

FLUORSPAR

By M. Michael Miller

Traditionally, fluorspar has been considered vital to the Nation for both national security and economic reasons. It is used directly or indirectly to manufacture products such as aluminum, gasoline, insulating foams, refrigerants, steel, and uranium fuel. Most fluorspar consumption and trade involves either acid grade, which is greater than 97% calcium fluoride or metallurgical grade, which is 97% or less calcium fluoride.

In the United States, one producer supplied about 10% of the Nation's fluorspar requirements, calculated as a percentage of apparent consumption. This included fluorspar processed from mined ore and fluorspar processed from National Defense Stockpile material. Supplementing fluorspar as a domestic source of fluorine, but not included in fluorspar production or consumption calculations, was byproduct fluorosilicic acid production from some phosphoric acid producers. According to the Bureau of the Census and the U.S. Bureau of Mines (USBM), imports of fluorspar were essentially unchanged compared with the 1993 figures. Hydrofluoric acid (HF) imports were 8% higher than those reported in the previous year.

Legislation and Government Programs

The Defense Logistics Agency, Defense National Stockpile Center (DLA-DNSC), measures the fluorspar stockpile in standard dry tons (sdt). In 1994, it was authorized to sell 20,000 sdt (about 18,100 metric tons) of metallurgical grade and 300,000 sdt (about 272,000 metric tons) of acid grade during fiscal year 1994 (October 1, 1993 to September 30, 1994). During this period, the DLA-DNSC reported sales of 19,000 sdt (about 17,000 metric tons) of metallurgical grade from a stockpile in Large, PA, and 280,638 sdt (about 255,000 metric tons) of acid grade from stockpiles in Wilmington, DE. Cumulative sales of fluorspar from the Defense Stockpile, since the current disposal began in 1992 through 1994, are 36,265 sdt (about 32,900 metric tons) of metallurgical grade and 287,895 sdt (about 261,000 metric tons) of acid grade. According to the DLA-DNSC's fiscal year 1995 Annual Materials Plan, further sales of both metallurgical grade and acid grade were planned for fiscal year 1995.

The Environmental Protection Agency issued the final rule on its program for evaluating and regulating substitutes for ozone-depleting chemicals being phased out under the stratospheric ozone protection provisions of the Clean Air Act (CAA). In section 612 of the CAA, the agency is authorized to identify and restrict the use of substitutes for class I and class II ozone-depleting substances where it has determined that alternatives exist that reduce overall risk to human health and the environment. The program is called the Significant New Alternatives Policy (SNAP) program. The intended effect of this final rule is to expedite movement away from ozone-depleting compounds by identifying substitutes that offer lower overall risks to human health and the environment.¹ It is the acceptance of these new alternative compounds that will drive demand for fluorspar in the future.

The Division of Oral Health, Centers for Disease Control and Prevention, released an updated version of "Water Fluoridation - A Manual for Water Plant Operators." The manual provides technical information that will enable water plant operators to improve the operation and maintenance of their water fluoridation facilities. The fluoridation of public water supplies requires strict control of dosage rates for maximum dental health benefits. Accurate analytical determination of the fluoride level in the water is essential and is included in this manual. The manual covers the use of fluorosilicic acid, sodium fluoride, sodium fluorosilicate, and other fluoride chemicals.²

Production

Domestic production data for fluorspar were developed by the USBM from voluntary surveys of U.S. operations. Surveys were conducted to obtain fluorspar mine production and shipments and fluorosilicic acid production. Of the four fluorspar mining operations to which a survey request was sent, four responded, representing 100% of known domestic shipments. Actual production quantities and values in table 1 are withheld to protect company proprietary data, but an estimate of total shipments is provided. Of the 11 fluorosilicic acid operations surveyed, 9 respondents reported production, representing 100% of the quantity reported.

Illinois was the only State reporting mine production in 1994 and accounted for 100% of all reported U.S. shipments. Specific data on shipments of fluorspar by State and grade are withheld to avoid disclosing company proprietary data.

