberglass, and other items.

Metal.—Decreased military requirements for titanium metal resulted in a drop in sponge metal consumption of 50 percent below 1957. Nevertheless, the 4,100 tons of sponge metal used plus 2,600 tons delivered to the Government exceeded output, and sponge metal inventories were reduced. At the end of 1958 rate of consumption was about the same as that of production. The consumption of titanium

[2] Oil, Paint and Drug Reporter, Titanium Pigment Producers, Oblivious To Recession, Building 131,000 Tons More Capacity: Vol. 174, No. 3, July 21, 1958, pp. 3, 58, 60, 63.

TABLE 4.—Consumption of titanium concentrates in the United States, 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
1949–53 (average)	655,073	320,125	[2] 48,882	[2] 34,629	15,419	14,449
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	865,211	464,009	162,434	115,148	46,853	44,453
1957						
Pigments (mfg. TiO_2) [3]	832,350	429,019	114,168	80,866		
Titanium metal	(4)	(4)	(5)	(5)	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	(5)	(5)	604	578
Ceramics	22	12			353	330
Fiberglass					1,122	1,091
Miscellaneous [6]	16	9	837	613	776	729
Total	840,719	434,077	116,465	82,545	53,393	50,870
1958						
Pigments (mfg. TiO_2) [3]	726,659	376,730	116,096	81,849		
Titanium metal	(4)	(4)	(5)	(5)	7,878	7,525
Welding-rod coatings	666	394	937	680	11,001	10,384
Alloys and carbide	4,056	2,615	(5)	(5)	612	586
Ceramics	26	16			379	355
Fiberglass					867	845
Miscellaneous [6]	17	10	548	408	940	884
Total	731,424	379,765	117,581	82,937	21,677	20,579

[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite used to make pigments and metal. In 1949, 2,226 short tons of the mixed product was listed under rutile prior to 1957.
[2] 1952 and 1953 only.
[3] "Pigments" include all manufactured titanium dioxide.
[4] Included with pigments to prevent disclosing individual company confidential data.
[5] Included in "Miscellaneous" to prevent disclosing individual company confidential data.
[6] Includes consumption for chemicals and experimental purposes.

mill products, using shipments as a gage, was 2,600 tons, compared with 5,700 tons in 1957.

Titanium was used principally in military and commercial aircraft and also in missiles. Applications for the metal in aviation included tubes, fittings, firewalls, cowlings, bulkheads, skin sections, and jet compressors. The new commercial jet transports, the Convair 880, the Douglas DC–8, and the Lockheed Electra, reportedly used 2,500, 2,000, and 700 pounds of titanium, respectively.[3]

A study was published on the applications of titanium with particular emphasis on its use in military aircraft. Estimates of future consumption, production, and costs of titanium were discussed.[4]

Aviation uses of titanium continued to predominate, but industrial applications were increasing through intensive end-use research by the producers. Titanium was used on surfaces of mixers in contact with chlorides and various organic chemicals used by the pulp and paper industry; for tubing used in heating or cooling chromic acid solutions; and in other applications in contact with dilute nitric acid,

[3] American Metal Market, Higher Share of Titanium Going to Civilian Lines: Vol. 65, No. 28, Nov. 27, 1958, pp. 1, 7.
[4] Tyler, Paul M., Metal Progress, Present and Future Uses of Titanium: Vol. 74, No. 3, September 1958, pp. 109–122, 170–182.

hypochlorites, and brines in chemical process plants. Cast titanium valves became available commercially for the first time in 1958.

Owing to the corrosion resistance of titanium in sea water, marine applications also were developed in 1958. Potential uses included fuel tanks, sea-water condensers, mufflers, and exhaust pipes.

Titanium covered with a thin film of platinum was reported to be suitable for anodes in extremely corrosive solutions and as efficient as platinum at a much lower cost. Four of these anodes, 2 feet long and 7/8 inch in diameter, were used in England to provide cathodic protection for 15,000 square feet of steel piling submerged in polluted estuarine water.[5]

What is reported to be the smallest metal tubing ever produced was formed from a 0.010-inch thick strip of pure titanium. The tubing of the flexible, interlocking type has a 0.050-inch inside diameter and a 0.115-inch outside diameter and was used as a casing for control wires in atomic reactors.[6]

Pigments.—Notwithstanding the decline in titanium pigment production, the use of pigment, using shipments as a gage, increased 4 percent over 1957. Consumption of pigments not separately classified in table 5 included ceramics, roofing, siding, gems, for titanium chemicals, and in plastics. Use of titanium dioxide in curing concrete was reported as a promising new application but was not fully investigated in 1958. A new material, fibrous potassium titanate, was developed, and on a weight basis it was reported to be twice as effective as any known thermal insulator in the 1,300° F. range.[7]

TABLE 5.—Distribution of titanium-pigment shipments, by industries, percent of total

Industry	1949–53 (average)	1954	1955	1956	1957	1958
Distribution by gross weight:						
Paints, varnishes, and lacquers	72.0	64.3	65.3	65.3	64.9	65.8
Paper	7.1	10.1	10.1	10.3	10.9	11.5
Floor coverings (linoleum and felt base)	4.6	4.5	4.6	4.2	4.1	5.0
Rubber	3.0	3.1	3.4	3.4	3.6	3.9
Coated fabrics and textiles (oil-cloth, shade cloth, artificial leather, etc.)	1.7	2.4	2.7	2.8	3.2	2.9
Printing ink	1.1	1.2	1.3	1.3	1.4	1.5
Other	10.5	14.4	12.6	12.7	11.9	9.4
Total	100.0	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:						
Paints, varnishes, and lacquers	64.2	55.4	58.4	58.3	57.7	59.1
Paper	10.4	14.1	13.5	13.6	14.2	15.2
Floor coverings (linoleum and felt base)	5.5	5.2	5.2	4.9	5.0	6.4
Rubber	3.9	4.0	4.4	4.4	4.6	5.1
Coated fabrics and textiles (oil-cloth, shade cloth, artificial leather, etc.)	2.3	3.2	3.4	3.6	4.1	3.7
Printing ink	1.6	1.6	1.7	1.8	1.9	1.9
Other	12.1	16.5	13.4	13.4	12.5	8.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

[5] Chemical Age (London), Bright Future for I.C.I.'s Newly Developed Electrodes: Vol. 81, No. 2060, Jan. 3, 1959, p. 9.

[6] Materials in Design Engineering, Titanium Used in Smallest Tubing Ever Made: Vol. 49, No. 1, January 1959, p. 9.

[7] Iron Age, Fine Synthetic Fiber Material Blocks High Heat: Vol. 182, No. 19, Nov. 6, 1958, p. 113.

STOCKS

Stocks of ilmenite and rutile increased, but stocks of titanium slag decreased. Year-end stocks of titanium sponge held by producers, melters, and semifabricators totaled 1,000 tons, a considerable decrease from the 2,800 tons held at the beginning of the year. An additional 22,463 tons was held in the revolving sponge stockpile. Industry metal stocks were enough for nearly 3 months' supply at the 1958 consumption rate.

Stocks of titanium scrap held by melters and semifabricators increased from 3,600 tons at the beginning of 1958 to 4,100 tons at the end of the year.

TABLE 6.—Stocks of titanium concentrates in the United States at the end of the year, in short tons

	Ilmenite		Titanium slag		Rutile	
	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content
1957 [1]						
Mine	38, 758	18, 079			83	78
Distributors	195	116			3, 680	3, 512
Consumers	695, 792	361, 474	179, 361	126, 734	55, 208	52, 601
Total stocks	734, 745	379, 669	179, 361	126, 734	58, 971	56, 191
1958						
Mine	36, 932	17, 080			5, 626	5, 241
Distributors	164	97			2, 035	1, 939
Consumers	758, 371	388, 695	153, 494	108, 275	61, 298	58, 262
Total stocks	795, 467	405, 872	153, 494	108, 275	68, 959	65, 442

[1] Revised figures.

PRICES

Concentrates.—The price quoted for ilmenite in E&MJ Metal and Mineral Markets dropped on June 5, 1958, from \$26.25 to \$30 per long ton to \$23 to \$26 per long ton (59.5 percent TiO_2, f.o.b. Atlantic seaboard) and remained there throughout the year.

Rutile prices continued to decline as in the preceding year. The price of rutile (94 percent TiO_2, f.o.b. Atlantic seaboard) at the beginning of 1958, quoted by E&MJ Metal and Mineral Markets was \$120 to \$125 per short ton; by June 5, 1958, the price was down to \$95 to \$100 per short ton and remained constant to the end of the year.

Manufactured Titanium Dioxide.—The prices of rutile and anatase grades of manufactured titanium dioxide were unchanged in 1958. The price of calcium-rutile base pigments containing 30 percent TiO_2 increased in 1958 from \$0.09¼–\$0.09¾ per pound to \$0.09⅜–\$0.09⅞ per pound. The following prices were quoted in the Oil, Paint and Drug Reporter at the end of the year:

	Price
Anatase, chalk-resistant, regular and ceramic, carlots, delivered, per pound	$0.25½
Less than carlots, delivered, per pound	.26½
Rutile, nonchalking, bags, carlots, delivered East, per pound	.27½
Less than carlots, delivered East, per pound	.28½
Titanium pigment, calcium-rutile base, 30 percent TiO_2, bags, carlots, delivered, per pound	.09⅜
Less than carlots, delivered, per pound	.09⅞

Metal.—The price of titanium metal sponge and mill products continued to decline. Prices per pound quoted for titanium sponge metal in 1958 were as follows:

	January 1, 1958 through March 31, 1958	*April 1, 1958 through September 29, 1958*	*September 30, 1958 through December 31, 1958* [1]
Grade:			
A-1 [2]	$2.25	$2.05	$1.82
A-2 [3]	2.00	1.85	1.70

[1] During this period one producer quoted $1.62 per pound for sponge metal with a Brinell hardness of less than 100.
[2] Maximum iron content 0.2 percent with a Brinell hardness of less than 125.
[3] Maximum iron content 0.45 percent with a Brinell hardness of less than 170.

Prices per pound quoted for titanium mill products f.o.b. mill, commercially pure grades, in lots of 10,000 pounds were as follows:

	January 1, 1958 through April 22, 1958	*April 23, 1958 through October 22, 1958*	*October 23, 1958 through December 31, 1958*
Product:			
Sheet	$10.10-11.10	$9.10-9.60	(1)
Strip	9.50-10.00	8.50-9.00	(1)
Plate	8.00- 8.75	6.00-6.75	(1)
Wire	7.50- 8.00	6.50-7.00	(1)
Forging billets	6.00- 6.25	4.10-4.35	$3.80-4.35
Hot-rolled bars	6.15- 6.40	5.25-5.50	5.10-5.50

[1] Unchanged from April to October, 1958 price.

Ferrotitanium.—The price of all grades of ferrotitanium quoted in E&MJ Metal and Mineral Markets remained unchanged. Nominal prices quoted in 1958 were as follows:

Low-carbon: [1]	
Titanium, 40 percent; carbon, 0.10 percent maximum	$1.35
Titanium, 25 percent; carbon, 0.10 percent maximum	1.50
Medium-carbon: [2]	
Titanium, 17 to 21 percent; carbon, 3 to 5 percent	$290-$295
High-carbon: [2]	
Titanium, 15 to 19 percent; carbon, 6 to 8 percent	$240-$245

[1] Price a 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 [8]

Imports.—Imports of ilmenite concentrate, which included titanium slag from Canada, decreased 24 percent from 1957 to 348,000 tons. Most of the decrease was due to declining imports from Canada, which were 113,000 tons, 48 percent below 1957. Material from Canada was

[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.

virtually all titanium slag containing about 70 percent titanium dioxide. India supplied 212,000 tons, about the same as the previous year. In 1958, Australia was a source of a significant quantity of ilmenite for the first time and supplied 23,000 tons to the United States.

Rutile imports were 37,000 short tons, a 57 percent decline below 1957 and were virtually all from Australia.

Imports for consumption of titanium metal during the year were 2,073 short tons, valued at $6.3 million. Of this total, Japan supplied 2,071 short tons and the United Kingdom 2 tons.

TABLE 7.—Titanium concentrates [1] imported for consumption in the United States, by countries, in short tons

[Bureau of the Census]

Country of origin	1949–53 (average)	1954	1955	1956	1957	1958
ILMENITE						
North America: Canada [2]	36,742	107,521	166,307	196,660	217,762	112,874
South America	(3)					
Europe	12,062			40	33	55
Asia:						
Ceylon	(3)					
India	191,058	167,484	187,044	133,520	240,279	212,479
Malaya, Federation of	11			28,864	2,279	
Africa: Egypt	144					
Oceania: Australia	53			197		22,736
Grand Total	240,070	275,005	353,351	359,281	460,353	348,144
Value	$2,588,531	[4] $4,993,402	$7,031,060	[4] $9,197,835	[4] $10,316,853	$6,766,391
RUTILE						
North America: Mexico				50		
South America: Brazil						56
Europe				11		
Africa: French West Africa					94	
Oceania: Australia	10,605	14,965	19,526	48,845	84,743	36,507
Total as reported	10,605	14,965	19,526	48,906	84,837	36,563
Australia: In "zirconium ore" [5]	536	95				
Grand total	11,141	15,060	19,526	48,906	84,837	36,563
Value of "as reported"	$868,232	$1,323,183	$1,984,431	$7,147,827	$11,843,295	$4,512,937

[1] Classified as "ore" by Bureau of the Census.
[2] Chiefly titanium slag averaging about 70 percent TiO_2.
[3] Less than 1 ton.
[4] Data known to be not comparable with other years.
[5] Rutile content of zirconium ore as reported to the Bureau of Mines by importers.

Exports.—In 1958, the United States exported 37,000 tons of titanium dioxide and pigments, a decline of 30 percent below 1957. Canada, as in the past, the destination for most of the titanium-pigment exports, received 18,000 tons in 1958. Other countries that received 1,000 tons or more were as follows: France, 2,200; Belgium and Luxembourg, 2,000; Cuba, 1,300; Italy, 1,600; Mexico, 2,900; Philippines, 1,800; and Venezuela, 1,400.

Of the 1,200 tons of titanium concentrates shipped in 1958, 900 tons went to Canada and 200 tons to Norway. Small quantities were exported to the following countries: Colombia, Chile, Hong Kong, Mexico, Netherlands, Philippines, and West Germany.

TABLE 8.—Exports of titanium products from the United States, by classes

[Bureau of the Census]

Year	Ores 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
1949-53 (average)	998	$96,966	(3)	(3)	(4)	(4)	207	$65,753	35,388	$10,524,478
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	[5]64,806	[5]25,158,181
1957	2,019	276,472	71	77,629	779	9,404,232	367	130,046	52,960	19,687,188
1958	1,246	172,481	97	172,285	336	5,227,932	323	138,431	37,016	11,346 651

[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); 1953: 2 tons ($11,858).
[4] Not separately classified before 1952. 1952: 3 tons ($38,979); 1953: 31 tons ($798,077).
[5] Revised figure.

Exports of titanium sponge and scrap increased slightly over 1957 to 97 short tons. West Germany received 36 tons, Canada 30 tons, the United Kingdom 13 tons, and the remainder went to Sweden, Netherlands, France, Italy, and Japan. Exports of titanium-metal products decreased to 336 short tons in 1958, a 57 percent decrease below 1957. Canada received 327 tons, mostly as ingots. Cuba received 5 tons of mill shapes. The rest of the titanium products went to France, Sweden, Netherlands, Belgium and Luxembourg, West Germany, Italy, and the United Kingdom. Canada received 171 short tons of the 323 tons of ferroalloys exported in 1958. Italy received 135 tons; the remainer went to Chile, Sweden, Japan, Belgium and Luxembourg, United Kingdom, Australia, and Mexico.

WORLD REVIEW

Oversupply of rutile stocks at the beginning of 1958, coupled with decreased demand, led to a marked decline in world rutile production. Output from Australia, the leading producer, was particularly affected, decreasing 36 percent from 1957. Owing chiefly to a marked decrease in United States output world production of ilmenite declined 13 percent.

The United States was again the leading manufacturer of titanium sponge; its output was 4,600 tons. Japan was second with 1,800 tons. In 1957 Japan's production had been only one-fifth that of the United States. Production in the United Kingdom was estimated at 1,300 tons.

NORTH AMERICA

Canada.—The Quebec Iron and Titanium Corp. (QIT), Sorel, Quebec, closed its ilmenite-smelting plant in October. The company, two-thirds owned by Kennecott Copper Corp. and one-third by The New Jersey Zinc Co., planned to reopen the smelter early in 1959. Virtually the entire quantity of slag produced by QIT was exported to the United States and was used for making titanium pigments. The company attributed the decline in demand for titanium slag to decreased production of titanium pigments in the United States and

TABLE 9.—World production of titanium concentrates (ilmenite and rutile), by countries, in short tons [1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1949-53 (average)	1954	1955	1956	1957	1958
Ilmenite:						
Australia (sales) [2]	[3] 378	526	600	4,787	79,694	[4] 70,700
Brazil	143					5,691
Canada [5]	43,723	124,502	164,249	220,885	269,690	166,728
Egypt	1,267	2,900	2,694	4,547	[4] 3,700	[4] 3,700
Finland	[6] 3,465	55,765	93,668	113,444	116,568	117,384
Gambia		[7] 1,216			15,297	31,851
India	265,458	269,375	280,867	375,861	331,520	346,080
Japan [8]	[9] 1,930	2,638	5,097	9,634	9,055	3,837
Malaya (exports)	30,552	50,114	60,340	136,837	102,742	83,806
Mexico			12			166
Norway	122,556	164,448	173,981	209,990	231,693	233,585
Portugal	499	563	866	679	388	100
Senegal	5,164	13,779	30,424	21,716	39,573	36,128
Spain	976	1,397	7,388	5,962	9,796	[4] 17,100
Thailand				386	2,039	[4] 1,100
Union of South Africa	[6] 10		1,917	1,855	3,118	29,611
United States [10]	490,751	547,711	583,044	684,956	757,180	563,338
World total ilmenite (estimate) [1]	966,900	1,234,950	1,405,150	1,791,550	1,972,050	1,710,900
Rutile:						
Australia	31,954	50,018	66,767	108,434	144,372	[4] 92,900
Brazil	[7] 4	120	174	338	220	[4] 220
French Cameroon	194		110	168	44	
India	75	117	166	606	530	504
Norway	24		10	26	28	
Senegal	[11] 11			650	243	1,157
Union of South Africa	[6] 10				32	552
United States	7,136	7,411	8,513	11,997	10,702	7,406
World total rutile (estimate) [1]	39,400	57,700	75,740	122,200	156,200	102,750

[1] This table incorporates a number of revisions of data published in previous Titanium chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] Owing to high chromium content in the ore, sales are shown.
[3] Average for 1950-53 only; previous years are not available on sales basis.
[4] Estimate.
[5] Beginning 1950, includes Ti slag containing approximately 70 per cent TiO_2.
[6] Average for one year only, as 1953 was the first year of commercial production.
[7] Exports.
[8] Represents titanium slag.
[9] Average for 1952-53.
[10] Includes a mixed product containing ilmenite, leucoxene, and rutile for the years 1949-58.
[11] Average for 1951-53.

the availability of titanium ore from foreign sources at low prices. Despite decreased output, an expansion program that was begun in 1957 was virtually completed, and a new furnace was operated until October. The company stated that sales of ilmenite ore as an aggregate in high density concrete for coating underwater oil and gas lines and for shielding nuclear reactors continued to increase.[9]

EUROPE

Finland.—A new firm, Vuorikemia Oy (Mineral Chemicals Co.), was formed in Finland in 1958 to make titanium dioxide pigments from ilmenite produced by the Otanmäki Oy (Otanmäki Co.). Principal firms (all State-owned including Otanmäki Oy) involved in the venture were as follows: Outokumpu Oy (Outokumpu Co.), Rikkihappo-ja Superfosfaattitehtaat Oy (Sulfuric Acid and Superphos-

[9] Kennecott Copper Corporation, Forty-Fourth Annual Report, 1958, p. 17.

TABLE 10.—Quebec Iron & Titanium Corp. smelting operations, in short tons

Item	1954	1955	1956	1957	1958
Ore crushed	308,974	413,149	636,653	(1)	(1)
Ore smelted	268,139	348,578	470,745	627,255	381,732
Titanium slag produced	122,960	162,784	218,575	258,920	161,312
Titanium slag shipped	119,292	157,378	213,742	262,879	(1)
Estimated TiO_2 content of slag produced	88,408	117,042	150,640	185,360	(1)
Value of slag produced	$3,841,270	$5,192,810	$6,688,416	(1)	(1)
Desulfurized iron produced	90,562	121,312	159,874	187,529	117,878

[1] Data not available.

phate Co.), Imatran Voima Oy (Imatran Power Co.), and Typpi Oy (Nitrogen Co.).

The geology and mineralogy of the magnetite-ilmenite deposits at Otanmäki were described[10] and details given of the methods and instruments used in the exploration drilling of the area.

Germany, West.—Late in 1957 Farbenfabriken Bayer, AG., started production from its new titanium dioxide plant at Krefeld-Uerdingen. Initial capacity was estimated at 18,000 tons a year, but expansion to 50,000 tons per year was planned.[11]

Output combined with that from the 50,000-ton-a-year plant of Titangesellshaft, G.m.b.H., at Leverkussen, owned by the National Lead Co., was expected to meet West German requirements for titanium pigments.

Norway.—Titanium A/S, a subsidiary of the National Lead Co., planned to begin producing ilmenite concentrate in 1960 at its recently discovered ore body at Houge i Dalane, near Jossingfjord. Annual capacity of 300,000 tons of 44 percent TiO_2 ilmenite was expected to meet all requirements for the National Lead titanium pigment plant at Leverkussen, West Germany (Titangesellshaft), and was also to be sold to other pigment producers in Europe.

United Kingdom.—An article describing the production of titanium sponge, ingot, sheet, and bar by Imperial Chemical Industries, Ltd. (ICI), was published.[12] At Witton, North Yorkshire, ICI brought into operation the first of three new melting furnaces purchased from W. C. Heraeus, G.m.b.H. (West Germany). A 4,200-pound ingot can be melted in each furnace. The new rod mills and sheet rolling facilities at Waunarlwydd, South Wales, started in 1958. Annual capacity of the rod plant was given as 1,500 tons, the sheet mill, depending on the type and gage of the product, was rated at 50 to 300 tons per year. Annealing, finishing, and descaling operations were also described.

An article indicated that annual capacity of the ICI titanium sponge plant at Wilton was about 1,800 tons. Output in 1958 was estimated at 1,300 tons and consumption at about 500 tons.[13] Most of the remainder was reportedly being stockpiled by the Ministry of

[10] Paarma, H. E., and Levanto, A. E., Underground Exploration at Otanmäki Mine: Mine and Quarry Eng. (London), vol. 24, No. 12, December 1958, pp. 545–554.

[11] Chemical Age (London), Second German Titanium Dioxide Plant Starts Production: Vol. 78, No. 2004, Dec. 7, 1957, p. 932.

[12] Metallurgia, The Production of Wrought Titanium: Vol. 58, No. 345, July 1958, pp. 25–28.

[13] The Financial Times (London), I.C.I. Cuts Titanium Prices: No. 21,487, June 5, 1958, p. 9.

Supply through an agreement with the company that the Government would take up to 75-percent output.

ASIA

Ceylon.—Construction was started on a 60,000-tons-a-year plant to produce ilmenite concentrate from the sand deposits at Pulmoddai. Production by the Ceylon Mineral Sands Corp. was planned to start in late 1959.

Japan.—Production of titanium slag used for making titanium metal decreased to 3,700 short tons, about 40 percent of the 1957 output. Production came from three companies, Hokuetsu Electric Chemical Industrial, Co., Nisso Steel Manufacturing Co., and Morioka Electric Chemical Co. The Nisso Steel Manufacturing Co., which temporarily halted production in 1957, was the principal producer in 1958.

Output of titanium sponge metal in 1958, chiefly for export to the United States, was 47 percent below 1957 production. Exports of sponge totaled 1,962 tons, of which 1,959 tons went to the United States and the remainder to countries in Europe.

Malaya.—Export of ilmenite from Malaya decreased for the second year. Much of the decrease, aside from a lessened world demand, was due to curtailment of tin dredging operations from which ilmenite is recovered.

A report by the Malayan Department of Mines indicated that ilmenite from Malaya is probably a mixture of submicroscopic hydrated rutile and noncrystalline iron oxide. Intergrowths of ilmenite and rutile were also described and the behavior of these minerals in mineral dressing operations given.[14]

TABLE 11.—Titanium-sponge production in Japan, in short tons

Company	1952-53 (average)	1954	1955	1956	1957	1958
Osaka Titanium Co., Ltd	38	338	639	1,146	1,664	991
Toho Titanium Industry Co., Ltd	2	263	608	1,439	1,559	815
Nippon Soda Co., Ltd	3	37	115	183	170	6
Nippon Electric Metallurgical Co., Ltd	(1)	28	9			
Mitsui Mining & Smelting Co., Ltd	(1)	7	7			
Total	43	673	1,378	2,768	3,393	1,812

1 Less than 1 ton.

TABLE 12.—Titanium dioxide production, exports, and end of year stocks in Japan, 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	1958	1 30,033	1 13,988	2 2,625

1 January–November only.
2 Nov. 31, 1958.

14 Hockin, H. W., Ilmenite from Alluvial Deposits in Malaya: Ministry of Natural Resources, Federation of Malaya, Dept. of Mines, Res. Div., 1957, 9 pp.

TABLE 13.—Exports of ilmenite from Malaya, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1954	1955	1956	1957	1958
Australia			7,316	2,240	
Belgium	51	112		7,030	2,856
France	8,097	3,371	3,388	3,047	7,280
Italy		425	134	392	90
Japan	15,892	33,799	57,896	38,478	28,443
Netherlands	1,591	30	1,232	560	
United Kingdom	24,427	22,518	34,048	50,960	45,103
United States	56		32,683		
Other countries		85	140	35	34
Total	50,114	60,340	136,837	102,742	83,806

[1] Compiled from Customs Returns of Malaya.
[2] This table incorporates a number of revisions of data published in previous Titanium chapters.

AFRICA

Union of South Africa.—Production of ilmenite from the Anglo American Corp. mine, which is operated by the Umgababa Minerals, Ltd., near Durban, Natal, started in August 1958. Annual capacity of the plant was rated at 112,000 tons of ilmenite, 7,800 tons of rutile, and 11,000 tons of zircon.[15]

OCEANIA

Australia.—Owing to the low demand for rutile and the excess world production in 1957, most Australian mines operated at a reduced rate during 1958, and some stopped production altogether resulting in a drop in total output from 1957 of 36 percent to an estimated 93,000 tons. Moreover, the excess production of rutile in 1957 resulted in an oversupply of zircon, a coproduct, and the price of both commodities declined during 1958.

The Byron Bay, New South Wales, plant of Zircon Rutile, Ltd., which had been damaged by fire in late 1957, was rebuilt and began operation. Zircon Rutile, Ltd., and Crescent Rutile N.L., a new producer in 1957, were the principal suppliers of 3,500 tons of rutile traded to Red China under a barter agreement. A second agreement for an additional 3,500 tons was reportedly arranged.

Western Titanium N.L. at Capel, and Cable, Ltd., at Bunbury produced ilmenite from beach deposits in Western Australia. A third company in the area, Westralian Oil, Ltd., planned to produce ilmenite from its mine at Yoganup in the fall of 1958 or early 1959. Australia shipped 23,000 short tons of ilmenite to the United States during 1958.

[15] E&MJ Metal and Mineral Markets, Anglo American Corp. to Mine Ilmenite, Rutile, Zircon: Vol. 29, No. 24, June 12, 1958, p. 8.

TABLE 14.—Exports of rutile concentrate from Australia, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1954	1955	1956	1957	1958 [3]
Belgium	1,519	2,700	4,797	4,114	(4)
France	3,852	3,485	4,599	4,620	(4)
Germany, West	4,397	4,573	4,042	5,964	(4)
Italy	2,289	2,154	3,433	3,644	(4)
Japan	1,370	2,118	2,335	4,232	(4)
Netherlands	5,190	8,687	9,968	11,056	(4)
Sweden	1,742	3,093	3,591	3,938	(4)
United Kingdom	11,078	13,702	13,993	12,345	11,017
United States	16,148	23,798	51,754	79,086	22,289
Other countries	2,162	2,539	2,161	4,339	33,575
Total	49,747	66,849	100,673	133,338	66,881

[1] Compiled from Customs Returns of Australia.
[2] This table incorporates a number of revisions of data published in previous Titanium chapters.
[3] January through September, inclusive.
[4] Data not separately recorded.

TECHNOLOGY

During 1958 the Federal Bureau of Mines published several reports on various aspects of its titanium research.

Two reports on the examination of titanium placer deposits in Valley County, Idaho, were published.[16]

A report was published on tests made to determine carbon requirements and to study the effect of particle size and temperature on the chlorinating characteristics of high-titanium slags produced by electric-arc furnace smelting of alluvial Idaho ilmenite.[17]

The Bureau of Mines developed a trap that simplified the separation of iron chloride vapors from titanium tetrachloride when chlorinating high iron material such as ilmenite.[18] The iron chloride was condensed in the trap by a column of rock salt thus forming a low melting mixture, which could be intermittently tapped from the chlorinating apparatus. The titanium tetrachloride vapors pass through the salt.

A report showed that titanium could be electrorefined in a fused salt bath almost completely from its alloys containing molybdenum, tin, and zirconium; that refining from aluminum- and chromium-containing alloys was only slightly less successful; and refining from alloys containing vanadium and manganese was poor. Electrorefining improved the metal quality and the possibility of producing a high-purity titanium manganese alloy of any desired composition was discussed.[19]

[16] Storch, R. H., Ilmenite and Other Black-Sand Minerals in the Gold Fork Placer Deposit, Valley County, Idaho: Bureau of Mines Rept. of Investigations 5395, 1958, 15 pp.
Storch, R. H., Ilmenite and Other Black-Sand Minerals in the Deadwood Placer Deposit, Valley County, Idaho: Bureau of Mines Rept. of Investigations 5396, 1958, 15 pp.
[17] Barr, M. M., Gilbert, H. L., and Harper, D. D., Preliminary Studies in Chlorinating Titaniferous Slags from Idaho Ilmenite: Bureau of Mines Rept. of Investigations 5431, 1958, 14 pp.
[18] Perkins, E. C., Dolezal, H., and Lang, R. S., Trap for Romoving Ferric Chloride From Titanium Tetrachloride: Bureau of Mines Rept. of Investigations 5428, 1958, 4 pp.
[19] Nettle, J. R., Hill, T. E., Jr., and Baker, D. H., Jr., Electrorefining of Titanium From Binary Alloys: Bureau of Mines Rept. of Investigations 5410, 1958, 11 pp.

Theoretical indications pertaining to the major chemical reactions and possible side reactions of the sodium reduction of titanium tetrachloride were discussed in a report.[20] Major emphasis was given to describing equipment and the operation of a two-stage process that reduced titanium tetrachloride first to a subchloride and secondly to the metal.

Tests disclosed that alloys of titanium-manganese, titanium-aluminum-tin, titanium-copper, and titanium-aluminum have corrosion characteristics similar to commercially pure titanium.[21]

A review of the application and design principles of the moving-bed process for chlorinating titaniferous material was published in 1958.[22] Phase diagrams were given for the ternary system lime-silica-titania and the two binary systems SiO_2–$CaO \cdot TiO_2$ and $CaO \cdot SiO_2$–TiO_2 in a report discussing the factors affecting slag composition, viscosity, and temperature in smelting titaniferous iron ores.[23]

A report described production by the Union Carbide Metals Corp. of titanium metal by sodium reduction of titanium tetrachloride.[24] A process flow-sheet and methods of handling molten sodium metal and purifying titanium tetrachloride were explained.

A method for vacuum melting and casting titanium and other refractory metals was patented.[25] The method, developed by the Bureau of Mines, has opened a new area of applicability for titanium and other metals which are difficult to cast without contamination. Results of recent studies on the techniques involved were published.[26]

The variability of the surface finish, compressive strength, permeability, and thermal conductivity of an expendable graphitic mold used for casting titanium were studied as a function of the molding pressure and moisture content.[27]

A furnace that melts chemically reactive metals such as titanium by electron bombardment under a vacuum of 10^{-7} atmospheres [28] was described. The process was reported to be economically competitive with consumable electrode arc melting.

A comprehensive review of the consumable-electrode vacuum arc melting technique used for melting titanium and other metals was

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[20] Homme, V. E., Wong, M. M., and Baker, D. H., Jr., Sodium Reduction of Titanic Chloride: Bureau of Mines Rept. of Investigations 5398, 1958, 29 pp.

[21] Kenahan, Charles B., and Schlain, David, Chemical and Galvanic Corrosion Properties of Titanium Alloys: Bureau of Mines Rept. of Investigations 5423, 1958, 27 pp.

[22] Vener, Raymond E., Moving-Bed Processes—Present and Potential Applications: Handbook of Ideas for Better Mine, Mill and Smelter Operations, Eng. Min. Jour., pp. 95–105.

[23] Ross, H. U., Smelting Titaniferous Ores: Jour. Metals, vol. 10, No. 6, June 1958, pp. 407–411.

[24] Chemical Engineering, Sodium-Reduction Route Yields Titanium: Vol. 65, No. 5, Mar. 10, 1958, pp. 124–127.

[25] Beall, Robert A., Borg, John O., and Gilbert, Henry L. (assigned to the United States of America as represented by the Secretary of the Army), Method for Melting Refractory Metals for Casting Purposes: U.S. Patent 2,825,641, March 4, 1958.

[26] Roberson, A. H., Titanium and Zirconium Casting Developments by the U.S. Bureau of Mines: Jour. Inst. Metals, vol. 86, 1957–58, pp. 1–6.

Wood, F. W., Ausmus, S. L., and Calvert, E. D., A Casting Technology for Reactive Metals: Modern Castings, vol. 34, No. 7, July 1958, pp. 354–360.

[27] Antes, H. W., Norton, J. T., and Edelman, R. E., Foundry Characteristics of A Rammed Graphitic Mold Material For Casting Titanium: Modern Castings, vol. 33, No. 4, April 1958, pp. 69–76.

[28] Dayton, Stanley H., New Refining Process Purifies Refractory Metals: Mining World, vol. 20, No. 8, July 1958, pp. 40–43.

Chemical Week, Readying Electron-Beam Melting for the Refinery: Vol. 82, No. 5, Feb. 1, 1958, pp. 48–50.

reported.[29] Schematic diagrams of the vacuum arc melting furnace and of a skull type furnace, arc control methods, and comparisons with other melting techniques are described. Safety factors and types of vacuum pumps are also discussed.

Development of several new alloys increased the potential use of titanium at higher temperatures and greatly improved the workability. A new alloy reportedly held its strength at 1,100° F. for long periods; it contains 8 percent aluminum, 8 percent zirconium, and 1 percent tantalum and columbium combined.[30] An alloy having 13 percent vanadium, 11 percent chromium, and 3 percent aluminum was reported to be easily formed in the all-beta condition yet heat-treatable to high strengths.[31] One alloy containing 3 percent molybdenum and 0.25 percent beryllium was reported to show promise as a highly weldable and age hardenable alloy.[32]

Two articles showed that electrode passivation of titanium anodes, caused by formation of an oxide film, can be circumvented by plating a thin coating of platinum on the metal. The coating, which does not have to be continuous, carries the current.[33]

Methods described for forming titanium included hot spinning,[34] hot forming (press or drop hammer),[35] cold extrusion,[36] and explosive forming.[37] An aircraft manufacturer solved a forming problem with titanium by redesign. The technique used was spot welding pure titanium to an outer skin of titanium alloy, containing 8 percent manganese, thus giving the structure the necessary strength.[38]

Various techniques reported for machining titanium and its alloys reflected the industry's increasing facility and familiarity with this phase of metal processing and broadened the horizons of fabrication and design. Chemical milling of titanium and other light metals were described.[39] Two methods for machining honeycomb made from 0.001-inch titanium foil were reported.[40] In one method the honeycomb structure is filled with water, frozen, and machined at high speed. A guide to machining other forms of titanium also was published.[41]

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[29] Gruber, Helmut, Consumable-Electrode Vacuum Arc Melting: Jour. Metals, vol. 10, No. 3, March 1958, pp. 193–198.

[30] Steel, Titanium Alloy List Grows: Vol. 143, No. 15, Oct. 13, 1958, p. 118.

[31] Materials in Design Engineering, First All-Beta Titanium Alloy Has Strength of 240,000 psi: Vol. 48, No. 3, September 1958, pp. 131–132, 134, 136.

Metal Progress, New Titanium Alloys: Vol. 74, No. 3, September 1958, pp. 134, 136, 138, 140, 142, 145.

[32] Grossley, F. A., Iron Age, High Strength Titanium Alloy Has Good Weldability: Vol. 182, No. 18, October 1958, pp. 84–86.

[33] Chemical Trade Journal and Chemical Engineer (London), Titanium Anodes: Vol. 144, No. 3735, Jan. 2, 1959, pp. 18, 20.

Cotton, J. B., Further Aspects of Anodic Polarization of Titanium: Chem. and Ind. (London), No. 17, Apr. 26, 1958, pp. 492–493.

[34] Modern Metals, Titanium Problem Licked . . . By New Hot Spinning Process: Vol. 13, No. 11, December 1957, pp. 66–67.

[35] Steel, Hot Forming Titanium: Vol. 142, No. 9, Mar. 3, 1958, p. 109.

[36] Modern Metals, Battelle Cold Extrudes Hollow Titanium Parts: Vol. 14, No. 11, December 1958, p. 77.

[37] Metal Progress, Forming Metals at High Velocities: Vol. 74, No. 5, November 1958, pp. 68–76.

[38] Smith, C. P., Titanium Advances in Crusader III Design: Light Metal Age, vol. 16, Nos. 9 and 10, October 1958, pp. 6–7.

[39] Reed, F. H., Chemical Milling Light Metals: Light Metal Age, vol. 16, Nos. 3 and 4, April 1958, pp. 23–27.

Chemistry, Chemical Milling: Vol. 32, No. 3, November 1958, pp. 35–36.

[40] Gilbraith, Allen C., 2 Ways to Machine Titanium Honeycomb: Modern Metals, vol. 14, No. 3, April 1958, p. 78.

[41] Iron Age, Guide to Machining Titanium: Vol. 181, No. 17, Apr. 24, 1958, pp. 126–128.

Findings on optimum conditions for use of the titania-modified, sodium hydride bath for descaling titanium alloys were reported.[42] A furnace equipped with a purge chamber and quench tank designed to preserve the bright finish on small titanium parts was also described.[43]

The use of a sodium silicate coating to protect titanium from oxidation during heat treating was reported. The coating is sprayed on and removed with a caustic soda solution after heat treatment.[44] A continuous furnace for intermediate annealing of titanium sheet between cold-rolling operations was described.[45] A study of the influence of solution temperature on the flow characteristics and uniform elongation of alpha-beta alloys of titanium was reported.[46]

Owing to the adverse effect of hydrogen on titanium, its solubility in the metal has been extensively investigated. Studies show that hydrogen embrittlement of titanium is caused by the separation of a hydride or hydrogen-rich phase.[47] Moreover, solubility of hydrogen increases as the quantity of the beta phase increases, consequently, tolerance for hydrogen (before embrittlement occurs) increases as the percentage of the beta phase increases. A Soviet report is in agreement with these conclusions.[48] Aluminum, like the beta phase, appears to have the ability to solubilize hydrogen; however, the mechanism is not clearly understood.

A study of the cause of variation in composition of barium titanate, owing to methods of production, was reported.[49] Existence of a barium orthotitanate, which is soluble in water, was indicated, and suggestions for preventing its formation during the production of titanate were presented.

Factors affecting the opacification of glazes by precipitation of titanium dioxide were described in a report. The influence of temperature and of the oxides of boron, sodium, zinc, and particularly of aluminum, when firing, were discussed.[50]

Progress of the technologic development of titanium was reviewed in a report during 1958.[51] Properties and uses of the pure metal,

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42 Wheatley, Q. D., How to Avoid Hydrogen Pickup in Descaling Titanium Alloys: Metal Progress, vol. 74, No. 6, December 1958, pp. 112–113.

43 Metal Industry (London), Bright Heat-Treatment for Titanium: Vol. 93, No. 8, Aug. 22, 1958, p. 154.

44 Steel, Water Glass Solves Heat Treat Problem: Vol. 142, No. 25, June 23, 1958, pp. 100, 104.

45 Metal Industry (London), Annealing Titanium Sheet: Vol. 93, No. 20, Nov. 14, 1958, p. 412.

46 Griest, A. J., Robinson, H. A., and Frost, P. D., Effect of Composition and Heat-Treatment of the Uniform Elongation and Flow Properties of Alpha-Beta Titanium Alloys: Trans. Metallurgical Soc. of AIME, vol. 212, No. 1, February 1958, pp. 117–121.

47 Albrecht, W. M., and Mallett, M. W., Hydrogen Solubility and Removal for Titanium and Titanium Alloys: Trans. Metallurgical Soc. of AIME, vol. 212, No. 2, April 1958, pp. 204–210.

Berger, L. W., Williams, D. N., and Jaffee, R. I., Hydrogen in Titanium-Aluminum Alloys: Trans. Metallurgical Soc. of AIME, vol. 212, No. 4, August 1958, pp. 509–513.

Robinson, H. A., Frost, P. D., and Parris, W. M., Effect of Hydrogen on Some Mechanical Properties of a Titanium Alloy Heat-Treated to High Strength: Trans. Metallurgical Soc. of AIME, vol. 212, No. 4, August 1958, pp. 464–469.

Metal Industry (London), Hydrogen in Titanium: Vol. 93, No. 7, Aug. 15, 1958, pp. 133, 138.

48 Glazunov, S. G., Kornilov, I. I., and Yakimova, A. M., Effect of Hydrogen on the Structure and Properties of Titanium and Its Alloys: Izvestiya Akademii Nauk, Otdeleniye Tekhnicheskikh Nauk, No. 6, June 1958, pp. 30–36. (Abs., Sci. Information Rept., Central Intelligence Agency, Sept. 19, 1958, p. 83.)

49 Murray, John F., Some Causes and Effects of Phases Other Than Tetragonal $BaTiO_3$ in Barium Titanate: Am. Ceram. Soc. Bull., vol. 37, No. 11, November 1958, pp. 476–479.

50 Styhr, K. H., Jr., and Beals, M. D., Use of Titanium Dioxide in Self-Opacifying Glazes: Am. Ceram. Soc. Bull., vol. 37, No. 11, November 1958, pp. 480–485.

51 Inglis, N. P., and McQuillan, M. K., A Progress Report on Titanium: Indian Min. Jour. (Calcutta), vol. 6, No. 8, August 1958, pp. 8–14.

development of alloys, and techniques for extraction, melting, and fabrication, were discussed.

Standard methods for preventing and handling titanium fires were published by the National Fire Protection Association in 1958.[52] The standard calls attention to the fire and explosive hazards associated with producing, handling, and storing titanium.

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[52] National Fire Protection Association, Standard for Titanium, NFPA No. 481: May 1958, 32 pp.

Tungsten

By R. W. Holliday [1] and Mary J. Burke [2]

FURTHER curtailment of domestic mine production, lower industrial consumption, reduction of imports, and virtual completion of the U.S. Government purchase program were principal elements of the tungsten industry in 1958.

Domestic production of tungsten concentrate in the last half year came from only two producers, both mining complex ores containing other marketable minerals. In most other areas of the free world production also was curtailed greatly.

There was substantial progress in research to utilize more fully the high-temperature strength of tungsten.

TABLE 1.—Salient tungsten ore and concentrate statistics, thousand pounds of contained tungsten

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Mine production	5,853	13,166	15,833	14,761	8,032	(1)
Mine shipments	5,913	13,030	15,619	14,027	5,254	3,605
General imports	13,871	23,044	20,789	21,857	14,186	6,873
Imports for consumption	14,854	24,188	20,700	20,860	14,018	6,542
Consumption	7,867	4,037	8,967	9,061	8,544	5,320
Stocks:						
Producers	369	362	523	1,477	4,326	(1)
Consumers and dealers	4,108	3,913	3,502	2,980	4,103	4,670
Total	4,477	4,275	4,025	4,457	8,429	(1)
World: Production	55,105	74,520	78,327	78,422	71,379	60,434

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

LEGISLATION AND GOVERNMENT PROGRAMS

Government acquisition of tungsten concentrate for the national stockpile neared completion by yearend. Purchase from domestic producers had been suspended in December 1956. Deliveries from some foreign suppliers continued into late 1958, and deliveries under one contract continued into 1959. The above purchases were authorized under the Strategic and Critical Materials Stock Piling Act (Public Law 520, approved July 23, 1946) and the Defense Production Act of 1950 (Public Law 774, approved September 8, 1950).

The Defense Minerals Exploration Administration (DMEA) was superseded September 11, 1958, by the Office of Minerals Exploration (OME) as an agency of the Department of the Interior. From inception of the DMEA program in April 1951 a total of 478 applica-

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

tions for Government assistance in tungsten exploration was received, and 126 contracts were executed. Five contracts were in force at the end of 1958. There were 53 certifications of discovery. Maximum Government participation authorized was $3,740,581; Government expenditures were $2,515,727; and total estimated costs of the projects were $5,008,124. Tungsten was not "eligible" for financial assistance in exploration under OME regulations.

Section 8 of the Trade Agreements Extension Act of 1958 provided for investigation by OCDM, on application by an interested party, to determine whether imports of tungsten ores and concentrates threatened to impair the national security. Investigation was initiated following requests by several tungsten mining firms.

Stockpiling policy revisions became effective June 30 with issuance of Defense Mobilization Order V-7. Policy revisions included a change in stockpile objectives to assume a 3-year rather than a 5-year emergency. The order also stated that disposal of excesses (beyond maximum objectives) "shall be undertaken only if they do not cause serious economic disruption or adversely affect the international interests of the United States."

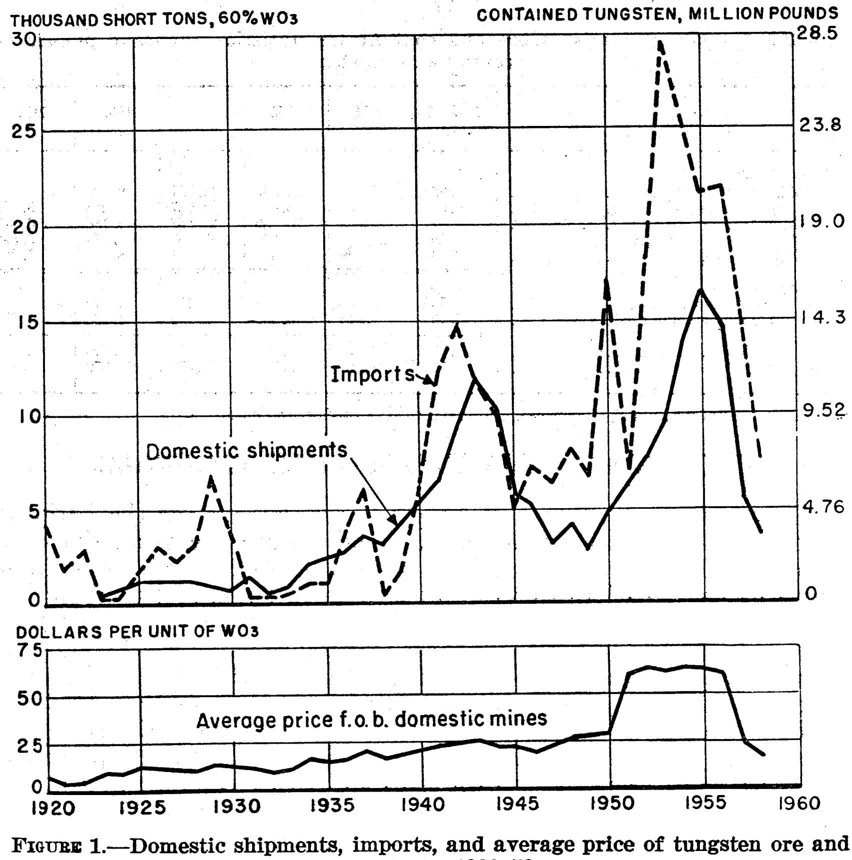

FIGURE 1.—Domestic shipments, imports, and average price of tungsten ore and concentrate, 1920–58.

DOMESTIC PRODUCTION

Domestic mine production of tungsten concentrate fell far below that of 1957, and only two producers were active during the last half year. Shipments from stocks-on-hand, however, were made from several mines.

In the last week of June operations were suspended at two of the largest U.S. tungsten mines. The Nevada-Massachusetts Co. had produced scheelite, with little interruption since 1925, from deposits in the Mill City area of Pershing County, Nev.; Tungsten Mining Corp., which became a subsidiary of Howe Sound Co. in 1958, had produced hubnerite from the Hamme mine in Vance County, N.C., beginning in World War II. A report by the Tariff Commission on the competitive status in the United States of tungsten ore and concentrate produced in this country and in foreign countries was published.[3]

Throughout 1958 the Pine Creek mine and mill of Union Carbide Nuclear Co. in Inyo County, Calif., produced tungsten concentrate from ores that contained other marketable minerals, principally molybdenite. Except for closing nearly 3 months, the Climax Molybdenum division of American Metal Climax, Inc. in Lake County, Colo., produced byproduct tungsten concentrate from molybdenum ore.

TABLE 2.—Tungsten concentrate shipped from mines in the United States

Year	Quantity			Reported value f.o.b. mines [1]		
	Short tons 60 percent WO_3 basis	Short ton units WO_3 [2]	Tungsten content (thousand pounds)	Total (thousands)	Average per unit of WO_3	Average per pound of tungsten
1949-53 (average)	6,213	372,757	5,913	$20,088	$53.89	$3.40
1954	13,691	821,463	13,030	51,433	62.61	3.95
1955	16,412	984,711	15,619	60,841	61.79	3.90
1956	14,737	884,323	14,027	51,201	57.90	3.65
1957	5,520	331,208	5,254	[3] 8,186	24.72	1.56
1958	3,788	227,255	3,605	3,991	17.56	1.11

[1] Values apply to finished concentrate and in some instances f.o.b. custom mill.
[2] A short-ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.862 pounds of tungsten (W).
[3] Estimated by Bureau of Mines.

CONSUMPTION AND USES

In only 2 years (1949 and 1954) of the last 20 has U.S. consumption of tungsten concentrate been less than in 1958. Concentrate was consumed by direct addition to the steel bath and in the manufacture of intermediate products such as ferrotungsten, metal powder, and chemicals.

Consumption of products, including imports, scrap, and scheelite used directly in steel, decreased 32 percent compared with 1957 and 43 percent compared with 1956, the first year in which these data were collected.

[3] U.S. Tariff Commission, Tungsten Ore and Concentrates: Report on Investigation 33, Sec. 332 of Tariff Act of 1930, Made Pursuant to a Resolution of the Committee on Finance, U.S. Senate, November 1958, 67 pp.

Steel and other alloys accounted for 38 percent of tungsten consumption, tungsten carbides 39 percent, and pure-metal uses 16 percent.

Approximately equal quantities of scheelite and ferrotungsten (tungsten content) were used in steel.

As a constituent of alloy steels, tungsten was used in hundreds of compositions, varying in tungsten content from less than 1 percent to about 22 percent. High-speed tool steel, the largest category, had numerous applications other than in tools.

Pure metal (wire, rod, and sheet) accounted for 34 percent of the consumption of hydrogen reduced tungsten metal powder and cemented carbides for 57 percent.

Tungsten carbides were of two principal types. Cemented or sintered carbide was made from hydrogen reduced tungsten metal powder converted to tungsten carbide powder, compacted and sintered with a cobalt binding material. It was used largely in cutting tools, rock drill bits, wear-resistant parts, and similar applications.

Cast or fused carbide, harder but more brittle than cemented carbides, was made from tungsten metal powder or scrap melted with a carbonaceous material and cast to a desired shape. The casting was used as such or crushed and sized for use as hardfacing.

TABLE 3.—Distribution of tungsten concentrate consumed

	Tungsten content (thousand pounds)		Short tons (60 percent WO_3)		Percent of total	
	1957	1958	1957	1958	1957	1958
Manufacturers of steel ingots and ferrotungsten	2,110	1,393	2,217	1,464	25	26
Manufacturers of hydrogen-reduced metal powder	3,760	2,274	3,951	2,389	44	43
Manufacturers of carbon-reduced metal powder and tungsten chemicals and consumption by firms making several products	2,674	1,653	2,810	1,737	31	31
Total	8,544	5,320	8,978	5,590	100	100

TABLE 4.—Consumption of tungsten products in the United States, and stocks at plants of consumers

(Thousand pounds of contained tungsten)

Product	Consumption		Stocks, Dec. 31	
	1957	1958	1957	1958
Tungsten-metal powder: [1]				
Hydrogen reduced	1,781	1,305	110	71
Carbon reduced	77	[2] 213	50	47
Tungsten carbide powder	2,819	1,737	72	46
Chemicals	334	296	18	27
Scheelite (including synthetic)	1,194	705	4	----------
Scrap	717	473	253	199
Other [3]	1,208	785	283	285
Total	8,130	5,514	790	675

[1] Does not include quantities consumed in manufacturing tungsten carbides.
[2] Increase is due to a change in the method of reporting and includes metal powder consumed in fused or cast carbides.
[3] Includes ferrotungsten, cobalt-chromium-tungsten, melting base, and tungsten-alloy powder.

TABLE 5.—Consumption of tungsten by class of manufacture

(Thousand pounds of contained tungsten)

Uses	1957	1958
Steel:		
High speed	2,128	1,114
Other tool steel	419	306
Alloy steel (other than tool)	298	323
High-temperature nonferrous alloys	295	181
Other nonferrous alloys	175	164
Metal (wire, rod, and sheet)	1,106	869
Carbides:		
Cemented or sintered	2,113	1,452
Other	1,165	711
Chemicals:		
Fluorescent powders	27	21
Pigments	92	114
Miscellaneous [1]	312	259
Total	8,130	5,514

[1] Includes diamond drill bits, electrical contact points, welding rods, and uses not classified by reporting firms.

Consumption of concentrate centered in two areas—71 percent in New York, New Jersey, and Pennsylvania and 28 percent in Illinois, Indiana, and Ohio. Most consumption of products was in the same areas, but 16 percent was used in California and Texas, mainly in hardfacing materials.

STOCKS

Stocks of tungsten concentrate held in the National Stockpile exceeded minimum and long-term objectives. Stocks of 4,296,000 pounds contained were held on June 30, 1958, by consumers and dealers and 5,003,000 pounds by domestic producers. Stocks held at the yearend by producers were not available for publication; stocks held by consumers and dealers are shown in table 1.

PRICES AND SPECIFICATIONS

As quoted by E&MJ Metal and Mineral Markets, the price of tungsten metal powder (98.8 percent in 1,000-lb. lots) was $3.15 a pound throughout the year. For hydrogen reduced tungsten metal powder (99.99 percent) the price was $3.85 a pound until May 26 when it was lowered to $3.33 to $3.80.

Ferrotungsten was quoted throughout the year at $2.15 a pound of contained tungsten in lots of 5,000 lb. or more (70–80 percent W) lump (1/4 inches), packed; f.o.b. destination continental United States.

FOREIGN TRADE [4]

Termination of U.S. purchase contracts have been reflected in greatly decreased imports of concentrate since 1956. This, together with reduced consumption of tungsten in 1958, accounted for the 52-percent reduction in imports of concentrate compared with 1957.

[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 6.—Prices of tungsten concentrate in 1958 [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	
January 9	$12 -$13	$11 -$12	90s bid–95s asked.
February 6	12 -13	11 -12	95s bid–101s asked.
March 6	11.50–12.50	10 -11.50	95s bid–100s asked.
April 3	11.50–12.50	10 -11.50	90s bid–95s asked.
May 1	11.50–12.50	10 -11.50	82s bid–85s asked.
June 5	10 -11	9 -10	76s bid–80s asked.
July 3	10 -11	9 -10	66s 6d–76s 6d.
August 7	9 -10	8 -9	62s 6d–67s.
September 4	7.50–8	7.50–8.50	60s–65s.
October 2	7.75–8	7.75–8.50	60s–65s.
November 6	8.25–8.50	8.25–8.50	72s–77s.
December 4	11.75–12	11.75–12	94s–99s.
Average	10.61	9.93	
Duty	7.93	7.93	
Average price duty paid	18.54	17.86	

[1] Published price quotations (from E&MJ Metal and Mineral Markets).
[2] Nearby arrival, 65 percent basis.

Brazil and Peru each supplied concentrate containing more than 1 million pounds of tungsten, and four other nations—Australia, Canada, Argentina, and Republic of Korea, in that order—each supplied more than 500,000 pounds.

Imports of tungsten metal, tungsten carbide, and combinations containing tungsten or tungsten carbide, in lumps, grains or powder, weighing 101,363 pounds tungsten content, were valued at $230,323. Imports of ferrochromium tungsten, chromium tungsten, chromium-cobalt tungsten, tungsten nickel, and other alloys not specifically provided for, weighing 83 pounds tungsten content, were valued at $983.

Imports of tungstic acid and other compounds of tungsten not specifically provided for were 220 pounds tungsten content valued at $1,299.

Semifabricated forms imported in the last 5 years are shown in table 9.

Exports and reexports of tungsten concentrate were 22 and 162 tons, respectively, gross weight, compared with 163 and 572 tons, respectively, in 1957.

Exports of ferrotungsten to Canada and the United Kingdom were 2,120 pounds gross weight valued at $3,508.

Tungsten metal powder, gross weight 129,481 pounds valued at $752,314, was exported to Canada (85,673 pounds), Italy (21,667 pounds), West Germany (14,064 pounds), and other countries.

Exports of tungsten metal and alloys in crude form and scrap were 76,977 pounds gross weight valued at $157,276. Reexports were 5,214 pounds valued at $4,303.

Semifabricated forms exported were 32,680 pounds gross weight valued at $761,836.

TABLE 7.—Tungsten ore and concentrate imported for consumption in the United States, by countries[1]

[Bureau of the Census]

Country	1957 Gross weight (thousand pounds)	1957 Tungsten content (thousand pounds)	1957 Value (thousand)	1958 Gross weight (thousand pounds)	1958 Tungsten content (thousand pounds)	1958 Value (thousand)
North America:						
Canada	3,188	1,624	$5,630	1,185	680	$2,161
Mexico	245	125	146	4	2	1
Total	3,433	1,749	5,776	1,189	682	2,162
South America:						
Argentina	3,643	1,910	5,150	1,178	586	1,580
Bolivia [2]	[3] 5,191	[3] 2,524	[3] 6,291	856	367	236
Brazil	3,612	2,011	3,980	4,595	2,609	2,628
Chile [2]	([4])	([4])	([4])	57	25	16
Peru [2]	1,992	1,149	3,437	1,591	928	2,635
Total	14,438	7,594	18,858	8,277	4,515	7,095
Europe:						
Netherlands	44	25	29	40	21	17
Portugal	1,270	722	1,655	42	23	14
Spain	264	150	319	---	---	---
Total	1,578	897	2,003	82	44	31
Asia:						
Burma	268	149	202	90	49	35
Hong Kong	---	---	---	([5])	([5])	([5])
Japan	23	13	26	---	---	---
Korea, Republic of	3,210	1,727	2,554	673	370	254
Malaya, Federation of	} 235	} 129	} 207	56	31	21
Singapore [6]				22	12	8
Thailand	95	53	99	45	25	20
Total	3,831	2,071	3,088	886	487	338
Africa: Belgian Congo	297	164	311	22	12	7
Oceania: Australia	2,875	1,543	4,489	1,549	802	2,327
Grand total	26,452	14,018	[7] 34,525	12,005	6,542	11,960

[1] Minerals Yearbook 1957, p. 1211, 1957 general imports should read: Bolivia, 4,893,893 pounds gross weight, 2,419,140 pounds tungsten content, $5,915,181. Chile revised to none.
[2] Imports shown from Chile probably were mined in Bolivia or Peru and shipped from a port in Chile.
[3] Revised figure.
[4] Revised to none.
[5] Less than 1,000.
[6] Effective Jan. 1, 1958.
[7] Data known to be not comparable with 1958.

WORLD REVIEW

At 1958 prices relatively few tungsten deposits in the free world properly could be classified as ore, and tungsten mining was curtailed in virtually every area. The potential free-world reserve, assuming a price range approximating that of the 1950–56 period, has been estimated at 580 million pounds contained tungsten. The United States has 143 million pounds, Republic of Korea 105 million pounds, Bolivia and Burma more than 70 million pounds each, and Brazil and Portugal more than 30 million each. The ore reserve in Communist China is largest in the world by far, estimated to be 2,000 million pounds contained tungsten.

Suspension of U.S. Government purchase for stockpiling was

TABLE 8.—Ferrotungsten imported for consumption in the United States, by countries

[Bureau of the Census]

Country	1957			1958		
	Gross weight (thousand pounds)	Tungsten content (thousand pounds)	Value (thousand)	Gross weight (thousand pounds)	Tungsten content (thousand pounds)	Value (thousand)
Europe:						
Austria	81	65	$123	46	37	$41
Belgium-Luxembourg	22	18	26			
Germany, West	70	55	94			
Portugal	147	120	151	48	39	34
Sweden	132	114	202	22	19	14
United Kingdom	52	43	78	56	46	45
Total	504	415	674	172	141	134
Oceania: Australia				22	18	20
Grand total	504	415	674	194	159	154

TABLE 9.—Tungsten or tungsten carbide forms imported for consumption in the United States

[Bureau of the Census]

Year	Ingots, shot, bars, or scrap		Wire, sheets, or other forms, n.s.p.f.		Total	
	Gross weight (pounds)	Value	Gross weight (pounds)	Value	Gross weight (pounds)	Value
1954	327,935	$661,164	440	[1] $10,346	328,375	[1] $671,510
1955	353,928	693,494	102,169	[1] 310,523	456,097	[1] 1,004,017
1956	485,583	840,271	168,103	578,328	653,686	1,418,599
1957	66,717	[1] 130,139	190,413	[1] 483,195	257,130	[1] 613,334
1958	53,299	57,543	196,190	348,179	249,489	405,722

[1] Data known to be not comparable to other years.

largely responsible for the free-world production decrease of 29 percent from 1957 output and 45 percent from the high of 1956.

NORTH AMERICA

Canada.—Canadian Exploration, Ltd. at Salmo, British Columbia, completed deliveries in June under its contract for sale of concentrate to the U.S. Government. Operation of its tungsten mill was suspended, but lead-zinc operations were continued. Exports of concentrate to the United States were 58 percent less than in 1957.

Mexico.—Production of tungsten concentrate in Mexico was negligible, and only 9,000 pounds, tungsten content, a decline of 95 percent from 1957, was exported to the United States.

SOUTH AMERICA

Argentina.—A contract for sale of tungsten concentrate to the U.S. Government expired June 30, and exports to the United States were 69 percent less than in 1957. Purchases by the Argentine State purchasing agency, Comite de Comercialization de Minerales, continued

TABLE 10.—World production of tungsten ore and concentrate (60 percent WO_3 basis), by countries, 1949–53 (average) and 1954–58, in short tons.[1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	746	1,809	1,618	1,893	1,602	575
Mexico	348	601	626	628	294	8
United States (shipments)	6,212	13,691	16,412	14,737	5,520	3,788
Total	7,306	16,101	18,656	17,258	7,416	4,371
South America:						
Argentina	347	1,120	1,213	1,293	1,440	1,105
Bolivia (exports)	3,368	4,900	5,935	5,255	4,809	3,867
Brazil (exports)	1,430	1,513	1,410	2,017	2,304	2,596
Peru	646	849	893	1,242	1,215	979
Total	5,791	8,382	9,451	9,807	9,768	8,547
Europe:						
Austria	----------	----------	----------	----------	140	146
Finland	32	139	146	74	----------	397
France	953	1,129	1,520	1,348	1,016	1,124
Italy	10	36	30	26	20	11
Portugal	4,562	5,076	5,122	5,506	4,756	2,058
Spain	2,051	2,905	1,728	1,354	1,132	1,017
Sweden	439	504	510	504	557	575
U.S.S.R.[2]	8,000	8,300	8,300	8,300	8,300	8,300
United Kingdom	74	101	80	68	55	[2] 55
Yugoslavia [2]	[3] 130	110	110	110	110	110
Total [2]	16,300	18,300	17,500	17,300	16,100	13,800
Asia:						
Burma [4]	1,657	1,323	2,927	2,982	2,873	1,667
China [2]	16,200	19,800	19,800	19,800	22,000	[5] 22,000
Hong Kong	101	33	28	30	42	46
India	9	1	----------	2	2	----------
Japan	313	860	990	1,200	1,144	851
Korea:						
North [2]	1,320	1,650	1,650	1,650	4,400	4,400
Republic of	3,503	4,575	3,757	4,472	4,580	3,621
Malaya	83	127	138	117	63	57
Thailand	1,543	1,323	1,367	1,411	1,080	725
Total [2]	24,700	29,700	30,700	31,700	36,200	33,400
Africa:						
Algeria	[6] 37	----------	----------	----------	----------	----------
Belgian Congo [4] [7]	814	1,687	1,733	2,142	1,914	1,483
Egypt	9	4	21	----------	----------	----------
Morocco: Southern Zone	17	14	----------	3	----------	----------
Nigeria	17	1	3	4	----------	----------
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	247	281	245	287	180	103
South-West Africa [4]	88	294	283	388	278	64
Tanganyika (exports)	22	6	10	7	----------	----------
Uganda (exports)	194	204	180	193	224	31
Union of South Africa	298	675	708	330	290	68
Total	1,743	3,166	3,183	3,354	2,886	1,749
Oceania:						
Australia	2,000	2,563	2,765	2,954	2,629	1,601
New Zealand	42	33	[2] 33	33	36	3
Total	2,042	2,596	2,798	2,987	2,665	1,604
World total (estimate)	57,900	78,300	82,300	82,400	75,000	63,500

[1] This table incorporates a number of revisions of data published in previous Tungsten chapters. Data do not add exactly to totals shown because of rounding where estimated figures are included in the detail.
[2] Estimate.
[3] One year only.
[4] Including WO_3 in tin-tungsten concentrates.
[5] Data represents 1957 production; however, 1958 production was probably much greater.
[6] Average for 1951–53.
[7] Including Ruanda-Urundi.

through the year and were 520 short tons (60 percent WO_3) of wolframite and 586 tons of scheelite. An Argentine-Soviet barter agreement was announced that included tungsten concentrate, but its effect on the tungsten industry has not been reported.

Bolivia.—Contracts for sale of concentrate to the U.S. Government were fulfilled by the end of 1957, and subsequent Bolivian exports were confined to contracts with private ore buyers. Exports declined 84 percent compared with 1957. The Kami and Bolsa Negra mines virtually closed by the end of June, and production at other mines was curtailed drastically.

Brazil.—Exports from Brazil increased by 27 percent compared with 1957 because the major producer, Mineracao Wah Chang, continued delivery of concentrate throughout the year under a contract with the U.S. Government. Termination of this contract was scheduled for early 1959.

Peru.—The only firm producing tungsten in 1958, Fermin Malaga Santolalla e Hijos, completed delivery of concentrate on December 1 under its contract with the U.S. Government, and production thereafter was reduced greatly. Exports decreased 36 percent compared with 1957.

EUROPE

Portugal.—Production of tungsten continued to decline and was about 60 percent less than in 1957. Exports to the United States declined by 96 percent.

U.S.S.R.—Little detailed information is available concerning the production of tungsten in U.S.S.R. Although Soviet publications have claimed "large reserves of tungsten ore," large quantities still are imported from China as well as from North Korea. Tungsten is undoubtedly substituted for molybdenum because of its relatively greater availability.

ASIA

Burma.—Exports of concentrate to the United States decreased 72 percent compared with 1957. The Mawchi mine, major producer before World War II, has been subject to insurgent harassment and never has returned to its prewar status. Since a raid in July, resulting in destruction of much equipment, the mine has operated only on a maintenance basis. Smaller individual operations using primitive methods continued a limited production.

China.—Although little detailed information concerning tungsten production is available, China is believed to continue as the foremost world producer. Exports were based primarily on barter agreements with the U.S.S.R., Hungary, Poland, and other Soviet-bloc countries. Increased production of steel in Communist China also undoubtedly has resulted in a substantial domestic consumption of tungsten.

Korea, Republic of.—Although production costs are among the lowest in the free world and substantial capacity exists, Korean output was curtailed greatly in 1958. Exports to the United States decreased 67 percent compared with 1957. The chemical plant at the Sangdong mine, reported to be about 80 percent complete, was not put into operation because of low prices and limited demand.

Thailand.—The one-third reduction in output compared with 1957, and closure of many small mines was due to lack of demand. The Mitsui Yip Co. mine and the Department of Mines Karacharaburi mine produced tungsten throughout 1958 on a modest scale.

AFRICA

Tungsten was produced in Uganda, the Federation of Rhodesia and Nyasaland, Belgian Congo, South-West Africa, and Union of South Africa but at a greatly reduced rate compared with recent years.

OCEANIA

Australia.—King Island Scheelite, Ltd., suspended operations in August, after fulfilling its contract commitments to the U.S. Government. In recent years this company supplied about two-thirds of the Nation's output. A small production continued from Aberfoyle Tin, N.L., and Storey's Creek Tin Mining Co., N.L.

TECHNOLOGY

Significant improvements in methods for shaping and fabricating tungsten were made. Because of its extremely high melting point (6,170° F.), tungsten historically has been fabricated by powder metallurgy techniques. Although these techniques still were dominant, a substantial effort was devoted to development of melting, casting, and extrusion processes.

Two of the "new" techniques for shaping tungsten are adaptations of ancient arts. Slip casting[5] is a form of powder metallurgy in which a fine suspension (or slip) is poured into a plaster pattern. The liquid of suspension is drawn by capillary action into the plaster, and the suspended particles are deposited on the surface of the pattern. After drying, the casting is fired. Solid or hollow shapes can be made.

Shaping tungsten sheet by spinning is also an adaptation of an ancient art, but one applied previously to the shaping of softer, more ductile materials. Shapes produced are roughly comparable to those formed on the potters wheel.

Another important development applicable to the forming of tungsten is the plasma arc torch producing controlled temperatures in excess of 15,000° F.[6]

With this torch, tungsten can be sprayed in single layer or multilayer thicknesses. Intricate shapes are made by deposition of tungsten on an acid soluble pattern. Removal of the pattern is then accomplished in an acid bath. Another plating technique of considerable promise involves deposition from unstable tungsten compounds in the gaseous state.

[5] L. M. Schifferli, Jr., Slip Casting: Jour. Metals, vol. 10, No. 5, August 1958, pp. 517–521.

[6] Iron Age, Plasma Arc Torch Ushers in New Fabricating Coating Methods: Vol. 122, No. 82, Dec. 4, 1958, pp. 136–137.

Articles on zone refining, melting and casting, and on the properties of tungsten were published.[7]

Federal Bureau of Mines research was confined largely to basic studies in preparing and evaluating pure tungsten. Other studies were on the effects imparted by impurity elements. Tungsten metal currently produced in laboratory quantities was extremely pure, but analytical methods beyond about 99.99 percent purity were not precise. Although no Bureau publications on tungsten metallurgical research were issued during 1958, a substantial effort was devoted both to the production and analysis of high-purity metal. Tungsten resource investigations also were conducted. Two bureau publications [8] were issued in 1958.

A volume published in 1958 contains much of the accumulated data on tungsten alloys.[9]

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[7] Carlson, R. G., Tungsten Zone Melting by Electron Bombardment: Jour. Electrochem. Soc., vol. 106, No. 1, January 1959, pp. 49–52.

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[8] Johnson, A. C., Exploration, Development, and Costs of the Stormy Day Tungsten Mine, Pershing County, Nev.: Bureau of Mines Inf. Circ. 7854, September 1958, 9 pp.

Campbell, William J., and Thatcher, John W., Determination of Calcium in Wolframite Concentrates by Fluorescent X-Ray Spectrography: Bureau of Mines Rept. of Investigations 5416, October 1958, 18 pp.

[9] Hansen, Max, Constitution of Binary Alloys: McGraw-Hill Book Co., Inc., New York, N.Y., 1958, 1305 pp.

Uranium

By James Paone [1]

OUTSTANDING developments in the uranium industry during 1958 were the Second International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, September 1–13, 1958, and the record-breaking production of uranium ore throughout the world. The United States, 68 other nations, and 9 international agencies participated in the world conference, at which new technical information was released on all phases of the peaceful uses of atomic energy.

Free-world uranium production was estimated at more than 35,000 tons of U_3O_8, and enlarged plant capacities were expected to increase output to 42,000 tons of U_3O_8 in 1959. The three leading uranium producers were Canada, United States, and Union of South Africa. Canada surpassed the United States as the leading world uranium producer.

Domestic production from 23 uranium mills totaled 12,560 tons of uranium concentrate and at the year's end was at a rate of 15,000 tons annually. Increased domestic mine output from fewer mines was the result of larger, integrated mine-mill operations; nine uranium mills were new producers, and two mills closed. Limited expansion of mill capacities was noted. A modified Federal domestic uranium-procurement program for 1962–66 was announced. The annual requirement for domestic uranium was forecast at 35,000 tons of U_3O_8 from 1960 to 1966.

Substantial progress throughout the world toward electrical production by atomic reactors was noted. Attention was being directed to the peaceful use of nuclear explosives for mining, excavation, and related programs. Nuclear-propelled submarines achieved historic and strategic importance.

LEGISLATION AND GOVERNMENT REGULATIONS

Exploration projects for uranium under the Defense Minerals Exploration Administration (DMEA) were continued under the newly established Office of Minerals Exploration, Department of the Interior.[2] There were 24 new DMEA contracts totaling $892,000 in 1958 compared with $1 million in 1957 and $2 million in 1956. Since

[1] Commodity specialist.
[2] 85th Congress, S. 3817, Public Law 85–701, Aug. 21, 1958.

the inception of the DMEA program, the Government has advanced $3,858,000 on uranium exploration in contracts totaling about $7 million. Uranium exploration under OME regulations was eligible for 50 percent Government participation, compared with 75 percent under DMEA. No OME contracts were made.

On April 2 the AEC announced that it would undertake limited expansion of domestic uranium procurement. The five areas in which additional mill capacities were allotted under the expansion included: (1) Southeast Texas and (2) North Dakota-South Dakota (lignites), 600 tons a day each; (3) Wyoming, 1,700 tons a day; and (4) Colorado Front Range and (5) Nevada (Austin), 200 tons a day each; a total of 3,300 tons a day.[3]

On November 24, 1958, the Atomic Energy Commission (AEC) announced a modification of the 1962–66 procurement program for domestic uranium concentrate. This program became effective when

TABLE 1.—Office of Minerals Exploration contracts involving uranium executed during 1958, by States [1]

State and contractor	County	Total amount of contract [2]
ARIZONA		
Uranium Petroleum Co	Coconino	$72,624
COLORADO		
Basic Exploration Co	Eagle	12,000
Four Corners Uranium Corp	Jefferson	15,380
Gaddis Mining Co	San Juan	17,924
Gibraltar Minerals Co	Saguache	30,630
Rex Uranium Corp	Montrose	30,320
New Idria Mining & Chemical Co. and Beaver Mesa Uranium, Inc.	Mesa	102,620
D. A. C. Uranium Co	Fremont	17,939
Hilary Minerals Co., Inc	San Miguel	26,824
La Salle Mining Co	Boulder	54,234
NEVADA		
Kohlimoos, Wm. Brandt & Corder, Ted	Nye	4,740
NEW MEXICO		
Food Machinery & Chemical Corp	McKinley	28,460
San Mateo Dome Project	do	103,400
Food Machinery & Chemical Co	do	22,200
UTAH		
Stocks-Gramlich, Inc	San Juan	28,286
Jen, Inc	do	30,758
Reynolds Metal Co	do	45,466
WASHINGTON		
Daybreak Uranium, Inc	Stevens	28,946
WYOMING		
Jenkins & Hand	Converse	62,892
Uranium Research & Development Co	Fremont	53,760
Douglas Corp	Converse	23,952
Kaye Minerals, Inc	Fremont	11,300
Balboa Mining & Development Co	Crook	26,194
Kanter-Levy Co	Big Horn	41,240
Total		892,089

[1] All contracts made under the Defense Minerals Exploration Administration program.
[2] Government participation, 75 percent.

[3] Atomic Energy Commission, Division of Raw Materials, A Report on the Domestic Mining and Milling Problems: Apr. 2, 1958, p. 35.

the following limitations to the Federal procurement of domestic uranium concentrate, 1962–66, were announced: (a) Existing contracts, (b) extensions of existing contracts, (c) new contracts or amendments to existing contracts to provide for the limited expansion of April 2, (d) and new contracts or amendments for purchasing concentrates in 1962–66 from ore reserves developed between November 1, 1957, and November 24, 1958. The revised procurement program is said to provide domestic producers a market of $250 million to $300 million a year through 1966.[4]

The AEC also announced during 1958 that domestic producers of uranium ores and concentrates would be permitted to make private sales of the materials to licensed domestic and authorized foreign buyers for peaceful use of atomic energy.

DOMESTIC PRODUCTION

Mine Production.—Production of uranium ore in the United States totaled about 5.2 million tons, an increase of nearly 40 percent over the 3.7 million tons produced in 1957. The ore contained an average grade of 0.27 percent U_3O_8 and was valued at approximately $116 million.

Principal uranium-producing States during the year, in order of value of mine production, were Utah, New Mexico, Colorado, Wyoming, Arizona, Washington, South Dakota, Alaska, California, Nevada, and Montana.

It was estimated that about 5,750 persons were employed by 624 domestic uranium shippers in 1958 compared with 5,500 persons and 727 shippers in 1957. Approximately 1,825 persons were employed in mills.

The number of producing mines decreased during the year, chiefly because the number of mines that produced less than 50 tons annually declined. Further decline in the number of shippers in the 50- to 100-ton and 100- to 250-ton ranges of annual output was anticipated by the AEC because production was not economic. The percentage of

TABLE 2.—Uranium mine production in 1958

State	Short tons	Average grade, percent U_3O_8	U_3O_8 pounds	Total value f.o.b. mine (thousands)
Alaska, California, Idaho, Montana, Texas	9,135	0.73	133,233	$621
Arizona	257,756	.32	1,648,644	7,049
Colorado	939,706	.28	5,405,117	22,577
New Mexico	1,888,499	.21	8,064,284	32,264
Nevada, Washington	156,173	.16	491,037	1,578
South Dakota	35,489	.20	142,375	530
Utah	1,239,767	.36	8,913,872	38,610
Wyoming	651,790	.25	3,282,698	13,286
Total	5,178,315	.28	28,081,260	116,515

[4] Atomic Energy Commission, Atomic Industrial Progress and Second World Conference: July–December 1958, 386 pp.

output by large producers rose. In 1958, 51 shippers of 8.2 percent of the total produced 89 percent of the uranium ore.

Lisbon Uranium Company, of Salt Lake City, Utah, was the first uranium producer to receive the $10,000 bonus paid by the AEC under Domestic Uranium Program Circular 2 for high-grade ore. Circular 2, which expired April 11, 1958, provided for a bonus of $10,000 for the discovery, production, and delivery to the Commission of not less than 20 tons of ore containing 20 percent or more U_3O_8. In the Ambrosia Lake area, near Grants, N. Mex., extensive development of underground mines continued; at least four potentially large mines started producing during the year. Exploration and development activities by large mining and construction companies disclosed significant ore reserves in the Gas Hills-Crooks Gap and Shirley Basin areas in Wyoming.[5]

During the year, the AEC uranium districts, defined for ore-control purposes, were reported to have the following uranium content averages in U_3O_8: Baggs, Wyo.-Maybell, Colo.—0.16 percent; Uravan mineral belt, Colorado—0.30 percent; Front Range, Colo.—0.40 percent; eastern Wyoming-Black Hills, S. Dak.—0.23 percent; central and northern Wyoming—0.24 percent; Big Indian Wash (Moab), Utah—0.37 percent; Monument Valley, southeastern Utah and northern Arizona—0.28 percent; Arizona (excluding Monument Valley)—0.20 percent; Salt Lake and Green River Area, Utah—0.20 percent; Shiprock, N. Mex.—0.27 percent; lignite area of North and South Dakota—0.20 percent; Washington—0.19 percent; southeastern Texas—0.25 percent; Austin, Nev.—0.18 percent; and California—0.29 percent.[6]

Private mills supplied 98 percent of ore purchases in 1958; the only AEC ore-buying station still operating was at Monticello, Utah. Ore reserves increased during the year.

Mill Production.—Uranium-concentrate production in 1958 totaled 12,560 tons of U_3O_8, valued at $238 million, an increase of 45 percent over production in 1957. The annual production at the end of 1958 was 15,000 tons; output in 1959 was expected to be about 18,000 tons of U_3O_8, valued at more than $300 million.

Nine new uranium mills began producing, and two mills closed—23 mills were operating at the end of 1958. The Vanadium Corp. of America plant at Naturita, Colo., was closed because it was obsolete, but the loss of milling capacity was more than offset by increased capacity at its Durango, Colo., mill. The Rifle, Colo., mill of Union Carbide Nuclear treated 300 tons of ore a day; it was replaced with a new plant with a capacity of 1,000 tons a day. The second largest domestic uranium mill, Kermac Nuclear Fuels Corp. mill at Grants, N. Mex., with a rated capacity of 3,300 tons of ore a day began production during the year. Other mills that began delivering uranium concentrate to the AEC included Freemont Minerals, Inc., Gunnison Mining Co., Homestake-New Mexico Partners, Homestake-Sapin Partners, Lucky Mc Uranium Corp., and Phillips Petroleum Co.

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[5] Mecia, J. A., The Gas Hills Uranium District of Wyoming: Min. Cong. Jour., vol. 44, No. 3, March 1958, pp. 69–72.
[6] Mining Record, vol. 69, No. 16, Apr. 17, 1958, pp. 1, 8.

TABLE 3.—Uranium processing plants, Dec. 31, 1958

Company	Location	Present contract terminates	Capacity, tons of ore per day	Estimated cost of mill (thousands)
The Anaconda Co	Grants, N. Mex	Mar. 31, 1962	3,500	$19,358
Climax Uranium Co	Grand Junction, Colo	July 31, 1960	330	3,088
Dawn Mining Co	Ford, Wash	Mar. 31, 1962	400	3,100
Fremont Minerals, Inc	Riverton, Wyo	Nov. 30, 1963 [1]	500	3,500
Government-owned [2]	Monticello, Utah		350	5,000
Gunnison Mining Co	Gunnison, Colo	Mar. 31, 1962 [1]	200	2,025
Homestake-New Mexico Partners	Grants, N. Mex	do	750	5,325
Homestake-Sapin Partners	do	June 30, 1963 [1]	1,500	9,000
Kermac Nuclear Fuels Corp	do	Dec. 31, 1966 [1]	3,300	16,000
Kerr-McGee Oil Industries	Shiprock, N. Mex	Oct. 31, 1959	300	3,161
Lakeview Mining Co	Lakeview, Oreg	Nov. 30, 1963	210	2,600
Lucky Mc Uranium Corp	Fremont County, Wyo	Mar. 31, 1962 [1]	750	6,900
Mines Development, Inc	Edgemont, S. Dak	do	400	1,900
Phillips Petroleum Co	Grants, N. Mex	Dec. 31, 1966 [1]	1,725	9,500
Rare Metals Corp. of America	Tuba City, Ariz	Mar. 31, 1962	300	3,600
Texas-Zinc Minerals Corp	Mexican Hat, Utah	Dec. 31, 1966	1,000	7,000
Trace Elements Co	Maybell, Colo	Mar. 31, 1962	300	2,208
Union Carbide Nuclear Co	Rifle, Colo.[3]	do	1,000	8,500
Do	Uravan, Colo	do	1,000	5,000
Uranium Reduction Co	Moab, Utah	do	1,500	8,250
Vanadium Corp. of America	Durango, Colo	do	750	813
Vitro Uranium Co	Salt Lake City, Utah	do	600	5,500
Western Nuclear Corp	Split Rock, Wyo	do	400	3,600
Total			21,065	134,928

[1] First deliveries of U_3O_8 to AEC made in 1958.
[2] Operated by National Lead Co., Inc.
[3] Union Carbide Nuclear Co. also buys ore at Slick Rock, Colo., and Greenriver, Utah, as feed for the Rifle, Colo., mill.

Domestic milling activity was greatest in the Ambrosia Lake uranium district, where about 51 percent of the total rated domestic milling capacity was concentrated; 5 mills in the district had a capacity of 10,775 tons of ore a day. Of this tonnage, about 55 percent was processed by acid leaching methods and the remaining 45 percent, by carbonate leaching methods. The Anaconda Bluewater mill, Grants, N. Mex., capacity of 3,500 tons a day, was the largest uranium mill producing during the year. First deliveries of uranium concentrate to the AEC were made as follows: Fremont Minerals, Inc., in January, Gunnison Mining Co. in February, Homestake-New Mexico Partners in April, Lucky Mc Uranium Corp. in March, Phillips Petroleum Co. in August, Homestake-Sapin Partners in September, and Kermac Nuclear Fuels Corp. in December.

Approximately 174 tons of U_3O_8 concentrate was a byproduct from chemically processing Florida phosphate rock in Florida and Illinois, from treating Idaho euxenite at the Mallinckrodt Chemical Co. plant in St. Louis, Mo., and from reprocessing residues of the Vitro Corp. refinery in Canonsburg, Pa.

The first transaction was made in 1958 under the AEC regulation permitting private sales of uranium ores and concentrates. U_3O_8 from the Uranium Reduction Co. was sold to Davison Chemical Division, W. R. Grace & Co., Erwin, Tenn., for conversion to nuclear fuel.

Refinery Production.—Three feed-material plants refined all of the uranium mill concentrate purchased by the AEC in 1958; the Government-owned plants were operated by Mallinckrodt Chemical Works at Weldon Spring, Mo., and by National Lead Co. of Ohio at Fernald, Ohio, and the privately owned General Chemical Division, Allied Chemical Corp., Metropolis, Ill., plant. Deliveries by General Chemical Division were expected to begin early in 1959. At the end of 1958 the original Mallinckrodt plant in St. Louis, Mo., was replaced by the Weldon Spring plant.

Principal products from the AEC refineries at Fernald, Ohio, and at Weldon Spring, Mo., continued to be uranium hexafluoride (UF_6) for use in the gaseous-diffusion isotope-separation plants, and uranium metal for use in AEC plutonium-production reactors. General Chemical Division produced only uranium hexafluoride. The combined capacity of the three feed-material plants was said to be in excess of the rate of concentrate procurement expected under the AEC program.

The following five firms produced natural uranium fuel materials commercially:

Mallinckrodt Chemical Works, Hematite, Mo.
Davison Chemical Division, W. R. Grace & Co., Erwin, Tenn.
Nuclear Materials and Equipment Corp., Apollo, Pa.
Shattuck Chemical Co., Denver, Colo.
Spencer Chemical Co., Kansas City, Mo.

The Mallinckrodt plant at Hematite was described in an article.[7]

Five licensed companies at the following plants reclaimed unirradiated enriched uranium from scrap generated in fuel fabrication and fuel-material preparation:

Davison Chemical Division, W. R. Grace & Co., Erwin, Tenn.
Englehard Industrial, Inc., Baker Platinum Division, Newark, N. J.
Mallinckrodt Chemical Works, Hematite, Mo.
Nuclear Materials and Equipment Corp., Apollo, Pa.
Spencer Chemical Co., Kansas City, Mo.

Production of Fissionable Material.—Three Government-owned gaseous-diffusion plants, operated by private industry, continued to produce enriched uranium (U-235):

Union Carbide Nuclear Corp., Oak Ridge, Tenn.
Union Carbide Nuclear Corp., Paducah, Ky.
Goodyear Atomic Corp., Portsmouth, Ohio.

Four firms converted enriched uranium hexafluoride (UF_6) from AEC gaseous-diffusion plants to enriched uranium fuel materials for use in fuel elements and for research and development:

Davison Chemical Division, W. R. Grace & Co., Erwin, Tenn.
Mallinckrodt Chemical Works, Hematite, Mo.
Nuclear Materials and Equipment Corp., Apollo, Pa.
Spencer Chemical Co., Kansas City, Mo.

The first three of these firms also began to prepare enriched uranium metal commercially. Before 1958, enriched uranium was prepared solely for the AEC.

CONSUMPTION AND USES

Energy Uses.—Major use of uranium continued to be for the AEC program as material for national defense and as fuel for research,

[7] Chemical and Engineering News, Uranium Plant Expands: Vol. 36, No. 18, May 5, 1958, pp. 52, 54.

test, power, and propulsion reactors. During the year the United States firms or the Government completed construction of 37 nuclear reactors at home and in several foreign countries.

Production Reactors.—Plutonium continued to be produced from feed materials at AEC plants at Hanford, Wash., and at Savannah River, S.C. At Hanford, Wash., a design study for an improved production reactor was authorized. The new reactor would incorporate features permitting the addition of 300 megawatts of electric generating equipment in the future.[8]

Nonmilitary Power Reactors.—Civilian nuclear powerplants with nearly 80 megawatts of electrical capacity continued operation during 1958. A 200-kilowatt (electrical) boiling-water power-and-space-heat reactor built by Argonne National Laboratory for the AEC at Idaho Falls, Idaho, began operating. Six nuclear powerplants, and two power-reactor experiments, the powerplant for the NS (nuclear ship) *Savannah*, and two power reactors for export, were being built. Before the end of 1960, five nuclear powerplants generating a total of 557 megawatts of electricity were expected to be in operation; two more generating 85.5 megawatts each were to be completed in 1961; and four with a total capacity of 139 megawatts were scheduled for completion in 1962. The Shippingport Atomic Power Station, the largest operating power reactor in the United States, was dedicated in May and underwent two full-power, 1,000-hour tests.

Military Reactors.—A total of 36 nuclear-powered U.S. Navy ships were operating, launched, under construction, or authorized at the end of 1958. Of these, 5 submarines, *Nautilus*, *Seawolf*, *Skate*, *Swordfish*, and *Sargo*, were operating; 3 others, *Seadragon*, *Skipjack*, and *Triton*, were launched; 15 submarines were under construction; and 10 other submarines were authorized. Also one aircraft carrier and two guided missile cruisers were under construction.

Outstanding accomplishments by nuclear-propelled submarines included passage across the North Pole by the USS *Nautilus* and by the USS *Skate* under the polar ice cap. The USS *Seawolf* established an underwater cruising record of 60 days.

The Army Package Power Reactor (APPR–1), Fort Belvoir, Va., continued to operate satisfactorily. A package boiling-water reactor developed to supply 200 kilowatts of electricity and 400 kilowatts of space heat for small, remote military installations, was started.

Research continued under the Aircraft Reactors Program on the development of nuclear-propulsion systems for aircraft, rockets, and ramjets.

Research and Test Reactors.—The Materials Testing Reactor and the Engineering Test Reactor continued to operate and the Oak Ridge Research Reactor was started in 1958; three general test reactors were being built, and one was planned. In addition, 39 civilian research and training reactors and 7 specialized test reactors were operable in the United States on Dec. 31, 1958; 44 were under construction, and 17 were planned.

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[8] Engineering News-Record, vol. 161, No. 15, Oct. 9, 1958, p. 19.

TABLE 4.—Power reactors in operation or under construction in 1958

Designation and operator	Date critical	Type	Capacity (electrical kw.)	Location
OPERATING				
Shippingport Atomic Power Station (AEC and Duquesne Light Co.).	1957	Pressurized water	60,000	Shippingport, Pa.
Experimental Breeder Reactor No. 1 (AEC).	1957	Fast breeder	150	Arco, Idaho.[1]
Boiling Reactor Experiment (AEC)	1956 [2]	Boiling water	2,000	Do.[1]
Experimental Boiling Water Reactor (AEC).	1956	do	4,500	Lemont, Ill.
Vallecitos Boiling Water Reactor (General Electric Co. and Pacific Gas and Electric Co.).	1957	do	5,000	Pleasanton, Calif.
Sodium Reactor Experiment (AEC and Southern California Edison Co.).	1957	Sodium graphite	6,000	Santa Susana, Calif.
Organic Moderated Reactor Experiment (AEC).	1957	Organic moderated	None	Arco, Idaho.[1]
Homogeneous Reactor Experiment No. 2 (AEC).	1957	Aqueous homogeneous	300	Oak Ridge, Tenn.
Army Package Power Reactor No. 1 (AEC).	1957	Pressurized water	1,855	Fort Belvoir, Va.
Argonne Low Power Reactor	1958	Boiling water	200	Arco, Idaho.[1]
UNDER CONSTRUCTION				
Dresden Nuclear Power Station (Commonwealth Edison Co.).	1959	do	180,000	Morris, Ill.
Consolidated Edison Thorium Reactor.	1960	Pressurized water	151,000	Indian Point, N.Y.
Enrico Fermi Atomic Power Plant (Power Reactor Development Co.).	1960	Fast breeder	90,000	Lagoona Beach, Mich.
Yankee Atomic Electric Co	1960	Pressurized water	110,000	Rowe, Mass.
AEC and Rural Cooperative Power Association.	1961	Boiling water	22,000	Elk River, Minn.
Hallam Nuclear Power Facility (AEC and Consumers Public Power District).	1962	Sodium graphite	75,000	Hallam, Nebr.
Los Alamos Power Reactor Experiment No. 2 (AEC).	1959	Aqueous homogeneous	None	Los Alamos, N. Mex.
Experimental Breeder Reactor No. 2.	1960	Fast breeder	16,500	Arco, Idaho.[1]

[1] National Reactor Testing Station.
[2] Shut down in June.