Ozark-Mahoning Co., the Nation's largest fluorspar producer and a subsidiary of Elf Atochem North America Inc., operated three mines and a flotation plant in Pope and Hardin Counties, IL. Ozark-Mahoning closed its Denton Mine in the third quarter of 1994, but made up lost mine production from its remaining two mines. It operated two shifts per day at its No. 1 Mine and one shift per day at its Annabell Lee Mine. It also processed some material from the National Defense Stockpile to supplement its production. Seaforth Mineral & Ore Co. Inc. dried imported fluorspar at its facilities at Cave-In-Rock, IL, and East Liverpool, OH, for sale primarily to consumers in the ceramics, glass, and steel industries. The company supplemented its supplies by purchasing 106,638 sdt (about 97,000 metric tons) of acidspar from the National Defense Stockpiles in Wilmington, DE.

Silverspar Minerals, Inc. invested money in the renovation and upgrade of the former Babb-Barnes flotation mill near Salem, KY. Mill feed will initially be supplied by material purchased from the National Defense Stockpile. The mill was scheduled to be up and running by the middle of 1995.³ The original mill was built in the early 1970's and was last operated in 1978 by Frontier Spar Corp., a wholly owned subsidiary of Marathon Oil Co.

Four companies operating nine plants processing phosphate rock for the production of phosphoric acid sold a reported 54,900 tons of byproduct fluorosilicic acid at a value of about \$6.58 million. This was equal to 96,700 tons of 92% fluorspar equivalent. Since fluorosilicic acid is a byproduct of the fertilizer industry and is not manufactured for itself alone, shortages may occur when fertilizer production goes down.

Consumption

Domestic consumption data for fluorspar were developed by the USBM from voluntary surveys of U.S. operations. The consumption survey was sent to 72 operations quarterly and

to 4 additional operations annually. Of the operations surveyed quarterly, 90% responded. Of the operations surveyed on an annual basis, 100% responded. (See table 1.)

Acid-grade fluorspar, containing greater than 97% calcium fluoride (CaF_2), was used primarily as a feedstock in the manufacture of HF and to produce aluminum fluoride. Ceramic-grade fluorspar, containing 85% to 95% CaF_2 , was used for the production of glass and enamel, to make welding rod coatings, and as a flux in the steel industry. Metallurgical-grade fluorspar, containing 60% to 85% or more CaF_2 , was used primarily as a fluxing agent by the steel industry. Fluorspar is added to the slag to make it more reactive. It increases the fluidity of the slag (by reducing its melting point) and thus increases the chemical reactivity of the slag. Reducing the melting point of the slag brings lime and other fluxes into solution to allow the absorption of impurities.

Reported domestic consumption by the HF industry in 1994 increased by 11%. Reported consumption by the steel industry in basic oxygen and electric arc furnaces decreased by about 7% in 1994, although U.S. raw steel production in 1994 increased by about 3% compared with 1993.

In the ceramic industry, fluorspar was used as a flux and as an opacifier in the production of flint glass, white or opal glass, and enamels. Fluorspar was used in the manufacture of aluminum, brick, cement, and glass fibers, and was also used in the melt shop by the foundry industry.

Three companies reported fluorspar consumption for the production of HF. The largest use of HF, accounting for 60%-65% of HF withdrawn from the system, was for the production of a wide range of fluorocarbon chemicals, including fluoropolymers, chlorofluorocarbons (CFC's), hydrochlorofluorocarbons (HCFC's), and hydrofluorocarbons (HFC's). CFC's, HCFC's and HFC's were produced by seven companies: Allied-Signal Corp., Ausimont USA Inc., E. I. du Pont de Nemours & Company Inc., Elf Atochem North America Inc., I.C.I. Americas Inc., La Roche Chemicals Inc., and MDA Manufacturing Ltd. The latter is a joint venture between Daikin America Inc. and 3M Corp. producing HCFC-22 and hexafluoropropane for captive use in fluoropolymer manufacturing. According to preliminary data from the U.S. International Trade Commission, production of trichlorofluoromethane (CFC-11) decreased by 74% to 8,481 tons and chlorodifluoromethane (HCFC-22) increased by about 6% to 139,444 tons. The number of producers of dichlorodifluoromethane (CFC-12) decreased to

the point where production figures had to be withheld. No information is currently collected on production of the HCFC and HFC replacement compounds.

Some of the replacements for CFC's will be HCFC's 22, 123, 124, 141b, and 142b. These HCFC substitutes have ozone-depletion potentials much lower than that of CFC-11, CFC-12, and CFC-113, which in total have accounted for more than 90% of CFC consumption. HCFC-22 has been used for home air conditioning for years, and HCFC-141b and HCFC-142b have replaced most of the CFC-11 and CFC-12 used in foam blowing. Unfortunately, because of the recently agreed upon phaseout schedule for HCFC's and the likelihood that the schedule will be accelerated, the market for HCFC's will exist for only a relatively short time. Industry expects HCFC's to be produced and utilized at least through the end of this decade.

The HFC replacements have no ozone-depletion potential because they contain no chlorine atoms. The most promising HFC candidate is HFC-134a, which is already replacing CFC-12 in auto air conditioners and is expected to replace CFC-12 in medium temperature range refrigeration systems. HFC's 32, 125, 143a, and 152a also are being produced domestically, but in much smaller quantities. These four HFC's hold potential for use by themselves or more likely as blends for specific uses, and some interim replacements may be mixtures of these compounds and HCFC's. HFC 227 is being evaluated for use in medical aerosols. HFC 245 and 356 are being tested as potential replacements for HCFC-141b in blowing agents for thermosets such as polyurethane.

The manufacture of aluminum fluoride for use in aluminum reduction cells was a major use of HF. In the Hall-Héroult process, alumina is dissolved in a bath of molten cryolite, aluminum fluoride, and fluorspar to allow electrolytic recovery of aluminum. About 20 kilograms of fluorides were consumed for each metric ton of aluminum produced in a prebaked aluminum smelter. Aluminum fluoride was used by the ceramic industry for some body and glaze mixtures and in the production of specialty refractory products. It was used in the manufacture of aluminum silicates and in the glass industry as a filler.

HF was consumed in the manufacture of uranium tetrafluoride that was used in the process of concentrating uranium isotope 235 for use as nuclear fuel and in fission explosives. It also was used in stainless steel pickling, petroleum alkylation, glass etching, and in oil and gas well treatment.

HF was used as a cleaner and etcher in the

electronics industry. Allied-Signal Inc. announced it was combining technologies with Chemical Suppliers Inc. (CSI) to manufacture high-purity 49% HF for the electronics market. Plans called for the construction of a 1,630-ton-per-year (1,800-short-ton-per-year) high-purity HF plant at Allied-Signal's Geismar, LA, site. Startup was scheduled for the second quarter 1995. Allied-Signal would supply bulk quantities to electronic chemical suppliers and CSI would sell directly to semiconductor manufacturers. At present, electronic chemical suppliers purchase merchant-grade HF and process their own high-purity HF.⁴

HF was used as the feedstock in the manufacture of a host of fluorine chemicals used in dielectrics, metallurgy, wood preservatives, herbicides, mouthwashes, decay-preventing dentifrices, plastics, and water fluoridation.

Byproduct fluorosilicic acid was used in water fluoridation (56%), either directly or after processing to sodium silicofluoride, to make aluminum fluoride for the aluminum industry (28%), and in other uses (15%). (See table 2.)

Stocks

Consumer stocks at yearend were 49,400 tons, a decrease of 34% from the level reported in 1993. Consumer and distributor stocks contained an additional 251,000 tons purchased from the National Defense Stockpile. As a result of these sales, as of December 31, 1994, the National Defense Stockpile fluorspar inventory contained about 632,000 sdt (573,000 metric tons) of acid-grade material, about 263,000 sdt (239,000 metric tons) of metallurgical-grade material, about 900 sdt (816 metric tons) of nonstockpile, acid-grade material, and about 107,000 sdt (97,000 metric tons) of nonstockpile, metallurgical-grade material. The fluorspar stockpiles were at 22 sites across the country. Since the sale of the majority of the Wilmington, DE, stockpile, the largest acid-grade stockpiles are in Memphis, TN; North Gate, CO; and New Haven, IN. The largest metallurgical-grade and submetallurgical-grade stockpiles are in Large, PA; Warren, OH; New Haven, IN; and Pine Bluff, AR.