Radioisotopes.—The AEC continued to be the sole domestic producer of radioisotopes. Demand for radioisotopes grew as shipments increased 37 percent over the preceding year, totaling about 228,000 curies compared with 166,000 curies in 1957. The gross income from sales of radioisotopes by AEC was about $2.6 million, the same as in 1957. The increased volume made possible reductions in prices on many of the radioisotopes.

Radioisotopes were used by industry chiefly for gaging, radiography, tracing, and process control; by the medical profession in radiodiagnosis, therapy, and radio therapy; and by civil defense agencies and other organizations for radiological monitoring training. By the end of 1958 licensed users of radioisotopes totaled over 4,400 of which 44 percent were medical, 33 percent industrial, and 23 percent other types of users.

Weapons.—Research and development programs directed toward improving and increasing the United States arsenal of nuclear weapons included those arms in a variety of sizes and of greatly reduced radioactive fallout and smaller, immediately ready, more rugged weapons, for use in more advanced weapons systems.

Other Uses.—The Plowshare Program, a study of potential peaceful applications of nuclear explosives in excavating, mining, power and isotope production, and other uses, gained attention from industry and other Government agencies.[9]

In June the AEC removed prohibitions on non-nuclear uses of uranium. Uses in ceramic and glass products, primarily as a coloring agent, and in photographic products, was resumed. Before this restriction, consumption of uranium for nonenergy industrial applications amounted to about 200 tons of U_3O_8 yearly.

PRICES AND SPECIFICATIONS

Uranium Ore and Concentrate.—Prices established by the AEC were unchanged from those in effect in 1957 for purchase of uranium ores. AEC Domestic Uranium Program Circulars 5 (revised) and 6 in effect, provided for minimum price guarantees until March 31, 1962, and for production bonuses until March 31, 1960. Circulars 1 and 2 were effective from 1948 to 1958. Circulars 5 (revised) and 6 were published in Part 60, Title 10, of the Code of Federal Regulations and in the Uranium and Radium chapter of the 1954 Minerals Yearbook.

The 1962–66 purchases under the modified program announced on November 24 will be at the previously established price of $8 per pound of U_3O_8 in an acceptable concentrate.

Prices of uranium as mill concentrates offered by the AEC ranged from $20 to $30 per kilogram.

Uranium Metal.—Pure uranium metal in large quantities was available from the AEC to qualified and licensed users at $40 a kilogram. Prices for depleted uranium varied with the content of fissionable uranium 235; depleted uranium as uranium hexafluoride with a low U-235 content was selling for $5 per kilogram of contained uranium, f.o.b. Paducah, Ky.

Special Nuclear Materials.—Prices for uranium-235 shown in the uranium chapter of Minerals Yearbook for 1956, remained in effect. In December, the AEC established base charges, at which uranium-233 and plutonium would be made available for use in research and development, by lease to licensed private individuals and companies in the United States and by sale or lease to foreign governments under agreements for cooperation. Base charges were set at $15 a gram of uranium-233 and $12 a gram of plutonium; the annual lease charge would be 4 percent of the base charge, in each instance.

Uranium-Containing Magnesium Fluoride Slag.—The AEC set a charge of $26 per kilogram of contained uranium on the magnesium fluoride slag f.o.b. Weldon Spring, Mo. This slag is a byproduct of natural uranium metal produced by the AEC, contains about 3 percent uranium, and is subject to AEC licensing regulations.

[9] Johnson, Gerald W., Nuclear Explosions: Min. Cong. Jour., vol. 44, No. 11, November 1958, pp. 78–80.

Radioisotopes.—The AEC made major reductions in the price of five long-lived radioactive fission byproducts. Depending upon quantity purchased, the new prices per curie ranged from \$1 to \$2 for cesium 137, \$1.75 to \$3.25 for promethium 147, \$1 to \$2 for cerium 144, and \$5 to \$10 for strontium 90. Technetium 99 is priced from \$80 to \$140 per millicurie. Most new prices were less than 10 percent of those formerly in effect.

Uranium Concentrate Specifications.—The following specifications for uranium concentrates purchased by AEC were in effect at the end of the year:[10]

1. Minimum U_3O_8 content of 75 percent.
2. Maximum V_2O_5 content of 2 percent of the U_3O_8 content.
3. Maximum PO_4 content shall not exceed the sum of 1.31 times the iron (Fe) content plus 2 percent of the U_3O_8 content provided that the total phosphate content shall not exceed 6 percent of the U_3O_8 content.
4. Maximum Mo content of 0.60 percent of the U_3O_8 content.
5. Maximum B content of 0.20 percent.
6. Maximum halogens, Cl, Br, and I, expressed as Cl, content of 0.10 percent of the U_3O_8 content.
7. Maximum F content of 0.10 percent of the U_3O_8 content.
8. Maximum As content of 2 percent of the U_3O_8 content.
9. Maximum CO_3 content of 4 percent of the U_3O_8 content.
10. Maximum SO_4 content (including total sulfur reported as SO_4) of 10 percent of the U_3O_8 content.
11. Maximum moisture H_2O content of 10 percent (determined on an as received basis and drying at 110° C).
12. All uranium concentrate shall pass through a screen with a ¼-in. opening.
13. Maximum Ca content of 1.5 percent of the U_3O_8 content.
14. Maximum quantity of U_3O_8 insoluble in nitric acid to be 0.10 percent of the U_3O_8 content as determined by the standard method used by the AEC for making all such determinations for insolubility of U_3O_8.

FOREIGN TRADE

Uranium deliveries under long-term contracts from foreign producers comprised about 60 percent of the United States supply. Uranium concentrate was delivered to the United States in 1958 from Canada, Union of South Africa, Belgian Congo, Australia, and Portugal.

The AEC announced in 1958 that private sales of uranium concentrates would be permitted to authorized foreign atomic-energy markets. International trade by the United States in atomic-energy products for 1958 was estimated at \$35 million and included power and research reactors, nuclear-energy equipment, fuel-element fabrication, and design and engineering services.

WORLD REVIEW

The International Atomic Energy Agency (IAEA), formed in 1957, had 69 member states by the end of 1958. IAEA missions and research teams visited and appraised the needs and possibilities of 17 Latin American countries and several countries in the Near and Far

[10] Nelli, J. R. Manser, W. C., and Arnold, D. S., Uranium Concentrate Specifications: Jour. Metals, vol. 11, No. 1, January 1959, pp. 33–35.

East. The Canadian Government offered 3 short tons of Reactor-grade uranium to the Agency for use by Japan. The Agency also had options on more than 5.5 tons of uranium 235 and quantities of natural uranium, uranium oxide, thorium, and monazite.

The following nations of the free world produced an estimated 35,000 short tons of U_3O_8, in order of output: Canada, United States, Union of South Africa, Australia, Belgian Congo, France, Portugal, Italy, and the Federation of Rhodesia and Nyasaland. About 66 uranium mills or plants in the free world produced concentrates by a variety of chemical processes.

The Second International Conference on the Peaceful Uses of Atomic Energy was held at Geneva, Switzerland, September 1–13. Much new technical information was released on all phases of the peaceful applications of atomic energy. Some of the technical information is described in the Technology section. Promising new applications of nuclear energy were described.

NORTH AMERICA

Canada.—Production of uranium in Canada led all other metals in value during the year and totaled 13,537 tons of U_3O_8 valued at $274.4 million, compared with 6,557 tons valued at $133 million in 1957. By the end of 1958 Canada had become the leading producer of uranium concentrates in the free world, a position formerly held by the United States. Canadian deliveries to the United States totaled 12,695 tons U_3O_8 during the year; about 13,400 tons was scheduled for delivery in 1959.

The Government-owned Eldorado Mining and Refining, Ltd. (purchasing agent), announced that the contract price for uranium concentrate averaged $10 per pound.[11] Eldorado's new uranium-metal plant at Port Hope, Ontario, produced its first ingot.[12] Previously Canada purchased uranium metal from the United States for its reactors at Chalk River, Ontario.

The Canadian Government announced in May that uranium producers would be permitted to sell uranium to other countries for testing and research purposes. Individual sales are to be limited to 250 pounds of uranium, and the total sold to one country may not exceed 2,500 pounds unless the country has an agreement with the Canadian Government for cooperation in peaceful uses of atomic energy.

Trade agreements were made to sell 11 tons of uranium fuel to Switzerland, 12 tons to West Germany, and a contract entered for the sale of uranium valued at $105 million to Great Britain in the 12 months beginning April 1, 1962.

The Atomic Energy of Canada, Ltd. (AECL), continued its studies in nuclear research including atomic-power evaluation and application, production and sale of radioisotopes for research, medical, industrial, and other uses. Chalk River, Canada's nuclear research center operated four reactors during the year. A Nuclear Power Plant Division was set up by AECL to coordinate work on a

[11] South African Mining and Engineering Journal (Johannesburg), vol. 69, No. 3408, June 6, 1958, p. 977.

[12] Precambrian (Winnipeg, Canada), Eldorado's Refinery Plays Key Role in Nuclear Program: Vol. 31, No. 11, November 1958, pp. 44–46.

nuclear power demonstration reactor (NPD) and to develop a 200-megawatt electrical output, nuclear powerplant, known as CANDU (Canadian Deuterium Uranium Reactor). An official group studying Canada's economic prospects predicted the possible need between 1975 and 1985 for some 50 nuclear powerplants in the 100-megawatt range, largely in Southern Ontario.[13]

Alberta.—Exploration by the Research Council of Alberta revealed deposits of uranium in a 150-square-mile area of northeastern Alberta, in the sheared metasedimentary rocks near Andrew Lake and at Spider Lake.[14]

Northwest Territories.—A decrease in the reserve was noted in 1958 at the Eldorado historic Port Radium mine, indicating that the reserve would be exhausted by the end of 1960.

Rayrock Mines expanded the capacity of its mill to 175 tons of ore a day and was considering expansion to 200 tons a day to treat ore on a custom basis from the Consolidated Northland mine.

Ontario.—The largest uranium-producing area in Canada was the Blind River area of northern Ontario, containing 90 percent of Canada's uranium reserve.

Northspan Uranium Mines, Ltd., an amalgamation of Lacnor Uranium Mines (formerly Lake Nordic Uranium Mines), Panel Consolidated Uranium Mines, and Spanish American Mines maintained its output of about 445,000 pounds U_3O_8 a month. Rio Tinto's Algom Uranium Mines, Ltd., continued operating its Quirke and Nordic mills, each with a capacity of 3,000 tons a day. Consolidated Dennison Mines, Ltd., reached its rated mill capacity of 6,000 tons a day. The estimated ore reserve was 136 million tons, and the plant was the largest uranium-producing operation in the world. Stanleigh Uranium

TABLE 5.—Canadian uranium mines and mills[1]

Company	Mine	Area	Mill capacity, tons per day
Algom Uranium Mines, Ltd	Quirke	Blind River, Ontario	3,000
Do	Nordic	do	3,000
Can-Met Explorations, Ltd	Can-Met	do	3,000
Consolidated Dennison Mines, Ltd	Consolidated Dennison	do	6,000
Milliken Lake Uranium Mines, Ltd	Milliken	do	3,000
Northspan Uranium Mines, Ltd	Lake Nordic	do	4,000
Do	Panel	do	3,000
Do	Spanish American	do	2,000
Pronto Uranium Mines, Ltd	Pronto	do	1,500
Stanleigh Uranium Mining Corp., Ltd	Stanleigh	do	2,000
Stanrock Uranium Mines, Ltd	Stanrock	do	3,000
Eldorado Mining and Refining, Ltd	Beaverlodge	Beaverlodge, Saskatchewan.	2,000
Gunnar Mines, Ltd	Gunnar	do	1,800
Lorado Uranium Mines, Ltd	Lorado	do	750
Bicroft Uranium Mines	Bicroft	Bancroft, Ontario	1,200
Canadian Dyno Mines, Ltd	Dyno	do	1,100
Faraday Uranium Mines, Ltd	Faraday	do	1,400
Eldorado Mining and Refining, Ltd	Port Radium	Northwest Territories	300
Rayrock Mines	Marion Lake	do	150
Total			42,200

1 Purchase contracts with Eldorado listed in Uranium chapter, Minerals Yearbook 1957.

13 Atomic World, Nuclear Energy in Canada: Vol. 10, No. 3, March 1959, pp. 107–109.
14 Western Miner and Oil Review (Vancouver, B.C.), Minerals in Alberta's Precambrian: Vol. 31, No. 9, September 1958, p. 47.

Mining Corp., Ltd., resumed milling after its fire in the mill building in 1957. Full capacity production of 3,000 tons a day was expected by mid-1959. Milliken Lake Uranium Mines, Ltd., a subsidiary of the Rio Tinto group, began milling during the year. Can-Met Explorations, Ltd., and Pronto Uranium Mines, Ltd., mined and milled at full capacity.

In the Bancroft area of southeastern Ontario, Bicroft Uranium Mines, decreased shipments to the rate stipulated in its contract with Eldorado. Canadian Dyno Mines, Ltd., was approaching its full mill capacity of 1,100 tons a day. The Faraday Uranium Mines, Ltd., government contract for the delivery of uranium concentrates was increased; the original contract of $29.7 million was raised to $45 million when Faraday contracted to mill sufficient ore from the Greyhawk Uranium Mines, Ltd. Amalgamated Rare Earth Mines was negotiating to construct a 1,000-ton-a-day mill for its three uranium properties in the Bancroft area.

Saskatchewan.—Uranium concentrate production from the Province was at a rate of about 2,500 tons valued at $50 million annually; total production capacity at the end of the year was about 4,500 tons of ore a day. The Gunnar Mines, Ltd., mill on the north shore of Lake Athabasca expanded to a capacity of 2,000 tons a day, and underground production supplemented output from the open pit. Eldorado Mining and Refining, Ltd., the Crown-corporation, continued production at the Eldorado property through the Ace, Fay, and Verna shafts. In addition to processing its own ore, the 2,000-ton-per-day mill was custom milling uranium ore from Rix-Athabasca Uranium Mines, Ltd. Lorado Uranium Mines, Ltd., increased its mill capacity to 750-tons-a-day and was custom milling ore from Cayzor Athabasca Uranium Mines, Ltd., Black Bay Uranium, Ltd., Lake Cinch Mines, Ltd., and St. Michael Uranium Mines, Ltd. National Explorations, Ltd., curtailed mining in October because its shipping-grade ore was depleted. Nesbitt LaBine Uranium Mines planned further exploration of its properties, and Jesko Uranium Mines was expected to start production in 1959.

Quebec.—Over 40 occurrences of radioactive minerals containing uranium or thorium were described in a geological report, Radioactive Mineral Occurrences of the Province of Quebec, by the minister of mines for Quebec. Discoveries of uranium started a staking rush in the Kipawa area of Quebec.

Labrador.—A high-grade deposit of uranium was outlined by British Newfoundland Exploration (Brinex) when it prospected the Labrador coast, about 125 miles north of Goose Bay.

Guatemala.—Special regulations were proposed for exploring and exploiting radioactive materials. The Guatemalan Bureau of Mines and Hydrocarbons with the assistance of the Guatemalan Atomic Energy Commission would administer the regulations.

Mexico.—It was reported that uranium deposits were found in more than a dozen places in the State of Coahuila. Most important of the deposits was said to be in Sierra de G'omez. Other important deposits are in Chihuahua, Durango, and Oaxaca. Uranium mining in the rich mining area of villa de Aldama in Chihuahua was reported by the Mexican National Nuclear Energy Commission.

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SOUTH AMERICA

Brazil.—Late in 1957, geologists of the Radioactive Research Institute of Minas Gerais located an autunite deposit in the Serra da Moeda, Belo Vale, Minas Gerais. In Sao Paulo, the Geographical and Geological Institute discovered another deposit of uranium at Agua da Prata. The ore averaged 0.22 to 0.23 percent U_3O_8.[15]

The Brazilian Ambassador signed an agreement in Washington, D.C., on December 26, 1957, authorizing United States citizens to search for uranium in Brazil. Two plants to process uranium ores were to be built by a French firm under contract to the Brazilian Atomic Energy Commission.

The uranium-bearing gold deposits in reef-type conglomerate near Jacobina were described.[16]

The Institute of Atomic Energy, in existence 2 years, indicated that significant progress was being made in the field of nuclear energy. Its reactor was producing isotopes particularly for medical purposes. The erection of a high-level radiation laboratory and a plant for producing uranium metal from domestic ores was being planned.

British Guiana.—Under direction of the United Kingdom Atomic Energy Authority, reconnaissance for uranium was begun in the northwest part of the country, which was considered the most promising.

Chile.—Important deposits of uranium were found in Canto de Agua, Atacama Province. The Minister of Mines announced that uranium ore would be produced by a company formed by National Smelter Co. and the Chilean Mining Bank. Geologists of the Chilean Corporation of Development (CORFO) discovered large deposits of radioactive minerals in the Province of Aysén.

The National Radioactive Minerals Society, Ltd., a semigovernmental organization, was authorized to purchase, beneficiate, and sell uranium and other radioactive minerals as well as to explore and exploit any mineral deposits acquired.

The Anaconda Company was considering the possibility of using atomic power to supplement the hydroelectric supply of the Chuquicamata mine and plant.

Colombia.—The Compania Minera de Urano began mining uranium during the year, and in 1959 production of uranium ore was expected to reach 10,000 tons. Permission to install a plant with a capacity to treat 30 tons of uranium ore a day in the Department of Santander was being sought.

Peru.—Discovery of uranium ore in La Convencion Province, Department of Cuzco, led to governmental restriction on mineral filing and to negation of further mining claims in the Province. The Peruvian Atomic Energy Commission announced in March that the Peruvian Government would exploit rich uranium deposits in Vilacabamba, Cuzco.

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[15] Mining Journal (London), Brazil Speeds Uranium Search: Vol. 250, No. 6390, Feb. 7, 1958, p. 152.

[16] Bateman, J. D., Uranium-Bearing Auriferous Reefs at Jacobina, Brazil: Economic Geology, vol. 53, No. 4, June–July, 1958, pp. 417–425.

Surinam.—Traces of uranium and other radioactive material were found during the year, but none indicated the presence of significant deposits.

EUROPE

Euratom, the European Atomic Community consisting of Belgium, France, The Federal Republic of Germany, Italy, Luxembourg, and The Netherlands, entered into a joint agreement with the United States for installing 1,000 megawatts of electrical capacity from nuclear powerplants in the six nations, using reactors designed in the United States.

A Euratom report issued during the year, indicated that the quantity of uranium available to the six Euratom countries was less than 700 tons of U_3O_8 per year. The report further indicated that 8 power reactors and 25 research reactors were completed, under construction, or planned.

Austria.—Austria's atomic energy program made a significant gain with the signing of a contract between the Austrian Study Company for Atomic Energy and a United States firm for a 5-megawatt swimming-pool-tank-type research reactor; the United States AEC would contribute $350,000 to help finance the project.

Belgium.—The Société Générale Métallurgique de Hoboken was reportedly capable of delivering pure uranium salts and oxides from Belgian Congo deposits; this potential output could supply 800 to 1,000 tons of uranium a year. The experimental reactor constructed at the Centre d'Etudes Nucleaires de Mol with United States aid continued to operate satisfactorily; a second reactor for materials testing was under construction. The first license for export of a United States manufactured power reactor was issued by the U.S. AEC. The license authorized shipment of a 1.5-electrical-megawatt experimental power reactor to Belgium for installation at the nuclear development center at Mol.[17]

Bulgaria.—Geologists from the U.S.S.R. were reported to have discovered significant uranium deposits about 70 kilometers from Sofia in Bulgaria.[18]

Czechoslovakia.—High-grade uranium deposits were discovered in the abandoned silver mines of Katharinenberg and others in the Bohemian Forest and near Pribram. Major uranium-ore production center was at Krusne-Hory. Construction was to have been started during the year on plants for processing uranium ores and for production of metallic uranium. Construction also began on the first Czechoslovak atomic power plant in the village of Bohunice, about 6 miles from Trnava. Czechoslovakia planned to build ten atomic power plants by 1970.

Denmark.—Contrary to reports at the Geneva Conference that Denmark would soon begin developing uranium in Greenland, the Danish Atomic Energy Commission indicated that it was uneconomic to work the uranium-thorium deposits in Greenland.

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[17] Chemical Trade Journal and Chemical Engineer (London), vol. 143, No. 3731, Dec. 5, 1958, p. 1364.
[18] Engineering and Mining Journal, vol. 159, No. 8, August 1958, p. 222.

Finland.—Among the many reports of discoveries of uranium, the most significant appeared to be the deposits at Eno, Askola, and at Perno.[19] A new company, Ab Perno Oy, was established to work uranium deposits in southern Finland. Ore grade was about 0.55 percent U_3O_8. A plant to process uranium was planned.

France.—The uranium reserve in continental France was adequate for a 10-year supply at 1958 production rate of 800 tons. Overseas supplies of uranium were expected to play an important role in France's atomic energy program. Deposits in Mounana, Gabon Territory (French Equatorial Africa) were to be producing at least 300 tons of uranium annually by 1962.

Production of uranium metal was estimated to be 825 short tons in 1959; 1,100, in 1960; and 1,650, in 1962. All requirements for metallic uranium were met by production from the Bouchet plant. A second feed-materials plant, under construction at Malvezy, near Narbonne, in southern France, was expected to be operating by mid-1959.

In 1958 the active uranium-mining regions were: (1) south Brittany (Vendee), (2) the Vosges Mountains, (3) northwestern Massif Central (La Crouzille), and (4) northeastern Massif Central (Forez). The mineral districts were served by three processing plants and a fourth was under construction. Development of French uraniferous resources and projections for the future of the uranium industry in France (table 7) were described.[20]

At Marcoule in southern France a new atomic reactor, designed to produce 88 pounds of plutonium annually and more than 30 megawatts of electricity, began operating in July. A smaller atomic reactor was already operating and a third went critical late in the year, bringing France's plutonium production up to 220 pounds a year.[21]

Germany, East.—East Germany remained the major producer of uranium ore in Europe, but its mining of uranium ore in 1957 was uneconomic. Apparently, the U.S.S.R. paid only 450 million East marks for the 1957 production, but the output cost about 850 million East marks. The entire production of radioactive materials was

TABLE 6.—French uranium ore processing plants, 1958

Mining region	Plant	Average content of ore treated, percent U_3O_8	Approximate capacity, tons of ore per day
West of France	L'Ecarpiere	0.10	1,000
Northwest of Massif Central	Bessines	.125	[1] 750
Northeast of Massif Central:			
Forez	Bois Noirs	.185	500
Morvan	Gueugnon	.60	100
Total			2,350

[1] Under construction; full capacity of 2,000 tons a day expected by 1960.

[19] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 24.
[20] Gabriel, R., France and Uranium: Indian Min. Jour. (Calcutta), vol. 6, No. 6, June 1958, pp. 9–12.
[21] Chemical Age (London), vol. 80, No. 2039, Aug. 9, 1958, p. 227.

shipped to the U.S.S.R. Exploration for uranium continued near Aue and Georgenstadt, and good possibilities were reported for the uranium reserve in Thuringia, especially near Greiz.

Germany, West.—Discovery of a uranium deposit near Ellweiler in the Rhineland-Palatinate area was to be followed by open-pit mining. The deposit, said to be about 100,000 tons of ore containing 0.1 percent U_3O_8 was to be mined by Gewerkschaft-Brunhilde, a private firm in Hanover. Germany's first uranium mine, operated since 1950 in Weissenstadt, curtailed operations late in 1957 because of high production costs.

West Germany became the first country, other than the United States and the United Kingdom, to sign a purchase contract for uranium from Canada. The contract for 12 tons of uranium oxide was expected to be followed by an order for 500 tons of oxide to be delivered over a 5-year period.[22]

Degussa Co. of Frankfurt was negotiating for an agreement on technical cooperation with Mallinckrodt Chemicals Works, St. Louis, Mo., in uranium refining. Degussa was also negotiating for a uranium-recovery process worked out by the Junta de Energia Nuclear of Spain.[23]

Construction began on the first of five experimental atomic power reactors, which the West German Atomics Ministry scheduled for operation by 1965. Financial arrangements were being worked out for installing one of six atomic power stations to be built by 1963 within the six Euratom countries. Two reactors were operated for research during 1958 and the Ministry announced that five new atomic research reactors would be in operation in West Germany early in 1960.

Greece.—The Greek Government Institute of Geology and Subsurface Research announced that known deposits of uranium in Greece did not warrant further attention. A Special Committee on Mines recommended that the greatest possible freedom, consistent with laws and regulations, be given for the search and exploitation of radioactive minerals.

Hungary.—Significant quantities of uranium in coal of the Transdanubian Oblast were reported by associates of the Institute of Atomic-Nuclear Research in Hungary. The Institute was testing methods for extracting uranium from lignite.

The Department of Chemistry, Central Physics Research Institute, Budapest, published a report on research on chemical processing of Hungarian uranium ores. The report described chemical concentration methods using ion exchange, and fluidized-solids techniques.

A 2-megawatt atomic reactor was begun late in 1958 to make investigations in neutron physics and radiation chemistry, prepare radioisotopes, and promote the training of personnel, who will help construct an atomic powerplant later with aid from the U.S.S.R.

Italy.—Surveys indicated that Italy would be able to produce 190 tons of uranium annually within 3 years; 70 percent from Val Gardena and other parts of the Eastern Alps, the remainder from Permian

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[22] Mining Journal (London), vol. 250, No. 6406, May 30, 1958, p. 638.
[23] Chemical Week, vol. 83, No. 4, July 26, 1958, p. 65.

shales of the Alpi Cozie and Alpi Maritime.[24] The uranium reserve of the Val Gardena area included 50,000 tons of measured ore averaging 0.20 percent U_3O_8; 1 million tons of indicated ore at 0.15 percent U_3O_8; and 5 million tons of inferred ore at 0.10 percent U_3O_8. The Alpi Cozie and Alpi Maritime ore reserves included: Measured—100,000 tons at 0.15 percent U_3O_8; indicated—500,000 tons at 0.15 percent U_3O_8; and inferred—1.5 million tons at 0.15 percent U_3O_8.

The first full-scale atomic power reactor was under construction at Latina and contracts were let for a second atomic power station to be built south of Rome.

Norway.—Reports of uranium discoveries were noted in many parts of the country including Finmark, far north of the Arctic Circle. The Norwegian Geological Survey (Norges Geologiske Undersokelse) investigated the Finmark occurrences in 1957 and reported that the district contained large areas of radioactive ore. Deposits in Mjallaacce, at Reisadalen in the Nordreisa area, were said to be several miles in extent. Investigations continued in the northern regions of Norway where commercial deposits of uranium would necessarily have to be high grade to be mined at a profit.

The atomic reactor at Kjeller near Oslo continued to produce a large quantity of radioisotopes, used chiefly for medical and biological purposes in the Scandinavian countries and the Netherlands. Construction progressed satisfactorily on the Halden reactor. The Atomic Energy Institute continued to study the atomic propulsion of ships.

Poland.—Polish uranium ore, said to be higher in grade than that extracted in Yugoslavia, was exported to the U.S.S.R. After 1959, Poland planned to use uranium ore for its own industrial purposes. Experiments were to be conducted at the Institute for Nuclear Research on processing of Polish uranium ore and on production of uranium metal for use in Poland's experimental atomic reactors and in a proposed large-scale power reactor.

Portugal.—Uranium deposits in Portugal continued to supply some of the requirements of the Combined Development Agency. Portugal also had uranium deposits in the overseas Territories of Angola and Mozambique.

Studies by Portuguese technologists indicated that a nuclear power program for the country should be held in abeyance pending complete development of the country's water resources. The Nuclear Energy Board of Portugal announced that a plant with an annual capacity of 100 to 150 tons of uranium metal was proposed.

Spain.—Preliminary work for a detailed exploration of the Mentrida area, north of Toledo, was underway. The Junta de Energia Nuclear of Spain announced the discovery of a new and simplified method of extracting uranium from its ores; details of the process were not available.

The Centrales Nucleares del Norte, a joint venture of two private electric power companies, announced plans for constructing a 200-megawatt atomic powerplant at Sabron, which is to be producing by 1965.

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[24] Chemical Age (London), vol. 80, No. 2056, Dec. 6, 1958, p. 950.

Sweden.—The output of uranium oxide in 1957 was estimated at 10 short tons, compared with about 5.5 tons in 1956. Plans were being made to develop a new uranium mine, the Ranstadsverket, at Haggum north of Stenstorp in Skaraborgs län. The cost of developing the mine and erecting a uranium-refining plant was estimated at 125 million kronor (1 krona equals US$.193). The new plant, scheduled for completion in 1962, would employ 330 persons. Anticipated annual production of 120 tons of uranium will require about 900,000 tons of uraniferous shale.

Atomenergie was reported to have applied for a mining concession from the King-in-Council to carry on additional research and experimental mining of deposits containing uranium, thorium, and beryllium in three localities in the Skultorp and Stenstorp communities. Previous borings and samples from mining uranium-containing schists in the Billingen area averaged ¾ pound of uranium per ton of schist. The deposits average about 12 feet in thickness and contain about 27,500 short tons of recoverable uranium.[25]

Sweden's atomic energy program for the next 10 years includes the following construction: A combined power- and heat-producing reactor to be completed by 1961, two power-producing plants in the 100-megawatt range to be completed by mid-1960, and one or more power reactors producing several hundred megawatts of electricity by 1969.[26]

U.S.S.R.—Information presented at the Geneva Conference during the year indicated that uranium deposits in the Soviet Union are primarily in acidic igneous rock; many data were presented on mineralogy and genesis of deposits, but description of specific deposits, reserves, and related information were omitted.

A widely used method of prospecting for radioactive minerals in the Soviet Union is that of measuring by means of portable electronic units the radon content of soil samples and gases emanating from the ground. Under ideal conditions the method permits accurate definition and contouring of a radioactive anomaly in areas where deep soil cover over uraniferous strata makes the geiger or scintillation counters unsuitable.[27]

The Pervomisky uranium mine in the Ukraine, about 93 miles southwest of Dnepropetrovsk, was described by a Canadian geologist after a visit to the mine in May.[28] Although grade and tonnage were restricted information, mine production was estimated at 1,000 to 1,500 tons of ore a day, ranging from 0.2 to 0.25 percent U_3O_8 in grade.

The mineralization occurs as uraninite disseminations and pitchblende stringers in highly schistose formations. Access to the mine is by three circular, concrete-lined shafts, 600 meters (2,000 feet) in depth. Miners work a 6-hour shift, 3 shifts per day.

Soviet advances in electrical power generation from nuclear power were presented at the Geneva Conference in September. During the year, the U.S.S.R. had the largest operating nuclear powerplant in

[25] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 3, March 1959, pp. 21–22.
[26] South African Mining and Engineering Journal (Johannesburg), Sweden's Atomic Programme: Vol. 69, No. 3431, pt. 2, Nov. 14, 1958, pp. 984–989.
[27] South African Mining and Engineering Journal, Radioactive Mineral Research in the U.S.S.R.: Vol. 69, No. 3386, pt. I, Jan. 3, 1958, p. 983, 985.
[28] Northern Miner, June 5, 1958, pp. 17, 21.

the world. One of six natural-uranium reactors, scheduled to be built at the plant site in Siberia, was producing 100 megawatts of electricity at full capacity. In 1958 the Soviet Union completed the first stage of a nuclear powerplant in Voronezhskaya Oblast in Siberia designed to produce 600 megawatts of electricity. A boiling-water reactor of 50 megawatts output was under construction in Ul'yanovskaya Oblast on the Volga. In the Ural Mountains, a nuclear energy electric powerplant with a capacity of 400 megawatts was under construction. The use of a liquid-metal core and of organic and other types of coolants in reactors was being investigated.[29]

An explosion at a Soviet Union reactor station near Sverdlovsk in the Urals contaminated a 5,000-square-mile area necessitating the evacuation of 12 villages and some collective farms northwest of Sverdlovsk. The catastrophic accident probably resulted from experiments with atomic weapons.

United Kingdom.—Results of airborne radio-metric reconnaissance in West and Central Cornwall were promising enough to warrant test pitting, trenching, and exploratory drilling of the areas. The remainder of Cornwall and much of Devon and Somerset was being investigated by an airborne survey. Extending the search area to include parts of Wales, Northern England, and the southern upland of Scotland was being considered.

The United Kingdom contracted to pay $105 million for uranium oxide from Canada in 1963; a previous contract calls for payment of $115 million for uranium to be delivered in the 1958–62 period. More sales for the post-1963 period were being negotiated. Total deliveries under the two contracts are estimated at 9,000 to 11,000 tons of metal. The United Kingdom also received uranium from South Africa, Australia, the Federation of Rhodesia and Nyasaland and other countries.

Requirements of uranium for the nuclear power program in Great Britain were placed at about 7,500 tons of natural uranium fuel by 1963.

The Springfield Works, the only plant in Great Britain that processes uranium concentrates into metal, expanded its facilities for manufacturing uranium fuel elements and for making UF_6 for the gaseous-diffusion plant at Capenhurst.[30]

The Atomic Energy Authority announced a decision to abandon the first plutonium pile at Windscale, where an accident took place in October 1957. The concrete box enclosing the reactor was to be sealed and left for a century or more until the radioactivity inside has decayed.

Britain's Central Electricity Generating Board was planning a 650-megawatt nuclear power station. The nuclear power program calls for 5,000 to 6,000 megawatts of nuclear capacity to be installed by the end of 1965.

Yugoslavia.—The small, Yugoslav-built atomic reactor at Vinca was successfully tested during the year. A larger reactor with a thermal output of 10 megawatts was under construction at Vinca with Soviet assistance.

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[29] Yemel'yanov, V. S., The Future of Nuclear Power in the U.S.S.R.: Atomnaya Energiya (Moscow), vol. 5, No. 3, September 1958, pp. 217–222.

[30] Chemical Age (London), Uranium Processing at Springfields: Vol. 81, No. 2064, Jan. 31, 1959, pp. 199–201.

ASIA

India.—Detailed and systematic surveying, designed to estimate the reserve of nuclear raw materials, indicated that the total estimated reserve in India was approximately 30,000 tons of uranium and 500,000 tons of thorium. About half of the reserve is in the large deposits in Bihar, where the construction of a mill with an initial capacity of 500 tons of ore a day and provision for doubling the capacity later was planned.

India's Atomic Energy Commission planned an atomic powerplant fueled by natural uranium, construction to begin in 1960 or 1961.

Japan.—Preliminary surveys for uranium in Japan showed that five sites in Gifu Prefecture and one in Toyama Prefecture contain uranium and that, at least one, the Hirase molybdenum mine in Onogum, Gifu Prefecture, would be workable. Three more mines in the northern part of Gifu Prefecture—the Kurokawa (copper), the Ebisu (tungsten), and the Naegi—would probably assay over the 0.1 percent U_3O_8. Because processing and refining facilities were lacking and uranium for power consumption was not required until 1960, the deposits will probably not be worked until 1960.

The Japanese Government announced the following tentative price schedule for uranium ore, which must be sold only to the Japan Atomic Fuel Corporation: 0.1 percent U_3O_8—$13.89 per ton; 0.2 percent U_3O_8—$36.67 per ton; 0.3 percent U_3O_8—$55.56 per ton. The prices are considerably higher than those paid in the United States, the cost of producing refined uranium is probably about the same as obtaining it from the United States.

A large uranium vein extending over a distance of 9 miles was found in the Tottori-Shimane border area, 3 miles north of the uranium deposits at Ningyo Pass. The deposits found in conglomerate layers were said to measure 20 feet at their deepest point. The Japanese expedition to Antarctica reported the discovery of uranium ore outcroppings on the Prince Harold coast, near the Japanese base on the island of Ongul.[31]

The Japanese government contracted to buy 3,000 kilograms (3.3 tons) of uranium from the IAEA at a price of $35.50 per kilogram.

AFRICA

Belgian Congo.—The uranium ore reserve at the famous Shinkolobwe mine was practically exhausted, according to an Euratom report. The Belgian Congo has been producing about 850 tons of uranium annually; about 75 percent of the annual production was under option to the Combined Development Agency. Production figures revealed for the first time indicate that the Shinkolobwe mine produced about 343,000 short tons of uranium ore in 1957.

The Belgian Congo authorities announced a decision to purchase a small experimental atomic reactor.[32]

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[31] Western Mining and Industrial News, vol. 26, No. 4, April 1958, p. 7.
[32] Chemistry and Industry (London), Nuclear Reactor for the Congo: No. 44, Nov. 1, 1958, p. 1418.

Egypt.—Discovery of uranium deposits was reported by the Nuclear Survey Department of the Egyptian Atomic Energy Commission. Samples were sent to the U.S.S.R., India, and Yugoslavia to be analyzed.

French Equatorial Africa.—Developing a uranium deposit discovered in 1956 at Mounana-Franceville in the region of Haut Ogoove and establishing an ore-concentrating plant [33] was planned.

Kenya.—A radiometric aerial survey for uranium over 4,000 square miles of the Coast Province in Kenya was begun by the United Kingdom AEA.

Mozambique.—Official statistics on the Mozambique mining industry in 1957 showed that the country produced 66 tons of davidite in 1957.

Rhodesia and Nyasaland, Federation of.—Uranium was produced for the first time when a small treatment plant was completed at the Nkana mine in April 1957. In 1957 more than 52,000 pounds of U_3O_8 concentrate was recovered from uraniferous sections of Nkana's Mindola ore body. The concentrate was purchased by the United Kingdom.

Occurrences of uraninite, davidite, and betafite have been found both in the northern province and in the Wankie area near the Shire Valley to the south.[34]

Union of South Africa.—In the Union of South Africa, 17 authorized plants produced 6,200 short tons of U_3O_8 compared with 5,700 tons in 1957. Negotiations in South Africa in May resulted in agreement with the South African Atomic Energy Board that, beginning July 1, production deliverable to the Combined Development Agency would not exceed 6,200 tons annually. Uranium produced in excess of 6,200 tons could be sold elsewhere.[35]

The Union of South Africa was reportedly negotiating with Japan for the sale of 6.5 tons of South African uranium oxide at a price of about US$10 per pound.

OCEANIA

Australia.—Australia produced 650 tons of uranium oxide compared with 500 tons in 1957. It was estimated that Australian production of uranium concentrate in 1959 will increase to 1,100 tons.

Australia's third uranium-treatment plant at the Mary Kathleen mine began operating in June after many thousands of tons of ore from the opencut mine had been stockpiled. The plant used ion exchange and treated 1,000 tons of ore daily. The uranium oxide was shipped to the United Kingdom. Other extraction plants were at Rum Jungle and at Port Pirie.

The Northern Hercules gold-treatment plant was converted for uranium; ore from the South Alligator River area was treated by a solvent-extraction process. The United Kingdom arranged to purchase the output.

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[33] Bureau of Mines, Mineral Trade Notes: Vol. 46, No. 6, June 1958, pp. 25–26.
[34] South African Mining and Engineering Journal, vol. 69, No. 3425, Oct. 3, 1958, pp. 685, 687.
[35] Jeal, E., The Uranium Industry of South Africa: Mining World and Engineering Record (London), vol. 174, No. 4518, September 1958, pp. 355, 358.

At Rum Jungle, opencut operations at White's deposit were curtailed in October, and mining was temporarily transferred to Dyson's opencut. The Rum Jungle plant continued to treat stockpiled ore.[36]

High-grade uranium ore was discovered near Olary, South Australia.

WORLD RESERVES

The inferred uranium reserve of the free world was estimated to be about 1.5 million tons of U_3O_8 according to data presented at the 1958 Geneva Conference, an increase of one-half million tons over the reserve in 1957.

Ninety percent of the uranium reserve is in sedimentary rocks ranging in age from the Precambrian conglomerates of South Africa and Canada to late Tertiary sandstones in the United States.[37]

Discovery rate of domestic uranium ore during the year was about 10 million tons or about twice that required to meet mill requirements for 1958.

TABLE 7.—Free world uranium reserves, Dec. 31, 1958

Country	Ore, thousand short tons	Grade (percent U_3O_8)	Tons U_3O_8 (thousand)
Union of South Africa	1,100,000	0.034	370
Canada	377,000	.102	380
United States	82,500	.27	223
France			50–100
Australia			10
Belgian Congo			7.5
Total free world including estimate for other countries			1,500

TABLE 8.—United States uranium ore reserves, Dec. 31, 1957–58 [1]

State	Dec. 31, 1957		Dec. 31, 1958	
	Quantity (million tons)	Grade (percent U_3O_8)	Quantity (million tons)	Grade (percent U_3O_8)
New Mexico	53.3	0.26	54.9	0.26
Wyoming	9.2	.26	11.5	.31
Utah	5.7	.37	5.6	.35
Colorado	4.1	.29	4.4	.30
Arizona	1.4	.32	1.4	.34
Washington, Oregon, Nevada	1.9	.23	2.3	.24
North Dakota, South Dakota	.6	.25	.6	.26
Others (Texas, California, Montana, Idaho, Alaska)	1.8	.23	1.8	.23
Total	78.0	.27	82.5	.27

[1] In addition to reserves in place there was ore stockpiled at mills or AEC buying stations to balance ore production with mill requirements and to assure a balanced mill feed. The stockpile contained 2,000,000 tons with a grade of 0.28 percent U_3O_8 in December 1957 and 1,750,000 tons of the same grade in December 1958.

[36] Bureau of Mines, Mineral Trade Notes: Vol. 48, No. 4, April 1959, p. 21.
Canadian Mining Journal (Gardenville, Quebec, Canada), Mining in Australia: Vol. 79, No. 8, August 1958, p. 90.

[37] Johnson, J. C., Resources of Nuclear Fuel for Atomic Power: Second International Conf. on the Peaceful Uses of Atomic Energy, Geneva, September 1958, United Nations, Geneva, Switzerland, vol. 2, Survey of Raw Materials Res., pp. 3–10.
Griffith, J. W., and others, Types and Ore Reserves of Canadian Radioactive Deposits: Second International Conf. on the Peaceful Uses of Atomic Energy, Geneva, September 1958, United Nations, Geneva, Switzerland, vol. 2, Survey of Raw Material Res., pp. 35–39.

TECHNOLOGY

Exploration.—Appraisal of uranium resources of the United States were discussed at the Geneva Conference.[38] Resources of ore-grade material in the United States are several hundred million tons, containing 0.1 or more percent U_3O_8. New mineralogical, geochemical, and geological knowledge was presented at the Conference. The uranium in the black ores of the Colorado Plateau was identified as amorphous black UO_3. Geochemical techniques were being used more widely to study radioactive disequilibrium of altered ores. Perhaps the most important new development in prospecting for uranium in sedimentary rocks was finding major deposits in geological environments favorable for petroleum and natural gas.

Mining.—Over half of the ore was produced from underground mines, however, discoveries of large shallow deposits have given increased importance to opencut-mining methods. At the 1958 Geneva Conference, mining methods and costs of the larger domestic opencut uranium mines were described. Mining costs for producing uranium from opencut mines in the United States ranged from $4.80 to $11.80 per ton of ore; in underground mining, the costs ranged from $6 to about $15 per ton. (See table 10.)

In the Ambrosia Lake district in northwestern New Mexico, eight shafts were being sunk, ranging from 350 to more than 1,000 feet in depth. Water was the most difficult problem confronting many Ambrosia Lake operators. Although the mines at the northwest end of the district are relatively dry, the ones to the southeast may have inflows of 2,000 to 5,000 gallons per minute when fully developed.[39] Two types of underground development commonly were used in the Ambrosia Lake district; one was to drive standard-size-track haulageways in waste beneath the ore and mine the ore through raises using slushers on the stoping levels; the other was to drive the haulage levels in the ore and use trackless haulage equipment on the undulating bottoms.

Mining methods used in major Canadian mines include open-pit, conventional underground mining using track haulage, and trackless mining utilizing diesel and electric-driven equipment.[40]

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[38] Second United Nations International Conference on the Peaceful Uses of Atomic Energy, September 1958, vol. 2, Survey of Raw Material Resources, 843 pp. Specifically, the following papers:
Nininger, R. D., Geologic Distribution of Nuclear Raw Materials, pp. 7–10.
Butler, A. P., Jr., Geologic Appraisal of Uranium Resources of the United States, pp. 11–16.
Page, Lincoln R., Some New Mineralogical, Geochemical, and Geologic Aids in Uranium Exploration, pp. 123–125.
Kratchman, Jack, Regional Exploration Criteria for Uranium, pp. 325–329.

[39] Argall, G. O., Jr., Water Makes Mining Tough and Sloppy at Deep Ambrosia Lake U_3O_8 Mine: Min. World, vol. 20, No. 9, August 1958, pp. 30–33, 83.

[40] Second United Nations International Conference on the Peaceful Uses of Atomic Energy, September 1958, vol. 3, Processing of Raw Materials, 608 pp. Specifically, the following papers:
Dare, W. L., Underground Uranium Mining on the Colorado Plateau, pp. 24–31.
Baker, D. D., and others, Open Cut Mining of Uranium Ore in the Western United States, pp. 18–23.
Barrett, R. E., and others, Mining Methods and Production Costs at Major Canadian Uranium Mines, pp. 3–17.

TABLE 9.—Underground uranium mining costs and productivity in the United States

Area	Cost per ton of ore							Tons mined per man-shift
	Development	Mining						
		Labor and supervision	Explosives	Drill steel and bits	Other direct costs	Indirect costs	Total	
Average for 10 Salt Wash mines in Colorado	$3.08	$7.06	$0.75	$0.27	$1.64	$2.13	$14.93	2.1
Big Buck mine, Utah	---------	1.25	.66	.27	2.08	1.62	5.88	10.4
1957 average for 6 mines in the Big Indian district, Utah (south end of field)	---------	1.98	.65	.20	.96	2.29	6.08	13.3
1957 average for 6 mines in the Big Indian district, Utah (north end of field)	.88	3.93	.62	.18	1.60	2.29	9.50	5.7
Average 1955–57 for 2 mines at Temple Mountains, Utah	.87	4.05	.63	.16	1.38	1.34	8.43	4.1

A longwall method of mining was proving successful for extraction of uranium ore in a San Juan County, Utah, mine.[41]

Radiation dangers to workers in uranium mines received increased attentions from the Bureau of Mines, the Public Health Service, State Agencies, and private mining companies. The Bureau listed ways to control radiation hazards in uranium mining.[42]

Milling.—During the year products were recovered in three domestic mills by ion exchange, in eight mills by solvent extraction, in five mills by resin-in-pulp, and in four mills by caustic precipitation. Three mills employed two processes each; one mill, ion exchange and solvent extraction, another mill, caustic precipitation and solvent extraction, and the remaining mill, caustic precipitation and resin-in-pulp.

Reduction of costs in uranium recovery were discussed at the 1958 Geneva Conference. Three avenues of research in uranium processing where milling economics might be improved included leaching, beneficiation, and new-process development.[43]

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[41] Mining Record, vol. 69, No. 27, July 3, 1958, p. 5.