Prices

The following is a comparison of yearend 1994 prices published by Industrial Minerals (Metal Bulletin PLC) to yearend 1993 prices. No domestic price for fluorspar was available for 1994. Published yearend producer prices for Mexico were unchanged for both acid grade and metallurgical grade. South African prices

for acid grade decreased. No specific f.o.b. China or c.i.f. Gulf of Mexico prices were available for Chinese fluorspar. According to Industrial Minerals, the average U.S. Gulf port price, dry basis, for acid grade increased in 1994. Due to the lag between when purchase prices are negotiated and when material is delivered, the average import values shown in table 1 do not reflect the significant changes that occurred in list prices during 1994. (See table 3.)

Yearend price quotations from the Chemical Marketing Reporter (CMR) were unchanged at \$0.6875 per pound for anhydrous HF and were unchanged at \$52.00 per 100 pounds for aqueous HF, 70%, in tanks. These quotations were equivalent to about \$1.52 per kilogram for anhydrous HF and \$114.64 per 100 kilograms for aqueous HF, 70%, in tanks. The CMR yearend price quotation for hydrofluosilicic acid (fluorosilicic acid), 23% basis, in tanks, Midwest and East Coast terminals, was unchanged at \$165 per short ton (about \$182 per metric ton).

Foreign Trade

According to the Bureau of the Census, U.S. exports of fluorspar increased by about 84%. All U.S. exports were believed to be reexports of material imported into the United States or exports of material purchased from the National Defense Stockpile. (See table 4.)

Problems occurred with import statistics for acid-grade fluorspar entering the Houston Customs District. The problems were caused by the Customs reporting requirements for a Foreign Trade Zone (FTZ) and reporting errors for the value of some imports. Fluorspar imported into a FTZ for the production of HF is not listed as an import for consumption. Merchandise classified as having "nonprivileged foreign status" imported into the United States from a FTZ is listed as an import. This is merchandise that has been manipulated or manufactured in the FTZ so as to effect a change in tariff classification, e.g., fluorspar manufactured into HF. During the period 1991-94, these problems affected import statistics on shipments from China, Kenya, Morocco, Namibia, and the Republic of South Africa. For the years where import data were missing, Bureau of the Census sources were supplemented by information supplied by industry or the reported HF imports were converted to fluorspar equivalent and added to the appropriate country totals. Revisions or USBM adjustments were made to import data for 1991-94, as shown in tables 1 and 5.

In 1994, imports for consumption of fluorspar were essentially unchanged when

compared with those the previous year, according to Bureau of the Census and USBM data. China was once again the largest supplier of fluorspar to the United States, followed by, in descending order, the Republic of South Africa and Mexico. China accounted for nearly 61% of U.S. fluorspar imports. The average c.i.f. unit value, in dollars per metric ton, was \$97.70 for acid grade and \$74.90 for subacid grade. (See table 5.)

There is a 13.5% ad valorem tariff on subacid-grade fluorspar imports that applies to both most-favored nation (MFN) and non-MFN countries. The tariff on acid grade for MFN countries is \$2.10 per long ton (\$2.07 per metric ton) and for non-MFN countries \$5.60 per long ton (\$5.51 per metric ton).

Imports for consumption of HF increased by 8% to a quantity equivalent to approximately 102,000 tons of fluorspar. Imports of synthetic and natural cryolite decreased 18% to a quantity equivalent to approximately 5,340 tons of fluorspar. Imports of aluminum fluoride decreased by 40% to a quantity equivalent to approximately 35,600 tons of fluorspar. (See tables 6, 7, and 8.)

World Review

World fluorspar consumption and production continued to trend downward. In order of rank, China, Mexico, Mongolia, and the Republic of South Africa were the major producers. The international fluorspar industry experienced the continuing effects of major changes in the traditional markets of aluminum, fluorochemicals, and steel. (See table 9.)

Canada.—The Government of Newfoundland and Labrador accepted a proposal from Northern Resource Investments Ltd. (NRI) to attempt to reactivate fluorspar mining operations at St. Lawrence on the Burin Peninsula of Newfoundland. NRI planned to conduct engineering, marketing, and feasibility studies during 1995. If results are favorable, preparation for mine reactivation will begin in 1996, with full mine production expected by late 1996. No mineral rights or mining assets were granted, but NRI has the exclusive right to obtain mining leases and to purchase the mining assets up to April 1996, upon completion of a positive feasibility study.⁵

China.—The Chinese central Government installed an export license and quota system for fluorspar exports effective April 1, 1994. The China Chamber of Commerce for the Import and Export of Metals, Minerals, and Chemicals and the Ministry of Foreign Trade and Economic Cooperation control the new system.

Total export quotas were set and individual exporters were required to submit bids for an

export license. The bids were as a fee per ton of fluorspar exported. In three rounds of bidding that covered exports for 1994 and 1995, the export license fees were reported as being \$9 per ton, \$16 per ton, and \$20 per ton in successive rounds of bidding.⁶

In addition to the export license fee system, the central Government imposed, effective April 1, 1994, a mining fee on domestic- and foreign-owned mining operations, which amounts to 1.18% of the value of minerals mined from all mining enterprises. This fee is expected to be fixed at 1.18% for at least 1 or 2 years. Between 1996 and 2000, the Government plans to raise the fee to 5% to 7%, and then to about 10%.⁷

The new export license and quota system reduced the number of exporters, limited the total tonnage be exported, and required export license fees. These factors, plus inflation pressures in China, more direct competition between international buyers, and the mining fees led to dramatic price increases for Chinese fluorspar.

European Union.—On March 4, 1994, the Commission of the European Communities imposed a definitive antidumping duty on imports of fluorspar originating in China. The duty was imposed on imports of fluorspar presented in filter cake form or in powder form, containing more than 97% calcium fluoride falling within harmonized code 2529.22.0000 or containing less than 97% calcium fluoride falling within harmonized code 2529.21.0000, originating in China. The duty was equal to the difference between a minimum price of ECU 113.50 per ton (dry net weight) and the net free at Community frontier price before customs clearance.⁸

South Africa, Republic of.—The Buffalo Fluorspar Mine, owned by Transvaal Mining and Finance Company Ltd., a wholly owned subsidiary of General Mining Union Corporation (Gencor), and managed by Gencor's Samancor Group, closed in early 1994. The mine, near Naboomspruit in the Waterberg area of Transvaal, about 250 kilometers north of Johannesburg, began operations in 1948. Reasons given for the closure were a deteriorating business environment, reduced output, lower prices, and only 2 years of reserves.⁹ Product inventories at the time of closure were about 50,000 tons, which were all to be sold in 1994.¹⁰

Thailand.—Thailand produced nearly 24,000 tons of metallurgical grade in 1994. In 1993, when production totaled 48,400 tons, all production came from Mae Hong Son and Lamphun in the Northern Region and Phetchaburi and Kanchanaburi in the Central Region. Acid-grade production, which had

ceased in 1986, was restarted in 1991 and 1992. Krabi Fluorite Company, a joint venture with Dong-Il Trading Company Limited of South Korea, produced acid grade mainly for domestic use. Operations were shut down in August 1992, because of high operating costs and high silica content in the product.¹¹

Current Research and Technology

Researchers at Hashimoto Chemical Corp. and Tohoku University in Japan have developed advanced process technology utilizing granular CaCO_3 to recover CaF from spent fluoride chemicals from semiconductor manufacturing. The new process utilizes a multistage column reactor to treat dilute HF and buffered HF ($\text{NH}_4\text{F-HF-H}_2\text{O}$) producing a minimum 98% CaF_2 , with a maximum 2% CaCO_3 , and 0.1% SiO_2 . The effluent contains 5 parts per million (ppm) F (as ion), 2 ppm CaF_2 maximum, and 100 ppm SiO_2 . Currently, Ca(OH)_2 , $\text{Al}_2(\text{SO}_4)_3$, and other chemical materials are used to treat spent fluoride chemicals and produce large amounts of waste sludge.¹²