[42] Westfield, J., Flinn, R. H., Look, A. D., and Morgis, G. G., Engineering Control of Health and Safety Hazards in Uranium Mines: Bureau of Mines Inf. Circ. 7834, 1958, 20 pp.

Hymas, K. I., The Ventilation of Quirke Mine: Canadian Min. Jour. (Gardenville, Quebec, Canada), vol. 79, No. 10, October 1958, pp. 93–96.

[43] Second United Nations International Conference on the Peaceful Uses of Atomic Energy, September 1958, vol. 3, Processing of Raw Materials, 608 pp. Specifically, the following papers:

Barnes, J. W., The Role of Process Development in Western United States Uranium Procurement, pp. 183–190.

Upchurch, T. B., Prospects for Research and Development Effort to Decrease Costs of Recovering Uranium From Its Ores, pp. 191–194.

Brown, E. A., Gilmore, A. J., Gow, W. A., McNamara, M., and Simard, R., Some Variations of Uranium-Ore Treatment Procedures, pp. 195–200.

Painter, L. A., and Izzo, T. F., Operation of the Resin-in-Pulp Uranium Processing Mill at Moab, Utah, pp. 383–386.

Brown, K. B., Coleman, C. F., Crouse, D. J., Blake, C. A., and Ryon, A. D., Solvent Extraction Processing of Uranium and Thorium Ores, pp. 472–487.

Rosenbaum, J. B., Borrowman, S. R., and Clemmer, J. B., Solvent Extraction for Recovering Uranium and Vanadium From Salt-Roast-Process Solutions, pp. 505–509.

The Anaconda Co. Bluewater mill continued to process all limestone and some sandstone ores by carbonate leach and other sandstone ores by first an acid leach and then resin-in-pulp recovery. Kermac Nuclear Fuels, Grants, N. Mex., employed a sulfuric acid, solvent-extraction process. The ore is ground to about 28-mesh, and leached in agitators with sulfuric acid and an oxidant. A sandslime separation is made in cyclones, the sands are washed countercurrently in classifiers, and the slimes are washed in a countercurrent decantation thickener circuit. Pregnant liquor is treated by solvent extraction, followed by precipitation of uranium with ammonia. The resulting yellow cake is filtered and washed on drum filters, then dried and packaged.

The Phillips Petroleum Co. Ambrosia mill, Grants, N. Mex., Homestake-Sapin Partners' mill, and Homestake-New Mexico Partners' mill employed carbonate leaching followed by caustic precipitation. These three mills could process a wide range of sandstone and limestone ores. The process includes crushing, sampling, and ball-mill grinding in sodium carbonate solution to about 65-mesh. Classifier overflow is thickened to 50 percent solids and leached at 180° F. for 36 hours in pachuca tanks. The leach pulp is then diluted, thickened, filtered, and the residue washed. The clarified pregnant solution is treated with caustic soda to precipitate yellow cake, which is filtered, dried, and packed for shipment. The main differences between the two Homestake mills are in the methods of leaching the ores and of drying the yellow cake.[44]

The Lucky Mc Uranium Corp. mill in Wyoming was the first in the United States to use the moving-bed process, which is chemically similar to other ion exchange circuits but differs in that it represents a radical mechanical departure. The resin-loaded columns are interconnected to permit the resin to be pumped out of any column after adsorption is completed, passing through backwashing and elution columns before it is returned for further adsorption service. Desirable features of the moving-bed, ion exchange system were said to be lower capital cost because smaller columns can be used for adsorption and elution while one column is enough for all the backwashing, a lower resin inventory, less mechanical attrition of the resin, and higher efficiency of the system because elution can be carried out on a resin that contains more uranium.

A summary of research work underway on the production of uranium tetrafluoride (UF_4) at the mill site was presented during the year.[45] UF_4 has been produced in laboratory experiments in an acid-leach solvent-extraction circuit and experiments indicate possibilities of producing UF_4 from alkaline leach processes.

Aqueous reduction to UF_4 became a possibility when copper was found to be apparently of certain value as a catalyst for uranium.[46]

[44] Osborn, C. E., Milling Uranium Ores of the Ambrosia Lake Area, New Mexico, Present and Future: Mines Mag., vol. 48, No. 3, March 1958, pp. 35–38.
[45] Report on the Third Annual AIME Uranium Symposium at Moab: Intermountain Ind. and Min. Rev., vol. 60, No. 6, June 1958, pp. 33–36.
[46] Long, R. S., Ellis, D. A., and Magner, J. E., UF_4 Production in Uranium Mills: Min. Cong. Jour., vol. 44, No. 4, April 1958, pp. 74–76.

Vanadium

By Phillip M. Busch [1] and Kathleen W. McNulty [2]

DURING 1958, decreases were registered in the output of vanadium in ore and concentrate, the production of vanadium pentoxide and forrovanadium, consumption of vanadium, and exports of ferrovanadium and alloys containing vanadium. Exports of vanadium pentoxide increased about 26 percent.

The Vanadium Corp. of America closed its uranium-vanadium mill at Naturita, Colo., January 31, 1958.[3] This mill was the oldest operating uranium-vanadium mill on the Colorado Plateau; its ore capacity was about 350 tons daily. The 430-ton-a-day Durango mill of the Vanadium Corp. of America was rebuilt, and facilities were expanded to approximately 750 tons of ore daily.

TABLE 1.—Salient vanadium statistics, short tons of contained vanadium

	1949-53 (average)	1954	1955	1956	1957	1958
United States:						
Production:						
Ore and concentrate processed	3,115	4,805	5,656	5,701	7,307	6,829
Recoverable vanadium in ore and concentrate [1]	2,108	3,026	3,286	3,867	3,691	3,030
Vanadium pentoxide	1,945	3,151	3,669	3,937	[2] 3,612	2,791
Imports:						
Ore and concentrate	475	198	92			
Vanadium-bearing flue dust	(3)					
Exports:						
Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium (gross weight)	[4] 85	70	220	139	134	76
Vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates [5]	15	21	865	928	500	631
World: Production (estimate)	3,107	3,868	3,996	4,230	4,295	4,231

[1] Measured by receipts at mills.
[2] Revised figure.
[3] Averages less than a ton.
[4] Classified as ferrovanadium 1949-52.
[5] Classified as "Ore and concentrate," 1949-52, but probably included vanadium pentoxide.

LEGISLATION AND GOVERNMENT PROGRAMS

Details on procurement of vanadium were revealed in the record of hearing before the House of Representatives Committee on Appropriations.[4] Because the national stockpile goal for vanadium

[1] Commodity specialist.
[2] Statistical clerk.
[3] Mining Record, Vanadium Changes Its Milling Set-up in Southwest Colo.: Vol. 69, No. 23, June 5, 1958, p. 3.
[4] American Metal Market, Vanadium Purchases by U.S. Discussed at Recent Hearings: Vol. 65, No. 139, July 19, 1958, pp. 1, 2.

had been reached, the Atomic Energy Commission (AEC) wanted to reduce its vanadium purchases to be consistent with obligations published in AEC ore buying Circular 5 (revised) covering uranium-vanadium carnotite ores. When the uranium program was begun, carnotite ores were the only domestic source of uranium. As an incentive to maximum uranium production, an outlet for the vanadium in excess of commercial demand was created. Provisions for the purchase of vanadium pentoxide were included in AEC contracts with certain uranium-vanadium producers. Modification, extensions, or the status of AEC contracts in July 1958 were as follows:

Union Carbide Nuclear Co.—The obligation to purchase vanadium pentoxide produced at the company mill at Rifle, Colo., was terminated. Liability for the purchase of vanadium pentoxide from the mill at Uravan, Colo., was reduced from approximately 630,000 pounds to a maximum of 210,000 pounds of vanadium pentoxide per month with no liability under certain operating conditions.

Vanadium Corp. of America.—The contract that became effective July 1, 1958, included no purchases of vanadium pentoxide produced at the Durango, Colo., mill.

Climax Uranium Co.—The previous contract extends to October 1, 1960, for their mill at Grand Junction, Colo.; beyond this date, removing the vanadium commitment will be considered.

Kerr-McGee Oil Industries, Inc.—At Shiprock, N. Mex., this company processed uranium-vanadium ores produced on the Navajo Indian Reservation, and it was required to pay for the vanadium content of ores meeting certain specifications. An existing AEC contract for purchasing uranium concentrate from this mill included reimbursement for the vanadium content of certain ores. Instead of producing vanadium pentoxide, the AEC stockpiled the mill tailings containing vanadium.

Uranium Reduction Co.—This company operated a mill at Moab, Utah. Its contract with the AEC included payment for vanadium in tailings; the obligation for payment of vanadium in tailings was expected to be terminated during renegotiations of the contract.

Atomic Energy Commission.—The AEC processed ore at Monticello, Utah, but did not recover vanadium pentoxide. Payment was made, however, for the vanadium content of ores meeting the specifications in Circular 5 and purchased at the Monticello buying station. These ores may be sold to mills that recover vanadium pentoxide, or treated at Monticello and the vanadium-bearing tailings stored for future processing.

Commitments for the purchase of vanadium by the AEC terminate March 31, 1962.

DOMESTIC PRODUCTION

Ore.—Production of vanadium in ore and concentrate in 1958 was about the same as in 1957.

The "Four Corners" area of the Colorado Plateau, consisting of southwestern Colorado, northwestern New Mexico, northeastern Arizona, and southeastern Utah, continued to be the center of vanadium-ore mining of the United States. A small quantity of ore was also produced in Wyoming. Vanadium produced from ores mined in these five States was a byproduct or coproduct of uranium production.

Colorado continued as the leading ore-producing State; however, its output of recoverable vanadium was about 24 percent less than 1957. In 1958, ore-processing mills were operated by Climax Uranium Corp. at Grand Junction, Union Carbide Nuclear Co. at Uravan, and Vanadium Corp. of America at Durango.

Production of recoverable vanadium in ore and concentrate in Utah decreased about 26 percent from 1957.

TABLE 2.—Recoverable vanadium in ore and concentrate produced in the United States, by States, short tons of contained vanadium

State	1949–53 (average)	1954	1955	1956	1957	1958
Colorado	1,588	2,264	2,298	2,791	3,132	2,395
Utah	140	288	498	549	508	376
Arizona and other States [1]	380	474	490	527	51	259
Total	2,108	3,026	3,286	3,867	3,691	3,030

[1] Includes Idaho, 1949–54; Montana, 1957; New Mexico, 1950–54, 1956–58; South Dakota, 1954; and Wyoming, 1954, 1956–58.

TABLE 3.—Vanadium and recoverable vanadium in ore and concentrate produced in the United States, in short tons

Year	Mine production [1]	Recoverable vanadium	Year	Mine production [1]	Recoverable vanadium
1949–53 (average)	3,030	2,108	1956	5,635	3,867
1954	4,930	3,026	1957	7,294	3,691
1955	4,983	3,286	1958	7,266	3,030

[1] Measured by receipts at mills.

Oxide.—Production of vanadium pentoxide in 1958 decreased 23 percent from 1957. Vanadium pentoxide from domestic ores was produced in three plants in 1958 and six plants in 1957. The figures in table 4 include the vanadium pentoxide produced as a byproduct of foreign chromite ores 1949–58; as produced from Peruvian concentrate, 1949–55; and as a byproduct of domestic phosphate rock, 1949–54.

TABLE 4.—Production of vanadium pentoxide in the United States, in short tons [1]

Year	Gross weight	V_2O_5 content	Year	Gross weight	V_2O_5 content
1949–53 (average)	3,922	3,473	1956	7,963	7,030
1954	6,368	5,628	1957	[2] 7,224	[2] 6,449
1955	7,426	6,552	1958	5,470	4,983

[1] Includes a relatively small quantity recovered as a byproduct of Peruvian concentrate and foreign chrome ore.
[2] Revised figure.

Ferrovanadium.—Ferrovanadium was produced in the United States by two companies, Vanadium Corp. of America and Electro Metallurgical Co. Production was about 55 percent less than in 1957.

CONSUMPTION AND USES

Ore and Concentrate.—The quantity of domestic and foreign vanadium ore and concentrate consumed at domestic plants to produce vanadium pentoxide and ferrovanadium was about 13.7 million pounds (vanadium content), a decrease of 7 percent from 1957.

Vanadium Products.—Approximately 81 percent of the total consumption of vanadium reported in 1958 was in the form of ferrovanadium. Consumption of vanadium by uses indicated that about 83 percent was used in high-speed and other alloy steel.

TABLE 5.—Vanadium consumed and in stock in the United States in 1958, by forms, short tons of vanadium

Form	Stocks at consumers' plants Dec. 31, 1957	Consumption	Stocks at consumers' plants Dec. 31, 1958
Ferrovanadium	218	1,022	203
Oxide	12	69	14
Ammonium metavanadate	13	88	12
Other	70	80	47
Total	313	[1] 1,259	276

[1] Represents approximately 90 percent of total consumption of 1.399 short tons.

TABLE 6.—Vanadium consumed in the United States in 1958, by uses

Use	Short tons	Use	Short tons
High-speed steel	194	Chemicals	68
Other alloy steels	845	Other	55
Alloy cast iron	19		
Nonferrous alloys	78	Total	[1] 1,259

[1] Represents approximately 90 percent of total consumption of 1,399 short tons.

Over 80 percent of the vanadium reported consumed was in the form of ferrovanadium used in manufacturing tool steels, constructional steels, wear-resistant cast irons and alloys, in welding rod electrodes, permanent magnet alloys, and as a deoxidizer for low-carbon steel. Commercial vanadium metal was used for iron-free or low-iron alloys, and a high-purity vanadium metal was used for special purposes and for research. A vanadium-aluminum alloy containing 2.5 to 40 percent vanadium was used to control thermal expansion, electrical resistivity and grain size of aluminum alloys, and to improve high-temperature strength. A product containing 80 to 85 percent vanadium alloyed with 13 to 17 percent aluminum was used as a low-impurity master alloy to produce titanium metal alloys. Aluminum, titanium, and boron alloyed with 25 percent vanadium was used in alloy steels to increase depth hardening and physical properties. Vanadium oxide was used in welding electrode coatings, and as an additive to steels under special conditions. Ammonium metavanadate and vanadium pentoxide were used as catalysts, in glass and in ceramic glazes, and for research.

For tool and structural steels, only a small proportion of vanadium was used. In high-speed steels, the vanadium content ranged from 0.50 to 2.50 percent although higher percentages were sometimes used. Alloy tool steels, other than high-speed steels, contained 0.20 to 1.00 percent vanadium. The quantity of vanadium added to engineering steels usually ranged from 0.10 to 0.25 percent. Most steels containing over 0.50 percent vanadium were for special purposes, such as dies, twist drills, reamers, and roughing and finishing tools. Vanadium was used alone in some carbon steel; but in most engineering and structural steels, it was usually combined with chromium, nickel, manganese, boron, and tungsten.

STOCKS

Stocks of various forms of vanadium held at consumers' plants December 31, 1958, decreased about 12 percent from those on December 31, 1957.

PRICES

Vanadium oxide (V_2O_5) contained in ore was quoted at 31 cents per pound from March 1951 through 1958. This quotation disregards penalties based upon the grade of ore or the presence of objectionable impurities, such as lime, which are important to the refiners, because 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 for alloying, in 100-pound lots, was $3.65. High-purity vanadium was quoted at $40 a pound.

FOREIGN TRADE [5]

No vanadium ore or concentrate for domestic consumption was imported in 1958; however, 1,500 pounds of material valued at $535 and classed as vanadic acid, anhydride, salts and compounds and mixtures of vanadium was imported from Switzerland. Imports for previous years may be found in the 1957 Minerals Yearbook.[6]

Exports of ferrovanadium and other alloying materials containing over 6 percent vanadium were about 43 percent less in 1958 than in 1957; those of vanadium ore, concentrates, pentoxide, vanadic oxide, vanadium oxide, and vanadates were 26 percent greater, and exports of vanadium flue dust and other waste materials were about 90 percent less.

WORLD REVIEW

Finland.—Early in 1958 additional equipment that would increase production of vanadium pentoxide 990 to 1,100 short tons per year was installed at the Otanmäki plant.[7] Analysis of the vanadium pen-

[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.
[6] Bureau of Mines, Vanadium: Chapter in Minerals Yearbook (table 7), 1957, p. 1262.
[7] U.S. Embassy, Helsinki, Finland, State Department Dispatch 741: June 16, 1958, p. 3.

TABLE 7.—Exports of vanadium from the United States, 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)	
	1957	1958	1957	1958	1957	1958
North America:						
Canada	204,878	125,354	4,846	8,921		
Mexico			1,214	4,480		
Total	204,878	125,354	6,060	13,401		
South America:						
Argentina			568			
Bolivia			896			
Brazil			2,122	1,951		
Uruguay	880					
Venezuela		1,000				
Total	880	1,000	3,586	1,951		
Europe:						
Austria			96,343	646,673		
Belgium-Luxembourg	1,000		3,333	24,069		
France			158,524	194,233		
Germany, West	59,570	22,064	135,927	17,226	24,690	
Italy			48,522	54,523	39,528	
Netherlands			33,486	91,071	51,942	11,202
Norway			632			
Sweden		2,205	62,974			
Switzerland			11,089			
Trieste				18,242		
United Kingdom	560	1,120	5,765	1,092		
Total	61,130	25,389	556,595	1,047,129	116,160	11,202
Asia:						
India			283	582		
Japan	1,100	330	433,816	198,020		
Total	1,100	330	434,099	198,602		
Grand total:						
Pounds	267,988	152,073	1,000,340	1,261,083	116,160	11,202
Value	$519,955	$294,933	$2,114,700	$2,624,960	$118,894	$2,100

toxide produced at the Otanmäki plant, in percent, is as follows: V_2O_5, about 98.5; Na_2O and K_2O, about 1.0; Fe_2O_3, 0.6 to 1.5; SiO_2, 0.2 to 0.1; S, 0.01 to 0.015; As_2O_5, traces; and, P_2O_5, 0.01 to 0.03.[8]

Union of South Africa.—Production of vanadium from magnetite lenses in the Bushveld complex was begun by the Minerals Engineering Co. of South Africa (Pty.) Ltd.[9] Ore, mined from outcrops along the Stoffberg branch of the South African Railway system, was shipped to the company mill at Witbank.[10]

Approximately 10,000 tons of magnetite ore containing about 1.6 percent V_2O_5 was fluxed monthly with 1,000 tons of crude salt and fed into a pair of multidecked wedge roasters.[11] The vanadate was

[8] U.S. Embassy, Helsinki, Finland, State Department Dispatch 219: Oct. 6, 1958, p. 1.
[9] Mining World, Johannesburg, Union of South Africa: Vol. 20, No. 2, February 1958, p. 33.
[10] Rhodesian Mining Journal, South Africa May Become Important Vanadium Seller: Vol. 30, No. 368, January 1958, p. 29.
[11] U.S. Embassy, Johannesburg, Union of South Africa, State Department Dispatch 157: Nov. 26, 1958, p. 7.

leached from the calcine in open vats, and, after treating with ammonium chloride, filtering and firing, a product containing over 98 percent V_2O_5 was recovered and packed in steel drums for export. Due to severe oxidation of the furnace rakes and the high price of ammonium chloride, operating costs were high. The company claimed that improved processing and further capital investment would make the operation profitable. Vanadium was recovered as a pure oxide and shipped to European customers. The scale of future production depends upon market requirements. The ore reserve was estimated to be adequate for 10 years.

TABLE 8.—World production of vanadium in ores and concentrates, in short tons[1]

[Compiled by Pearl J. Thompson and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America: United States (recoverable vanadium)	[2] 2,108	[2] 3,026	3,286	3,868	3,691	3,030
South America:						
Argentina	(3)	(3)	----	(3)	(3)	(3)
Peru (content of concentrate)	462	209	78	----	----	----
Europe: Finland	----	----	----	43	290	430
Africa:						
Angola	----	----	----	11	1	20
Rhodesia and Nyasaland, Federation of: Northern Rhodesia (recovered vanadium)	62	----	----	----	----	----
South-West Africa (recoverable vanadium)	474	633	632	308	305	435
Union of South Africa (Transvaal)	----	----	----	----	8	316
World total (estimate)[1] [4]	3,106	3,868	3,996	4,230	4,295	4,231

[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, 1949–54.
[3] Negligible.
[4] Total represents data only for countries shown in table and excludes vanadium in ores produced in Belgian Congo, Mexico, Morocco (Southern Zone), Norway, Spain, and U.S.S.R., for which figures are not available; the table also excludes quantities of vanadium recovered as byproducts from other ores and raw materials.

TECHNOLOGY

At the annual Reactive Metals Conference,[12] vanadium for cladding fuel elements in sodium-cooled "breeder" reactors was discussed. Vanadium shows promise for required strength, chemical inertness to uranium, resistance to sodium attack, relatively low nuclear cross section, and desirable properties of conductivity and fabricability. The feasibility of using alloys of vanadium has been proved in sodium-cooled fast reactors but extreme oxidation and high costs are problems to be solved.

Medical researchers of the University of Cincinnati think that vanadium may hold down cholesterol levels in the blood.[13]

[12] American Metal Market, Reactive Metals Outlook Surveyed at Conference: Vol. 65, No. 104, May 29, 1958, pp. 1, 4.
[13] Wall Street Journal, Metal May Give Workers Unexpected Health Benefit: Vol. 152, No. 31, Aug. 13, 1958, p. 2.

Indicative of the many research activities conducted on vanadium was the wide range of subjects for which patents were issued.[14]

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[14] Dunn, Holbert E., Mayer, Bruno, and O'Brien, Crafton and Ellis J. (assigned to Vanadium Corp. of America, Process for Extracting Vanadium Values From Ores, Slags, Concentrates and the Like: U.S. Patent 2,822,240, Feb. 4, 1958.

Quaely, Martin F. (assigned to Westinghouse Electric Corp.), Electrodepositing Black Chromium-Vanadium Coatings and Members Therewith: U.S. Patent 2,824,829, Feb. 25, 1958.

Eisenberg, Philip H., and Raleigh, Douglas O (assigned to Sylvania Electric Products, Inc.), Electroless Deposition of Vanadium Alloys: U.S. Patent 2,827,400, Mar. 18, 1958.

Eisenberg, Philip H., and Raleigh, Douglas O. (assigned to Sylvania Electric Products, Inc.), Electroless Deposition of Vanadium Alloys: U.S. Patent 2,828,227, Mar. 25, 1958.

Bailes, Richard H., and Ellis, David A. (assigned to the United States of America as represented by the Chairman of the Atomic Energy Commission), Catalytic Promotion of the Adsorption of Vanadium on an Anionic Exchange Resin: U.S. Patent 2,849,279, Aug. 26, 1958.

Carnahan, Thomas D., and Ray, Edwin H. (assigned to B. F. Drakenfeld & Co., Inc.), Vanadium-Bearing Ceramic Pigment: U.S. Patent 2,847,317, Aug. 12, 1958.

Cleary, Harold J. (assigned to the United States of America as represented by the Chairman of the Atomic Energy Commission), Superconducting Vanadium Base Alloy: U.S. Patent 2,857,268, Oct. 21, 1958.

Busch, Lee S., Bauer, George W., and Moorhead, Paul E. (assigned to Mallory-Sharon Metals Corp.), Titanium-Vanadium-Aluminum Alloys: U.S. Patent 2,864,697, Dec. 16, 1958.

Brundin, Nils H. (Hoganas, Sweden), and Landberg, Gustav Edvard Henry (Gayle, Sweden) (assigned to Hoganas-Billesholms Aktiebolag, Höganäs, Sweden), Method of Recovering Vanadium from Vanadium-Containing Iron Ores: U.S. Patent 2,859,107, Nov. 4, 1958.

Bailes, Richard H., Ellis, David A., and Long, Ray S. (assigned to the United States of America as represented by the Chairman of the Atomic Energy Commission), Anionic Exchange Process for the Recovery of Uranium and Vanadium From Carbonate Solutions: U.S. Patent 2,864,667, Dec. 16, 1958.

Vermiculite

By L. M. Otis [1] and Nan C. Jensen [2]

PRELIMINARY estimates indicated that less crude vermiculite was produced in 1958 than in 1957. Imports of crude from South Africa, about 3 percent of estimated domestic crude production, were 32 percent less than in 1957.

TABLE 1.—Salient statistics of vermiculite production, in thousand short tons

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Crude	197	196	204	193	184	[1] 182
Average value per ton	$11.77	$12.98	$13.24	$13.20	$14.15	[1] $14.35
Exfoliated	(2)	145	158	159	161	(2)
Average value per ton	(2)	$74.55	$63.31	$60.93	$61.47	(2)
World: Crude	232	242	263	[3] 254	249	[1] 238

[1] Estimate.
[2] Data not available.
[3] Revised figure.

DOMESTIC PRODUCTION

Final 1958 production figures were not available for crude and exfoliated vermiculite in time for inclusion in this chapter. Preliminary estimates made by the industry of crude production are shown.

Crude Vermiculite.—Only two domestic producers mined an estimated total of 182,000 short tons of crude vermiculite valued at $2.6 million. Montana and South Carolina were the only producing States.

Exfoliated Vermiculite.—The estimated decline in domestic production of crude and the substantial drop in imports of crude from South Africa indicated lower output of exfoliated vermiculite in 1958.

An article described the local geology and mining procedures of the Zonolite Co. at Libby, Mont. Mining consisted of benching the top of a mountain in 20-foot steps. The ore occurs in serpentine and granite with numerous intrusive dikes and stocks. Material excavated was reported to be 1.8 million tons annually; 700,000 tons of ore was processable.[3]

[1] Commodity specialist.
[2] Supervisory statistical assistant.
[3] Western Mining and Industrial News, Zonolite Co.'s Vermiculite Operation Near Libby, Mont., Has Largest Deposit of This Mineral Known in the United States: Vol. 26, No. 4, April 1958, pp. 1–2.

TABLE 2.—Screened and cleaned domestic crude vermiculite sold or used by producers in the United States

Year	Short tons	Value (thousands)	Year	Short tons	Value (thousands)
1949–53 (average)	196,873	$2,318	1956	192,628	$2,542
1954	195,538	2,538	1957	183,987	2,603
1955	204,040	2,702	1958	[1] 182,000	[1] 2,610

[1] Estimate.

TABLE 3.—Exfoliated vermiculite sold or used by producers in the United States [1]

Year	Producers	Plants	Short tons	Value	
				Total	Average per ton
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
1958	(2)	(2)	(2)	(2)	(2)

[1] Includes Hawaii.
[2] Data not available.

CONSUMPTION AND USES

The use of exfoliated vermiculite did not change materially; the principal markets remained in the construction industry. Building plaster, lightweight concrete, and loose-fill-insulation took the major part of the exfoliated product. Other less important uses included packing in refrigerators, cold-storage rooms, incubators, fireless cookers, ovens, and safes; seed propagation; soil conditioning; herbicide, insecticide, fungicide, and fumigant carrier; and beds for transporting hot steel ingots.

PRICES

The year-end E&MJ Metal and Mineral Markets quoted crude vermiculite: Per short ton, f.o.b. mines, Montana, $9.50 to $18; South Africa, $30 to $32, c.i.f. Atlantic ports.

The average mine value of all domestic crude sold or used in 1958 was estimated at $14.35, compared with $14.15 in the preceding year and $13.20 in 1956.

No figures were available for estimating the average value of exfoliated vermiculite production.

FOREIGN TRADE

The Union of South Africa continued to be the only important source of vermiculite imports. Its reserve was estimated by some authorities to be the largest in the world.

Canada, Cuba, and Venezuela consumed substantial quantities of crude vermiculite from the United States.

WORLD REVIEW

NORTH AMERICA

Canada.—Production of exfoliated vermiculite in 1957 was 27,000 short tons, an increase of 6 percent over 1956. The average value decreased from $59 a ton in 1956 to $53 in 1957. A small part of the raw vermiculite was mined from a deposit near Perth, Ontario; the rest came from the United States and the Union of South Africa.

Four companies exfoliated vermiculite at 10 locations. Sixty-six percent of Canadian sales were for loose-fill insulation, 28 percent for insulating plaster, 2 percent for aggregate in lightweight concrete, and 4 percent for acoustic plaster, heat-insulating materials, fertilizer conditioner, and underground pipe insulation.[4]

TABLE 4.—World production of vermiculite, by countries,[1] in short tons [2]

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

Country [1]	1949-53 (average)	1954	1955	1956	1957	1958
Argentina	[3] 245	-------	551	614	287	[4] 330
Australia	96	-------	-------	1	-------	-------
Egypt	[5] 293	-------	-------	-------	33	-------
India	[3] 86	3	138	1,038	[4] 1,100	[4] 1,100
Kenya	19	807	380	497	33	96
Morocco	-------	-------	-------	-------	147	-------
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	480	-------	-------	305	460	280
Tanganyika	-------	-------	-------	-------	-------	91
Union of South Africa	34,181	45,633	57,482	58,717	62,619	54,314
United States (sold or used by producers)	196,873	195,538	204,040	192,628	183,987	[4] 182,000
World total [1] [2]	232,273	241,981	262,591	253,800	248,666	[4] 238,000

[1] In addition to countries listed, vermiculite is produced in Brazil, Egyptian Sudan, 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 revisions of data published in previous Vermiculite chapters.
[3] Average for 1950–53.
[4] Estimate.
[5] Average for 1951–53.

SOUTH AMERICA

Brazil.—Vermiculite was advertised for sale in São José dos Campos, São Paulo. It was reported produced from deposits in Congonhal, São Paulo, and Liberdade, Minas Gerais, but no information was available on quantity or quality.

ASIA

Pakistan.—The Geological Survey of Pakistan issued Information Release 5, Preliminary Report on Vermiculite Near Doki River in Western Ras Kon Range, Kalat Division, West Pakistan. This report described the geology of the area and the geographic distribution of the vermiculite. Preliminary estimates were 11½ million tons of high-grade and 50 million tons of low-grade vermiculite schist. More detailed prospecting was planned.[5]

[4] Wilson, H. S., Lightweight Aggregates in Canada, 1957: Dept. of Mines and Tech. Surveys, Ottawa, Review 29, May 1958, 4 pp.
[5] U.S. Embassy, Karachi, Pakistan, State Department Dispatch 623: Jan. 23, 1958.

AFRICA

Egyptian Sudan.—A trial lot of 135 short tons of vermiculite was produced and shipped to the United States for tests.

TABLE 5.—Exports of crude vermiculite from Union of South Africa, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1957	1958 [3]	Country	1957	1958 [3]
North America:			Europe—Continued		
Canada	3,632	4,432	United Kingdom	12,242	6,956
Cuba	592	----------	Asia:		
United States	8,681	5,941	Israel	396	----------
South America:			Japan	282	56
Uruguay	54	33	Africa:		
Venezuela	199	201	French West Africa	149	----------
Europe:			Rhodesia and Nyasaland,		
Austria	133	164	Federation of	498	291
Belgium	619	276	Oceania:		
Denmark	1,563	841	Australia	1,160	767
Finland	82	111	New Zealand	76	51
France	8,013	6,861	Other countries	567	716
Germany, West	3,410	2,119			
Italy	5,020	4,294	Total	49,528	34,655
Netherlands	1,738	314	Total value [4]	$968,559	$675,625
Sweden	173	114	Average value	$19.56	$19.50
Switzerland	249	117			

[1] Compiled from Customs Returns of Union of South Africa.
[2] This table incorporates revisions of data published in previous Vermiculite chapters.
[3] January through September inclusive.
[4] Converted to U.S. currency at the rate of US$2.7828 (1957) and US$2.7993 (1958).

Tanganyika.—A plant built in Tanganyika planned to exfoliate vermiculite from the Morogoro District.

Union of South Africa.—The geology and history of mining of vermiculite in South Africa was described in an article. The reserve was said to be the largest in the world.[6]

TECHNOLOGY

The Department of Ceramic Engineering of Clemson Agricultural College made and tested structural units composed of mixtures of clay and vermiculite. The use of correct manufacturing procedures was found to produce a unit with a bulk density approximately one-half that of conventional structural clay products. Such units had a crushing strength in excess of 1,500 pounds per square inch and could be easily sawed, machined, and finished with glazes or engobes.[7]

An announcement outlined the aims and purposes of the Vermiculite Association, Inc.; the membership was reportedly worldwide in scope—miners, producers, and processors of vermiculite and vermiculite products. This association has offices in Rego Park, N. Y., and foreign affiliates and sponsors research at nationally known testing laboratories.[8]

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[6] South African Mining and Engineering Journal, Vermiculite Mining in South Africa: Vol. 69, No. 3394, Feb. 28, 1958, pp. 355, 357.
[7] Robinson, G. C., Lightweight Structural Clay Products Made With Vermiculite: Jour. Am. Ceram. Soc., Ceram. Abs., vol. 41, No. 2, February 1958, p. 74.
[8] Building Science Directory of the Building Research Institute, The Vermiculite Association: Series No. 108–58, 1 p.

The geology, general extent, and location of vermiculite in Virginia was outlined in a bulletin[9] that described occurrences in Louisa, Buckingham, Bedford, Franklin, Pittsylvania, Henry, Charlotte, and Halifax Counties.

The Vermiculite Institute issued instruction sheets for using vermiculite concrete as roof insulation over vented galvanized steel roof decks and over structural or precast concrete roof decks.[10]

A mixture of 10 parts granulated exfoliated vermiculite to 1 part DDT, used at the rate of 10 pounds per acre on lawns and shrubs, could free an area of mosquitoes; the time varied from a day to a week, depending on the weather.[11]

A decorative brick for interior-construction finish consisting of vermiculite, cement, and pigment was described in an article.[12]

Vermiculite was used in the South African goldfields in constructing underground firewalls, proving so effective that the Transvaal and Orange Free State Chamber of Mines now require its use. The method is first to build a temporary seal of fireproofed bags filled with loose vermiculite to reduce air and heat circulation until permanent seals of vermiculite block can be erected.[13]

Patents.—A method was patented for making Christmas-tree ornaments and other novelties by pouring a mixture of gypsum plaster, asbestos fines, and a hardenable paste into a cardboard mold. When the mixture hardened it was successively coated with a polyvinyl compound; a mixture of salt, exfoliated vermiculite, and an organic plastic material; and sodium silicate. While the sodium silicate was wet, the mass was sprayed with glass beads, tinsel, or other light-reflective material.[14]

A method of coating exfoliated vermiculite particles with a water resistant material was patented. A bed of exfoliated vermiculite, heated from 600° to 800° F., was sprayed with an aqueous emulsion of asphalt. The water, vaporizing on contact with the hot vermiculite, left a steam dispersion of asphalt throughout the bed and substantially waterproofed each particle.[15]

A paving mixture consisting of exfoliated vermiculite, rubber, sand, and asphalt was patented. The vermiculite absorbs the bitumen, resulting in a resilient, lightweight paving, especially suitable for playgrounds, tennis courts, and the like.[16]

A mill that removed iron mineral contaminants from exfoliated vermiculite was patented. The pure vermiculite can then be suspended in a colloidal solution of oils or greases to form a lubricant.[17]

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[9] Gooch, Edwin O., Vermiculite: Virginia Minerals, Commonwealth of Virginia, Department of Conservation and Development, Division of Geology, University Station, Charlottesville, Va., vol. 3, No. 1, January 1957, 6 pp.

[10] Engineering News-Record, vol. 161, No. 11, Sept. 11, 1958, p. 125.

[11] Chemical and Engineering News, Bugs Beware: Vol. 36, No. 28, July 14, 1958, p. 92.

[12] The Northwest, Producing A Do It Yourself Material: January-February 1958, p. 10.

[13] Mining Journal (London), Vermiculite Firewalls In Deep Mines: Vol. 251, No. 6433, Dec. 5, 1958, p. 637.

[14] Glaser, C. F., Ornamental Device: U.S. Patent 2,821,802, Feb. 4, 1958.

[15] Sucetti, G. (assigned to Zonolite Co., Chicago, Ill.), Lightweight Water Resistant Aggregate and Method of Making the Same: U.S. Patent 2,824,022, Feb. 18, 1958.

[16] Bernier, N. M., and Wiseblood, N., (Bernier interest assigned to California Stucco Products of New England, Inc., Cambridge, Mass.), Paving Mixture Comprising Vermiculite, Rubber, Sand, and a Bituminous Binder: U.S. Patent 2,863,841, Dec. 9, 1958.

[17] Rouse, B. H. (by R. M. Rouse, administratrix, one-half assigned to O. G. Rouse, Russell, Kans.), Flapper Mill For Grinding Suspensions of Vermiculite: U.S. Patent 2,844,328, July 22, 1958.

A comminuted mixture of peat moss and exfoliated vermiculite, used in a patented plant receptacle, facilitated trimming dwarf-plant roots, such as Ming trees; thereby growth was stunted.[18]

A fire-resistant, sound-deadening composition that comprised exfoliated vermiculite, 41° Baumé water glass, anhydrous NaOH, and water[19] was patented.

A method of continuous manufacture of lightweight building slabs was patented, using gypsum or portland cement as the binder and exfoliated vermiculite as the aggregate.[20]

A patented livestock bedding composition suitable for racehorse and other animal stalls consisted of plus-¼-inch exfoliated African vermiculite treated with iodine, a polyhydric alcohol or a mixture of the two. The vermiculite protects the animals' feet and will not be eaten, eliminating the necessity of muzzling.[21]

Exfoliated vermiculite was cited in a patent as a preferred carrier for certain polynitriles to soils.[22]

Vermiculite exfoliated by usual methods can thereafter be further exfoliated 30 to 40 times the original unexfoliated volume, according to a patent.[23] This increase was obtained by sprinkling with an aqueous solution of $MgSO_4$ and heating above the solution's boiling point.

Exfoliated vermiculite was patented[24] for use in preparing and forming shell-mold structures by means of frozen mercury patterns.

A premixed, precoated concrete aggregate that could be bagged, stored, and readily poured from the bag was patented, consisting of gravel, sand, and a lightweight aggregate, such as exfoliated vermiculite. The sand and gravel is first precoated with a hygroscopic calcium or magnesium salt, and later with a bituminous emulsion.[25]

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[18] Hawkins, W. L., Plant Receptacle: U.S. Patent 2,814,161, Nov. 26, 1957.

[19] Kendall, F. E., and Golar, P. (assigned to the E. F. Hauserman Co.) A Fireproof, Sound-Deadening Composition Comprises Exfoliated Vermiculite, 41° Baumé Water Glass, Anhydrous NaOH, and Water: Canadian Patent 565,582, Nov. 4, 1958.

[20] Sterrett, R. W. (assigned to Zonolite Co., Chicago, Ill.), Canadian Patent 560,850, July 22, 1958.

[21] Combs, J. T., and Carlock, C., Animal Bed: U.S. Patent 2,848,976, Aug. 26, 1958.

[22] Beresworth, F. C. (assigned to the Dow Chemical Co., Midland, Mich.), Method and Composition for Ammonia Fumigation of Soils: U.S. Patent 2,830,887, Apr. 15, 1958.

[23] Zell, Arno, German Patent 948,314, Aug. 30, 1956.

[24] Kohl, E. F., and Kazenas, Z. (Kazenas interest assigned to Mercast Corp., a Delaware corporation), Shell Mold Structures: U.S. Patent 2,820,265, Jan. 21, 1958.

Kohl, E. F., Shell Mold Structure: U.S. Patent 2,820,266, Jan. 21, 1958.

Kohl, E. F., Methods of Making Shell Molds with Thin Core: U.S. Patent 2,820,268, Jan. 21, 1958.

[25] Sucetti, G., Construction and Coating Materials: U.S. Patent 2,861,004, Nov. 18, 1958.

Water

By R. T. MacMillan [1]

IN 1958 the water supply of the Nation, as measured by precipitation, steam flow, reservoir storage, and ground water levels, was average or above average in most areas. Few serious water shortages or unusually destructive floods occured during the year. However, the urgency of the problem of adequate water supply for the future was recognized by the Federal Government in providing greatly increased support to the Office of Saline Water whose function is to develop economical methods for converting salt water into fresh water on a large scale.

LEGISLATION AND GOVERNMENT PROGRAMS

Public Law 85–883 (72 Stat. 1706) providing for the construction of 5 demonstration plants for saline water conversion was approved in September.[2] In passing this law the Congress recognized that there is a rapidly developing shortage of water in the United States, in addition to many current localized deficiencies, and that there is a need for Government leadership in translating into action the findings of the research and development program carried out under the Saline Water Act of 1952 (66 Stat. 328) and amendments (69 Stat. 198).[3]

Administered by the Secretary of the Interior, the law authorizes the expenditure of not more than $10 million for the construction, operation, and maintenance of not less than 5 demonstration plants for converting sea water or brackish water into water suitable for agricultural, industrial, municipal, and other beneficial uses. At least 3 of the plants are to be designed for sea water conversion; 2 of these will have a daily capacity of more than 1 million gallons.

At least 2 plants are to be designed for converting brackish water, 1 of which will have a daily capacity of more than 250,000 gallons. The three sea water plants will be built at sites on the Atlantic, Pacific, and Gulf Coasts. The brackish water plants will be in the interior, 1 in the Southwest and 1 in the Northern Great Plains area. Sites will be selected by the Secretary of the Interior who will also select the processes to be used.

Substantial progress was made in mine water control in the anthracite region under the joint Federal-State program initiated in 1955 (69 Stat, 30 U.S.C. Supp. V, Secs. 571–576). During 1958 five mine drainage projects totaling $2.5 million were approved for Federal

[1] Commodity specialist.
[2] Public Law 85-883, 85th Cong., 2d sess., S. J. Resolution 135, approved Sept. 2, 1958.
[3] Senate Report No. 1593, 85th Cong., 2d sess., Saline Water Program, May 19, 1958, 29 pp.

participation. Under the provisions of the law equipment and installation costs of the continuing program are shared equally by the State and Federal Governments while operating costs are provided by the producing companies.

In addition to the installation of mine drainage pumps having a total capacity of 119,000 gallons a minute, improvements were made in surface drainage by back filling strip pits and constructing ditches and flumes designed to prevent water from seeping into mine workings. By these measures an estimated 1 billion gallons of water a year was prevented from entering mines.

DOMESTIC SUPPLY

A convenient measure of the water supply of the Nation is the total flow or runoff from the major rivers. In 1958, as in the previous year, runoff was in the median range for about three-fourths of the Nation. Areas of deficiency, mostly in the North Central States, were smaller than in any year since 1936. In the Southwest excessive runoff covered a large area and there was no region of deficiency.

The flows of the Mississippi River at Vicksburg, Miss., and the Ohio at Metropolis, Ill., were 118 and 135 percent, respectively, of the median annual flows of these rivers. At Hermann, Mo., the mean discharge of the Missouri River was 5 percent above average—the largest flow at this point since 1952.

The Columbia River near The Dalles, Ore., showed an average flow of 9 percent above its median after adjustments for storage in 8 major power reservoirs had been made; the Colorado River flowed at 8 percent above its median. Of the major rivers only the St. Lawrence flowed less than normal, averaging 98 percent of the median flow below Lake Ontario.

Storage of water in major power reservoirs ranged from average to above average. Above average storage was noted in the northeastern and western areas of the Nation. Storage in Lakes Meade and Mohave was 25 percent above average.

Irrigation reservoirs were near average levels except in certain areas of Oregon, Wyoming, and South Dakota where notable deficiencies occurred. Storage in most municipal and industrial reservoirs was near average. San Diego's municipal reservoirs not supplied from the Colorado River increased to 23 percent of their capacity—about 8 times more than they held in 1957.

As a result of 2 years of average or above average precipitation over large areas of the Nation the ground water in most states was replenished and the level in many key observation wells was normal or above. In many instances a downward trend of several years was reversed. However, in many heavily pumped areas including California, New Mexico, and Texas, the respite was temporary and ground water levels continued to fall.[4]

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[4] Geological Survey (in collaboration with Canada Department of Northern Affairs and Natural Resources), Water Resources Review: Annual Summary, Water Year 1958, Oct. 17, 1958, 17 pp.
U.S. Department of Commerce, Climatological Data: National Summary, vol. 9, No. 13, Annual 1958, 113 pp.

The production of heavy water (D_2O), used as a coolant and moderator in some nuclear power plants, was terminated at the Terre Haute, Ind., plant because of the large inventory available. The Savannah River, Ga., plant continued production on a reduced scale. Much of the production was exported.

CONSUMPTION AND USES

Uses of water requiring its withdrawal from streams, lakes, or aquifers are conveniently classified under the following headings: Irrigation, self-supplied industrial, public supplies, and rural. Water for generating hydroelectric power is excluded because this water is available for reuse without treatment. Nonwithdrawal uses include navigation, recreation, waste disposal, and conservation of wildlife.

As in previous years the leading uses of water were for irrigation and industry. Water for domestic purposes was estimated to be less than 10 percent of the total water used.

Extrapolation of the growth curve of water use from 40 billion gallons a day in 1900 to 240 billion gallons a day in 1955 showed an estimated total water use of 295 billion gallons a day in 1958. Estimates of total water use in 1980 were 597 billion gallons a day.

This estimated use of water in 1980 is approximately half the total potential water supply of the United States based on average runoff figures. However, runoff figures in certain areas have varied widely from the average. Water reuse, which may occur many times in some watersheds, was not considered in this evaluation.

By 1980 water shortages were predicted for the Western Gulf-Rio Grande area, southern California, and possibly in the Delaware, Hudson, and Chesapeake regions.[5]

The mineral industry continued to be an important user of water in mining and processing ores and minerals. The effect of various anions and cations in water used for the flotation separation of certain minerals was studied by Bureau of Mines engineers. Copper concentrates produced by flotation in brackish water were of poorer grade than in similar tests using distilled water.

Water injected into oil-bearing strata in the secondary recovery of oil was estimated to be about 3,000 million barrels in 1958. About 20 percent was fresh water and the remainder was brine. An estimated 185 million barrels of oil was recovered. Water used in pressure maintenance of producing wells was not included.

PRICES

Prices of water ranged widely depending on the availability and treatment required. For small quantities of municipal water at the tap the estimated median price for 1958 was unchanged from 1957 at $.35 per thousand gallons. Larger quantities usually were sold at lower rates.

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[5] Steel, Water Water Everywhere?: Vol. 143, No. 13, Sept. 29, 1958, pp. 58–59.

Water used by industry was largely self supplied and costs depended on the quality required, the expense of development, treatment, and distribution. Costs were usually below municipal water costs.

Irrigation water was usually less expensive than industrial water; although prices ranged much higher, the median was unchanged at less than 2 cents per thousand gallons.

The price of heavy water (D_2O) was maintained at $28 per pound by the Atomic Energy Commission. It continued to be available in 125 and 500 pound stainless steel drums from the AEC.

WORLD REVIEW

Research and development projects on economic methods for converting saline water were reported under way in several foreign countries. Among the more important projects were the following:

1. United Kingdom—distillation research (particularly scale prevention) and electrodialysis.
2. Netherlands, South Africa, and Israel—electrodialysis.
3. France—low temperature difference method of distillation.
4. North Africa, Australia, and Italy—solar distillation.

Kuwait.—Four multistage flash evaporator plants were installed in Kuwait, each supplying 630,000 gallons a day of drinking water from the highly saline brines of the Persian Gulf. After several months of operation the problems of scaling and corrosion associated with sea water distillation, had been largely overcome.[6]

Netherlands Antilles.—The world's largest sea water purification plant was inaugurated June 6 on the island of Aruba, Netherlands Antilles. The plant was designed and constructed at a cost of $10 million for the Territorial Government, by Singmaster & Breyer, metallurgical and chemical process engineers. It combines salt water distillation with the commercial production of electricity. Steam generated in high pressure oil fired boilers operates electric generators and the exhaust steam is used to distill 2.7 million gallons a day of water, which is more than enough to supply the potable water requirements of both Aruba's population of 55,000 and its major oil refining industry. Aruba has an average rainfall of less than 15 inches annually. Maximum capacity of the turbo-generators is 15,000 kilowatts. Cost of distilled water production has not yet been determined, but the Aruban Government estimates it will be about $1.75 a thousand gallons.

Union of South Africa.—A large electrodialysis plant for demineralizing brackish water was under construction in the Orange Free State. Designed for water having a salt content about 6,000 parts per million, the plant will freshen 2½ million gallons a day of the brackish water resulting from the operation of underground mines. The intake water will be filtered and conditioned before entering the electrodialysis plant which will have 2 stages, each consisting of 4 large presses 15 feet high and 12 feet long. A press will have 10 packs of 200 membranes each.[7]

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[6] Hearings Before Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs: United States Senate, 85th Cong., 2d sess. on S. J. Res. 135 and S 3370, Mar. 20, 21, 1958, p. 132.

[7] Chemical Trade Journal and Chemical Engineer (London), Water Demineralizing: Vol. 163, No. 3726, Oct. 31, 1958, p. 1051.

TECHNOLOGY

Various distillation, membrane, and freezing processes for demineralizing saline water were investigated under the sponsorship of the Office of Saline Water, United States Department of the Interior.[8]

A long-tube-vertical evaporator test facility was operated at Wrightsville Beach, N. C., to determine conditions necessary for minimum scaling and corrosion. Calcium carbonate scaling was controlled by providing a circulating sludge of calcium carbonate in the evaporating brine thus providing nucleii on which the calcium carbonate precipitating from the brine can deposit, leaving the metal walls and tubes of the evaporator clean. Whether or not this method can be used to control calcium sulfate scale was under investigation.

Other distillation processes were studied including (1) rotary vapor compression distillation, (2) forced circulation vapor compression distillation, (3) multistage flash distillation with and without nuclear process heat, and (4) solar distillation.

Several membrane processes were investigated. One of the limiting factors in membrane processes is the membrane itself. Some fundamental research investigations were directed toward improving selectivity conductance, durability, and other characteristics of osmotic membranes. Cell design, particularly for the electrodialysis process, received considerable attention.

Electrodialysis was one of the leading methods for freshening brackish water. In this process the salts are removed from the brines under the influence of an electric current. In passing through a membrane stack the brines must pass through narrow channels having walls of an anion-permeable membrane on one side and a cation-permeable membrane on the other. When current is passed through the cell the anions and cations are caused to migrate in opposite directions through the membranes permeable to them and fresh water remains in the cell while more concentrated brines are produced in the surrounding cells. Development of ion-selective membranes having low electrical resistance helped to make electrodialysis one of the leading conversion processes, particularly for brackish water.

Freezing processes for demineralizing salt solutions have an inherent advantage over distillation processes in that less theoretical energy is required. However, brine is trapped or occluded in the interstices of the crystals and must be washed free for the resulting fresh water to have satisfactory quality.

The problem of separating the ice and brine was largely overcome in tests conducted in 1957 and 1958. One of the most promising freezing processes to be developed was the so-called direct freezing method in which refrigeration was accomplished by mechanical compression and absorption of water vapor. Other direct processes were studied in which a refrigerant was mixed with the brine and allowed to evaporate producing a slurry of ice crystals which were separated and washed free of brine.

[8] U.S. Department of the Interior, Saline Water Conversion Report for 1958, January 1959, 42 pp.

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Some estimates of the costs of converting saline water (5,000 to 35,000 parts per million of dissolved salts) by several methods are shown in table 1.

The Industrial Water Laboratory of the Bureau of Mines continued to furnish consulting boiler water service to Government-owned heating and power plants. Recommendations were based on the analysis of water samples, deposits, and information on operating procedure furnished by the plants. The number of boilers serviced in 1958 was estimated to be 9,900 requiring over 13,000 boiler water analyses.

TABLE 1.—Estimates as to cost per 1,000 gallons by various saline water conservation processes in United States (without sale of power or other byproducts)[1]

	1952 existing installations		1957 designed or projected installations		1960–70 anticipated (if further research is successful)	
	Sea water 35,000 parts per million	Brackish 5,000 parts per million	35,000 parts per million	5,000 parts per million	35,000 parts per million, less than—	5,000 parts per million, less than—
Distillation (including solar)	$2–$5	$2–$5	$1–$3	$1.00–$3.00	$0.50	$0.50
Membrane processes	(2)	(2)	6	.80	1.00	.25
Freezing	(2)	(2)	(2)	(2)	.50	.50
Others	(2)	(2)	(2)	(2)	.50	.25

[1] Hearings Before Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs: United States Senate, 85th Cong., 2d sess. on S. J. Res. 135 and S. 3370, Mar. 20, 21, 1958, p. 116.
[2] Not developed.

Research on corrosion problems in condensate return lines also was continued. This corrosion was attributed to carbonic acid in the condensate resulting from alkalinity (bicarbonate content) in the feed water. A Bureau test kit consisting of a composite nipple for insertion in the condensate lines enabled engineers to determine the extent of the corrosion and to make proper recommendations.

The growing concern over adequate water supply resulted in numerous articles on water conservation and pollution control.

The theory, effectiveness, costs, and techniques of adding monomolecular films of fatty alcohols to the surface of reservoirs for reducing evaporation loss were discussed. Compounds found to be most effective were octadecanol $CH_3(CH_2)_{17}OH$ and hexadecanol $CH_3(CH_2)_{15}OH$. Spread on the surface of reservoirs by floats or by forming a stabilized aqueous suspension, the material forms a film which reduces evaporation loss on the average by 40 percent. Possible savings on 1,300 major reservoirs and lakes in the United States totaled 14.7 billion gallons per day. Costs were estimated at $4.52 per acre foot or about $0.014 per thousand gallons of water saved.[9] No harmful effects on fish or other life were noted.

A system of waste water treatment by a large oil refinery included biological oxidation in cooling tower systems. A savings of up to 50 percent of plant requirements was claimed for the system of reusing waste water following various types of treatment which

[9] Dressler, R. G., and Johanson, A. G., Water Reservoir Evaporation Control: Chem. Eng. Prog., vol. 54, No. 1, January 1958, pp. 66–69.

included cooling in redwood towers where biological oxidation was believed to be more effective than in conventional equipment. Substantial reduction of pollution in plant effluent was effected.[10]

Recirculation of treated sewage effluent as the potable water supply for a town of 12,000 was practiced for a 5-month period at Chanute, Kans. As a result of a long continued drought the normal water sources for the town dried up and it became necessary to impound the sewage plant effluent as a source of supply for the town's water treatment plant. Additional chlorine was added to control biological growth and additional samples were taken and analyzed as a precautionary measure to insure the absence of pathogenic organisms and to note the build-up of particular substances. During the reuse period 86 percent of the biological oxygen demand (BOD) and 76 percent of the chemical oxygen demand were removed in the sewage treatment. Total nitrogen and ammonia were also substantially reduced. However, only about 25 percent of the alkyl benzene sulfonate and 67 percent of the complex phosphates (both from synthetic detergents) were removed. Chloride content gradually increased to 500 parts per million. Although the treated water assumed a pale green color and had a tendency to froth, its biological quality based on standard tests was satisfactory during the reuse period and no sickness was attributed to the water. The public at Chanute accepted the situation as unavoidable, but, on the whole, rejected the water for human consumption. The period of water reuse was a test of the effectiveness of the sewage treatment methods and of chlorine as a disinfectant. However, low efficiency of the water treatment processes in removing plankton, amoeba cysts, and other organisms was noted.[11]

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[10] Chemical Engineering Progress, Fluor, Sun Oil, Team to Offer Industry Industrial Waste Water Treatment Technique: Vol. 54, No. 2, February 1958, pp. 114, 116.

[11] Metzler, D. F., Culp, R. L., Stoltenberg, H. A., Woodward, R. L., Walton, G., Chang, S. L., Clarke, N. A., Palmer, C. M., and Middleton, F. M., Emergency Use of Reclaimed Water for Potable Supply at Chanute, Kan.: Jour. Am. Water Works Assoc., vol. 50, No. 8, August 1958, pp. 1021–1060.

Zinc

By O. M. Bishop [1] and Esther B. Miller [2] [3]

Contents

AN OVERSUPPLY of metal, declining consumption, cessation of Government stockpiling of domestic metal, and lower metal prices characterized the zinc industry in 1958. Industrial consumption and Government acquisitions declined markedly. Sharply curtailed smelter output failed to prevent stock buildups. Abundant competitive imports displaced a considerable volume of domestic ore and metal, depressing mine output in the United States to the low level of 1933. The United Nations, concerned over continuing world overproduction, held committee meetings in London and Geneva to explore possible solutions to the problem. On October 1, the United States imposed quotas on imports of lead and zinc, designed to give the domestic industry a larger portion of the U.S. market.

During the first 4 months of the year decreased shipments of zinc to consumers were somewhat offset by continued shipments to Government account. A moderate upturn in industrial demand beginning in August and restriction of imports beginning in October caused increased domestic mine and smelter output and modest stock declines by the end of the year.

[1] Commodity specialist.
[2] Statistical assistant.
[3] 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.

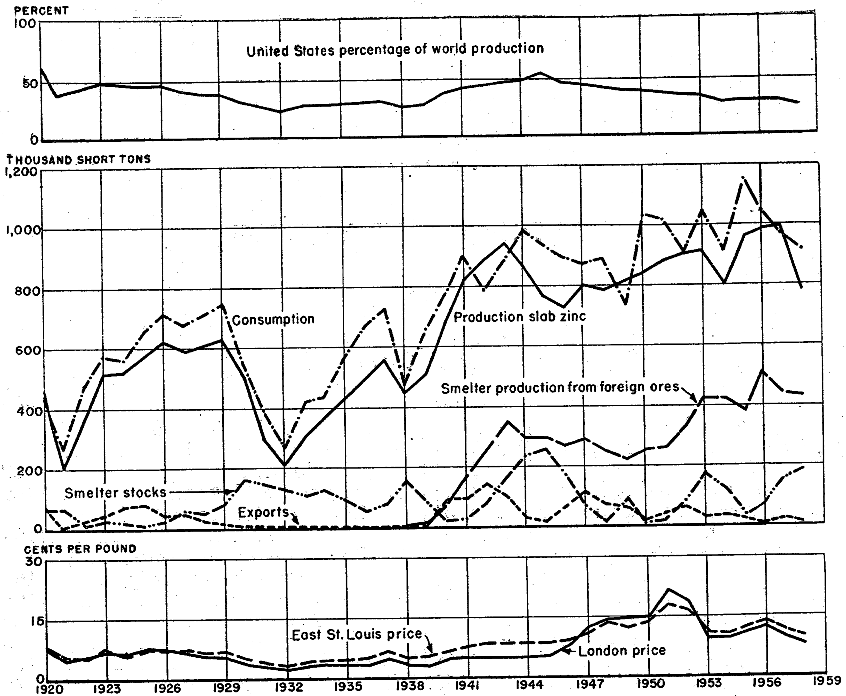

FIGURE 1.—Trends in the zinc industry in the United States, 1920–58. Consumption figures represent primary slab zinc plus zinc contained in pigments made directly from ore.

TABLE 1.—Salient zinc statistics

	1949–53 (average)	1954	1955	1956	1957	1958
United States:						
Production:						
Domestic ores, recoverable content........short tons..	622, 240	473, 471	514, 671	542, 340	531, 735	412, 005
Value........thousands..	$185, 043	$102, 180	$126, 609	$148, 503	$123, 235	$84, 113
Slab zinc:						
From domestic ores short tons..	574, 567	380, 312	582, 913	470, 093	539, 692	346, 240
From foreign ores..do....	297, 526	422, 113	380, 591	513, 517	446, 104	435, 006
From scrap (redistilled slab).......short tons..	55, 731	68, 013	66, 042	72, 127	72, 481	46, 605
Total slab zinc..do....	927, 824	870, 438	1, 029, 546	1, 055, 737	1, 058, 277	827, 851
Secondary zinc [1]...do....	241, 894	204, 393	239, 298	209, 935	192, 367	184, 182
Imports (general):						
Ores (zinc content) short tons..	357, 178	455, 427	478, 044	525, 350	[2] 526, 014	462, 008
Slab zinc..............do....	144, 245	156, 858	195, 696	244, 978	[2] 269, 007	195, 199
Exports of slab zinc........do....	36, 764	24, 994	18, 069	8, 813	10, 785	1, 736
Stocks:						
At producers' plants..do....	78, 020	123, 396	39, 264	66, 875	155, 833	184, 025
At consumers' plants [4].do....	74, 912	103, 706	123, 544	104, 094	88, 342	93, 266
Consumption:						
Slab zinc..............do....	890, 331	884, 299	1, 119, 812	1, 008, 790	935, 620	868, 327
Ores (recoverable zinc content)...........short tons..	116, 789	99, 247	118, 135	113, 388	[3] 110, 311	[3] 94, 938
Secondary (recoverable zinc content) [5]......short tons..	233, 907	197, 146	231, 133	200, 844	185, 662	178, 900
Price, Prime Western grade, East St. Louis..cents a pound..	14. 22	10. 69	12. 30	13. 49	11. 40	10. 31
World:						
Mine production....short tons..	2, 600, 000	2, 930, 000	[2] 3, 210, 000	[2] 3, 420, 000	[2] 3, 510, 000	3, 350, 000
Smelter production........do....	2, 337, 000	2, 700, 000	2, 970, 000	3, 120, 000	3, 240, 000	3, 010, 000
Price, Prime Western, London cents a pound..	15. 75	9. 78	11. 30	12. 19	10. 18	8. 24

[1] Excludes redistilled slab zinc. [2] Revised figure. [3] Includes ore used directly in galvanizing. [4] Excludes remelt zinc. [5] Excludes redistilled slab and remelt zinc.

LEGISLATION AND GOVERNMENT PROGRAMS

United Nations.—Because of international concern over the effects of zinc oversupply, the United Nations, acting through its Interim Coordinating Committee on International Commodity Agreements, held talks in London in September, and in Geneva in November. The dimensions of the problem were thoroughly reviewed and a framework for possible multilateral corrective action was discussed.

Import Quotas.—On September 22, 1958, President Eisenhower, acting on the April 24, 1958 recommendation of the U.S. Tariff Commission proclaimed the imposition of import quotas on zinc (and lead) metal and ore beginning on October 1, 1958.

The quotas were set at 80 percent of the U.S. average annual competitive import rate in the years 1953 through 1957. Allocations were on a quarterly basis, and major exporting countries received individual quota allowances, while other countries were included in a group quota. The quotas limited annual competitive imports of zinc in ore to 379,840 tons (72 percent of the 1957 general imports) and imports of zinc in pigs, slabs, and certain other forms to 141,120 tons (52 percent of the 1957 general imports).

Exploration Program.—The Defense Minerals Exploration Administration (DMEA) continued to encourage exploration of zinc and other metals until June 30, 1958, when its authorizing legislation expired. During the first 6 months of 1958, 15 contracts providing for $681,825 in Government participation were approved. The Office of Minerals Exploration (OME) was created August 21, 1958, under Public Law 701 (85th Congress). The new agency, OME, continued the mineral exploration functions of DMEA, but no new contracts were entered into during the remainder of 1958 as details of administrative procedures were not fully established. Public Law 701 was more restrictive than predecessor legislation for exploration assistance. Applicants for exploration assistance were required to provide evidence that funds were not available from commercial sources at reasonable terms, and in no case could OME assistance exceed $250,000 on one exploration contract.

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 1958 CCC contracted for 38,860 tons of zinc metal (109,584 tons in 1957) to be added to the Government's supplemental stockpile.

General Services Administration (GSA).—The 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 in early 1958. Such purchases are included in the 34,488 tons reported by the American Zinc Institute as that shipped by domestic producers.

Foreign zinc received at GSA warehouses under barter agreements during the year totaled 40,216 tons (193,929 tons in 1957). Such zinc was placed in the supplemental stockpile and cannot be removed except by act of Congress.

TABLE 2.—DMEA contracts involving lead and zinc executed in 1958, by States

State and contractor	Property	County	Date approved	Total amount [1]
CALIFORNIA				
Archibald Trucking Co	Archibald Dart	Trenty and Humbolt	Apr. 25	$9,860
COLORADO				
Horn & Burger	Wellington mine	Summit	June 23	75,600
Knight Mining Co	New York claims	do	Mar. 6	20,380
Norbute Corp	Saints John mine	do	May 8	190,760
IDAHO				
Viking Mines, Inc	Garfield mine	Blaine	May 16	36,846
MISSOURI				
American Zinc, Lead & Smelting Co.	Boss-Bixby	Dent and Iron	Apr. 7	99,870
MONTANA				
John Zupan	Doctor Kalloch mine	Judith Basin	May 5	11,768
NEVADA				
Hamilton Corp	Hamilton mine	White Pine	June 18	37,520
NORTH CAROLINA				
Appalachian Sulphides, Inc	Ore Knob	Ashe	June 25	58,190
Roland F. Beers, Inc	Denton	Davidson	May 23	13,080
TENNESSEE				
Benjamin H. Putnam	Luttrell Prospect	Union	June 20	86,975
The New Jersey Zinc Co	Little War Creek	Hancock	Feb. 26	106,780
UTAH				
New York Mining Co	Mayflower	Wasatch	June 23	564,880
VIRGINIA				
The New Jersey Zinc Co	Chaffin Mineral Reservation.	Wythe	June 12	44,920
Roland F. Beers, Inc	Pruitt #4	Spotsylvania	Mar. 17	6,222
				1,363,651

[1] Government participation was 50 percent in exploration projects for lead and zinc in 1958.

DOMESTIC PRODUCTION

MINE PRODUCTION

Mines in the United States produced 412,000 tons of recoverable zinc—23 percent less than in 1957 and the smallest annual quantity produced since 1933. The decline was attributed to growing industry stocks and lower metal prices resulting from decreased industrial consumption, large imports, and termination of Government purchases of domestically produced zinc for the National Stockpile. Following the downward trend established in the second half of 1957, output during the first quarter of 1958 declined slightly. A modest upturn in March and April was reversed by low output during the summer months. Government imposition of import quotas in October led to a slight increase in mine production during the last quarter of the year.

TABLE 3.—Mine production of recoverable zinc in the United States, by States, in short tons

State	1949-53 (average)	1954	1955	1956	1957	1958
Western States and Alaska:						
Alaska	2	------	------	------	------	------
Arizona	51, 762	21, 461	22, 684	25, 580	33, 905	28, 532
California	7, 828	1, 415	6, 836	8, 049	2, 969	51
Colorado	48, 041	35, 150	35, 350	40, 246	47, 000	37, 132
Idaho	77, 807	61, 528	53, 314	49, 561	57, 831	49, 725
Montana	73, 976	60, 952	68, 588	70, 520	50, 520	33, 238
Nevada	16, 132	1, 035	2, 670	7, 488	5, 292	91
New Mexico	33, 675	6	15, 277	35, 010	32, 680	9, 034
Oregon	6	------	------	------	------	------
South Dakota	------	------	------	------	------	------
Texas	6	------	------	------	------	------
Utah	33, 759	34, 031	43, 556	42, 374	40, 846	44, 982
Washington	19, 325	22, 304	29, 536	25, 609	24, 000	18, 797
Total	362, 319	237, 882	277, 811	304, 437	295, 043	221, 582
West Central States:						
Arkansas	17	------	------	------	------	------
Kansas	25, 302	19, 110	27, 611	28, 665	15, 859	4, 421
Missouri	9, 909	5, 210	4, 476	4, 380	2, 951	362
Oklahoma	46, 510	43, 171	41, 543	27, 515	14, 951	5, 267
Total	81, 738	67, 491	73, 630	60, 560	33, 761	10, 050
States east of the Mississippi River:						
Illinois	20, 057	14, 427	21, 700	24, 039	22, 185	24, 940
Kentucky	1, 778	458	------	417	837	1, 258
New Jersey	54, 764	37, 416	11, 643	4, 667	12, 530	607
New York	40, 102	53, 199	53, 016	59, 111	64, 659	53, 014
North Carolina	------	------	------	------	2	------
Pennsylvania	------	------	------	------	------	10, 812
Tennessee	36, 048	30, 326	40, 216	46, 023	58, 063	59, 130
Virginia	12, 596	16, 738	18, 329	19, 196	23, 080	18, 472
Wisconsin	12, 838	15, 534	18, 326	23, 890	21, 575	12, 140
Total	178, 183	168, 098	163, 230	177, 343	202, 931	180, 373
Grand total	622, 240	473, 471	514, 671	542, 340	531, 735	412, 005

Western States.—Mines of the Western States produced 221,600 tons of recoverable zinc—25 percent less than the 1957 output. However, contribution of Western States to the Nation's total mine output remained virtually unchanged, being slightly above 50 percent in both years.

Despite curtailments and shutdowns that dropped Idaho production 14 percent to 49,700 tons, the State ranked first among the Western zinc-mining States and third in the Nation. The Bunker Hill Co. cut its Coeur d'Alene mining operations from a 5- to 4-day work-week in February. In May, American Smelting & Refining Co. also reduced its Page mine operation to a 4-day week. Increased industrial demand and the imposition of import quotas prompted both companies to return to the 5-day week during the last quarter of the year. The three most productive zinc mines in Idaho, in descending quantitative order, were the Star mine of the Bunker Hill Co., the Page mine of American Smelting & Refining Co., and the Bunker Hill mine of the Bunker Hill Co., all in the Coeur d'Alene district.

Utah was second among the Western producers. Mine output was 45,000 tons—10 percent greater than that of 1957. The United States and Lark mine of United States Smelting, Refining & Mining Co. continued to be the largest producer in the State. In October, McFarland and Hullinger, contract miners of the Ophir mine, suspended production after 14 years of operation. In June, DMEA approved a half-million-dollar contract with New Park Mining Co. for an exploration venture in search of ore in the Mayflower mine area.

Mine output of zinc in Colorado slumped 21 percent to 27,100 tons, placing the State third among Western States. Colorado's largest zinc-producer was the Eagle mine at Gilman, which continued on a full production schedule throughout 1958. In June, the Emperius Mining Co. closed its mines at Creede, the first general shutdown there in 25 years, but the operations were reopened on a curtailed basis in November.

Mines in Montana produced 34 percent less zinc than in 1957. The Anaconda Company mines at Butte accounted for four-fifths of the State total of 33,200 tons. Anaconda's Anselmo mine, long a leading producer in the State, was closed from July through September.

Mines in Arizona yielded 28,500 tons of recoverable zinc—approximately 5,400 tons less than the 1957 quantity. The Iron King mine of Shattuck Denn Corp. was the largest producer. Old Dick mine operated by Cyprus Mines Corp. was closed early in the year. The San Xavier was operated intermittently.

Mine production in Washington dropped from 24,000 tons of recoverable zinc in 1957 to 18,800 in 1958. The largest producing mines were the Pend Oreille of Pend Oreille Mines and Metals Co. and the Grandview of American Zinc, Lead & Smelting Co. Pend Oreille, operating its mine on a 4-day-work-week basis, produced 607,700 tons of crude ore that yielded 12,100 tons of zinc and 6,030 tons of lead in concentrates. Despite curtailed output, increased wage rates, and higher costs for supplies, economy measures and technical improvements reduced total cost-per-ton from $3.878 to $3.284.[4]

The Grandview mine at Metaline Falls, Wash. was operated at capacity during the year, producing 16,067 tons combined zinc and lead concentrates (14,366 tons in 1957).[5]

Mine output in New Mexico was 9,000 tons of recoverable zinc—about one-fourth of the 1957 quantity. The Empire Zinc Division of New Jersey Zinc Co. closed its mine and mill at Hanover at the end of April but maintained the unit on a standby basis. Production at the Lynchburg mine, Magdalena, N. Mex., was also suspended April 30, to coincide with closing of the Hanover mill where Magdalena ore was treated.[6] United States Smelting, Refining & Mining Company's Bayard mine group and mill were closed in May.

California and Nevada productions were small as mines shut down during 1957 remained closed throughout 1958.

West Central States.—Mines in the West Central States of Kansas, Oklahoma, and Missouri produced 10,100 tons of recoverable zinc—

[4] Pend Oreille Mines & Metals Co., Annual Report 1958, pp. 3, 4.
[5] American Zinc, Lead & Smelting Co., Annual Report, 1958, p. 15.
[6] New Jersey Zinc Co., Annual Report, 1958, pp. 9–10.

about 30 percent of the quantity mined in 1957. Responding to lower metal prices, most mines of the West Central States had operated intermittently during the second half of 1957. Shutdowns were numerous during the first half of 1958 and by midyear all zinc mines in the area had ceased production. In the Tri-State district, the National Lead Co. Ballard mine near Baxter Springs, Kans., was closed indefinitely in January. In July, Eagle-Picher Co. closed its remaining mines and Central Mill, thereby completing shutdown of the district that for some 60 years prior to 1950 was the largest zinc producer in the United States. Recovery of minor quantities of zinc from Southeast Missouri Lead Belt ores ceased in July.

TABLE 4.—Mine production of recoverable zinc in the United States, by months, in short tons

Month	1957	1958	Month	1957	1958
January	50,406	39.020	August	43.090	29.856
February	46.344	34,693	September	35.514	30,694
March	51.040	36.602	October	39.746	32,738
April	52,367	40.232	November	36.043	33.290
May	47.791	36,208	December	39,895	35.785
June	46.154	33,690			
July	43.345	29,197	Total	531,735	412,005

States East of the Mississippi River.—Zinc recoverable from ores mined east of the Mississippi River totaled 180,400 tons—11 percent less than the 1957 quantity. The Eastern States' contribution to the Nation's total zinc output rose from 38 percent in 1957 to 44 percent in 1958.

Mine output in Tennessee was 59,100 tons. Though the State's total zinc production was essentially the same as that of 1957, decreased output in other States placed Tennessee first among the Nation's mine producers. Large increases in productive capacity in recent years, sustained by an adequate and expanding resource base, gives Tennessee the potential to maintain a leading role. Tennessee Coal and Iron Division of United States Steel Co. operated its Jefferson City mine on a curtailed basis. The Grasselli mine was idle the entire year and the Coy mine was not brought into the production stage. The Flat Gap mine in Hancock County remained on standby throughout the year. During July, American Zinc, Lead and Smelting Co. closed its mines for 3 weeks to decrease zinc surpluses. American Zinc Co. announced plans to install crushers and heavy medium concentrating units at two company mine sites to decrease the volume of ore shipped to the Mascot mill. The company's North Friends Station, Mascot No. 2, and Young mines were operated at capacity during the year. Ore discoveries in the nearly depleted North Friends Station mine during the year effectively prolonged anticipated life of the mine. The 66-inch-diameter ventilation shaft at the Young mine was completed during 1958. The ore reserve held by American Zinc Co. in East Tennessee was estimated by their geology department to be 85 million tons, which would yield 4,750,000 tons of 60 percent zinc concentrate.[7]

[7] American Zinc, Lead & Smelting Co., 59th Annual Report, 1958, pp. 15–16.

New Jersey Zinc Co. completed new installations at its Jefferson City operation, which doubled the capacity of the original 1,000-ton mine-mill unit. The mine and mill were operated at capacity during the year.

The second largest zinc-producing State in the Nation was New York, which had an output of 53,000 tons. During 1957, mines in New York had produced 64,700 tons—a record for the State. The lower annual total was attributed to a cutback from a 6- to 5-day work-week at the Balmat and Edwards mines early in the year. Zinc concentrate produced from these two St. Joseph Lead Co. mines decreased from a record high of 117,513 tons in 1957 to 98,753 tons in 1958. The concentrate was reduced to metal at the company's Josephtown smelter.[8]

Mine output in Virginia slumped 20 percent to 18,500 tons. The Tri-State Zinc Co. stopped production at its Timberville mine in

TABLE 5.—Twenty-five leading zinc-producing mines[1] in the United States in 1958 in order of output

Rank	Mines	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	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	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp.	Do.
6	Austinville	Austinville	Virginia	The New Jersey Zinc Co	Do.
7	Star	Coeur d'Alene	Idaho	The Bunker Hill Co	Do.
8	Jefferson City	Eastern Tennessee.	Tennessee	The New Jersey Zinc Co	Zinc.
9	Davis-Bible Group.	do	do	United States Steel Corp., Tennessee Coal & Iron Div.	Do.
10	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co.	Lead-zinc.
11	Mascot No. 2	Eastern Tennesee.	Tennessee	American Zinc Co. of Tennessee.	Zinc.
12	Young	do	do	do	Do.
13	Page	Coeur d'Alene	Idaho	American Smelting & Refining Co.	Lead-zinc.
14	Friedensville	Lehigh County	Pennsylvania	The New Jersey Zinc Co	Zinc.
15	Treasury Tunnel-Black Bear-Smuggler Union.	Upper San Miguel.	Colorado	Idarado Mining Co	Copper-lead-zinc.
16	Edwards	St. Lawrence County.	New York	St. Joseph Lead Co	Zinc.
17	Graham-Snyder-Spillane-Feehan.	Upper Mississippi Valley.	Illinois	The Eagle-Picher Co	Do.
18	Shullsburg	do	Wisconsin	do	Do.
19	Bunker Hill	Coeur d'Alene	Idaho	The Bunker Hill Co	Do.
20	Gray	Upper Mississippi Valley.	Illinois	Tri-State Zinc Co., Inc	Do.
21	United Park City.	Park City Region.	Utah	United Park City Mines Co.	Do.
22	Grandview	Metaline	Washington	American Zinc, Lead & Smelting Co.	Do.
23	Bayard	Central	New Mexico	United States Smelting, Refining & Mining Co.	Do.
24	Hanover	do	do	The New Jersey Zinc Co	Do.
25	Burra-Boyd	Polk County	Tennessee	Tennessee Copper Co	Copper-zinc.

[1] Excludes old slag dump of the Bunker Hill Co., Kellogg, Idaho.

[8] St. Joseph Lead Co., Annual Report, 1958, p. 9.

January but continued underground development. The New Jersey Zinc Company's Austinville mine, which ranked fifth among the leading zinc-producing mines in the United States in 1957, was operated on a curtailed basis during the second half of 1958. The adjacent Ivanhoe mine was closed in July after reaching the production stage only a few months prior to the shutdown.

Cutbacks and shutdowns in the Wisconsin portion of the Northern Illinois and Wisconsin district were partly offset by increased zinc output at several large mine units in both Illinois and Wisconsin. Major operating mines in the field were the Shullsburg and Graham groups of Eagle-Picher Co. and the Bautsch group of Tri-State Zinc, Inc. American Zinc, Lead and Smelting Co. mines and mills remained closed throughout the year.

In January, New Jersey Zinc Company's recently developed Friedensville mine in Pennsylvania started making daily shipments to its 2,500-ton-per-day mill and operated the unit on a restricted basis throughout the year. Optimum production was anticipated by mid-1959. Concentrate was shipped by truck to the company smelter at Palmerton, 25 miles from the mine.[9]

In the Southern Illinois and Kentucky district zinc was produced as a byproduct from fluorspar mining.

The Sterling mine of the New Jersey Zinc Co. in Sussex County, N.J., remained closed throughout 1958.

The 25 leading zinc-producing mines in the United States in 1958, listed in table 6, yielded 84 percent of the total domestic output of zinc. The three leading mines supplied 23 percent, and the first six mines contributed 38 percent.

TABLE 6.—Mine production of recoverable zinc in the principal districts [1] of the United States, in terms of recoverable zinc, in short tons

District	State	1957	1958
Eastern Tennessee [2]	Tennessee	58,063	59,130
St. Lawrence County	New York	64,659	53,014
Coeur d'Alene	Idaho	54,825	49,532
Upper Mississippi Valley	Northern Illinois, Iowa,[3] Wisconsin	37,490	30,680
Summit Valley (Butte)	Montana	43,169	26,580
West Mountain (Bingham)	Utah	24,953	25,664
Big Bug	Arizona	17,647	20,100
Metaline	Washington	17,244	18,796
Park City region	Utah	12,322	11,550
Lebanon County	Pennsylvania		10,812
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	30,895	9,688
Central	New Mexico	30,623	8,321
Kentucky-Southern Illinois	Kentucky-Southern Illinois	7,107	7,658
Smelter (Lewis and Clark County)	Montana	5,090	5,546
Pima (Sierritas, Papago, Twin Buttes)	Arizona	1,288	3,059
Harshaw	do	3,848	1,888
Creede	Colorado	1,819	1,019
Flint Creek	Montana	1,619	778
Eureka (Bagdad)	Arizona	5,924	737
New Jersey	New Jersey	12,530	607
Warm Springs	Idaho	1,208	17

[1] Districts producing 1,000 short tons or more in either year.
[2] Includes zinc recovered from copper-zinc-pyrite ore in Polk County.
[3] No production in Iowa since 1917.

[9] New Jersey Zinc Co., Annual Report, 1958, p. 7.

SMELTER AND REFINERY PRODUCTION

The zinc smelting and refining industry operated 17 primary reduction plants and 11 secondary plants that produced slab zinc, zinc pigments, zinc slabs, zinc dust, and zinc alloys. Some 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 half of all zinc-base scrap.

Production at primary zinc plants totaled 805,000 tons of slab zinc, of which 24,300 tons was redistilled. In addition to slab zinc, primary plants also produced zinc oxide, zinc dust, and zinc-base alloys.

Primary-plant capacity for slab zinc at the end of 1958 was reported to be 1,168,900 tons. The 5 electrolytic plants reported 2,542 of their 4,072 electrolytic cells in use at the end of the year and an output of 326,400 tons or 68 percent of their 479,500 tons of capacity. The 8 horizontal-retort plants reported 34,772 of their 48,272 retorts in use during the year. The four remaining primary smelters were the continuous-distilling vertical-retort plants at Meadowbrook, W. Va.; Depue, Ill.; Palmerton, Pa.; and Josephtown, Pa.; the first three used New Jersey Zinc Co. externally gas-fired vertical retorts, and that at Josephtown used electrothermic distillation retorts. Combined horizontal and vertical-retort production of 454,800 tons was only 66 percent of the reported 1958 capacity of 689,400 tons.

The list of primary smelters published in the Zinc Chapter of the 1957 Minerals Yearbook was unchanged.

Slag-Fuming Plants.—Many lead smelters recover a zinc fume product from lead blast-furnace slags which contain 7½ to 12½ percent zinc.

Five such plants in the United States treated 790,700 tons of hot and cold lead slag (including some crude ore at the Tooele plant), which yielded 148,600 tons of oxide fume containing 98,000 tons of recoverable zinc. Corresponding figures for 1957 were 867,100, 159,300, and 105,200 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 secondary smelters, although about a third usually is reduced at primary smelters and most of the sal ammoniac skimmings is processed at chemical plants. Secondary smelters depend on the galvanizers and scrap dealers for their supply of scrap materials. All of the 11 secondary zinc smelters listed in the Zinc Chapter of the 1957 Minerals Yearbook were in operation.

Primary and secondary smelting plants treating zinc-base scrap in 1958 produced 46,600 tons of redistilled zinc, 5,200 tons of remelt and 26,500 tons of zinc dust. The zinc content of these products totaled 77,400 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 7, 8, and 9.

Additional details on 101,100 tons of zinc recovered in processing copper-base scrap (table 9) may be obtained in the Secondary section of the copper chapter of this volume.

TABLE 7.—Stocks and consumption of new and old zinc scrap in the United States in 1958, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks, end of year
Smelters and distillers:						
New clippings	142	2,353	2,211		2,211	284
Old zinc	372	4,935		4,783	4,783	524
Engravers' plates	457	2,611		2,590	2,590	478
Skimmings and ashes	3,361	17,237	13,385		13,385	7,213
Sal skimmings	429	830	458		458	801
Die-cast skimmings	2,254	10,503	9,242		9,242	3,515
Galvanizers' dross	4,354	54,786	52,840		52,840	6,300
Die castings	4,028	34,366		32,661	32,661	5,733
Rod and die scrap	1,578	7,872		6,917	6,917	2,533
Flue dust	186	5,549	5,612		5,612	123
Chemical residues	402	7,554	7,516		7,516	440
Total	17,563	148,596	91,264	46,951	138,215	27,944
Chemical plants, foundries, and other manufacturers:						
New clippings	13	119	128		128	4
Old zinc	14	94		98	98	10
Engravers' plates		68		67	67	1
Skimmings and ashes	2,236	4,389	5,389		5,389	1,236
Sal skimmings	7,554	20,309	15,804		15,804	12,059
Galvanizers' dross	82	103	28		28	157
Die castings	32	1,058		1,066	1,066	24
Rod and die scrap	6	36		38	38	4
Flue dust	100	466	462		462	104
Chemical residues	1,392	14,665	15,041		15,041	1,016
Total	11,429	41,307	36,852	1,269	38,121	14,615
Grand total:						
New clippings	155	2,472	2,339		2,339	288
Old zinc	386	5,029		4,881	4,881	534
Engravers' plates	457	2,679		2,657	2,657	479
Skimmings and ashes	5,597	21,626	18,774		18,774	8,449
Sal skimmings	7,983	21,139	16,262		16,262	12,860
Die-cast skimmings	2,254	10,503	9,242		9,242	3,515
Galvanizers' dross	4,436	54,889	52,868		52,868	6,457
Die castings	4,060	35,424		33,727	33,727	5,757
Rod and die scrap	1,584	7,908		6,955	6,955	2,537
Flue dust	286	6,015	6,074		6,074	227
Chemical residues	1,794	22,219	22,557		22,557	1,456
Total	28,992	189,903	128,116	48,220	176,336	42,559

TABLE 8.—Production of secondary zinc and zinc-alloy products in the United States, gross weight in short tons

Products	1949–53 (average)	1954	1955	1956	1957	1958
Redistilled slab zinc	55,731	[1] 68,013	[1] 66,042	[1] 72,127	[1] 72,481	46,605
Zinc dust [2]	26,761	26,714	30,118	28,048	26,715	26,512
Remelt spelter	4,775	4,456	5,019	7,900	6,404	5,236
Remelt die-cast slab	7,860	9,418	12,729	12,900	10,328	12,980
Zinc-die and die-casting alloys	4,167	4,037	6,377	4,306	6,440	6,082
Galvanizing stocks	254	186	325	369	240	249
Rolled zinc	3,184	2,701	2,915	2,179	185	10
Secondary zinc in chemical products	37,552	26,078	28,917	30,675	33,361	32,482

[1] Includes redistilled slab made from remelt die-cast slab.
[2] Includes zinc dust produced from other than scrap.

TABLE 9.—Zinc recovered from scrap processed in the United States, by kind of scrap and form of recovery, in short tons

Kind of scrap	1957	1958
New scrap:		
Zinc-base	108,319	87,566
Copper-base	75,933	71,312
Aluminum-base	3,004	1,490
Magnesium-base	59	38
Total	187,315	160,406
Old scrap:		
Zinc-base	42,207	38,643
Copper-base	32,899	29,754
Aluminum-base	1,585	1,436
Magnesium-base	98	93
Total	76,789	69,926
Grand total	264,104	230,332

Form of recovery	1957	1958
As metal:		
By distillation:		
Slab zinc [1]	71,737	46,150
Zinc dust [2]	26,255	26,010
By remelting	6,705	5,282
Total	104,697	77,442
In zinc-base alloys	15,640	17,683
In brass and bronze	105,437	99,641
In aluminum-base alloys	4,758	2,941
In magnesium-base alloys	157	143
In chemical products:		
Zinc oxide (lead-free)	15,729	16,016
Zinc sulfate	5,322	(3)
Zinc chloride	11,407	10,748
Miscellaneous	957	5,718
Total	159,407	152,890
Grand total	264,104	230,332

[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."

SLAB ZINC

Domestic smelter output of slab zinc fell 22 percent to the lowest production since 1946. Included in the 827,900 tons of slab zinc produced is molten zinc used directly in alloying operations. Of the 1958 output, 781,200 tons was primary metal and 46,600 tons was redistilled secondary zinc. The primary production was 44 percent from domestic ores and 56 percent from foreign ores; 58 percent was distilled and 42 percent was electrolytic slab zinc. The redistilled slab output was the smallest since 1946; of the total, 52 percent was produced at primary plants and 48 percent at secondary plants.

Prime Western-grade zinc, which accounted for 41 percent of the total (41 percent in 1957) was the principal grade produced in 1958. Special High grade constituted 36 percent (34 percent in 1957), High Grade 11 percent (14 percent), Brass Special 10 percent (8 percent), Intermediate 2 percent (3 percent) and Select a small fraction of 1 percent in both 1958 and 1957.

TABLE 10.—Primary and redistilled secondary slab zinc produced in the United States, in short tons

Year	Primary			Redistilled secondary	Total (excludes zinc recovered by remelting)
	From domestic ores	From foreign ores	Total		
1949–53 (average)	574,567	297,526	872,093	55,731	927,824
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
1958	346,240	435,006	[2] 781,246	46,605	[2] 827,851

[1] Includes a small tonnage of slab zinc further refined into high-grade metal.
[2] Includes production of zinc used directly in alloying operations.

TABLE 11.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, in short tons

CLASSIFIED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled	Redistilled secondary		Total
			At primary smelters	At secondary smelters	
1949–53 (average)	345,260	526,833	20,790	34,941	927,824
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
1958	326,449	454,797	24,297	22,308	[1] 827,851

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		
1949–53 (average)	278,487	187,308	19,288	53,733	7,124	381,884	927,824
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
1958	298,442	86,859	19,388	81,841	1,300	340,021	[1] 827,851

[1] Includes production of zinc used directly in alloying operations.

TABLE 12.—Primary slab zinc produced in the United States, by States where smelted, in short tons

Year	Arkansas	Idaho	Illinois	Montana	Oklahoma	Pennsylvania	Texas and West Virginia[1]	Total	
								Short tons	Value
1949–53 (average)	20,321	51,724	109,781	215,699	152,035	178,945	143,588	872,093	$255,009,295
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
1958	17,952	55,454	[2] 82,844	148,921	122,138	[3] 187,243	[4] 166,694	781,246	159,686,682

[1] Includes Missouri, 1948–53, 1955, 1956.
[2] Includes Missouri.
[3] Includes West Virginia.
[4] Texas only.

Pennsylvania again ranked first in production of slab zinc, with Texas in second place and Montana third. The slab zinc output of Pennsylvania, West Virginia, Oklahoma, and Arkansas was distilled; that of Montana and Idaho was electrolytic. Illinois and Texas slab output was in part distilled and in part electrolytic.

BYPRODUCT SULFURIC ACID

Sulfuric acid was made from sulfur dioxide gases produced in roasting zinc sulfide concentrate at primary zinc smelters where the demand for sulfuric acid was warranted. At several such plants elemental sulfur also was burned to increase acid-making capacity. In 1958 acid production at zinc roasting plants was 738,400 short tons valued at $12.4 million, compared with 855,400 tons valued at $15.5-million in 1957.

ZINC DUST

The zinc dust included in data shown in tables 8, 9 and 13 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 ranged from 95 percent to 99.8 percent and averaged 98.1 percent. Total shipments of zinc dust were 26,200 tons, of which 500 tons were shipped abroad. Producers' stocks of zinc dust were 2,400 tons at the end of the year.

Most of the zinc dust was made from zinc scrap, chiefly galvanizers' dross, but some is recovered from zinc ore.

TABLE 13.—Zinc dust [1] produced in the United States

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per pound			Total	Average per pound
1949-53 (average)	26,761	$9,151,786	$0.171	1956	28,048	$9,368,032	$0.167
1954	26,714	7,266,208	.136	1957	26,715	7,859,583	.147
1955	30,118	9,216,108	.153	1958	26,512	7,253,653	.137

[1] All produced by distillation.

CONSUMPTION AND USES

In 1958 zinc consumed as refined metal in slab or pig form totaled 868,300 tons (935,600 tons in 1957); as ore and concentrates of ore to make pigments and salts, 94,900 tons (110,300); and as scrap to make alloys, zinc dust, pigments and salts, 178,900 tons (185,700). Together these uses accounted for 1,142,100 tons of primary and secondary zinc or 7 percent less than the 1,231,600 tons so consumed in 1957. The quantity of zinc consumed directly in making pigments and salts is reported in table 21. Yet other zinc in concentrate form is consumed directly in unreported pigments and salts, in galvanizing, and in making zinc dust. Zinc consumed in scrap form and the manufactured products other than remelt and redistilled are reported in tables 7, 8 and 9.

Slab zinc consumption as reported by about 700 consumers, was 868,300 tons, a decline of 7 percent from 1957 and 22 percent below the record of 1,119,800 tons in 1955.

Zinc used in galvanizing steel products increased to 381,200 tons and was again the largest industry use. Zinc used in zinc-base alloys was the second most important use of the metal but the total so used declined 16 percent to 316,800 tons. Slab zinc used in brass products continued to decrease, totaling only 101,400 tons.

Galvanizing of steel products used 44 percent of the 868,300 tons used by all industry, manufacture of zinc-base alloys accounted for 36 percent, and brass products took 12 percent. The remaining

TABLE 14.—Consumption of slab zinc in the United States, by industries, in short tons [1]

Industry and product	1949–53 (average)	1954	1955	1956	1957	1958
Galvanizing: [2]						
Sheet and strip	158,027	181,558	200,403	203,713	168,221	194,196
Wire and wire rope	46,217	44,882	48,171	42,937	36,468	35,638
Tubes and pipe	83,920	76,891	98,206	86,277	70,463	67,318
Fittings	13,863	10,513	10,586	10,652	9,965	8,904
Other	93,477	89,619	93,775	[3] 95,567	[3] 82,640	[3] 75,173
Total galvanizing	395,504	403,463	451,141	439,146	367,757	381,229
Brass products:						
Sheet, strip, and plate	69,248	52,284	67,550	56,207	52,873	46,967
Rod and wire	42,053	30,899	46,830	39,413	33,711	32,568
Tube	16,264	12,097	15,363	13,666	11,915	9,645
Castings and billets	5,859	5,499	7,518	6,337	5,818	4,423
Copper-base ingots	5,682	6,594	8,062	7,197	7,286	7,094
Other copper-base products	1,292	895	920	1,184	787	678
Total brass products	140,398	108,268	146,243	124,004	112,390	101,375
Zinc-base alloy:						
Die castings	258,131	279,676	417,333	349,200	363,830	309,408
Alloy dies and rod	6,493	8,857	11,754	9,322	10,149	5,400
Slush and sand castings	1,831	2,313	1,720	1,985	2,060	2,022
Total zinc-base alloy	266,455	290,846	430,807	360,507	376,039	316,830
Rolled zinc	58,739	47,486	51,589	47,359	41,269	40,616
Zinc oxide	16,917	18,701	22,433	19,160	20,428	13,331
Other uses:						
Wet batteries	1,490	1,264	1,420	1,345	1,336	846
Desilverizing lead	2,475	2,740	2,676	2,939	2,808	2,521
Light-metal alloys	2,950	3,526	3,484	5,830	4,958	3,657
Other [4]	5,403	8,005	10,019	8,500	8,635	7,922
Total other uses	12,318	15,535	17,599	18,614	17,737	14,946
Total consumption [5]	890,331	884,299	1,119,812	1,008,790	935,620	868,327

[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, 28,286 tons in 1957, and 28,502 tons in 1958.
[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, 6,805 tons in 1957, and 8,073 tons in 1958.