Texaco Refining and Marketing Inc. and UOP developed and tested additive technology to reduce aerosol formation of HF used in petroleum alkylation. HF is used as a catalyst to produce alkylate, a paraffinic gasoline-blending component with high octane and low vapor pressure. HF released under certain conditions, (i.e., superheated and released under pressure) may lead to aerosol formation, which is a suspension of fine liquid particles in a vapor cloud. Aerosol formation adds greatly to the quantity of HF contained in the cloud and thus adds to the hazards posed to workers and the public. The Texaco-UOP technology is an internal, passive mitigation solution. If an HF loss occurs, aerosol formation is reduced by the additive in the acid. HF alkylation accounts for about 65% of total alkylate production worldwide, but safety concerns have put its future in doubt.¹³

Outlook

Consumption of acidspar by the chemical industry for the production of HF is the largest market for fluorspar. The largest use of HF is in the manufacture of fluorocarbons (CFC's, HCFC's, and HFC's). The fluorocarbon market accounts for about 65% of HF demand and is thus the driving force in HF demand. Forecasting the demand for fluorocarbons in the near future is extremely difficult owing to the uncertainty of when and to what extent consumers will switch over to HCFC and HFC replacements. HF demand for fluorocarbon production is expected to be flat in the near

term and then edge upward.

No significant growth is expected long term in the other smaller HF markets.

The aluminum industry consumes fluorine from different sources and in different forms. Cryolite is the most important fluoride needed in aluminum smelting, but aluminum fluoride makes up for cell losses of both cryolite and aluminum fluoride. Aluminum fluoride is manufactured from fluorspar, HF, or fluorosilicic acid. Despite forecasts for growth in world aluminum production, the outlook for aluminum fluoride consumption is negative in the long term. The aluminum industry is eliminating the older inefficient Söderberg smelting technology, introducing process improvements, and tightening raw material specifications. Replacing the Söderberg plants will account for the bulk of the fluoride savings. Most of these older plants are in China and the former Soviet Union, so they will see the biggest impact on aluminum fluoride and fluorspar consumption.¹⁴

Consumption of metallurgical-grade fluorspar by the U.S. steel industry decreased again in 1994. The decreasing level of consumption is mainly a result of continuing changes in technology, improvements in efficiencies, and tighter raw material specifications. These factors indicate that U.S. consumption of metallurgical grade by the steel industry will continue to decrease through the 1990's. Small, nonsteel markets should remain stable, but account for no more than 20,000 tons per year.

The international market for metallurgical grade is still huge. Worldwide, the steel industry is still the largest consumer of fluorspar. However, with the spread of more efficient steelmaking process, the unit consumption of fluorspar is expected to fall. This will probably offset overall gains in steel production, primarily in developing countries.

After pronounced price increases in 1994, prices may begin to level off in the latter part of 1995. The rise in prices has been driven by developments in China, but at some point Chinese suppliers may find themselves losing market share to fluorspar producers in other countries now able to undercut the Chinese prices. The question will be is there enough alternative supply available from non-Chinese suppliers. North American customers may look to increased production in Mexico, the possible reactivation of Canada's St. Lawrence Fluorspar Co. in 1996, and possibly production from Silverspar Minerals' Salem, KY, flotation mill. The latter is supposed to receive mill feed purchased from the National Defense Stockpile and be on-line by the middle of 1995.

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⁴Chemical Week. AlliedSignal To Debut Electronic-Grade Hydrofluoric Acid. V. 156, No. 6, Feb. 15, 1995, p. 21.

⁵Government of Newfoundland and Labrador. Press Release. Jan. 1995.

⁶Private communication from J. Xu, China National Nonferrous Metals Import & Export Corp., Nov. 1994.

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¹⁴Reynolds, M. S. Future Trends in Fluoride Production and Consumption (Pres. at FLUORSPAR 1995 an Industrial Minerals conference, Bracknell, UK, May 22-23, 1995. 26 pp.