8 percent went into rolled zinc products, zinc oxide, light-metal alloys, desilverizing lead, and miscellaneous uses.

Rolling mills used 40,600 tons of slab zinc and remelted and rerolled 12,800 tons of metallic scrap produced in fabricating plants operated in connection with the rolling mills. An additional 200 tons of purchased scrap (new clippings and old zinc) also was melted and rolled.

Output of rolled zinc continued to decline, totaling 38,900 tons. Stocks of rolled zinc at the mills were 2,200 tons at the end of 1958 compared with 2,400 tons on hand January 1. In addition to shipments of 22,300 tons of rolled zinc the rolling mills consumed 28,500 tons of rolled zinc in manufacturing 18,300 tons of semifabricated and finished products.

Of the commercial grades of slab zinc used, Special High grade accounted for 42 percent of the total, Prime Western 36 percent, Brass Special 11 percent, High Grade 2 percent, Select and Remelt together 1 percent. All grades of zinc were used in brass products and all grades but Select were used in galvanizing. Special High grade accounted for 98 percent of all grades used in making zinc-base alloys.

TABLE 15.—Rolled zinc produced and quantity available for consumption in the United States

	1957			1958		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Production:						
Sheet zinc not over 0.1 inch thick	11,317	$7,077,606	$0.313	12,388	$7,308,801	$0.295
Boiler plate and sheets over 0.1 inch thick	614	265,022	.216	419	174,769	.208
Strip and ribbon zinc [1]	25,904	9,568,389	.185	24,566	9,749,501	.198
Foil, rod, and wire	1,897	1,091,456	.288	1,496	763,332	.255
Total rolled zinc	39,732	18,002,473	.227	38,869	17,996,403	.231
Imports	732	244,722	.167	901	285,271	.158
Exports	2,677	1,534,800	.287	3,818	2,637,346	.345
Available for consumption	38,388			36,101		
Value of slab zinc (all grades)			.116			.102
Value added by rolling			.111			.129

[1] Figures represent net production. In addition 12,686 tons of strip and ribbon zinc in 1957 and 12,769 tons in 1958 were rerolled from scrap originating in fabricating plants operating in connection with zinc rolling mills.

TABLE 16.—Consumption of slab zinc in the United States in 1958, by grades and industries, in short tons

Industry	Special High grade	High grade	Intermediate	Brass Special	Select	Prime Western	Remelt	Total
Galvanizers	15,883	7,887	5,164	72,191		277,733	2,371	381,229
Brass mills [1]	22,166	53,198	1,112	8,215	1,269	14,067	1,348	101,375
Die casters [2]	311,282	393	24			1,490	3,641	316,830
Zinc rolling mills	9,383	7,955	8,611	11,968	2,010	689		40,616
Oxide plants	913	347				11,997	74	13,331
Other	5,396	1,219	345	167	1	7,179	639	14,946
Total	365,023	70,999	15,256	92,541	3,280	313,155	8,073	868,327

[1] Includes brass mills, brass-ingot makers, and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.

CONSUMPTION OF SLAB ZINC BY AREAS

Table 17 shows the distribution of slab-zinc consumption by areas.

Consumption of Slab Zinc for Galvanizing.—Among the 35 States consuming zinc for galvanizing, Ohio, Pennsylvania, Illinois, and Indiana were the leaders. Those States used 60 percent of the total. 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 as reported by the Iron and Steel Institute, totaled 2,829,000 tons, an 18-percent increase over 1957 and only 1 percent less than in the record year, 1956. Zinc consumed in galvanizing steel sheet and strip averaged 1 ton per 14.6 tons of these products shipped in 1958. The ratios for 1956 and 1957 were, respectively, 1 to 14.5 and 1 to 14.2 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, Ohio, and New York ranked second, third, fourth, and fifth, respectively.

Consumption of Slab Zinc for Zinc-Base Alloys.—Zinc used in making zinc-base alloys declined 16 percent as compared to 1957, owing to a 29-percent reduction in the number of automobiles and trucks produced. Cutbacks in the manufacture of home appliances was also a factor in the reduced demand for zinc die-casting alloys. Illinois, Michigan, Ohio, New York, and Indiana, in order of use, accounted for 73 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 40,600 tons, 2 percent less than in 1957. 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.

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.

TABLE 17.—Consumption of slab zinc in the United States in 1958, by industries and States, in short tons

	Galvanizers	Brass mills [1]	Die casters [2]	Other [3]	Total
Alabama	(4)	(4)	---	(4)	29,956
Arizona	(4)	---	---	(4)	(4)
Arkansas	---	---	---	(4)	(4)
California	22,342	1,928	17,249	296	41,815
Colorado	(4)	(4)	(4)	(4)	(4)
Connecticut	2,976	32,635	(4)	(4)	37,752
Delaware	---	(4)	(4)	---	(4)
District of Columbia	---	(4)	---	---	(4)
Florida	(4)	---	---	---	(4)
Georgia	(4)	---	---	---	(4)
Idaho	---	---	---	(4)	(4)
Illinois	48,657	15,099	66,841	17,182	147,779
Indiana	42,203	(4)	17,698	(4)	76,107
Iowa	870	---	---	(4)	3,324
Kansas	---	(4)	(4)	(4)	(4)
Kentucky	(4)	(4)	(4)	---	(4)
Louisiana	(4)	---	---	(4)	(4)
Maine	(4)	(4)	---	---	(4)
Maryland	30,706	(4)	---	(4)	30,990
Massachusetts	3,661	(4)	---	(4)	6,552
Michigan	3,808	9,733	63,971	69	77,581
Minnesota	2,073	(4)	---	(4)	2,112
Mississippi	(4)	---	---	---	(4)
Missouri	3,552	(4)	4,634	(4)	9,259
Montana	---	---	---	---	---
Nebraska	(4)	---	(4)	(4)	1,936
New Hampshire	---	(4)	---	---	(4)
New Jersey	(4)	5,111	12,361	(4)	22,616
New York	(4)	6,668	32,362	(4)	51,288
North Carolina	---	---	(4)	---	(4)
Ohio	76,452	8,278	47,287	1,115	133,132
Oklahoma	(4)	---	---	(4)	(4)
Oregon	468	(4)	(4)	(4)	1,111
Pennsylvania	59,476	(4)	15,403	(4)	104,999
Rhode Island	536	(4)	(4)	(4)	572
South Carolina	(4)	---	---	---	(4)
Tennessee	(4)	---	(4)	(4)	1,785
Texas	9,334	(4)	(4)	(4)	34,206
Utah	(4)	(4)	---	(4)	(4)
Virginia	(4)	(4)	(4)	(4)	403
Washington	1,239	---	(4)	(4)	1,672
West Virginia	(4)	(4)	---	---	8,855
Wisconsin	(4)	4,729	(4)	---	10,395
Total [5]	378,858	100,027	313,189	68,180	860,254

[1] Includes brass mills, brass-ingot makers and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] 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; excludes remelt zinc.

ZINC PIGMENTS AND SALTS [10]

Production and Shipments.—Production of the principal zinc pigments, of zinc and leaded zinc oxide, and of the principal zinc salts, zinc chloride and zinc sulfate, was adequate for all the requirements of the domestic market.

Production of lead-free zinc oxide and the leaded variety was down 13 percent and 14 percent, respectively, from 1957 output. The reduced output of lead-free zinc oxide resulted from cutbacks of 7 percent in rubber manufacture. Zinc chloride and zinc sulfate production increased 4 percent and 2 percent, respectively, owing to moderate gains in building activity.

The pigments and salts were manufactured from various zinc-bearing materials, including ore, slab zinc, scrap, and residues. The zinc in pigments and salts produced directly from ore exceeded 83,000 tons, that in zinc oxide and zinc chloride produced from slab zinc exceeded 13,100 tons, and zinc in pigments and salts produced from scrap zinc exceeded 35,700 tons.

Lead-free zinc oxide was made by several processes; 66 percent was produced from ores and residues by the American process, 24 percent from metal by the French process, and 10 percent by "Other" processes from scrap residues and scrap materials. Leaded zinc oxide was made from ores, zinc chloride from slab zinc and secondary zinc materials, and zinc sulfate from ore and scrap zinc materials.

Three grades of leaded zinc oxide classified according to lead content were produced. There was no production of 5 percent or less leaded zinc oxide reported; the more-than-5- through 35-percent

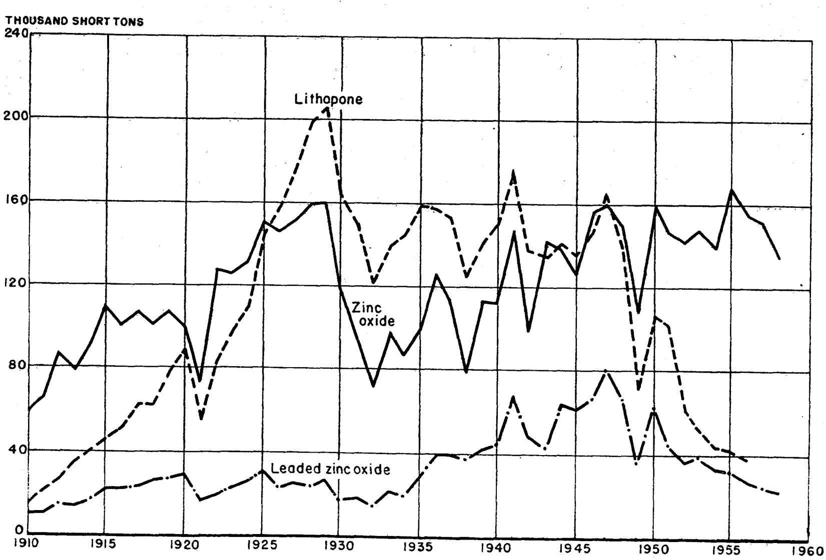

FIGURE 2.—Trends in shipments of zinc pigments, 1910–58.

[10] Prepared by Arnold M. Lansche, commodity specialist and Esther B. Miller, statistical assistant.

TABLE 18.—Salient statistics of the zinc pigments [1] industry of the United States

	1949–53 (average)	1954	1955	1956	1957	1958
Shipments:						
Zinc oxide..........short tons..	141,903	140,285	168,541	154,955	151,267	135,991
Leaded zinc oxide........do....	44,528	33,972	32,661	27,164	24,203	23,288
Value of pigments..........dollars..	61,899,600	50,438,000	58,031,000	55,245,000	47,036,000	42,797,000
Value per ton received by producers:						
Zinc oxide..............dollars..	276	255	258	271	271	270
Leaded zinc oxide........do....	278	258	259	282	249	263
Foreign trade:						
Value of imports..........do....	454,820	[2] 475,913	685,186	770,156	1,043,629	2,263,865
Value of exports..........do....	1,845,149	897,065	771,621	846,883	985,325	789,995
Export balance..........do....	1,390,329	421,152	86,435	76,727	−58,304	−1,473,870

[1] Excludes lithopone; figure withheld to avoid disclosing individual company confidential data.
[2] Due to changes in tabulating procedures by the U.S. Department of Commerce data known not to be comparable to earlier years.

grade constituted the bulk of production; smaller quantities were produced in the more-than-35- through 50-percent and over-50-percent grades. Total shipments of leaded zinc oxide were 23,000 tons, 4 percent below 1957. Output in 1958 (comparison with 1957 in parentheses) for the 35-percent lead and under was 22,000 (24,800) tons, and 680 (1,600) tons of over 35-percent lead.

Both ordinary lithopone and high strength (titanated lithopone) were made.

A list of zinc pigment manufacturers and their plants and products, is given below:

Manufacturer:	*Location*
Zinc chloride:	
American Cyanamid Co	Bound Brook, N.J.
American Smelting & Refining Co	Alton, Ill.
Do	Omaha, Nebr.
Do	Perth Amboy, N.J.
Do	Selby, Calif.
Chemical & Pigment Co., The	Oakland, Calif.
Chemicals Inc	Chicago, Ill.
E. I. du Pont de Nemours & Co	Cleveland, Ohio.
Do	East Chicago, Ind.
Jordan Co	Chicago, Ill.
Mallinckrodt Chemical Works	St. Louis, Mo.
Marathon Battery Co	Wausau, Wisc.
Maryland Pigment & Research Co	Cockeysville, Md.
Zinc sulfate:	
Bunker Hill Co	Kellogg, Idaho
Chemical & Pigment Co., The	Oakland, Calif.
E. I. du Pont de Nemours & Co	Cleveland, Ohio
Eagle-Picher Co., The	Galena, Kans.
Mallinckrodt Chemical Works	St. Louis, Mo.
Maryland Pigment & Research Co	Cockeysville, Md.
Merck & Co., Inc	Rahway, N.J.
Sherwin-Williams Co., The	Coffeyville, Kans.
Tennessee Corp	East Point, Ga
Virginia Smelting Co	West Norfolk, Va.
Zinc oxide and leaded zinc oxide:	
American Chemet Corp	East Helena, Mont.
American Zinc Co. of Illinois	Hillsboro, Ill.
American Zinc Oxide Co	Columbus, Ohio
Chemical & Pigment Co., The	Oakland, Calif.
Eagle-Picher Co., The	Galena, Kans.
Do	Hillsboro, Ill.
Monsanto Chemical Co	St. Louis, Mo.

Manufacturer—Continued
Zinc oxide and leaded zinc oxide—Continued

New Jersey Zinc Co	Palmerton, Pa.
Pacific Smelting Co	Torrance, Calif.
Rohm & Haas Co	Bristol, Pa.
Royce Chemical Co	Carlton Hill, N.J.
St. Joseph Lead Co	Josephtown, Pa.
Sherwin, Williams Co., The	Coffeyville, Kans.
Superior Zinc Corp	Bristol, Pa.
United Industrial & Chemical Corp	Bayonne, N.J.

Combined shipments of lead-free and leaded zinc oxide approximated 159,000 tons, 9 percent below 1957; shipments of the two zinc salts reported on approximated 99,500 tons, up 8 percent. Shipments of lead-free zinc oxide and the leaded variety declined 10 and 4 percent, respectively. Shipments of zinc chloride increased 12 percent; there was a slight increase for zinc sulfate. Value of shipments of lead-free zinc oxide declined $1 per ton to $270, leaded zinc was up $14 to $263, zinc chloride increased $6 to $133, and zinc sulfate was down $14 to $146 compared with 1957.

Consumption.—*Lead-free zinc oxide.*—Total zinc oxide shipments were 10 percent below 1957, primarily because of a reduction of 17 percent in the requirements of the rubber industry which normally consumes half of all zinc oxide. Shipments of zinc oxide to the coated fabrics and textiles, floor covering, and other industries

TABLE 19.—Production and shipments of zinc pigments and salts [1] in the United States

Pigment or salt	1957				1958			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value [2]			Short tons	Value [2]	
			Total	Average			Total	Average
Zinc oxide [3]	152,730	151,267	$41,007,424	$271	132,564	135,991	$36,671,762	$270
Leaded zinc oxide [3]	26,420	24,203	6,028,233	249	22,844	23,288	6,125,033	263
Zinc chloride, 50° B	61,186	58,569	7,455,739	127	63,593	65,761	8,754,543	133
Zinc sulfate	33,752	33,620	5,368,063	160	34,513	33,737	4,927,162	146

[1] Excludes lithopone; figure withheld to avoid disclosing individual company confidential data.
[2] Value at plant, exclusive of container.
[3] Zinc oxide containing 5 percent or more lead is classed as leaded zinc oxide. In this table data for leaded zinc oxide include a small quantity containing less than 5 percent lead.

TABLE 20.—Zinc pigments and salts [1] shipped by manufacturers in the United States, in short tons

Year	Zinc oxide	Leaded zinc oxide	Zinc chloride (50° B.)	Zinc sulfate
1949–53 (average)	141,903	44,528	58,001	21,862
1954	140,285	33,972	48,252	19,027
1955	168,541	32,661	54,161	23,864
1956	154,955	27,164	53,201	32,200
1957	151,267	24,203	58,569	33,620
1958	135,991	23,288	65,761	33,737

[1] Excludes zinc sulfide and lithopone, figures withheld to avoid disclosing individual company confidential data.

TABLE 21.—Zinc content of zinc pigments[1] and salts produced by domestic manufacturers, by sources, in short tons

Pigment or salt	1957: Zinc in pigments and salts produced from— Ore: Domestic	Ore: Foreign	Slab zinc	Secondary material[2]	Total zinc in pigments and salts	1958: Zinc in pigments and salts produced from— Ore: Domestic	Ore: Foreign	Slab zinc	Secondary material[2]	Total zinc in pigments and salts
Zinc oxide	61,399	19,300	19,423	22,129	122,251	60,096	8,767	13,077	24,049	105,989
Leaded zinc oxide	9,599	6,334	--------	--------	15,933	9,164	4,901	--------	--------	14,065
Total pigments			19,423	22,129	138,184	69,260	13,668	13,077	24,049	120,054
Zinc chloride	--------	--------	(3)	13,873	13,873	--------	--------	(3)	11,700	11,700
Zinc sulfate	(3)	(3)	--------	(3)	11,948	(3)	(3)	--------	(3)	11,869

[1] Excludes zinc sulfide and lithopone; 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.

declined to 2,300 tons, 971 tons, and 22,000 tons, or 36, 22, and 6 percent, respectively, in 1958.

Shipments of zinc oxide to the paints and ceramics industries increased 2 percent and 8 percent, respectively, over 1957.

Leaded Zinc Oxide.—Paint manufacturing used 99 percent of the leaded zinc oxide. Rubber and miscellaneous other uses required the remainder.

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 zinc sulfate, receiving 60 and 33 percent of the shipments (dry basis) respectively. The remainder was consumed in paint and varnish processing, flotation reagents, glue manufacture, and the medicinal trade.

Prices.—The quoted price of lead-free zinc oxide in 1958 ranged from 14.50 cents a pound to 16.75 cents, carlots ($290 to $335 a ton); the average value of shipments of this commodity was $270 a ton, $1 less than 1957. Leaded zinc oxide average value of shipments was $263 a ton up $14 compared with 1957; the quoted price a pound ranged from 15.13 to 15.50 cents, carlots (about $303 to $310 a ton). Zinc chloride, 50° B., average value of shipments increased $6 a ton to $133. Zinc sulfate shipments declined in value $14 to $146 a ton in 1958.

Foreign Trade.—Imports of zinc pigments and salts increased in value and quantity 89 and 90 percent, respectively, over 1957. Zinc pigments and salts imported totaled about 13,200 tons, the largest quantity imported since 1922. Zinc oxide composed 89 percent of these imports.

TABLE 22.—Distribution of zinc oxide shipments, by industries, in short tons

Industry	1949-53 (average)	1954	1955	1956	1957	1958
Rubber	72,832	71,058	86,677	80,459	81,745	68,176
Paints	32,437	31,157	33,932	32,485	32,605	33,335
Ceramics	9,321	8,990	10,617	10,160	8,459	9,095
Coated fabrics and textiles [1]	6,750	6,322	11,263	8,447	3,623	2,327
Floor coverings	2,819	1,749	2,281	1,436	1,249	971
Other	17,744	21,009	23,771	21,968	23,586	22,087
Total	141,903	140,285	168,541	154,955	151,267	135,991

[1] Includes the following tonnages for rayon: 1954—5,603; 1955—5,769 (revised); 1956—7,721; 1957—2,838; 1958—1,149.

TABLE 23.—Distribution of leaded zinc oxide shipments, by industries, in short tons

Industry	1949-53 (average)	1954	1955	1956	1957	1958
Paints	43,900	33,690	32,178	26,825	23,904	23,021
Rubber	99	7	} 483	339	299	267
Other	529	275				
Total	44,528	33,972	32,661	27,164	24,203	23,288

TABLE 24.—Distribution of zinc sulfate shipments by industries, in short tons

Year	Rayon		Agriculture		Other		Total	
	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis
1949-53 (average)	9,814	7,726	5,549	4,732	6,499	4,846	21,862	17,304
1954	6,615	5,740	7,067	6,139	5,345	4,278	19,027	16,157
1955	10,732	9,537	8,187	7,089	4,945	3,722	23,864	20,348
1956	21,083	18,825	7,051	6,291	4,066	3,190	32,200	28,306
1957	19,903	17,785	9,818	8,261	3,899	3,465	33,620	29,511
1958	19,796	17,747	11,525	9,819	2,416	2,191	33,737	29,757

TABLE 25.—Value of zinc pigments and salts imported into and exported from the United States

[Bureau of the Census]

	Imports for consumption			Exports		
	1956	1957	1958	1956	1957	1958
Zinc pigments:						
Zinc oxide	$770,156	$1,043,629	$2,263,865	$846,883	$985,325	$789,995
Zinc sulfide	156,675	104,930	91,273	(1)	(1)	(1)
Lithopone	[2] 19,931	8,124	9,307	239,892	177,891	122,462
Total	[2] 946,762	1,156,683	2,364,445	1,086,775	1,163,216	912,457
Zinc salts:						
Zinc arsenate	2,570	-----------	3,776	(1)	(1)	(1)
Zinc chloride	112,702	104,498	92,046	(1)	(1)	(1)
Zinc sulfate	84,058	74,710	60,171	(1)	(1)	(1)
Total	199,330	179,208	155,993	(1)	(1)	(1)
Grand total	[2] 1,146,092	1,335,891	2,520,438	(1)	(1)	(1)

[1] Data not available.
[2] Data known to be not comparable to other years.

Exports declined in value and quantity 22 and 24 percent, respectively, compared with 1957. Exported zinc oxide was down 19 percent, and lithopone down 38 percent.

TABLE 26.—Zinc pigments and salts imported for consumption in the United States

[Bureau of the Census]

Year	Short tons							Total value
	Zinc oxide		Lithopone	Zinc sulfide	Zinc chloride	Zinc arsenate	Zinc sulfate	
	Dry	In oil						
1949–53 (average)	1,687	8	410	11	279	(1)	118	$603,230
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
1958	11,729		69	295	547	1	565	2,520,438

1 Less than 1 ton.
2 Data known to be not comparable to other years.

TABLE 27.—Zinc pigments exported from the United States

[Bureau of the Census]

Year	Short tons		Total value	Year	Short tons		Total value
	Zinc oxide	Lithopone			Zinc oxide	Lithopone	
1949–53 (average)	5,523	11,640	$3,645,099	1956	2,748	1,387	$1,086,775
1954	3,111	3,013	1,351,526	1957	3,144	991	1,163,216
1955	2,649	1,892	1,072,581	1958	2,543	613	912,457

STOCKS

National Stockpile.—Inventories in the National Stockpile at the beginning of 1958 equalled or exceeded the minimum objective and were nearing the long-term objective level. During the first 4 months of 1958, 34,488 tons of domestically produced zinc was reported by industry [11] to have been shipped to Government account for the long-term objective. The total of all such shipments reported by industry for 1945 through 1958 was 1,170,951 tons. GSA also acquired 40,216 tons of foreign zinc in 1958, under barter contracts authorized under the Agricultural Trade Development and Assistance Act of 1954 and amendments. The 294,307 tons acquired in 1956 through 1958 under this program were placed in the supplemental stockpile.

Producers' Stocks.—Smelters stocks of slab zinc began the year at 155,800 tons and reached a peak of nearly 258,000 tons at the end of July. Thereafter improved consumption and cuts in imports forced by quotas acted to reduce stocks to 184,000 tons by the end of the year.

11 Kimberley, J. L., A Review of the Zinc Industry in the United States During 1958, American Zinc Institute, 60 East Forty-Second St., New York 17, N.Y., Feb. 17, 1959, 16 pp.

TABLE 28.—Stocks of zinc at zinc-reduction plants in the United States at end of year, in short tons

	1954	1955	1956	1957	1958
At primary reduction plants	121,847	37,322	64,794	153,338	182,111
At secondary distilling plants	1,549	1,942	2,081	2,495	1,914
Total	123,396	39,264	66,875	155,833	184,025

Consumers' Stocks.—Stocks of slab zinc at consumers' plants rose from 88,300 tons (revised) to 93,300 tons by the end of 1958. An additional 5,100 tons of slab zinc were in transit to consumer plants. At the average monthly rate of consumption, total consumer stocks plus metal in transit represented about a 6-weeks' supply.

TABLE 29.—Consumers' stocks of slab zinc at plants at the beginning and end of 1958, by industries, in short tons

	Galvanizers	Brass mills [1]	Zinc die casters [2]	Zinc rolling mills	Oxide plants	Other	Total
Dec. 31, 1957 [3]	40,879	12,115	29,452	4,062	231	1,603	[4] 88,342
Dec. 31, 1958	47,902	12,573	26,436	5,019	178	1,158	[4] 93,266

[1] Includes brass mills, brass ingot makers, and foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] Revised figures.
[4] Stocks on Dec. 31, 1957 and 1958, exclude 495 tons (revised figure) and 1,011 tons, respectively, of remelt spelter.

PRICES

The quoted price for Prime Western slab zinc, E. St. Louis, was 10 cents a pound on January 1. That price was maintained until October 2, when a ½-cent increase was realized. On October 8 the price advanced to 11.0 cents, and on November 10 to 11.50 cents a pound where it remained through December 31, averaging 10.31 cents a pound for the year.

The average monthly zinc quotation on the London Metal Exchange was £65.905 a long ton (equivalent to 8.24 cents a pound computed at the exchange rate recorded by the Federal Reserve Board). The price opened the year at £62.568 a long ton (7.88 cents a pound) and ranged from a low of £61.854 struck in May to a high of £75.275 (9.41 cents a pound) in November; the price at the end of December was £74.342 (9.29 cents a pound).

Prices for new and old scrap zinc varied with market quotations for slab zinc. Sales of clean new zinc clippings, trimmings, and engravers' or lithographers' plates averaged 4.25 cents a pound in January at which it remained through September. In October, November, and December the average price increased 0.19 cents, 0.44 cents, and 0.12 cents, respectively, and closed the year at 5.00 cents a pound; the price ranged from 4.00 cents to 5.25 cents a pound and averaged 4.38 cents. Old zinc scrap ranged in average price from 3.00 cents a pound to 3.75 cents, averaging 3.22 cents.

TABLE 30.—Price of zinc concentrate and zinc

	1954	1955	1956	1957	1958
Joplin 60-percent zinc concentrate:[1] Price per short ton dollars	65.72	77.50	83.89	76.94	60.55
Average price common zinc at—					
St. Louis (spot) [1] cents per pound	10.69	12.30	13.49	11.40	10.31
New York [1] do	11.19	12.80	13.99	11.90	10.81
London [2] do	9.78	11.30	12.19	10.18	8.24
Price indexes (1947–49 average=100):[3]					
Zinc (New York)	88	101	111	94	86
Lead (New York)	88	94	100	91	76
Copper (New York)	142	177	199	144	125
Straits tin (New York)	100	103	110	105	103
Nonferrous metals	124	143	156	137	128
All commodities	110	111	114	118	119

[1] Metal Statistics, 1959.
[2] E&MJ Metal and Mineral Markets English quotations converted into American money on basis of average rates of exchange recorded by Federal Reserve Board.
[3] Based upon price indexes of U.S. Department of Labor.

TABLE 31.—Average monthly quoted prices of 60-percent zinc concentrate at Joplin, and of common zinc (prompt delivery or spot), St. Louis and London [1]

Month	1957			1958		
	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	84.00	13.50	12.91	56.00	10.00	7.88
February	84.00	13.50	12.43	56.00	10.00	8.05
March	84.00	13.50	12.08	56.00	10.00	8.00
April	84.00	13.50	12.30	56.00	10.00	7.86
May	71.90	11.92	10.72	56.00	10.00	7.79
June	63.04	10.84	9.29	56.00	10.00	8.02
July	56.00	10.00	9.32	56.00	10.00	7.95
August	56.00	10.00	9.16	56.00	10.00	7.98
September	56.00	10.00	9.06	56.00	10.00	8.13
October	56.00	10.00	8.65	62.50	10.87	8.81
November	56.00	10.00	8.44	66.80	11.40	9.41
December	56.00	10.00	7.85	68.00	11.50	9.29
Average for year	76.94	11.40	10.18	60.55	10.31	8.24

[1] Joplin: Metal Statistics, 1959, p. 565. St. Louis: Metal Statistics, 1959, p. 563. 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 32.—Average price received by producers of zinc, by grades, in cents a pound

Grade	1954	1955	1956	1957	1958
Grade A:					
Special High Grade	11.46	12.79	14.26	12.13	10.45
High Grade	11.05	12.59	13.98	11.70	10.13
Grade B: Intermediate	11.36	12.30	14.06	11.69	10.81
Grades C and D:					
Brass Special	10.93	12.21	13.71	11.31	10.38
Select	10.02	11.13	13.41	10.56	10.48
Grade E: Prime Western	10.39	11.74	13.13	11.24	9.98
All grades	10.83	12.29	13.73	11.64	10.22
Prime Western; spot quotation at St. Louis [1]	10.69	12.30	13.49	11.40	10.31

[1] Metal Statistics,1 959, p. 563.

FOREIGN TRADE

Imports.—The United States depended on imports of zinc ore and metal for a considerable part of its supply. Despite reduced consumption and cutbacks in Government stockpiling in early 1958, imports continued at high levels during the first 9 months of the year. Beginning October 1, quotas[12] were imposed, which limited competitive imports per calendar quarter to 94,960 tons of zinc in ores and concentrate and 35,280 tons of zinc as metal (exclusive of zinc dust, but including all kinds of zinc-base scrap). The quotas established were 80 percent of the average dutiable imports into the United States during 1953–57. Specific quotas for zinc in ore were allocated on a calendar quarter in the following quantities: Mexico—35,240 short tons, Canada—33,240 tons, Peru—17,560 tons, and all other countries combined—8,920 tons. Zinc in blocks, pigs and slabs and in zinc-base scrap were allocated on a calendar quarter basis to Canada—18,920 short tons, Belgium and Luxembourg—3,760 tons, Mexico—3,160 tons, Belgian Congo—2,720 tons, Peru—1,880 tons, Italy—1,800 tons and all other countries combined—3,040 tons. The proclamation specified that the quotas were not applicable to zinc imported by or for the account of the United States or a wholly owned corporation of the U.S. Government.

General imports (imports for immediate consumption plus entries into warehouses) presented in table 33 show all physical entries of unmanufactured zinc into the United States, and the imports for consumption (imports for immediate consumption plus withdrawals from warehouses) given in table 34 gives a close approximation of dutiable imports entering the United States. The zinc content of ore and concentrate under imports for consumption exceeds that in ores and concentrates under General Imports by about 77,000 tons of zinc because withdrawals from warehouses for consumption exceeded entries into warehouses by that amount.

General imports of zinc declined 138,000 tons from the 1957 record to 657,000 tons; imports for consumption declined 224,000 tons to 724,000 tons.

Of the general imports of zinc in ores, Mexico supplied 34 percent, Canada 34 percent, Peru 22 percent, other Latin American countries 4 percent, and the remaining supplier countries 6 percent. Of the general imports of zinc blocks, pigs, and slabs, Canada supplied 48 percent, Mexico 12 percent, Peru 5 percent, Belgium-Luxembourg 11 percent, Belgian Congo 11 percent, and the remaining countries 13 percent.

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[12] A proclamation, by the President of the United States of America, Modification of Trade Agreement Concessions and Imposition of Quotas on Unmanufactured Lead and Zinc, Washington, D.C., Sept. 22, 1958.

TABLE 33.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, in short tons [1]

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
Ores (zinc content):						
North America:						
Canada-Newfoundland-Labrador	110,164	156,830	173,157	177,087	158,220	155,927
Cuba	46		3,704	1,155	1,209	223
Guatemala	4,552	3,755	8,353	11,433	[2] 9,313	6,483
Honduras	286	792	1,433	2,288	2,589	1,435
Mexico	162,585	175,692	186,461	193,007	192,519	158,609
Other North America	12	(3)		4	(3)	(3)
Total	277,645	337,069	373,108	384,974	[2] 363,850	322,677
South America:						
Argentina	1,231			2	165	9
Bolivia	10,463	11,440	1,833	7,294	[2] 7,633	7,328
Chile	882	1,797	4,858	346	1,400	977
Peru	37,937	93,216	83,915	98,541	[2] 119,004	103,002
Other South America	344	31	142	212	8	121
Total	50.857	106,484	90,748	106,395	[2] 128,210	111,437
Europe	15,822	4,886	3,043	1,923	1,398	80
Asia:						
Philippines	779	444	465	828	777	92
Other Asia	543			66	79	240
Total	1,322	444	465	894	856	332
Africa:						
Union of South Africa	6,258	4,183	5,050	13,400	21,048	21,700
Other Africa	601				1,896	1,032
Total	6,859	4,183	5,050	13,400	22,944	22,732
Oceania	4,673	2,361	5,630	17,764	8,756	[4] 4,750
Grand total: Ores	357,178	455,427	478,044	525,350	[2] 526,014	462,008
Blocks, pigs, or slabs:						
North America:						
Canada	96,282	105.154	113,402	116,875	103,964	93,475
Mexico	18,762	9.726	19,480	17,153	23,536	23,256
Total	115,044	114,880	132,882	134,028	127,500	116,731
South America: Peru	2,247	6,757	9,767	6,590	22,947	9,736
Europe:						
Austria				2,296	1,020	110
Belgium-Luxembourg	6,913	7,540	17,748	32,353	[2] 34,163	21,707
Germany [5]	4,632	3,109	6,642	15,285	8,772	2,673
Italy	6,143	5,285	6,190	13,486	10,010	6,166
Netherlands	2,115	1,461	1,079	5,965	2,504	2,520
Norway	3,243	717	504			2,769
United Kingdom	1,374	22	79	611	[2] 1,791	672
Yugoslavia	1,035			500	10,909	5,781
Other Europe	160			110		
Total	25,615	18,134	32,242	70,606	[2] 69,169	42,398
Asia:						
Japan	45			4,883	2,887	2,039
Other Asia	6					
Total	51			4,883	2,887	2,039
Africa:						
Belgian Congo	176	13,895	15,228	17,782	33,007	20,991
Mozambique		112			(6)	
Rhodesia and Nyasaland, Federation of	[7] 213		280	3,808	[2] 3,974	1,064
Other Africa	88		1,264			
Total	477	14,007	16,772	21,590	36,981	22,055
Oceania: Australia	811	3,080	4,033	7,281	9,523	2,240
Grand total: Blocks, pigs, or slabs	144,245	156,858	195,696	244,978	[2] 269,007	195,199

[1] Data include zinc imported for immediate consumption plus material entering country under bond.
[2] Revised figure.
[3] Less than 1 ton.
[4] Includes 52 tons imported from French Pacific Islands.
[5] West Germany, 1952–58.
[6] Revised to none.
[7] Northern Rhodesia.

TABLE 34.—Zinc imported for consumption in the United States, by classes [1] [2]

[Bureau of the Census]

Year	Ore (zinc content)		Blocks, pigs, slabs [3]		Sheets		Old and worn-out	
	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)
1949-53 (average)	307,428	$43,290	141,929	$37,142	127	$57	1,261	$244
1954	480,918	[4] 52,482	160,138	33,714	259	88	771	70
1955	384,648	36,811	195,059	46,452	431	[4] 148	176	28
1956	462,379	49,231	244,726	65,034	454	172	185	36
1957	[5] 679,416	[5] 88,516	[5] 268,824	[4] [5] 64,129	732	245	227	32
1958	538,566	51,361	185,693	35,612	901	285	235	31

Year	Dross and skimmings		Zinc dust		Total value [6] [7]
	Short tons	Value (thousand)	Short tons	Value (thousand)	
1949-53 (average)	3,260	$281	364	$72	$81,086
1954	316	33			[4] 86,387
1955	108	3	72	18	[4] 83,460
1956	417	61	72	18	[4] 114,552
1957	363	57	112	[4] 28	[4] [5] 153,007
1958	737	77	96	14	87,380

[1] Excludes imports for manufacture in bond and export, which are classified as "imports for consumption" by Bureau of the Census.

[2] Old, dross and skimmings, 5-year averages in the following Minerals Yearbooks should be revised to read: 1955, p. 1294, 5,212 tons ($632,252); 1956, p. 1345, 5,715 tons ($630,383); 1957, p. 1307, 5,392 tons ($649,566).

[3] Minerals Yearbook, 1956, p. 1345, 5-year average should read 106,699 tons.

[4] Data known to be not comparable with other years.

[5] Revised figure.

[6] In addition manufactures of zinc were imported as follows: 1949–53 (average) $42,845; 1954—[4] $41,454; 1955—[4] $190,076; 1956—[4] $287,361; 1957—[4] $264,348; 1958—$389,803.

[7] Total value 5-year averages in the following Minerals Yearbooks should be revised to read: 1955, p. 1294, $39,158,756; 1956, p. 1345, $45,897,281; 1957, p. 1307, $68,861,018.

TABLE 35.—Zinc imported for consumption in the United States, in ores, blocks, pigs, or slabs, by countries, in short tons [1]

[Bureau of the Census]

Country	1949–53 (average)	1954	1955	1956	1957	1958
Ores (zinc content):						
North America:						
Canada-Newfoundland-Labrador	105, 244	177, 200	152, 307	145, 610	217, 441	169, 474
Cuba	156		428	1, 103	1, 247	52
Guatemala	4, 657	1, 819	8, 137	13, 209	10, 337	6, 093
Honduras	136	613	78	458	3, 562	1, 478
Mexico	130, 308	169, 232	155, 647	187, 305	261, 265	208, 202
Other North America	12				2	111
Total	240, 513	348, 864	316, 597	347, 685	493, 854	385, 410
South America:						
Argentina	882				105	9
Bolivia	7, 331	15, 367	170	5, 523	8, 644	6, 838
Chile	816	1, 570	4, 686	390	3, 035	1, 072
Peru	31, 892	89, 723	57, 454	91, 691	147, 073	110, 165
Other South America	308	64	83	11	70	121
Total	41, 229	106, 724	62, 393	97, 615	158, 927	118, 205
Europe	15, 609	11, 564	3, 043	861	223	11
Asia:						
Philippines	779	444	465	816	942	92
Other Asia	600	628			9	211
Total	1, 379	1, 072	465	816	951	303
Africa:						
Union of South Africa	4, 429	10, 879	7	407	19, 751	28, 007
Other Africa	589				(2)	524
Total	5, 018	10, 879	7	407	19, 751	28, 531
Oceania: Australia	3, 680	1, 815	2, 143	14, 995	5, 710	[3] 6, 106
Grand total: Ores	307, 428	480, 918	384, 648	462, 379	679, 416	538, 566
Blocks, pigs, or slabs:						
North America:						
Canada	96, 290	105, 154	113, 402	116, 875	103, 964	93, 327
Mexico	17, 233	9, 306	18, 730	16, 929	23, 690	22, 804
Total	113, 523	114, 460	132, 132	133, 804	127, 654	116, 131
South America: Peru	1, 802	8, 963	9, 767	6, 590	22, 947	9, 736
Europe:						
Austria				2, 296	1, 020	55
Belgium-Luxembourg	6, 913	7, 540	17, 748	32, 353	34, 163	17, 969
Germany [4]	4, 632	3, 109	6, 642	15, 257	8, 772	2, 035
Italy	6, 143	5, 032	6, 303	13, 486	10, 010	5, 816
Netherlands	2, 115	1, 461	1, 079	5, 965	2, 504	730
Norway	3, 243	717	504			2, 601
United Kingdom	1, 024	1, 769	79	611	1, 791	112
Yugoslavia	1, 035			500	10, 572	5, 009
Other Europe	160			110		
Total	25, 265	19, 628	32, 355	70, 578	68, 832	34, 327
Asia:						
Japan	45			4, 883	2, 887	1, 708
Other Asia	6					
Total	51			4, 883	2, 887	1, 708
Africa:						
Belgian Congo	176	13, 895	15, 228	17, 782	33, 007	20, 991
Rhodesia and Nyasaland, Federation of	[5] 213		280	3, 808	3, 974	560
Other Africa	88	112	1, 264			
Total	477	14, 007	16, 772	21, 590	36, 981	21, 551
Oceania: Australia	811	3, 080	4, 033	7, 281	9, 523	2, 240
Grand total: Blocks, pigs, or slabs	141, 929	160, 138	195, 059	244, 726	268, 824	185, 693

[1] Excludes imports for manufacture in bond and export, which are classified as "imports for consumption" by Bureau of the Census.
[2] Less than 1 ton.
[3] Includes 52 tons imported from French Pacific Islands.
[4] West Germany, 1952–58.
[5] Northern Rhodesia.

Exports.—Exports of slab zinc declined 84 percent to about 1,700 tons.

TABLE 36.—Slab and sheet zinc exported from the United States, by destinations, in short tons

[Bureau of the Census]

Destination	Slabs, pigs, and blocks				Sheets, plates, strips, or other forms, n.e.s.			
	1955	1956	1957	1958	1955	1956	1957	1958 [1]
North America:								
Canada	8	8	13	6	2,062	2,596	2,581	1,864
Cuba	11	86	31	31	132	105	123	132
Mexico	961	839	513	508	583	716	315	425
Other North America	4	21	58	46	43	90	40	57
Total	984	954	615	591	2,820	3,507	3,059	2,478
South America:								
Argentina	6,062		6		9			
Brazil	35	49	17		71	61	69	87
Chile	6	96	40	36	8	7	37	
Colombia	2		55	14	270	344	408	195
Venezuela	14	1		8	50	97	72	86
Other South America		7	3		26	37	21	61
Total	6,119	153	121	58	434	546	607	429
Europe:								
Belgium-Luxembourg	2,883	1,428	1,064		2		5	47
Denmark	84					34	64	105
Germany, West		279	336		30	46	34	73
Italy					12	14	7	1
Netherlands	112	44	476		12	9	22	122
Switzerland	224	448			30	34	26	87
United Kingdom	7,504	5,040	6,504	672	50	30	11	106
Other Europe	1	25	(2)		72	10	40	178
Total	10,808	7,264	8,380	672	208	177	209	719
Asia:								
India		2	672		38	68	53	36
Korea, Republic of	132	433	912		1			
Philippines	7		8	5	84	85	53	73
Other Asia	17	7	77	406	29	40	24	32
Total	156	442	1,669	411	152	193	130	141
Africa:								
Union of South Africa					38	21	51	42
Other Africa	2			4	(2)			3
Total	2			4	38	21	51	45
Oceania					5			6
Grand total	18,069	8,813	10,785	1,736	3,657	4,444	4,056	3,818

[1] Due to changes in classification by the Bureau of the Census data known to be not strictly comparable to earlier years.
[2] Less than 1 ton.

TABLE 37.—Zinc ore and manufactures of zinc exported from the United States

[Bureau of the Census]

Year	Zinc ore, concentrates (zinc content)		Slabs, pigs, or blocks		Sheets, plates, strips, or other forms, n.e.s.		Zinc scrap and dross (zinc content)		Zinc dust	
	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)	Short tons	Value (thousand)
1949–53 (average)[1]	2,696	$639	36,764	$13,478	5,541	$3,137	2,873	$444	(2)	(2)
1954[1]	-----	-----	24,994	5,394	4,045	2,183	16,689	2,023	509	$151
1955[1]	-----	-----	18,069	4,175	3,657	2,193	21,612	2,250	445	162
1956[1]	854	162	8,813	2,465	4,444	3,031	14,921	1,540	372	136
1957[1]	7	(3)	10,785	2,553	4,056	2,950	5,469	822	595	195
1958[1]	-----	-----	1,736	627	[4] 3,818	[4] 2,637	5,344	364	519	170

[1] Effective Jan. 1, 1952, zinc and zinc-alloy semifabricated forms, n.e.c., were exported as follows: 1952—$191,746 (quantity not available); 1953—286 tons ($151,496); 1954—543 tons ($257,316); 1955—651 tons ($295,685); 1956—582 tons ($301,230); 1957—485 tons ($246,527); 1958 [4]—1,168 ($542,069).

[2] Not included in 1949–53 averages; 1949—690 tons (261,484); 1950—506 tons ($186,557); 1951—723 tons ($400,656); 1952 included with "scrap"; 1953—502 tons ($181,055).

[3] Less than $1,000.

[4] Due to changes in classification by the Bureau of the Census, data not strictly comparable to earlier years.

Tariff.—The duty on slab zinc remained at 0.7 cent a pound, that on zinc contained in ore and concentrate at 0.6 cent a pound, and that on zinc scrap at 0.75 cent a pound throughout 1958. The duties on zinc articles under the Tariff Act of 1930 were unchanged in 1958, remaining as shown on page 1290 of Volume I of the 1953 Minerals Yearbook.

WORLD REVIEW

NORTH AMERICA

Canada.—Canadian mines produced 424,000 tons of recoverable zinc—3 percent more than in 1957. Smelter output of slab zinc was 252,000 tons compared with 247,000 tons in 1957. Exports of zinc in ores and concentrates and in refined slab totaled 218,000 and 196,000 tons, respectively. Though the volume of exports rose 11 percent, lower market prices caused a 14-percent drop in value. Consumption of zinc in Canada rose sharply to 60,000 tons from the 51,000 tons used internally in 1957.

Consolidated Mining & Smelting Co. continued to lead Canadian zinc production. According to the company annual report the Sullivan silver-lead-zinc mine at Kimberly, British Columbia, produced 2,444,000 tons of crude ore. A pillar blast set off in July fragmented 800,000 tons of ore, the largest single blast in the history of the mine. The Bluebell lead-zinc mine at Riondel, British Columbia, produced 256,000 tons and the H. B. zinc-lead mine near Salmo, British Columbia yielded 458,000 tons of ore. The company's Sullivan pit and Tulsequah mines remained closed during the year. In addition to output of Consolidated-owned mines, the company produced zinc from treatment of purchased ores and from retreatment of plant residues and lead-blast furnace slag. Production of slab zinc at the company's electrolytic plant at Trail, British Columbia, was 193,500 tons, 76 percent of the total Canadian output.

TABLE 38.—World mine production of zinc (content of ore),[1] by countries,[2] in short tons [3]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country [2]	1949-53 (average)	1954	1955	1956	1957	1958
North America:						
Canada [4]	343,233	376,491	433,357	422,633	413,741	424,116
Cuba	----------	----------	1,134	1,638	752	[5] 110
Greenland [5]	----------		----------	6,050	9,350	6,700
Guatemala	[6] 5,824	4,400	10,400	12,000	10,300	11,600
Honduras [7]	287	791	1,433	2,288	2,589	1,478
Mexico	228,379	246,441	296,961	274,351	267,891	247,030
United States [4]	622,240	473,471	514,671	542,340	531,735	412,005
Total	1,199,963	1,101,594	1,257,956	1,261,300	1,236,358	1,103,039
South America:						
Argentina	15,560	20,850	23,260	26,350	32,420	40,060
Bolivia (exports)	28,079	22,403	23,509	18,818	21,678	15,677
Chile	[6] 1,973	[5] 1,650	3,200	2,969	2,747	1,336
Peru	116,458	174,784	183,074	193,037	170,258	142,265
Total	162,070	219,687	233,043	241,174	227,103	199,338
Europe:						
Austria	4,053	5,140	5,787	5,868	6,334	6,463
Bulgaria [5]	17,600	33,500	35,200	39,400	50,000	55,000
Finland	3,924	5,000	23,300	43,000	47,400	51,800
France	14,000	12,500	12,100	13,870	13,800	16,250
Germany:						
East [5]	4,500	7,200	7,700	7,700	7,700	7,700
West	83,686	103,867	101,558	101,898	104,015	93,904
Greece [8]	6,037	7,900	13,500	22,300	26,900	20,200
Ireland	[6] 1,386	1,719	2,769	1,798	1,792	463
Italy	106,146	129,707	132,057	134,912	144,623	150,796
Norway	6,283	5,917	7,411	7,007	7,735	9,246
Poland [5]	[9] 133,000	129,000	139,000	138,000	143,000	154,000
Spain	78,700	97,300	101,800	96,100	89,100	91,400
Sweden	42,795	64,407	64,810	72,797	74,528	71,450
U.S.S.R.[5] [9]	181,000	258,000	300,000	351,000	386,000	400,000
United Kingdom	1,030	3,905	3,167	1,563	1,085	283
Yugoslavia	50,550	63,052	65,800	63,400	64,000	66,200
Total [2] [5]	742,000	937,000	1,025,000	1,109,000	1,177,000	1,204,000
Asia:						
Burma	1,345	6,400	9,100	8,100	10,200	12,100
India	[6] 1,760	2,600	2,900	4,200	4,500	4,300
Iran [10]	[11] 8,270	5,800	6,300	5,200	5,000	9,900
Japan	76,043	120,581	119,787	135,585	149,921	155,637
Korea:						
North [5]	----------	----------	16,500	33,000	40,000	40,000
Republic of	115	----------	----------	440	311	369
Philippines	[11] 918	----------	----------	1,050	330	----------
Thailand	476	3,000	3,200	2,400	1,820	600
Turkey [5]	1,280	6,100	770	1,090	2,120	2,090
Total [2] [5]	95,000	158,300	175,100	212,000	238,500	249,200
Africa:						
Algeria	11,996	31,538	35,982	35,703	31,483	35,082
Belgian Congo	97,812	92,927	74,700	129,551	118,176	125,652
Egypt	714	262	757	692	----------	----------
French Equatorial Africa	344	----------	----------	----------	----------	----------
Morocco: Southern zone	21,462	37,908	47,686	46,549	53,864	54,953
Rhodesia and Nyasaland, Fed. of: Northern Rhodesia	[9] 26,648	38,672	38,070	38,134	40,353	38,034
South-West Africa	15,476	22,030	23,230	29,350	54,700	44,760
Tunisia	3,749	5,707	6,311	5,200	3,914	4,566
Total	178,201	229,044	226,736	285,179	302,490	303,047
Oceania: Australia	224,546	282,978	287,352	311,452	326,573	294,462
World total (estimate) [2]	2,600,000	2,930,000	3,210,000	3,420,000	3,510,000	3,350,000

[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, Czechoslovakia, Rumania, and China also produce zinc, but production data are not available; estimates are 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 1950-53.
[7] United States imports.
[8] Includes zinc content of mixed ores.
[9] Smelter production.
[10] Year ended March 21 of year following that stated.
[11] Average for 1951-53.

TABLE 39.—World smelter production of zinc by countries,[1] in short tons [2] [3]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
North America:						
Canada	220,430	253,365	256,542	255,564	247,316	252,127
Mexico [4]	59,344	60,477	61,878	62,136	62,353	63,329
United States	872,093	802,425	963,504	983,610	985,796	781,246
Total	1,151,867	1,116,267	1,281,924	1,301,310	1,295,465	1,096,702
South America:						
Argentina	9,350	[5] 12,000	14,881	16,200	16,150	16,980
Peru	3,861	16,935	18,801	10,419	32,483	32,034
Total	13,211	28,935	33,682	26,619	48,633	49,014
Europe:						
Austria	------------	------------	1,493	7,932	10,291	11,698
Belgium [6]	206,133	234,897	233,625	254,289	259,755	236,730
Bulgaria	------------	------------	1,497	6,435	8,282	9,000
France	81,061	122,249	123,624	124,106	143,905	165,190
Germany, West	142,381	184,804	197,026	204,964	202,548	146,816
Italy	50,013	72,134	77,792	81,086	81,193	78,656
Netherlands	24,048	28,702	31,347	31,980	33,085	29,285
Norway	44,780	49,010	50,176	53,762	53,299	49,663
Poland [5]	130,000	156,600	172,200	169,000	175,000	180,000
Spain	23,510	25,652	26,291	25,381	24,138	26,750
U.S.S.R.[5]	181,000	258,000	300,000	351,000	386,000	400,000
United Kingdom	77,405	90,989	91,108	91,247	86,111	83,537
Yugoslavia	13,964	15,040	15,176	21,890	32,473	34,445
Total [5]	980,000	1,245,000	1,328,000	1,431,000	1,504,000	1,459,000
Asia:						
China [5]	240	13,800	15,500	19,000	24,000	[7] 24,000
Japan	63,224	112,296	124,075	150,169	152,152	155,399
Total [5]	63,500	126,100	139,600	169,200	176,200	179,400
Africa:						
Belgian Congo	[8] 8,599	35,274	37,443	46,390	54,227	58,905
Rhodesia and Nyasaland, Fed. of: Northern Rhodesia	26,069	29,736	31,248	32,396	33,040	33,880
Total	34,668	65,010	68,691	78,786	87,267	92,785
Oceania: Australia	93,908	117,066	113,220	117,592	123,589	128,547
World total (estimate)	2,337,000	2,700,000	2,970,000	3,120,000	3,240,000	3,010,000

[1] In addition to countries listed Czechoslovakia and Rumania also produce zinc, but production data are not available; estimates are included in the total.
[2] Data derived in part from the Yearbook of the American Bureau of Metal Statistics, the United Nations Monthly Bulletin and the Statistical Yearbook, and the Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London).
[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] In addition other zinc-bearing materials totaling 30,288 tons in 1953; 18,545 in 1954; 37,442 in 1955; 39,554 in 1956; 30,504 in 1957; 19,472 in 1958.
[5] Estimate.
[6] Includes production from reclaimed scrap.
[7] Figure represents estimate of 1957 production. However, 1958 production was probably much greater.
[8] One year only, as 1953 was first year of commercial production.

The annual report of the Pend Oreille Mines and Metals Co. showed that the Reeves McDonald Mines, Ltd., produced 417,000 tons of crude ore at its Remac, British Columbia mine that yielded 31,068 tons of concentrates containing 14,110 tons zinc and 3,986 tons lead plus values in silver and cadmium.

Sheep Creek Mines, Ltd., Nelson, British Columbia, reported discovery of an extension of its lead-zinc orebody. Production for the year ended May 31, 1958, was 183,300 tons of ore milled.

Hudson Bay Mining & Smelting Co. operating mines on the Manitoba-Saskatchewan boundary, was Canada's second largest producer of zinc. The mill treated 1,670,000 tons of crude ore, 93 percent of which was from the Flin Flon copper-zinc mine. The remaining 7 percent was from the Birch Lake, North Star and Schist Lake mines. The company continued development at its Chisel Lake mine 5 miles southwest of Snow Lake and at the Stall Lake mine 4 miles southeast of Snow Lake. The electrolytic zinc plant at Flin Flon (Manitoba) produced 59,850 tons of slab zinc during the year—24 percent of the total Canadian output.[13]

The Manitouwadge, Ontario mine of Willroy Mines, Ltd., was the third largest zinc producer in Canada. The mill treated 331,000 tons of ore that yielded concentrates containing 34,350 tons zinc, 3,300 tons copper, and considerable lead, silver and gold.[14] Exploration laterally to the Geco property boundary was underway and shaft sinking below the 800 level was proceeding rapidly at year's end.

Geco Mines, Ltd., at Manitouwadge, Ontario, having entered the production stage late in 1957, treated an average of 3,524 tons a day in 1958. Ore mill totaled 1,286,129 tons of 2.48 percent copper and 2.31 percent zinc, and about $1.10 in recoverable gold and silver values. Gross weight of zinc concentrates produced during the year was 35,061 dry tons that assayed 56.3 percent zinc. Exploration and development continued laterally and in depth. Stopes are the open, blast-hole type. A single blast in December fragmented 400,000 tons of ore. Electric slushers convey the ore to transfer raises that feed by gravity directly into an underground crusher. From the crushers, conveyor belts conduct the ore to 18-ton skips for hoisting to the surface plant.

In Quebec, Quemont Mining Corp., Ltd., milled 859,170 tons of ore containing 1.31 percent copper, 3.12 percent zinc, 44.7 percent pyrite, 0.194 ounce gold and 0.94 ounce silver. Among other products 41,016 tons of zinc concentrate were recovered. Other Quebec producers of zinc concentrate included Normetal Mining Corp., Ltd., which milled 355,374 tons of ore that assayed 3.20 percent copper and 4.46 percent zinc; Waite Amulet Mines, Ltd., which treated 288,206 tons of ore that averaged 3.47 percent copper and 3.57 percent zinc; and West McDonald Mines, Ltd., which produced 265,503 tons of ore (processed at the Waite Amulet mill) that yielded 8,800 tons of zinc and 198,000 tons pyrite concentrate. Barvue Mine, Ltd., announced amalgamation with Golden Manitou Mines, Ltd., to form the Manitou Consolidated Mines, Ltd. The Barvue mine, Quebec's major producer of zinc concentrates in 1957 was closed during 1958 but plans were announced[15] to reopen under the new company structure when demand for zinc increases.

The Mattagami Area of northwestern Quebec was the site of continued exploration. Interest initially was focused on the area by the discovery of the Watson Lake zinc-copper deposit by Mattagami Syndicate in 1957. Drilling by the Syndicate in 1958 was reported to have proved 14 million tons of ore containing 14.6 percent zinc and 0.56 percent copper plus minor silver and gold values.[16] New discovering in the Mattagami district near Allard River were made in 1958 by New Hosco Mines, Ltd., and by Kennco Explora-

[13] Hudson Bay Mining & Smelting Co., Annual Report, 1958, 20 pp.
[14] Northern Mines, vol. 64, No. 44, Jan. 22, 1959, p. 1.
[15] Mining World, vol. 21, No. 1, January 1959, p. 73.
[16] Metal Bulletin (London), No. 4333, October 1958, p. 17.

tions, Ltd. of Canada (a subsidiary of Kennecott Copper Corp.) several miles east of Bell River.

In New Brunswick, Heath Steele Mines Ltd. (subsidiary of American Metal Climax, Inc.), which began production in January 1957, closed in May 1958, owing to the depressed world metal market. The mine and 1,500-ton mill remained on a stand-by basis until economic conditions warrant reopening.[17] Brunswick Mining & Smelting Corp., Ltd., discontinued development and construction at its northern New Brunswick property in April 1958. A 2,000-ton mill at Bathurst was planned.

In Newfoundland, Buchans Mining Co., Ltd., operated its lead-zinc-copper property near Red Indian Lake at approximately the rate of the previous year. Mill capacity is 1,300 tons a day. A new concrete-lined shaft was deepened 1,880 feet to 2,123 feet. Eventual depth will be 4,010 feet.[18]

In the Yukon Territory, United Keno Hill Mines, Ltd., operated its Mayo district silver-lead-zinc mine. For the year ended September 30, 1958, ore output was 175,058 tons assaying 36.83 ounces silver a ton with 7.18 percent lead and 6.10 percent zinc.[19]

Mexico.—The Mexican Ministry of Economy announced plans for construction of an electrolytic zinc refinery at Trapuato. The plant will be owned jointly by the Mexican Government and private organizations and will cost $3.5 million. Also American Smelting & Refining Co. and the Mexican Government announced plans for a zinc refinery of the fractionating furnace type to be built at Tlalnepantla. The Tlalnepantla plant will produce Special High grade from Prime Western grade zinc produced at the company's smelter at Rosita, Coahuila.

American Smelting and Refining Co. continued zinc production from Mexican ores. The San Martin mine and mill at Sombrerete, Zacatecas was added by purchase to the extensive mine-mill units of the company in Mexico.[20] Slab zinc was produced by the American Smelting & Refining Co. in a horizontal retort smelter, at Rosita, Coahuila. The zinc fuming plant to recover zinc oxide from lead furnace slags at Chihuahua continued shipments of zinc fume to smelters in the United States.

American Metal Climax, Inc., through its Mexican subsidiary, Cia. Minera de Penoles, S. A., mined 338,000 tons of crude ore that, combined with small quantities of custom ore, yielded 30,000 tons of lead concentrate and 50,000 tons of zinc concentrate. The zinc concentrate was shipped to the Blackwell, Okla. smelter of a subsidiary company for reduction to metal. The 3½-mile haulage tunnel at the Avalos mine, started in 1957, was 60 percent completed by the end of 1958. Tax and royalty concessions granted by the Mexican Government will allow economic mining of the low-grade orebody developed by the haulage tunnel.

San Francisco Mines of Mexico, Ltd., at the San Francisco del Oro mine, Chihuahua during the year ended September 30, 1958 milled 857,500 tons of crude ore that yielded 57,100 tons of 66.52

[17] American Metal Climax, Inc., 1958 Annual Report, p. 18.
[18] American Smelting & Refining Co., 60th Annual Report, 1958, 12 pp.
[19] Mining Magazine (London), vol. 100, No. 3, March 1959, p. 163.
[20] See 1957 Minerals Yearbook, Zinc Chapter, p. 1313 for list of company units.

percent lead concentrate, 95,600 tons of 57.65 percent zinc concentrate, and 9,000 tons of 27.61 percent copper concentrate.

Fresnillo Co. continued to operate its lead-zinc mines at Fresnillo in Zacatecas and its Naica mine in Chihuahua. In the year ended June 30, 1958, the company mined and milled 958,200 tons of ore that contained approximately 39,000 tons of lead and 46,000 tons of zinc in addition to lesser values in copper, gold, and silver. Operations of Sombrerete Mining Co., a subsidiary of Fresnillo, produced 8,000 tons of lead concentrate and 1,600 tons of zinc concentrate from milling 137,500 tons of ore containing considerable gold and silver values.

El Potosi Mining Co. (subsidiary of Howe Sound Co.) operated its El Potosi mine in the Santa Eulalia district, Chihuahua. Production for the year averaged about 14,000 tons of ore a month. The company announced shutdown of the El Carmen mine at Batophilas, Chihuahua owing to exhausted reserves.

Minas de Iquala, S. A., subsidiary of the Eagle-Picher Co., operated its zinc-lead-copper mine and mill near Parral, Chihuahua.

SOUTH AMERICA

Argentina.—Compania Minera Aguilar, S.A., a subsidiary of St. Joseph Lead Co., operated its Aguilar mine in the Province of Jujuy throughout the year. Two major ore discoveries were made, and the mill was operated at capacity. The zinc concentrate was roasted at the Sulfacid, S. A. plant at Borghi and the sinter reduced to slab zinc at an electrothermic zinc smelter owned by Cia Metalurgica Austral-Argentine, S. A. Production of slab by the Austral smelter in 1958 was 9,800 tons. Power shortages during the year continued to limit output. St. Joseph Lead Co. announced that authorization had been granted to Sulfacid, S. A., a subsidiary organization, to erect a new electrolytic zinc smelter that will have an annual output of 6,500 tons slab zinc.[21]

Bolivia.—Bolivian authorities decided to forego export tax on zinc ores and concentrates in an effort to stimulate declining mine output. Leading Bolivian mine producers of zinc were Pulacayo and Animas mines.

Peru.—Zinc exports declined 9 percent in volume and 28 percent in value. Production of slab zinc at La Oroya smelter of Cerro de Pasco Corp. was 32,045 tons. The zinc concentrate smelted was derived entirely from company-owned mines. Compania de Minas Buenaventura, S. A., operated profitably throughout the year and was developing a new orebody and constructing a mill in the Central Andes.[22] Minas de Venturosa, S. A., after an unprofitable year's operation anticipated shutdown at the end of the year. The Santander mine of Cia. Minerales Santander, Inc., began production in late 1958. The 500-ton-per-day mill was scheduled to operate on ore from the open pit for at least 1 year. Contracts were arranged for European sale of the lead-copper-silver and zinc concentrates. Among other significant zinc producers in Peru were Volcan Mines Co., Cia Minera Atacocha, Cie des Mines de Huaron, and Northern Peru Mining Co.

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[21] St. Joseph Lead Co., Annual Report, 1958, p. 11.
[22] Cerro de Pasco Corp., Annual Report, 1958, p. 12.

EUROPE

Austria.—The lead-zinc mines of Austria produced 207,200 tons of crude ore. Bleiberger Bergwerks Union, Austria's dominant producer, treated zinc concentrates from company mines; as well as Italian concentrates, at the company's electrolytic plant at Gailitz to produce 11,000 tons of slab zinc.

Bulgaria.—Output of refined zinc was expected to rise 44,000 tons by 1962, according to details of the third Five Year Plan (1958–62) published in Sofia. Bulk of the increase was planned to come from the newly developed deposits in the Rhodope mountains near the Greek border. The Bulgarian reserve was estimated to be 50 million tons of ore.[23]

Czechoslovakia.—Approximately 50,000 tons of zinc were consumed in Czechoslovakia. The country's two horizontal retort plants contributed approximately half of internal industrial needs.

Finland.—Outokumpu Oy. reported milling 1,578,000 tons of crude ore that, in addition to copper, pyrite, and lead, yielded 94,407 tons of zinc concentrate.[24] Mining activity at Aijala and Metsamonttu was suspended in June pending favorable outcome of a drilling project to replenish dwindling reserves. Rushealan Marmori Oy. planned to build a concentrating plant at the site of its newly discovered ore body. The reserve was estimated to be 2,250,000 tons averaging 1.5 percent copper, 1 percent zinc and minor nickel and silver values.

France.—An Avonmouth improved vertical furnace for simultaneous treatment of mixed zinc-lead ores was planned by Société Miniere et Metallurgique de Penarroya. Site of the new smelter will be Noyelles-Godault, and capacity is expected to be 33,000 tons of slab zinc and 11,000 tons of lead bullion annually.

Germany, West.—Duisbuerger Kuperferhuette began production of zinc at its Duisburg copper works using byproduct zinc oxide as a raw material. The metal was sold through Metallgesellschaft of Frankfurt. Czechoslovakian demand for German zinc in the later part of the year put West German trade in a favorable position according to Reuter reports.[25]

Italy.—Sardinian mines underwent reorganization in 1958 to reduce production cost and thereby remain competitive under the depressed market for zinc. Ore dressing plants of Montevecchio, Monteponi, Fontana, and Raminosa were enlarged and modernized.

Poland.—Poland continued to be a major exporter of slab zinc to both Soviet bloc and other countries. Poland's five zinc plants were supplied mostly from domestic mines, but considerable quantities of concentrates were imported from Bulgaria, North Korea, and elsewhere.

Sweden.—The Geological Prospecting Department of Sweden reported a discovery in northern Gamtland of a deposit estimated to contain 5 million tons of ore averaging 1.5 percent copper and 3.4 percent zinc.

U.S.S.R.—To supplement its domestic ores the U.S.S.R. continued to import large quantities of zinc concentrates from North Korea and

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[23] Mining Journal (London), vol. 251, No. 6421, Sept. 12, 1958, p. 282.
[24] Mining World, Annual Survey and Directory, April 1959, p. 138.
[25] Metal Bulletin (London), No. 4351, Dec. 5, 1958, p. 19.

lesser quantities from China, Bulgaria, and Iran. Estimate of Soviet Union imports of zinc in concentrates was 81,000 tons. In addition the Soviet Union imported substantial quantities of slab zinc, mainly from Poland. Plans were made to erect three slag fuming plants in Altai, Kazakhstan. Slag piles from the Demidov mills and smelters that recovered only copper and precious metal have accumulated since the mid-19th century and contain large quantities of lead and zinc.

United Kingdom.—There was virtually no zinc production from mines in the United Kingdom, but smelting of imported concentrate was at the normal level. In February, the British Government announced its decision to suspend sales of zinc from its stockpile owing to the "uncertain market condition."

Yugoslavia.—Mines in Yugoslavia produced 1,980,000 tons of lead-zinc ore in 1958.[26] In Slovenia, the smelter at Celje increased slab zinc output to 19,466 tons. The electrolytic zinc plant at Sabac, Serbia produced 14,985 tons, and plans for expansion of electrolytic zinc output were announced.

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, 1958, the company produced 19,900 tons of zinc concentrate which was shipped to Europe for reduction to metal.

China.—Output of slab zinc at the vertical retort plant in Manchuria—China's only zinc smelter—was estimated at 24,000 tons, all from Chinese ores.

India.—Output of lead-zinc ores at the Zawar mine, India's only lead-zinc producer, rose 25 percent to total 133,900 tons of ore in 1958. The mill recovered 8,100 tons of zinc concentrate that was treated at Mitsui Company's Hikoshima smelter in Japan on a toll basis.

Iran.—Iranian, French, and German organizations were developing the lead-zinc ore bodies of the Khomein-Golpayeyan area 165 miles southwest of Tehran. Two modern flotation plants were under construction. In the past only high-grade ore amenable to hand-sorting was mined.

Japan.—Mitsubishi Metal Mining Company, Ltd., produced approximately 992,000 tons of crude ore from its Ikuno, Akenoke, Osarizawa, Hosokura, and Suttsu mines. The company refineries at Naoshima, Akita, and Hosokusa produced about 27,500 tons of electrolytic zinc and 16,500 tons of electrolytic lead in addition to copper, cadmium, bismuth, antimony, tin, and rare and precious metals and acid.[27]

AFRICA

Algeria.—Zinc concentrate totaling 59,000 short tons (containing about 35,000 tons of zinc) was shipped to France for smelting.

Belgian Congo.—The Prince Leopold copper-zinc mine of the Union Miniere du Haut Katanga at Kipushi, near Elisabethville,

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[26] Mining World, Annual Survey and Review, 1958, p. 142.

[27] Mitsubishi Metal Mining Co., Ltd., *Outline of the Company,* pp. 2–12. See also Lead Chapter, Minerals Yearbook, 1958.

was the only zinc producer in the Congo. According to the company's annual report production totaled 224,000 tons of zinc concentrate containing 56.99 percent zinc. Approximately 160,000 tons was roasted for sulfuric acid recovery, the sintered concentrate forming a product of commerce and the acid entering the company's ore-processing operations. Over 101,000 tons of roasted concentrate was sold to Metalkat (Societe Metallurgique du Katanga) for electrolytic processing, and 83,000 tons of raw and sintered concentrate was shipped to Belgium.

Morocco.—Production of zinc concentrate in Morocco was 96,000 short tons containing about 55,000 tons of zinc.

Rhodesia and Nyasaland, Federation of.—At Broken Hill, the Rhodesia Broken Hill Development Co., Ltd.,[28] mined 164,329 short tons of crude ore (182,604 in 1957). The leach plant treated 21,889 tons of silicate ore in addition to 86,692 tons of calcine and tailings. The new heavy-medium separation plant, which displaced the hand-sorting plant, treated 106,246 tons of feed to recover 87,398 tons of sink product that, in turn, was processed in the flotation plant. The sulfide plant production was 43,077 tons zinc concentrate assaying 55.2 percent zinc. Leach solution from the silicate ores and calcined concentrates were processed in the company's electrolytic plant to yield 33,900 tons of slab zinc. The company announced "complete technical success" in treatment of zinc concentrates shipped to Avonmouth, England for experimental smelting in the new Imperial Improved Vertical furnace-type smelter. Economic evaluation was in progress.

South-West Africa.—The Tsumeb Corp., Ltd., mined and milled 666,000 tons of ore averaging 25.7 percent combined copper, lead, and zinc during the year ended June 30, 1958. The company planned sinking an underground shaft below the 30th level. Tsumeb sold 22,637 tons of zinc during the year.[29]

Tunisia.—Production of zinc concentrates, all from the El Akhouat mine-mill unit, totaled about 7,600 short tons containing 4,570 tons of zinc.

OCEANIA

Australia.—The Broken Hill district of New South Wales was again the leading Australian zinc-producing area. Mining companies operating 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 2,050,000 short tons of crude ore that yielded zinc and lead concentrates containing about 220,000 tons of zinc, 250,000 tons of lead, and 8.8 million ounces of silver. Decreased output from the district was attributed to company cutbacks in recognition of the worldwide metal oversupply. In addition to curtailments several Broken Hill Companies announced intention to stockpile some zinc concentrate production that would otherwise enter world commerce. In response to declining shipments of concentrate, Broken Hill Associated Smelters at Port Pirie announced a 15-percent curtailment effective July 1.

[28] The Rhodesia Broken Hill Development Co., Ltd., 49th Annual Report, 1958, pp. 4–12.
[29] American Metal Climax, Inc., 1958 Annual Report, p. 30.

During the fiscal year ended June 30, 1958, Mount Isa Mines, Ltd., milled 909,000 short tons of silver-lead-zinc ores from its properties in the Cloncurry district of Queensland. The ore averaged 6.0 percent zinc, 8.3 percent lead, and 6.6 ounces of silver and yielded 40,463 tons of zinc concentrate containing 21,262 short tons of zinc. It also yielded 57,075 tons of lead bullion (containing 4,256,000 ounces of silver). From other ores the company produced 34,905 tons of blister copper.[30] Estimated ore reserves at the end of the fiscal year were 24.2 million tons containing 7.8 percent lead, 5.8 percent zinc and 5.6 ounces of silver a ton. A vigorous expansion program was carried forward by Mount Isa Mines to increase production and lower unit costs. Production level at fiscal year's end was 6,700 short tons a day, but ultimate capacity of 9,000 tons daily was planned by April 1959.

Lake George Mines, Pty., Ltd., during the fiscal year ended June 30, 1958, milled 235,600 tons of ore to produce concentrates containing 20,456 tons of zinc, 11,594 tons of lead, 1,083 tons of copper and 210,000 ounces of silver from ores mined in the Captain's Flat district of New South Wales.[31] Practically all the company's production was shipped to overseas smelters. Development on the 2,030-foot level of the mine confirmed the anticipated limitations of the Elliot orebody.

Consolidated Zinc Corp., Ltd., continued construction of its new Imperial Improved Vertical furnace process at Cockle Creek, New South Wales. The new smelter and related sintering plant is expected to cost about £5 million and will have a projected capacity of 38,000 tons slab zinc and a large quantity of lead bullion annually.[32] The Broken Hill district, 740 miles west of the smelter site, will supply the smelter feed.

For the fiscal year ended June 30, 1958, the mines of the Electrolytic Zinc Co. of Australasia, Ltd., in the Read-Rosebery district milled 235,000 short tons of ore that yielded 90,800 tons of lead, zinc, and copper concentrates. The lead and copper concentrates were shipped to smelters in the United States. The company's Risdon electrolytic plant, supplied by concentrates from the Broken Hill district and from the company's Read-Rosebery district mines, produced 128,500 tons of slab zinc.[33] The refinery, which in the past has been limited at times by inadequate power supply, operated at capacity during 1958.

TECHNOLOGY

A unified zinc research program was begun in 1958 by zinc producers in the United States, Canada, Mexico, Great Britain, South America, and Australia, working through the American Zinc Institute. Projects begun included research on new finishes for zinc die castings, development of improved zinc die casting alloys, corrosion of galvanized hot water tanks, wet storage stain of galvanized sheet, cathode protection of marine tankers, improvements in zinc

[30] American Smelting & Refining Co., Annual Report, 1958, 14 pp.
[31] Lake George Mining Corp., Ltd., Annual Report, 1958, 13 pp.
[32] Chemical Engineering and Mining Review, vol. 51, No. 4, Jan. 15, 1959, p. 35.
[33] Industrial and Mining Standard, vol. 118, No. 2870, Dec. 4, 1958, pp. 22–23.

lithographic plates, zinc battery cans, and exposure tests of exterior house paints containing zinc oxide.

Several papers reported research by the Federal Bureau of Mines [34] and the Federal Geological Survey.[35]

Zinc foil [36] 0.001 to 0.005 inch thick and 26 inches wide was produced in pilot plant quantities by American Smelting and Refining Co. The new, continuous process of making zinc foil consists essentially of electrolytically depositing zinc from a zinc sulfate bath onto a revolving drum from where the deposit is stripped in continuous sheets. This method of turning out thin sheets of zinc is said to be more economical than conventional metal rolling techniques, and to produce zinc with good ductility, tensile strength, and chemical purity. It is expected that the foil will find use in electrical applications, e. g., electrical condensers; and as a moisture barrier in insulating materials. Among metallic foils zinc foil is said to rank high in its ability to adhere to bitumastic materials. It is easily soldered and readily receives print.

In a preliminary study [37] the influence of aluminum and lead on the structure and properties of galvanized coatings was investigated over a range of both temperatures and immersion times. Immersion time and aluminum content of the bath had the most significant effect on such factors as coating weight, iron content of the coat, steel weight loss, iron-zinc alloy thickness, proportion of alloy in the coating, and ductility and adherence of the coating. Lead content of the bath had no significant effect on those factors but did affect surface appearance characteristics such as roughness, brightness, and spangling behavior.

"Hy-Phy Kirksite," [38] a new zinc-base alloy for metal-forming dies, was marketed by Morris P. Kirk & Sons Inc. The new alloy, an improvement over "Kirksite" A, developed by the Kirk firm in 1939, is said to have 400 percent greater impact strength, a greater degree of hardness, a substantially refined grain size, improved resistance to creep, more tensile strength, improved compressive strength, less metal per die, and lower die cost per stamping.

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[34] Young, W. E., Mining and Water-Control Methods at the Chief Lead-Zinc Mine, Chief Consolidated Mining Co., Juab County, Utah: Bureau of Mines Inf. Circ. 7828, 1958, 21 pp.
Johnson, A. C., Shaft-Sinking Methods and Costs at the T. L. Shaft, Eureka Corp., Ltd., Eureka, Nev.: Bureau of Mines Inf. Circ. 7835, 25 pp.
Brichta, L. C., and Ryan, J. P., Practical Evaluation of Electrical-Resistivity Surveys as a Guide to Zinc-Lead Exploratory Drilling, Badger-Peacock Camp and Vicinity, Cherokee County, Kansas, Bureau of Mines Rept. of Investigations 5426, 91 pp.
McWilliams, John R., Mining Methods and Costs at the Holden Mine, Chelan Division, Howe Sound Co., Chelan County, Wash.: Bureau of Mines Inf. Circ. 7870, 44 pp.
Netzeband, W. F., Mining Methods and Costs at the Rialto Mine, Nellie B. Division, American Zinc, Lead & Smelting Co., Ottawa County, Okla.: Bureau of Mines Inf. Circ. 7823, 23 pp.

[35] Anderson, C. A., and Creasey, S. C., Geology and Ore Deposits of the Jerome Area, Yavapai County, Ariz.: Geol. Survey Prof. Paper 308, 1958, 185 pp.
Miesch, A. T., and Nolan, T. B., Geochemical Prospecting Studies in the Bullwhacker Mine Area, Eureka district, Nevada: Geol. Survey Bull. 1000–H, 1958, pp. 397–408.
Larsen, E. S., Jr., Gottfried, David, Jaffe, H. W., and Waring, C. L., Lead-alpha Ages of the Mesozoic Batholiths of Western North America: Geol. Survey Bull. 1070–B, 1958, pp. 35–62.
Freeman, V. L., Ruppel, E. T., and Klepper, M. R., Geology of Part of the Townsend Valley, Broadwater and Jefferson Counties, Mont: Geol. Survey Bull. 1042–N, 1958, pp. 481–556.

[36] American Metal Market, Asarco Has New Zinc Foil Process: Vol. 65, No. 173, Sept. 6, 1958, p. 7.

[37] Sebisty, J. J., and Edwards, J. O., The Influence of Aluminum, Lead, and Iron on the Structure and Properties of Galvanized Coatings: Dept. of Mines and Technical Surveys, Ottawa, Canada, Mines Branch Research Report, Mar. 14, 1958, 47 pp.

[38] American Metal Market, New High-Strength Zinc Base Alloy for Metal Dies: Vol. 65, No. 12, Jan 17, 1958, pp. 1 and 7.

Oxidized minerals[39] such as malachite, smithsonite, calamine, and hydrozincite can be pulverized and leached instantaneously by a recently developed process (U.S. Patent 2,847,300) which subjects water slurries of these materials to a temperature of about 900° F. and a pressure of 505 p.s.i. Under these conditions the slurry is pumped through 400 feet of 0.5-inch iron pipe at 935 pounds an hour feed rate to an opposed nozzle grinder with a 5/32-inch orifice where 14-mesh particles are reduced in size to minus-325-mesh. Ammonia and carbon dioxide are introduced at the pressure release point, instantly dissolving the slurry solids. The process was reported to give a 93-percent recovery of the contained zinc in smithsonite.

Patents issued included a method,[40] for producing metallic zinc by distillation from a mixture of zinc oxide and an alkali metal carbonate and/or an alkali metal hydroxide; a process[41] for producing zinc by the distillation of zinc metal below its melting point from a mixture of a reducible zinc salt, an alkali metal chloride, and a reducing agent; and a distillation process[42] utilizing controlled temperature and pressure for recovering the zinc content of an impure zinciferous crude material in which the crude zinc is dispersed in an inert medium and therein reduced to metallic zinc by a reducing agent such as carbon, carbon monoxide, or a hydrocarbon gas.

In 1958 it was reported that a crystal[43][44] of very pure zinc oxide, serving as a semiconductor, performed as a miniature amplifier that operated at 1,000 cycles per second with a gain of over 15 decibels when immersed in a highly conducting electrolyte of 5 percent sodium tetraborate and boric acid solution.

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39 Engineering & Mining Journal, Texaco Patents Instant Oxide Leach Process: Vol. 159, No. 10, p. 116.

40 Schechter, William H. (assigned to Callery Chemical Co., Pittsburgh, Pa.) Method of Producing Metallic Zinc: U.S. Patent 2,823,110, Feb. 11, 1958.

41 Wyatt, James L. (assigned to Horizons Incorporated, South Euclid, Ohio) Method for the Preparation of Zinc: U.S. Patent 2,844,461, July 22, 1958.

42 Wyatt, James L. (assigned to Horizons Incorporated, South Euclid, Ohio) Recovery of Zinc: U.S. Patent 2,844,462, July 22, 1958.

43 Brown, Harvey E., Zinc Oxide Rediscovered: The New Jersey Zinc Co., 160 Front Street, New York, N.Y., 1957, p. 33.

44 Chemical and Engineering News, Prodigal Property: Vol. 36, No. 14, April 7, 1958, p. 51.

Zirconium and Hafnium

By F. W. Wessel [1]

FOR the first time since hafnium-free zirconium was created, production of the sponge overtook demand, making the supply situation easier. Seven nuclear powerplants using zirconium still required hafnium for control purposes.

LEGISLATION AND GOVERNMENT PROGRAMS

Late in 1958 the Atomic Energy Commission (AEC) called for bids on conversion to metal of all hafnium byproducts, which were incident to the zirconium produced in fulfillment of AEC procurement contracts. Conversion of 65,000 pounds of hafnium oxide over an 18-month period was called for. Specifications for zirconium and hafnium metal delivered by contractors to the AEC were unchanged from 1957.

TABLE 1.—Salient statistics of zirconium and hafnium in the United States

	1954	1955	1956	1957	1958
Zircon:					
Production ..... short tons	17,957	28,110	[1] 44,174	[2] 56,802	30,443
Average value	$45.70	$49.30	$49.30	$52.50	$47.70
Imports ..... short tons	18,562	29,091	31,140	41,692	19,225
Average value	$41.60	$43.30	$51.00	$53.80	$43.00
Zirconium sponge:					
Production ..... short tons	245	187	238	(3)	1,265
Price, year-end per pound	(3)	$10.00	(3)	$7.50	$6.00
Hafnium:					
Production ..... short tons	(3)	(3)	(3)	(3)	31

[1] Revised figure.
[2] Florida only.
[3] Data not available.

DOMESTIC PRODUCTION

Mine Production.—Output of zircon in 1958 decreased to 30,443 short tons (about half the 1957 quantity), valued at $1,023,680. Three companies furnished the Florida total of 30,302 tons. E. I. duPont de Nemours & Co. took over operation of its Trail Ridge Properties from Humphreys Gold Corp. in February. Humphreys Gold Corp. worked the Rutile Mining Co. of Florida mine in South Jacksonville until it was exhausted late in 1958 and then moved much of its equipment 5 miles south to a National Lead Co. property. Florida Minerals Co.

[1] Commodity specialist.

continued production at Vero Beach. Marine Minerals, Inc., at Aiken, S.C., ended its operation with a shipment of 141 tons early in the year.

Several zircon-bearing deposits under development in the South Atlantic States, in Texas and in Idaho were idle in 1958. In most instances development was suspended pending a better market for the products.

Metal Production.—Production of zirconium sponge was 2,529,600 pounds, over 98 percent of which was hafnium-free. This production was supplied by four companies: Carborundum Metals Corp., Columbia-National Corp., Mallory-Sharon Metals Co., and Wah Chang Corp.

Hafnium sponge and the hafnium content of hafnium oxide and hydroxide incidental to this zirconium production totaled about 62,500 pounds.

In February 1958 the Mallory-Sharon Metals Co. was formed. Shares were held in equal parts by National Distillers and Chemical Co., P. R. Mallory Co., Inc., and Sharon Steel Corp. and its assets included the zirconium (and titanium) sponge plant formerly owned by U.S. Industrial Chemical Co., the melting plant formerly operated by Reactive Metals, Inc., in Ashtabula, and other facilities in Niles, Ohio. Late in April the company purchased Johnston and Funk Titanium Corp., manufacturer of rod and wire, which corporation continued to operate under its own name. Early in August Mallory-Sharon bought a chlorinating plant, which was recently built in Ashtabula, Ohio, by Stauffer Chemical Co.

Also in 1958 Mallory-Sharon, in collaboration with Bridgeport Brass Co., manufactured tubing for the reactor at Dresden, Ill. Late in the year fabrication of a record 6,700-pound zirconium ingot was announced.

The Wah Chang Corp. returned its leased facilities at Albany, Oreg., to the Government during the first quarter of 1958, and concluded its zirconium production contract with the AEC during the last quarter, sharply decreasing its output.

Carborundum Metals Corp. installed a second consummable-electrode arc furnace at its Akron, N. Y., plant, doubling its melting capacity. Production of sponge at Akron under an AEC contract was concluded, and this part of the plant shut down; production of sponge at Parkersburg, W. Va., on a more recent AEC contract continued.

The Columbia-National Corp., Milton, Fla., shipped its first lot of zirconium sponge to the AEC in March; plant capacity installed by the end of the year was 0.8 million pounds.

Oregon Metallurgical Corp., Albany, Oreg., began delivering 350,000 pounds of zirconium ingot to Westinghouse Electric Co. and was stated to be spending $2.5 million to expand its facilities, financing partly by sales of additional stock.

Metal Hydrides, Inc., placed on the market two new zirconium hydride products of reactor and commercial grade.

The D. E. Makepeace Division of Engelhard Industries, Chase Brass and Copper Co., Superior Steel Division of Copperweld Steel Co., General Plate Division of Metals and Controls, Inc., Simonds Saw and Steel Co., Consolidated Reactive Metals, Inc., Michigan Seamless Tube Co., Alloy Tube Division of Carpenter Steel Co., Tube Reducing Corp., and Universal-Cyclops Steel Co. became fabricators of zirconium.

Union Carbide Metal Co. (formerly Electro Metallurgical Co.) and Vanadium Corp. of America were the main producers of zirconium alloys. The Norton Co., Lava Crucible Refractories Co., Corhart Refractories Co., Charles Taylor Sons Co., and Zirconium Corp. of America were the principal manufacturers of refractories and oxide.

CONSUMPTION AND USES

Apparent consumption of zircon in the United States in 1958 was about 54,000 tons. Of this quantity, an estimated 8,000 tons went into the production of metal and ferroalloys, and an estimated 7,000 tons was consumed for refractory purposes. Foundry sands and facings required most of the remainder; abrasives, ceramics, paints, and chemicals absorbed small quantities.

Consumption of zirconium sponge cannot be readily estimated because of the stocks held by the AEC; nevertheless, it probably approximated production in 1958. The major part found military use; a substantial quantity was used in private power reactors; not more than 50,000 pounds (about one fifth in photographic flash bulbs) was employed in industry not related to nuclear power.

Construction of nuclear-powered naval ships continued; zirconium was used in all of their reactor powerplants. The U.S.S. *Swordfish* and *Sargo*, submarines, were commissioned in 1958, and construction proceeded on 28 additional submarines. In addition, the guided-missile cruiser, U.S.S. *Long Beach*, and a guided-missile destroyer, each powered by two reactors, and the aircraft carrier, U.S.S. *Enterprise*, were under construction. Prototype reactors for the cruiser and carrier went critical late in October. The voyages of the U.S.S. *Nautilus* and *Skate* beneath the north polar icecap was a practical demonstration of the reliability of the reactors.

As a part of an AEC-sponsored program to determine the applicability of nuclear propulsion to cargo vessels, the keel of the NS *Savannah*, first nuclear-powered merchant ship, was laid in June. The reactor for this vessel used stainless steel; however, the subsequent decrease in the price of zirconium makes it likely that the latter will be used for replacement elements.

Ferroalloys consumed in 1958 were estimated to contain 505 tons of zirconium metal.

Zirconia refractories continued to be usd by the aluminum, brass, and glass industries; some zirconia was used in preparing zirconium metal powder.

During the year the Carborundum Co. was investigating the use of zirconium and hafnium compounds in ceramics.

Of no commercial consequence, but possibly a portent of the future, was the use of zirconia as a reflective surface on the satellite "Explorer", successfully sent into orbit in February.

STOCKS

Dealers' stocks of zircon concentrate declined to 3,060 tons during the year. In addition, an estimated 8,200 tons was in consumers'

525707—59——76

stockpiles at the end of 1958. Except for the Federal stockpile, stocks of baddeleyite virtually disappeared during the year.

PRICES AND SPECIFICATIONS

The price of a short ton of domestic zircon concentrate on January 1 was $50 f.o.b. Jacksonville and $55 f.o.b. Starke. In mid-July the price at Starke was reduced to $42, followed within a few weeks by a cut to $41 at Jacksonville. These prices remained constant from August 7 to the end of the year. Imported zircon sold at $50 to $51 per long ton c.i.f. Atlantic ports until May 8, the price then fell to $46–$48, where it remained for the rest of the year.

Australian zircon in London sold for £14 15s to £16 per long ton c.i.f. in February; by May this price had dropped to £13 to £14, aided by a cut in ocean freight rates.

Late in the year some Nigerian zircon was sold at a reported price of $150 per ton. In addition to its zirconia content, this ore contains about 5 percent HfO_2, about 3 percent ThO_2, and a small quantity of uranium.

On September 3, 1958, the Mallory-Sharon Metals Co. announced price reduction for hafnium-free zirconium sponge; the new price was $6.25 per pound in quantities over 500 pounds.

The price of powder for photographic flash-bulb use remained at $4 per pound during the year. Zirconium mill shapes sold at $11 to $30 per pound, depending on contract conditions.

The Johnston & Funk Titanium Corp. announced the following prices for Zircaloy 2 wire, effective March 15, 1958, per pound in lots of 500 pounds or more:

Wire: diameter, inches	*Price, per pound*
0.3125–0.241	$22.40
0.240–0.131	26.40
0.130–0.071	33.20
0.070–0.050	36.60
0.049–0.020	53.10
0.019–0.010	74.20

The prices of 12–15 percent zirconium ferrosilicon and of SMZ alloy closed the year at $0.925 and $0.2000 per pound, respectively, in bulk carloads. The 12–15 percent feroralloy contains 12 to 15 percent zirconium, 39 to 43 percent silicon, maximum 0.20 percent carbon, remainder iron; the SMZ alloy consists of 60 to 65 percent silicon, 5 to 7 percent each manganese and zirconium, remainder iron.

FOREIGN TRADE [2]

Imports.—Imports of zircon declined 54 percent in quantity and 58 percent in value.

Japan shipped to the United States 236,162 pounds of hafnium-free zirconium sponge, valued at $2,019,623, or $8.55 per pound. This was received by the Commodity Credit Corporation on behalf of

[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 U.S. Department of Commerce, Bureau of the Census.

AEC, and delivery under the contracts made during 1957, although less than originally called for, was considered complete. The contracts were not renewed.

TABLE 2.—Zirconium ore (concentrate) [1] imported for consumption in the United States, by countries, in short tons

[Bureau of the Census]

Country	1949-53 (average)	1954	1955	1956	1957	1958
Australia [2]	21,086	17,249	27,542	30,351	41,659	19,175
Brazil [3]	1,591	1,408	1,549	331		
Canada	28			303	14	
Nigeria						50
United Kingdom				155	19	
Total: Short tons	22,705	18,657	29,091	31,140	41,692	19,225
Value	$586,881	[4] $486,555	$813,448	$791,612	$1,142,472	$467,391

[1] Concentrate is zircon unless otherwise indicated below.
[2] Imports from Australia through 1954 were partly in the form of mixed concentrate, containing small quantities of rutile and ilmenite.
[3] Concentrate from Brazil includes some baddeleyite.
[4] Owing to changes in the tabulating procedures by the Bureau of the Census, data are known to be not comparable with other years.

Exports.—Exports of zircon in 1958 totaled 1,994 tons; 1,170 tons went to Canada, 410 tons to Mexico, and 414 tons to other countries. Total value of these shipments was $336,470, or $169 per ton. A total of 607 tons of zircon was re-exported to Canada.

Exports of 43 tons of crude metal, alloy, and scrap of widely varying unit value were distributed as follows: 51,258 pounds of material valued at $6 to $12 per pound to France (25,967 pounds), United Kingdom (21,825 pounds), and other European countries; 35,016 pounds of material valued at 50¢ to $2 per pound to Canada (22,735 pounds), Mexico (10,076 pounds), and Brazil. Total value of these exports was $558,979.

Semifabricated forms valued at $198,286 were exported principally to Sweden, the United Kingdom, and Canada; shipments totaled 14,282 pounds.

The Columbia-National Corporation in midsummer offered hafnium-free zirconium oxide and tetrachloride for export to free-world nations.