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TABLE 1
SALIENT FLUORSPAR STATISTICS 1/ 2/

		1990	1991	1992	1993	1994
United States:						
Production:						
Finished (shipments) e/	metric tons	63,500	58,000	51,000 3/	56,000 r/ 3/	49,000 3/
Value, f.o.b. mine	thousands	W	W	W	W	W
Exports 4/	metric tons	14,900	73,900	13,600	12,700	23,500
Value 5/	thousands	1,890	16,400	1,980	2,130	3,690
Imports 6/	metric tons	514,000	495,000	534,000	497,000	492,000
Value 7/	thousands	65,900 r/	59,200 r/	54,600 r/	47,000 r/	47,600
Value per ton, acid grade 7/		\$135.37 r/	\$124.27 r/	\$106.71 r/	\$97.60 r/	\$97.66
Value per ton, metallurgical grade 7/		\$101.55	\$95.64	\$84.72	\$73.43	\$74.88
Consumption (reported)	metric tons	565,000	484,000	485,000	447,000	486,000
Consumption (apparent) 8/	do.	567,000 r/	485,000 r/	569,000 r/	537,000 r/	543,000
Stocks, December 31:						
Consumer and distributor	do.	74,700	69,000	72,000	75,000	300,000 9/
Government stockpile	do.	1,180,000	1,180,000	1,180,000	1,160,000	909,000
Total (stocks):	do.	1,260,000	1,250,000	1,250,000	1,240,000	1,210,000
World: Production	do.	5,120,000 r/	4,210,000 r/	4,010,000 r/	3,930,000 r/	3,850,000 e/

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Does not include fluorosilicic acid (H₂SiF₆) or imports of hydrofluoric acid (HF) and cryolite.

3/ Includes fluorspar from the National Defense Stockpile benefited by Ozark-Mahoning Co., IL.

4/ Source: U.S. Bureau of the Census.

5/ F.a.s. values at U.S. ports.

6/ Source: U.S. Bureau of the Census as modified by the U.S. Bureau of Mines.

7/ C.i.f. values at U.S. ports.

8/ U.S. primary and secondary production plus imports minus exports plus adjustments for Government and industry stock changes.

9/ Includes fluorspar purchased from the National Defense Stockpile.

TABLE 2
U.S. (REPORTED) CONSUMPTION OF FLUORSPAR, BY END USE 1/

(Metric tons)

End use or product	1993	1994	1993	1994	1993	1994
	Containing more than 97% calcium fluoride (CaF ₂)		Containing not more than 97% calcium fluoride (CaF ₂)		Total	
Hydrofluoric acid (HF)	321,000	356,000	--	--	321,000	356,000
Basic oxygen furnaces	--	--	26,900	29,500	26,900	29,500
Electric furnaces	1,320	1,320	20,200	14,100	21,500	15,400
Iron and steel foundries	--	--	1,370	3,300	1,370	3,300
Other 2/	W	W	W	W	77,000	81,800
Total	W	W	W	W	447,000	486,000
Stocks (Consumer), December 31	73,000	48,900	2,400	497	75,000	49,400

W Withheld to avoid disclosing company proprietary data; included in "Other" and "Total."

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Includes aluminum fluoride, enamel, glass and fiberglass, primary aluminum, primary magnesium, and welding rod coatings.

TABLE 3
PRICES OF IMPORTED FLUORSPAR

(Dollars per metric ton)

Source-grade	1993	1994
Mexican, f.o.b., Tampico:		
Acidspar filtercake	100-110	100-112
Metallurgical grade	80 - 85	80 - 95
South African, acidspar dry basis, F.o.b. Durban	90 - 95	88-100
U.S. Gulf port, dry basis, acidspar.	95-100	120-130

Source: Industrial Minerals (Metal Bulletin PLC), No. 315, p. 54, Dec. 1993
and No. 327, p. 62, Dec. 1994.

TABLE 4
U.S. EXPORTS OF FLUORSPAR, BY COUNTRY 1/

Country	1993		1994	
	Quantity (metric tons)	Value 2/	Quantity (metric tons)	Value 2/
Australia	40	\$7,950	189	\$27,400
Canada	11,100	1,890,000	16,300	2,650,000
Colombia	57	8,350	339	58,700
Korea, Republic of	1,040	117,000	1,360	198,000
Mexico	212	23,700	2,900	296,000
Taiwan	--	--	1,930	371,000
Venezuela	290	71,700	276	64,100
Other 3/	27	3,950	185	28,900
Total	12,700	2,130,000	23,500	3,690,000

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ F.a.s. values at U.S. ports.