WORLD REVIEW

EUROPE

Germany, West.—A small quantity of zirconium metal was manufactured by Degussa at Hanau, and research on the zirconium-hafnium separation and on metallurgical testing methods was conducted.

Poland.—Research on beneficiation of black sands on the Baltic coast was being actively pursued; these sands have an estimated zircon content of 0.71 percent.

United Kingdom.—Murex, Ltd., was operating its 100-pound-per-day zirconium sponge facility during the year but reportedly intended to abandon operations at the completion of its contract with the British Government. William Jessop & Sons, Ltd., produced zirconium ingot.

Among other commodities, zirconium and zirconium-base alloys, less than 0.2 percent Hf, have been released for export to Soviet bloc countries.[3]

TABLE 3.—World production of zirconium ores and concentrates, by countries, in short tons[1]

[Compiled by Augusta W. Jann and Berenice B. Mitchell]

Country	1949–53 (average)	1954	1955	1956	1957	1958
Australia	[2] 31,451	46,427	54,514	81,153	99,658	[3] 64,000
Brazil [4]	3,589	4,173	3,312	2,829	1,799	[3] 2,000
Egypt	129	109	126	402	45	[3] 45
French West Africa	318	1,012	---	1,268	3,197	6,057
India	---	---	3	3	10	[3] 10
Madagascar	[5] 3	---	---	---	1	---
Malaya	---	---	91	51	47	41
Union of South Africa	---	---	---	---	---	1,129
United States [2]	[6] 21,790	17,959	28,110	44,174	[7] 56,802	[8] 30,443

[1] This table incorporates a number of revisions of data published in previous tables.
[2] Estimated zircon content of zircon-bearing concentrates.
[3] Estimate.
[4] Chiefly baddeleyite.
[5] Average for 1952–53.
[6] Average for 1952–54; previous years not available for publication.
[7] Includes Florida only.
[8] Excludes Idaho.

ASIA

Japan.—The Toyo Zirconium Co. continued to produce hafnium-free zirconium sponge for the United States Government throughout the first half of 1958, this period being an extension of delivery time allowed because of a fire in the company plant late in 1957. The plant (30-ton-per-day capacity) was reconstructed at Todo, Saitama prefecture.

Kobe Steel Works during the year sold ¥25 million worth of 1 mm. zirconium sheet to the Japanese Atomic Energy Institute.

AFRICA

Egypt.—In addition to small quantities of zircon and ilmenite several thousand tons of black sands was produced and presumably exported for separation.

Mauritania.—The Bureau Minière de la France d'Outre-Mer, a government corporation, was licensed to explore a large part of Mauritania for ilmenite, rutile, and zircon.

Nigeria.—Amalgamated Tin Mines of Nigeria, Ltd., during the year had several hundred tons of high-hafnium zircon concentrate immediately available.

Union of South Africa.—Production of titanium minerals and zircon began in early autumn at the Umgababa property of Anglo-American Corp.[4]

[3] American Metal Market, vol. 65, No. 161, Aug. 20, 1958, pp. 1, 7.
[4] Mining World, vol. 20, No. 9, August 1958, pp. 75–76.

OCEANIA

Australia.—Commercial interest in Australian beach sand deposits declined. To stimulate shipments the freight rates to United States Atlantic coast ports were reduced from $25 to $19 per ton, effective about mid-year.[5] Demand for zircon improved slightly during the last 4 months. In August, Crescent Rutile N.L. resumed capacity production at the rate of 5,000 tons of zircon per year;[6] in Western Australia, Westralian Oil, Ltd., by October was prepared to produce 14,000 tons of zircon annually.[7]

New Zealand.—A large black-sand deposit at Muriwai Beach, near Auckland, was investigated. Mining was planned by a Canadian company.[8]

TECHNOLOGY

Two technical meetings early in the year discussed in detail the comparative costs of zirconium and stainless steel for reactor use.[9]

In September, at the Second International Conference on the Peaceful Uses of Atomic Energy, Geneva, a number of the papers presented dealt with the preparation of zirconium and its application to nuclear reactors.[10]

Developments during the year included the successful welding of zirconium, not only to steel, but also to aluminum and copper. In December American Brass Co. demonstrated successful coextrusion of a uranium alloy element and a zirconium can.

Research during the year, based on published papers and patents, emphasized corrosion. Much work was done on preparation, melting and fabrication, and physical properties. Geology, mining, ceramics, chemistry, laboratory methods, cladding, and welding were also studied.

Basic studies of binary alloys of zirconium with antimony, beryllium, boron, columbium, gallium, indium, nickel, silver, thorium, titanium, uranium, and zinc, and ternary alloys of zirconium with iron and tin, tantalum and columbium, silicon and boron, and copper and chromium, appeared during the year.[11]

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[5] E&MJ Metal & Mineral Markets, vol. 29, No. 23, June 5, 1958, p. 12.
[6] Industrial and Mining Standard, vol. 113, No. 2864, Sept. 4, 1958, p. 28.
[7] Mining World, vol. 20, No. 2, February 1958, p. 95.
[8] Engineering and Mining Journal, vol. 159, No. 6, June 1958, p. 162.
[9] Benedict, Manson, An Economic Appraisal of Stainless Steel and Zirconium in Nuclear Power Reactors: Metal Progress, vol. 75, No. 2, February 1959, pp. 76–81.
[10] Proceedings of the Second United Nations International Conference on the Peaceful Uses of Atomic Energy: United Nations, New York, N.Y., vol. 4, 1958, pp. 271–294.
[11] Tanner, L. E., The System Zirconium-Iron-Tin: Armour Research Foundation, ARF-2068-5, Office of Technical Services, Washington 25, D.C., 1958, 61 pp.

The following were released by the Atomic Energy Commission: Proceedings of the Metallurgy and Materials Information Meeting, April 16–18, 1951, Oak Ridge, Tenn., sponsored by Oak Ridge National Laboratory, TID 5061, vol. 1, 588 pp., issued by Office of Technical Services, Washington 25, D.C.:

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Betterton, J. O., Jr., and Easton, D. S., The Silver-Zirconium System: Trans. AIME, vol. 212, August 1958, pp. 470–475.

Buzzard, R. W., Liss, R. B., and Fickle, D. P., The Uranium-Zirconium Binary System: Nuclear Science and Technol., vol. 2, Nos. 1–4, April–December 1952, 8 pp.

Beard, A. P., Harrison, J. W., and Clark, W. B., Preparation of Nuclear Poison and

The silver-cadmium-indium system was further studied to appraise its possibilities as a control-rod material in place of hafnium.[12]

Continued research in the technology of fused-salt electrolysis as a means not only of reclaiming light zirconium or hafnium scrap but also of electrowinning these metals from their halides may succeed in developing a process to take its place beside present inert atmosphere reduction methods.

Several important books on zirconium were published during the year,[13] and a supplemental bibliography of zirconium was issued.[14]

Control Alloys: Zirconium-Base-Boron Alloys: Knolls Atomic Power Laboratory, KAPL–1555, Office of Technical Services, Washington, D.C., July 1957, 25 pp.

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Anderko, K., [Contributions on the Binary Systems of Titanium with Gallium, Indium, and Germanium, and of Zirconium with Gallium and Indium] (in German): Z. Metallkunde, vol. 49, No. 4, April 1958, pp. 165–172.

Yemel'yanov, V. S., Godin, Yu. G., Yevstyukhin, A. I., [Study of the Zirconium Area of the Phase Diagram of Zr-Ta-Nb] (in Russian): Atomnaya Energiya, vol. 4, No. 2, 1958, pp. 161–170.

Parthe, E., and Norton, J. T., Ternary System Zirconium-Silicon-Boron: Meeting of Metallurgical Soc., AIME, October 1958.

[12] Cohen, I., Losco, E. F., and Eichenberg, J. D., Ag-In-Cd Could Replace Hf for PWR Control Rods: Nucleonics, vol. 16, No. 8, August 1958, pp. 122–217.

Neuhold, R. J., Fast Absorption of Hafnium and Cadmium-Silver Control Rods: Bettis Tech. Rev., June 1958, p. 58.

[13] Blumenthal, Warren T., The Chemical Behavior of Zirconium: D. Van Nostrand Co., Princeton, N.J., 1958, 398 pp.

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[14] Abshire, E., Bibliography of Zirconium: Bureau of Mines Inf. Circ. 7830, 1958, 216 pp. (Supplements Inf. Circ. 7771, 1957, 281 pp.).

Minor Metals[1]

William R. Barton[2] Donald E. Eilertsen,[2] Frank L. Fisher,[2] James Paone,[2] and H. Austin Tucker[2]

Contents

CESIUM AND RUBIDIUM[3]

RESEARCH on new uses for cesium and rubidium was greatly expanded in 1958 and many new applications for the elements were perfected or proposed.

Domestic Production.—Production of cesium and rubidium compounds and metals more than doubled. Companies reporting production were: Fairmont Chemical Co., Inc., Newark, N.J.; American Potash and Chemical Corp., Trona, Calif.; Maywood Chemical Works, Maywood, N.J.; Penn Rare Metals, Fort Washington, Pa.; and Var-Lac-Oid Chemical Co., New York, N.Y. A mixed potassium-rubidium-cesium carbonate (ALKARB) was produced by San Antonio Chemicals, Inc., San Antonio, Tex. Cs–137 was produced by Union Carbide Nuclear Co., at Oak Ridge National Laboratory, Oak Ridge, Tenn.

In addition to the metals the following cesium and rubidium compounds were regularly produced: Acid acetate, azide, bromide, carbonate, chloride, chromate, fluoride, hydroxide, iodide, nitrate, and sulfate.

Consumption and Uses.—Consumption of cesium and rubidium products continued to increase. All ALKARB production was committed, mostly to the glass and ceramics industry. The greatest consumption of separated cesium and rubidium compounds was in the research programs of potential users.

A new plasma thermocouple used cesium to convert heat to electricity. Allen B. Du Mont laboratories announced a new photomulti-

[1] 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.
[2] Commodity specialist.
[3] Prepared by William R. Barton.

plier tube, using cesium telluride, and Radio Corp. of America announced one, using a cesium-antimony dynode. The National Bureau of Standards used cesium as a time standard, and National Corp. used cesium as a frequency standard. The U.S. Department of Commerce perfected a rubidium magnetometer.

Prices.—Pollucite prices were not quoted as ore sales declined, and ALKARB became the preferred raw material in the United States. ALKARB was priced at $9.55 per 100-pound bag, f.o.b. San Antonio, Tex. Cesium and rubidium were priced at $1.10–$5 per gram depending upon company, quantity, and packaging. Technical-grade cesium and rubidium compounds were $13 to $27.50 per pound; high-purity compounds were $0.16 to $1.00 per gram. New, lower prices for Cs-137 radioisotope, effective March 1, 1958, were: Up to 20,000 curies, $2 per curie; 20,000–100,000 curies, $1.50 per curie; more than 100,000 curies, $1 per curie.

World Review.—The two principal producers of cesium products in West Germany were Hans-Heinrich Huette, Frankfurt, and Dr. Theodor Schuchard, GmbH, Munich. A Soviet paper described the work function of an antimony-cesium cathode.[4]

Technology.—The preparation of cesium and rubidium was described in detail.[5] A new scheme for preparing uranium metal was devised, based on the reaction of Cs_2UCl_6 with Mg in a $CsCl \cdot MgCl_2$ fused salt matrix.[6] Processes were described for recovering Cs-137 from radioactive plant waste solutions.[7] The use of cesium atoms in a sealed beam tube as a primary frequency standard was described.[8] The design parameters of ion propellant rocket engines were discussed.[9]

Several methods for using cesium as an ion-rocket propellant were under study. One system would use cesium dissolved in ethylene glycol dimethyl ether. Both Rocketdyne Division of North American Aviation, Inc., and the National Aeronautics and Space Administration had constructed research model ion engines. Dr. Ernst Stuhlinger, director of the Army Ballistic Missile Agency Research Projects Office, stated that small ion engines may be useful in correcting trajectory and orbital error in missile and satellite flights.[10]

Included among other potential uses for cesium or rubidium were in: Catalysts, heat-transfer systems, piezoelectric instruments, organic synthesis intermediates, and alkali storage batteries.

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[4] Zheludeva, G. A. [Work Function of the Antimony-Caesium Cathode]: Radiotekhika i Elektronika, vol. 3, No. 3, March, 1958, pp. 395–399.

[5] Lam, H. K. H., and Foster, H. R., Jr., Preparation of Cesium and Rubidium Metals: Pres. before Am. Chem. Soc., San Francisco, Calif., Apr. 17, 1958, 15 pp.

[6] Gruen, D. M., Fried, S., Graf, P., and McBeth, R. L., The Chemistry of Fused Salts: Second United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, Sept. 1–13, 1958, 26 pp.

[7] Moore, R. L., and Burns, R. E., Fission Product Recovery From Radioactive Effluents: Second United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, Switzerland, Sept. 1–13, 1958, 11 pp.

Barton, G. B., and Others, Recovering Fission Products: Ind. and Eng. Chem., vol. 50, No. 2, February 1958, pp. 212–216.

[8] Mainberger, W. A., Primary Frequency Standard Using Resonant Cesium: Electronics, Engineering Issue: Vol. 31, No. 45, Nov. 7, 1958, pp. 80–85.

[9] Boden, R. H., The Ion Rocket Engine: Pres. before Soc. Automotive Eng., Nat. Aeronautical Meeting, New York, N.Y., Apr. 10, 1958, 47 pp.

[10] Missiles and Rockets, Ion Engines May Adjust Chemical Vehicle Error: News and Business Edition, Oct. 14, 1958, p. 14.

GALLIUM [11]

Domestic Production.—Three firms produced gallium: The Aluminum Co. of America, at East St. Louis, Ill., The Anaconda Co., at Great Falls, Mont., and The Eagle-Picher Co., at Joplin, Mo. Less gallium was produced, but more gallium was shipped than in 1957.

Uses.—Gallium had numerous uses, but only small quantities were used in most commercial applications. The metal was used as a sealant for glass joints and valves in vacuum equipment, and in optical mirrors, thermometers, and as a minor component in low-melting alloys.

Prices.—During 1958, E&MJ Metal and Mineral Markets quoted gallium at $3 per gram in 1,000 gram quantities and $3.25 per gram in smaller quantities.

Technology.—A tantalum-lined gas compressibility bomb that permitted substitution of gallium for mercury as a compressing fluid, was developed by the Federal Bureau of Mines. The tantalum lining is compatible with gallium up to 450° C. enabling greater precision in pressure-volume-temperature (P–V–T) measurements. A method to recover gallium from the combustion gases of coal was patented.[12]

A floating zone method was developed for growing single crystals of gallium arsenide.[13] High-temperature rectifiers, transistors, and solar batteries may create potential uses for gallium arsenide.[14]

GERMANIUM [15]

Germanium has had an increasingly important role in electronics since 1948 when germanium transistors were introduced.

Domestic Production.—Production of germanium from primary raw material sources apparently dropped sharply in 1958 because of a decrease in requirements that resulted from improved technology and more efficient processing. Nevertheless, a record number of germanium semiconductor devices were produced. In addition to germanium dioxide and polycrystalline germanium of intrinsic quality, several producers offered single-crystal, dope-germanium of intrinsic quality for sale.

Consumption and Uses.—The use of germanium in electronic devices dominated consumption. More than 45 million germanium diodes, transistors, and rectifiers were produced in the United States, valued at an estimated $27 million.

Extensive studies of the physical and chemical properties of germanium resulted in several new applications. Germanium was found to be an effective catalyst at extremely low temperatures. It was reported to have widespread use as an ultrasensitive infrared

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[11] Prepared by Donald E. Eilertsen.

[12] Inagaki, Masaru (assignor to Zaidan Hojin Sekitan Sogo Kenkyujo, Tokyo, Japan), Recovery of Gallium Compounds From the Combustion Gases of Coal: U.S. Patent No. 2,848,398, Aug. 19, 1959.

[13] Industrial Laboratories, Crystal Growing Made Easier by New Method: Vol. 9, No. 6, June 1958, p. 61.

[14] Willardson, Robert K., and Shilliday, Theodore S., Where to Use the New Semiconductor Materials: Materials in Design Eng., vol. 47, No. 3, March 1958, pp. 114–118.

[15] Prepared by Frank L. Fisher.

detector.[16] A germanium resistance thermometer that can record accurate and reliable measurements of extremely low temperature was announced. It was expected to be used for outer space temperature measurements.

Prices.—The price of germanium in 1,000-gram lots for both the first reduction and intrinsic quality remained unchanged in 1958. The price of germanium in 10,000-gram lots was reduced twice during the year on January 16 and July 24.

Yearend germanium quotations reported by E&MJ Metal and Mineral Markets were as follows:

Grade	Cents per gram	
	Delivered	F.o.b. shipping point
First reduction, 1,000-gram lots	40	43½
Intrinsic quality, do	44½	48½
First reduction, 10,000-gram lots	38	37
Intrinsic quality, do	40.2	39

World Review.—*Belgium.*—Belgium continued to be the center of free world germanium refining; its facilities treated concentrates from the Belgian Congo and South-West Africa at the Olen smelter of Société Générale Metallurgique de Hoboken. The production of germanium as a byproduct of electrolytic zinc refining at Balen, Belgium, by the Société de la Vielle-Montagne S.A. was described.[17]

Technology.—Research continued on developing extraction of germanium from coal on a commercial scale. A survey of the percentage of germanium in Australian coals was published, which contained a comprehensive bibliography.[18] A report on the germanium content of powerplants was also published.[19]

Advances in germanium technology included introduction of industrial-scale zone melting and refining apparatus, improvements in single crystal growth and scrap recovery methods (salvaging significant quantities of germanium cuttings, grindings, and rejects previously discarded), and the successful adoption of semiautomatic germanium transistor testing equipment. Progress in single crystal growth was reviewed by Horn.[20] Research continued on the growth of single-crystal germanium special shapes, particularly ribbons, but the degree of success in this important stage of further miniaturization and simplification of processing was not announced.

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[16] Missiles and Rockets, New Infrared Detector Uses Germanium: Vol. 14, No. 19, Nov. 10, 1958, p. 32.

[17] Boving, T., and Andre, J., Germanium, Zinc's Important Byproduct: AIME Jour. Metals, vol. 10, No. 10, October 1958, pp. 659–661.

[18] Durie, R. A., and Schafer, H. N. S., Germanium in Australian Coals: Coal Research Section: Commonwealth Sci. and Ind. Res. Organization, Reference T.C. 27, September 1958, 25 pp.

[19] Corey, R. C., and Myers, J. W., Germanium in Coal Ash From Power Plants: Coal Utilization, vol. 12, No. 11, November 1958, pp. 33–35.

[20] Horn, F. H., Melted Layer Crystal Growth and Its Application to Germanium: Jour. Electrochemical Society. Vol. 105, No. 7, July 1958, pp. 393–395.

INDIUM [21]

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. Production and shipments of indium were each lower than in 1957.

Uses.—Indium was used in semiconductor devices, in bearings, and in special alloys. The leading use was for attaching leads to germanium electronic devices and rectifiers. The Indium Corp of America, Utica, N.Y., manufactured indium rod, wire, foil, fabricated shapes, solders, plating baths, and inorganic and organic salts for industrial use.

Prices.—In 1958 E&MJ Metal and Mineral Markets quoted indium, 99.9 percent pure, at $2.25 per troy ounce in small quantities and $1.25 to $2.25 per troy ounce in quantities over 5,000 ounces.

World Review.—The Dominion Bureau of Statistics estimated Canadian 1958 indium production at 69,000 troy ounces valued at $155,250, 82 percent less production than in 1957.

Technology.—A method of electrodepositing metals, particularly low-melting metals such as indium and some of its alloys, was patented.[22] A flowsheet diagram showing the method to produce 99.9993 percent indium from zinc-plant residue was published.[23]

High-temperature transistors are potential uses for indium phosphide; galvanomagnetic components are potential uses for indium antimonide and indium arsenide.[24]

RADIUM [25]

Domestic radium consumption declined, and imports of radium and radium salts in 1958 were the lowest since 1946.

A worldwide search for persons, who had taken radium internally 20 to 30 or more years ago, was begun by the Massachusetts Institute of Technology, cooperating with the Atomic Energy Commission to determine the biological effects of radioactivity over a long period of time. These persons included painters of luminous dial watches, patients who had received injections of radium compounds for relief of pain, and chemists and laboratory technicians who had worked with radium products.

Domestic Production.—There was no domestic radium production, and requirements were met by imports.

Radium, its derivatives, and related compounds were distributed by Canadian Radium & Uranium Corp., New York, N.Y.; Radium Chemical Co., Inc., New York, N.Y., sales representative for Union Minière du Haut Katanga; United States Radium Corp., Morristown, N.J.; and A. Bruce Edwards, Philadelphia, Pa., sales representative for Atomic Energy of Canada, Ltd.

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[21] Prepared by Donald E. Eilertsen.
[22] Schnable, George L. (assignor to Philco Corp., Philadelphia, Pa.), Method of Electrodepositing Metals: U.S. Patent 2,845,387, July 29, 1958.
[23] Jones, R. Clayton, Meet, Proclaim Western Canada's Bright Future: Eng. Min. Jour., vol. 159, No. 6, June 1958, p. 86.
[24] Willardson, Robert K., and Shilliday, Theodore S., Where To Use the New Semiconductor Materials: Materials in Design Eng., vol. 47, No. 3, March 1958, pp. 114–118.
[25] Prepared by James Paone.

Consumption and Uses.—Radium and radium salts continued to be sold and leased for industrial, medical, and scientific purposes during 1958. Uses were essentially the same as those described in the Minor Metals chapter of the 1957 yearbook.

Prices.—Throughout 1958 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 and radium salts were imported from Belgium, Canada, and the United Kingdom. The principal source of radium was Belgium, where high-grade uranium ores and slimes from the Belgian Congo uranium deposits were processed by Union Minière du Haut Katanga.

TABLE 1.—Radium salts and radioactive substitutes imported for consumption in the United States

[Bureau of the Census]

Year	Radium salts		Radioactive substitutes (value)[1] (thousand)
	Milligrams	Total value (thousand)	
1949–53 (average)	105,514	$1,706	$54
1954	57,879	857	150
1955	65,545	975	189
1956	43,221	633	[2] 514
1957	76,206	1,061	844
1958	38,419	538	908

[1] Includes artificial radioactive isotopes that are not substitutes for radium.
[2] Owing to changes in tabulating procedures by the Bureau of the Census, data known to be not comparable with other years.

Technology.—A Soviet paper was presented on separating radium from high-grade uranium ores. This paper indicated that radium concentration by fractional precipitation of chromates was simpler than the classical method of crystallizing the chloride and bromide salts. Extraction of ionium and protactinium were also described.[26]

RHENIUM [27]

Domestic Production.—Rhenium was produced by Chase Brass & Copper Co., at Waterbury, Conn., and by the Department of Chemistry, University of Tennessee, Knoxville, Tenn.

Uses.—Rhenium was used for filaments in mass spectrographs,[28] in research, and in developing other applications. Rhenium has potential applications in electronic equipment, electrical contacts, thermocouples, filler rod for welding molybdenum and tungsten, and in various alloys for high temperature applications.

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 more grams, $1.75 per gram.

[26] Shevchenko, V. B., and Others, Complex Utilization of Uranium Ores: Second International Conf. on the Peaceful Uses of Atomic Energy, Geneva, Switzerland, September 1958, United Nations, New York, N.Y., vol. 4, Production of Nuclear Materials and Isotopes, pp. 40–43.
[27] Prepared by Donald E. Eilertsen.
[28] Robinson, Charles F., and Sharkey, A. G., Jr., Rhenium as an Electron Emitter in Mass Spectrometry, Rev. of Scientific Instruments, vol. 29, No. 3. March 1958, pp. 250–251.

Technology.—The Bureau of Mines continued projects on a survey of sources and developing recovery methods for rhenium.

A method of recovering rhenium from molybdenite roaster gases by ion exchange was described.[29]

SELENIUM[30]

Selenium supply and demand were more nearly stable in 1958 after a decade first of scarcity and later of overproduction.

Legislation and Government Programs.—Selenium was in Group I of the national stockpile list of Critical and Strategic Materials throughout the year. Exploration for selenium was eligible for government financial participation under the Defense Minerals Exploration Administration (DMEA) and Office of Minerals Exploration (OME) programs.

Domestic Production.—Production of selenium decreased 32 percent. Recovery from secondary sources is estimated at less than 10 percent of the available supply. Most primary selenium was a byproduct of electrolytic copper refining.

TABLE 2.—Salient selenium statistics, thousand pounds of contained selenium

	1949–53 (Average)	1954	1955	1956	1957	1958
Production [1]	643	840	852	1,117	1,077	727
Shipments	646	861	882	1,035	625	737
Imports	201	184	192	235	148	184
Apparent consumption	847	1,045	1,074	1,270	773	920
Producers' stocks	152	96	76	191	651	551
Price, commercial grade, per pound	$2.00–$4.25	$4.25–$6.00	$5.00–$9.00	$9.00–$15.50	$7.50–$12.00	$7.00–$7.50

[1] Includes small quantities of secondary selenium in 1953–58.

Consumption and Uses.—The substantial gain in consumption of selenium was attributed in part to the lower and more stable price that prevailed throughout most of the year. Although sharp inroads were made by germanium and high-purity silicon in the competitive rectifier industry, the demand for selenium for rectifiers remained strong. The manufacture of electronic and electrical equipment mainly rectifiers, accounted for approximately half the 1958 consumption. This field required the premium high-purity grade seleninum. Other important users of selenium, in order of rank, were the pigment, glass, ceramic, metallurgical, and pharmaceutical industries.

Eight major Western Hemisphere producers formed the Selenium and Tellurium Development Committee to sponsor research on new uses for selenium. Companies reporting selenium production and shipments were: Allied Chemical Corp., American Metal Climax, Inc., American Smelting & Refining Co., International Smelting and Refining Co., Kawecki Chemical Co., and Kennecott Copper Corp.

[29] Zimmerley, Stuart R., and Malouf, Emil E. (assignor to Kennecott Copper Corp.), Extraction of Rhenium Incidental to Manufacture of Molybdenum Oxide: U.S. Patent 2,809,092, Oct. 8, 1957.
[30] Prepared by Frank L. Fisher.

Stocks.—Producer stocks of selenium decreased sharply; part of this decrease was attributed to inventory changes and to upgrading selenium from commercial- to high-purity grade.

Prices.—The prices quoted for selenium were lowered on February 19 to $7.00 a pound for commercial quality and $9.50 a pound for the high-purity grade, decreases of $0.50 and $1.00 a pound, respectively. The price of ferroselenium was unchanged at $2.00 a pound throughout 1958.

Foreign Trade.—Imports of selenium and selenium salts totaled 183,680 pounds. Canada supplied 149,629 pounds. Japan 28,981 pounds, Sweden 132 pounds, and West Germany 4,938 pounds. The total excludes selenium in lead flue dusts imported from Mexico and The Federation of Rhodesia and Nyasaland.

World Review.—*Canada.*—Selenium production was 403,264 pounds, compared with 321,000 pounds in 1957.[31]

Belgium.—Production of selenium was 48,942 pounds, compared with 24,471 pounds in 1957—a byproduct of Belgian Congo and Rhodesian copper electrolytic refining.

Finland.—Selenium production in Finland increased from 9,219 pounds in 1957 to 13,051 pounds; it was a byproduct of Outokumpu Oy copper output at Pori.

Japan.—The selenium was a byproduct at several copper refineries, a gold refinery and two ammonia sulfate plants—175,920 pounds in 1958, compared with 154,000 pounds in 1957.

Mexico.—Mexico produced 108,000 pounds of selenium, mostly contained in lead flue dusts. Production in 1957 was 175,000 pounds.

Peru.—Peru produced 8,419 pounds of selenium compared with 6,865 pounds in 1957.

Rhodesia and Nyasaland, Federation of.—Selenium contained in copper slimes totaled 24,805. Output in 1957 was 25,137 pounds.

Sweden.—Exports of selenium totaled 116,844 pounds in 1958, compared with 143,300 pounds in 1957.

Technology.—The International Nickel Company, Limited, announced the operation at Port Colborne, Ontario, of a new electrorefining process, which included recovering selenium as a byproduct of electrorefining nickel directly from a nickel sulfide matte.[32] The electrical and electronic industries were active in the research and development of selenium uses. Selenium was used to reduce pinhole porosity in high-alloy steel castings;[33] its use as a component of ternary semiconductors in thermoelectrics was the subject of considerable research.

SILICON[34] [35]

High-purity silicon output and consumption continued to increase in 1958. Production capacity increased approximately threefold.

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[31] Dominion Bureau of Statistics, Ottawa, Canada, Preliminary Estimate of Canada's Mineral Production, 1958: Jan. 2, 1959.

[32] Chemical and Engineering News, Process Refines Nickel: Vol. 60, No. 16, Apr. 16, 1958, p. 60.

[33] Mangone, R. J., Hall, A. M., Bryan, W. T., and Sims, C. E., Pinhole Porosity in High-Alloy Steel Castings, AIME, Jour. of Metals, Vol. 10, No. 12, December 1958, pp. 810–814.

[34] Data on lower grades of silicon, such as those used for alloying aluminum and copper alloys, and in producing silicones and silicon tetrachloride, are included in the Ferroalloys Chapter.

[35] Prepared by H. Austin Tucker.

Domestic Production.—From 50,000 to 60,000 pounds of high-purity silicon was produced, compared with 20,000 to 30,000 pounds in 1957. The estimated production rate at the end of 1958 was about 75,000 pounds a year. An estimated 20,000 pounds of solar-battery grade silicon was produced.

The highlight of 1958 was the large increase in productive capacity to fill the rapidly growing demand for high-purity silicon in semiconductor devices. Data on plants in operation at the end of 1958 are shown in table 3. International Metalloids, Inc., is a subsidiary of W.R. Grace, Inc. The E. I. duPont de Nemours & Co., Inc., began to expand its plant at Brevard, N.C., to accommodate a newer refining process. The new plants built by Du Pont and Merck each cost $5 million. Foote Minerals Company also started operating a semiworks facility at Exton, Pa., late in 1958.

In addition to the granular and rod forms of silicon, Du Pont and Grace marketed a densified product priced within the range shown for granular and rod material. Also, one company offered a single crystal form of silicon for about $2,000 per pound.

Consumption and Uses.—Consumption of high-purity silicon was estimated at 45,000 pounds valued at $14.8 million. From this quantity about 3.5 million transistors worth about $49 million and 26.2 million diodes and rectifiers valued at $67.8 million were used or

TABLE 3.—High-purity silicon producers in 1958

Producer	Plant location	Date started	Annual capacity (pounds)	Products: Specifications: Boron content (parts per billion)	Resistivity (ohm-cm.): P-type	Resistivity (ohm-cm.): N-type	Price per pound: Granular	Price per pound: Rod
E. I. du Pont de Nemours & Co., Inc.	Newport, Del.	1951	(1)	3	100	25	$320	$355
	Brevard, N.C.	July 1958	50,000	6	50	15	220	245
				11	25	5	130	155
International Metalloids, Inc.	Toa Alta, P. R.	1958	20,000	3	100	25	320	355
				6	50	15	220	245
Merck & Co., Inc.	Danville, Pa.	August 1958	25,000	.16	1,000–5,000	1,000–5,000	330	750
Sylvania Electric Products, Inc.	Towanda, Pa.	1956	(1)	2.8	100	40	------	359
				5.6	50	15	------	220
Texas Instruments, Inc.	Dallas, Tex.	1957	(1)	[2] 1	100	------	330	------
				[2] 3	40	15	220	------
				[2] 5	25	5	130	------
Eagle-Picher Co.	Miami, Okla.	1957	(1)	(4)	100	40	330	------
				(4)	40	15	220	------
Total capacity			[3] 165,000					

[1] Data not available.
[2] Total impurities, boron less than 1 part per billion.
[3] Includes 70,000 pounds estimated for plants shown by footnote 1.
[4] Less than 1.

shipped by the electronics industry.[36] About 7,000 pounds of solar-battery grade silicon were also consumed.

Silicon transistors were used in the U.S. "Explorer" satellite, and silicon infrared domes for use in antiaircraft missiles with infrared homing devices were developed.[37]

Prices.—About May 1 most of the industry reduced prices to the figures shown in table 3; prices had ranged from $5 to $40 a pound more.

Technology.—One of the most costly operations in refining silicon is zone-melting. It is time-consuming because only a small number of rods weighing a few pounds can be refined economically at one time. The quantity of boron, the principal impurity, is not decreased greatly in this process; the problem is logically solved by improving the methods for purifying the starting materials—silicon tetraiodide (SiI_4), silicon tetrachloride ($SiCl_4$), silane (SiH_4), and metallurgical silicon—thus producing a silicon metal that is more pure.

Largely for the foregoing reason, new methods of producing high-purity silicon were developed. A hydrogen reduction technique perfected in Germany produced silicon with 300—700 ohm-cm, resistivity. Several patents were granted on methods of purifying silicon tetrafluoride and silicon tetrachloride. Du Pont obtained a license to use a purifying process developed in the United Kingdom by Standard Telephones and Cables (London) and described in British patent 793,718. In this process highly pure silane is made by reacting an excess of lithium aluminum hydride with silicon tetrachloride. Troublesome diborane is kept to a minimum in the silane by the lithium compound, which converts trace quantities of boron trichloride in the reagents to lithium borohydride.[38] Texas Instruments, Inc., was believed to be using a reagent grade of silicon tetrachloride reduced with hydrogen at 1,200° C. by a method covered by British patent 799,876. Hydrogen chloride and silicon are formed. The former is removed by a reaction with vaporized zinc at 650° C.[39]

The purer the silicon the wider its use in electronic applications. When silicon with less than 1 part per billion impurities became available commercially early in 1958, the manufacture of silicon rectifiers expanded rapidly, particularly for use in the electrochemical industry. The maximum rating of silicon rectifiers made in 1958 was 50 amperes at 150° C. with 500 volts peak-inverse-voltage and 750 milliamperes with 1,000 volts peak-inverse-voltage.

TELLURIUM [40]

The introduction of thermoelectric devices to the public was given widespread publicity in 1958. The thermoelements in these devices were of tellurium alloys, and the potential importance of these new devices aroused considerable interest. The search for new sources

[36] Electronic Industries Association, Marketing Data Department monthly publications: Factory Sales of Semiconductor Diodes and Rectifiers, and Factory Sales of Transistors: December 1958, January–March 1959.
[37] Electronic News, vol. 3, Whole No. 119, Dec. 8, 1958, p. 18.
[38] Chemical Week, vol. 83, No. 10, Sept. 6, 1958, p. 78.
[39] Chemical Week, vol. 83, No. 24, Dec. 13, 1958, p. 32.
[40] Prepared by Frank L. Fisher.

of tellurium was begun by many mining companies. Research work in developing tellurides with improved thermoelectric performance was undertaken by a score of manufacturers.

Domestic Production.—A sharp drop in tellurium production reflected decreased demand attributable in part to a shift to selenium by consumers.

Tellurium was produced as a byproduct of lead and copper. Companies reporting shipments were: American Metal Climax, Inc.; American Smelting and Refining Co.; International Smelting and Refining Co.; Phelps Dodge Refining Corp.; and United States Smelting, Refining, and Mining Co. The quantity of tellurium-bearing plant residues in storage increased 2 percent.

TABLE 4.—Salient tellurium statistics, thousand pounds contained tellurium

	1950–52 (average)	1954	1955	1956	1957	1958
Production	135	97	180	233	255	170
Shipments	109	121	166	228	171	137
Stocks, end of year	151	104	77	126	167	134
Imports	(1)	(1)	(1)	(1)	2	6
Price per pound	$1.75	$1.75	$1.75	$1.50–$1.75	$1.50–$1.75	$1.65–$1.75

[1] Data not available.

Consumption and Uses.—Consumption of tellurium is estimated at 182,000 pounds. Its use as a thermoelectric material was in the design and planning stage. The consumption in thermoelectric devices is estimated at 10,000 pounds. The use of tellurium increased in 1955–57 largely because it was substituted for selenium.

Tellurium was used in the chemical industry and in metallurgy, ceramics, and rubber; few uses required significant quantities, which varied from more than 1.0 percent Te to frequently less than 0.1 percent Te.

Eight major Western Hemisphere producers formed the Selenium and Tellurium Development Committee to sponsor research on new uses for tellurium.

Prices.—The price of Commercial-grade tellurium was quoted at the 20-year average of $1.75 a pound at yearend. High-purity, Semiconductor-grade, tellurium in crystal form was quoted at $15.00 a pound for 99.99 plus percent Te and $30.00 a pound for 99.999 plus percent Te in 1958.

Foreign Trade.—Total imports of tellurium and tellurium compounds in 1958 was 5,575 pounds of tellurium compounds valued at $4,102. The imports were from Canada, Italy, Peru, and West Germany. Exports were not reported.

World Review.—*Canada.*—Preliminary estimates of Canadian tellurium production were 43,278 pounds valued at C$74,554 in 1958, compared with 31,523 pounds valued at C$55,167 in 1958.[41]

Peru.—Production of refined tellurium (metal content) in Peru in 1958 totaled 14,867 pounds. There had been no production in 1957.

[41] Work cited in footnote 31.

Technology.—Intensive research work was begun in 1958 on most phases of tellurium. The Soviet Union emphasized research on tellurium deposits and on the extraction from polymetallic ores.[42] In the United States research was focused on the physical properties of the numerous binary and ternary tellurides. Typical investigations included those on the ternary alloys by Bell Laboratories and on the properties of HgTe.[43]

THALLIUM [44]

Domestic Production.—Thallium was produced by the American Smelting and Refining Co., at Denver, Colo. Shipments of metal and compounds were approximately the same as in 1957.

Uses.—The principal use for thallium was as thallium sulfate in rodenticides. There were small but important uses in the field of electronics, such as thallium-activated sodium-iodide crystals used with photomultiplier tubes.

Price.—Throughout 1958, E&MJ Metal and Mineral Markets quoted the price of thallium metal at $7.50 per pound.

Technology.—Low-melting glasses that consisted of thallium, arsenic, sulfur, and selenium were developed for sealing electronic components from moisture.[45]

Thallium having 99.999-percent purity was available in the United Kingdom.[46]

The toxicity of thallium to employees using solutions containing organic thallium salts to separate industrial diamond from other abrasives were studied.[47]

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[42] Sindeeva, N. D. [Selenium and Tellurium in Deposits of Different Genetic Types]: Izv, Akad. Nauk, Ser Geolog, 1958, No. 5, Oct. 24, 1958, pp. 78–94.
Malkin, Y. Z., Sergiyenko, V. Y., Bovtuta, N. V., and Yudelevich, I. G. [Extraction of Tellurium and Indium From Antimonous Slags], Moscow, Tsvetnyye Metally, No. 8, August 1958, pp. 34–39.

[43] Wernick, J. H., Geller, S., and Benson, K. E., Constitution of the $AgSbSe_2$–$AgSbTe_2$–$AgBiSe_2$–$AgBiTe_2$ System. Jour. Phys. Chem. Solids, vol. 7, No. 2/3, 1958, pp. 240–248.
Black, J., Ku, S. M., Minden, H. T., Some Semiconducting Properties of HgTe: Jour. of the Electrochemical Soc., vol. 105, No. 12, December 1958, pp. 723–728.

[44] Prepared by Donald E. Eilertsen.

[45] Flaschen, Steward S., and Pearson, A. David, Low Temperature Sealing Glasses for the Protection of Electronic Components from Moisture, Bell Telephone Laboratories, Inc., oral pres. Oct. 10, 1958, Am. Ceram. Soc. (Electronics Div.), Asbury Park, N.J.

[46] Metal Bulletin (London), Thallium: No. 4316, Aug. 1, 1958, p. 24.

[47] Richeson, Edna M., Industrial Thallium Intoxication: Industrial Medicine and Surgery, vol. 27, No. 12, December 1958, pp. 607–619.

Minor Nonmetals

By A. E. Schreck,[1] and James M. Foley [2]

GREENSAND

THREE FIRMS, The Kaylorite Corp. (Dunkirk, Md.), National Soil Conservation, Inc. (Medford, N.J.), and Inversand Co. (Sewell, N.J.) reported production of greensand (glauconite) in 1958. Output from open pits in Calvert County, Md., and Burlington and Gloucester Counties, N.J., was more than double that in 1957.

Of the greensand sold, about 70 percent was used as a soil conditioner, based partly on its potassium content, and the remainder as a water softening agent.

Prices for greensand, f.o.b. mine, ranged from $13.25 to $70 per short ton.

TABLE 1.—Greensand marl sold or used by producers in the United States

Year	Short tons	Value	Year	Short tons	Value
1949–53 (average)	5,310	$243,216	1955	5,704	$217,671
1954	2,838	198,909	1956–58	(1)	(1)

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

MEERSCHAUM

Meerschaum, the mineral sepiolite, was used in manufacturing smokers' articles, such as pipe bowls and cigarette and cigar holders. As no domestic production of this mineral has been reported since about 1914, consumers relied upon imports for their raw-material supplies.

For many years Turkey was the world's principal producer of meerschaum; however, in 1957 production in both Kenya and Tanganyika exceeded that in Turkey. Production in Kenya totaled 11 short tons in 1957, in Tanganyika 4 tons, and in Turkey 1 ton (20 boxes of 50 kg. each). In 1956, output in Turkey totaled 845 boxes or about 47 short tons, in Kenya 30 tons, and in Tanganyika 7 tons.[3]

[1] Commodity specialist.
[2] Supervisory statistical assistant.
[3] Bureau of Mines, Mineral Trade Notes: Vol. 47, No. 5, November 1958, p. 34.

The Tanganyika Meerschaum Corp., Ltd., mechanized its mining operations during the year and reportedly increased the output of meerschaum pipes at its Nairobi (Kenya) factory.

Imports of meerschaum into the United States increased in 1958 compared with 1957. All imports were from Turkey.

TABLE 2.—Meerschaum imported for consumption in the United States [1]
[Bureau of the Census]

Year	Pounds	Value	Year	Pounds	Value
1949-53 (average)	9,160	$14,155	1956	13,140	[2] $21,770
1954	12,068	26,357	1957	10,538	20,046
1955	5,102	15,285	1958	17,392	15,432

[1] 1949-53: Turkey, 9,073 pounds, $13,985; Union of South Africa, 80 pounds, $138; Italy, 4 pounds, $24; Austria, 3 pounds, $8; 1954-56: All from Turkey; 1957: Turkey, 10,426 pounds, $19,649; Union of South Africa, 112 pounds, $397; 1958: All from Turkey.
[2] Data known to be not comparable with other years.

MINERAL WOOL

The value of mineral wool produced from rock, slag, and glass in the United States in 1957 was $209 million, according to the Bureau of the Census, an increase of nearly 5 percent over 1956. The 1957 figures are the latest available. In 1956 American Rock Wool Corp. opened a new plant in Corsicana, Tex.,[4] using iron slag, copper slag, and coke as raw materials. Molten material from foundry-type cupolas flows to a spinner, where steam under pressure is used to fiberize the molten slag. In 1958 Woolstone, Inc., began operations at a plant in Blythe, Calif., using wollastonite and coke as raw materials.[5] In this plant molten material from a cupola is divided into two streams and dropped on revolving disks, where steam fiberizes the droplets of molten material. Both plants installed automatic machines for forming batts from the mineral wool and bagging the batts.

The number of people employed in the mineral-wool industry averaged 12,000 in 1957, compared with 11,600 in 1956; the number of production workers averaged 9,000 in 1957, slightly below 1956.

The value of exports of mineral wool increased from $5.1 million in 1956 to $7.1 million in 1957 but decreased to $6.3 million in 1958.

Two types of equipment for making mineral wool were patented in 1958. One type utilized a hollow, cup-shaped rotor to receive molten material and discharge it centrifugally.[6] The second apparatus contained subdividers, so that the stream of molten material from the cupola formed numerous small streams which the inventor claimed could be fiberized efficiently and economically.[7] Other patents were

[4] Herod, Buren C., Rigid Laboratory Control, Full Automation Featured in Newest American Rock Wool Plant: Pit and Quarry, vol. 51, No. 1, July 1958, pp. 187–190.
[5] Doctorman, V. C., Wollastonite Spun Into Rock Wool: Rock Products, vol. 61, No. 8, August 1958, pp. 80–81.
[6] Tillotson, W. T. (assigned to American Rock Wool Corp.), An Apparatus for Fiberization: U.S. Patent 2,839,782, June 24, 1958.
[7] Muench, C. G. (assigned to The Celotex Corp.), Apparatus for Producing Mineral Wool: U.S. Patent 2,851,724, Sept. 16, 1958.

issued for a method of coloring mineral wool at the point of fiberization [8] and a method of treating wool to remove unfiberized material.[9]

STAUROLITE

Staurolite increased 68 percent in output and 91 percent in value in 1958 compared with 1957. Production data has been withheld to avoid disclosing individual company data. Staurolite was recovered as a byproduct of ilmenite and rutile production by E. I. du Pont de Nemours and Co., Inc., who operated the Highland and Trail Ridge plants in Clay County, Fla. The Marine Minerals Div. of Crane Co. recovered staurolite from Horse Creek, Aiken County, S.C., in 1958. Staurolite was used in portland-cement manufacture and sandblasting.

WOLLASTONITE

Wollastonite output in 1958 increased more than 40 percent over 1957 to establish a new high for the industry.

The Fox Knoll mine of the Cabot Carbon Co. in Essex County, N.Y., accounted for the bulk of the output. The remainder was supplied by several small producers from talus deposits in Riverside County, Calif.

California Limestone Products Corp. planned to increase production of wollastonite from its deposit in the Maria Mountains, near Blythe, Calif. An article describes the operation,[10] which will be worked as an open pit. The deposit is reported to contain at least 1 billion tons of high-grade material. Output will be converted to rock-wool insulation at the plant of Woolstone, Inc., about 10 miles from the deposit.

Wollastonite is used principally in ceramics, in floor and wall tiles in porcelain fixtures, in electrical insulators, as a paint extender, and as a filler in asphalt tile. The California material, due to weathering resembles driftwood and is used as an interior and exterior ornamental stone.

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; and less than carlots, ex warehouse, $44 per ton.

A patent was issued for using 50 to 80 percent crystalline wollastonite in making low-loss, ceramic insulator bodies.[11]

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[8] Owens, W. H. (assigned to American Rock Wool Corp.), Mineral Wool and Method of Treating and Coloring the Same: U.S. Patent 2,841,858, July 8, 1958.

[9] McMullen, J. C. (assigned to The Carborundum Co.), Fiber Treating Method and Apparatus: U.S. Patent 2,825,983, Mar. 11, 1958.

[10] Work cited in footnote 5, p. 2.

[11] Fenity, R. D., Harman, C. G., and Wainer, E. (assigned to The Star Porcelain Co., Trenton, N.J.), Low Loss Ceramic Insulators: U.S. Patent 2,839,414, June 17, 1958.

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, Stocks Prices (and specifications), Foreign Trade, World Review, World Reserves, 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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