3/ Includes Argentina, Chile, Dominican Republic, and Peru data.

Source: Bureau of the Census.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF FLUORSPAR,
BY COUNTRY AND CUSTOMS DISTRICT 1/

Country and customs district	1993		1994	
	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
CONTAINING MORE THAN 97% CALCIUM FLUORIDE (CaF ₂)				
Canada: Detroit 3/	10,000	\$600	3,610	\$216
China:				
Houston 4/	146,000 r/	13,600 r/	153,000	14,600
New Orleans	150,000	13,300	129,000	11,900
Total	296,000 r/	26,900 r/	282,000	26,500
France:				
Cleveland	15	2	--	--
Philadelphia	18	8	18	9
Total	33	10	18	9
Kenya:				
Houston 4/	--	--	3,050	274
Mexico:				
Laredo	27,100	3,330	9,390	1,130
New Orleans	1,430	140	1,020	98
Total	28,500	3,470	10,400	1,220
Morocco:				
Houston	--	--	7,250	910
New Orleans	--	--	8,180	856
Total	--	--	15,400	1,770
South Africa, Republic of:				
New Orleans	99,600	11,400	119,000	12,400
Grand total	434,000 r/	42,300 r/	433,000	42,300
CONTAINING NOT MORE THAN 97% CALCIUM FLUORIDE (CaF ₂)				
China:				
Baltimore	--	--	4,040	299
New Orleans	36,400	\$2,510	12,300	865
Total	36,400	2,510	16,300	1,160
Mexico:				
El Paso	3,380	235	4,250	335
Laredo	591	31	2,350	103
New Orleans	22,600	1,850	35,800	2,800
Total	26,600	2,120	42,400	3,240
Grand total	63,000	4,630	58,800	4,400

r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ C.i.f. values at U.S. ports.

3/ Data supplied by importer.

4/ Data contain fluorspar equivalent, back-calculated from imported HF produced in La Porte, TX, Foreign Trade Zone.

Source: Bureau of the Census, adjusted by the U.S. Bureau of Mines.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION
OF HYDROFLUORIC ACID (HF), BY COUNTRY 1/

Country	1993		1994	
	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Brazil	--	--	16	\$16
Canada	141	\$299	100	270
France	--	--	359	392
Germany	91	214	116	233
Japan	153	471	582	1,850
Mexico	62,200	58,500	67,000	60,200
Sweden	37	56	--	--
United Kingdom	366	402	38	39
Total	62,900	60,000	68,200	63,000

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.
2/ C.i.f. values at U.S. ports.

Source: Bureau of the Census, adjusted by the U.S. Bureau of Mines.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION
OF CRYOLITE, BY COUNTRY 1/

Country	1993		1994	
	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Canada	551	\$271	1,310	\$415
China	291	208	117	84
Denmark	552	490	143	135
Germany	1,530	1,210	1,660	1,480
Italy	428	496	688	768
Hungary	119	96	48	40
Japan	232	228	311	395
Other 3/	76	66	170	136
Total	3,780	3,070	4,450	3,460

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ C.i.f. values at U.S. ports.

3/ Includes data for France, Mexico, Russia, and the Czech Republic.

Source: Bureau of the Census, adjusted by the U.S. Bureau of Mines.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION
OF ALUMINUM FLUORIDE, BY COUNTRY 1/

Country	1993		1994	
	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Canada	5,390	\$4,740	2,730	\$1,740
China	1,650	1,250	21	14
Italy	2,660	2,170	1,990	7,770
Japan	6,470	5,560	17	37
Mexico	16,300	12,100	14,300	9,300
Norway	6,150	4,650	3,980	3,350
United Kingdom	450	254	429	261
Other	371 r/	296 r/	263	250
Total	39,400	31,100	23,700	22,700

r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ C.i.f. values at U.S. ports.

Source: Bureau of the Census, adjusted by the U.S. Bureau of Mines.

TABLE 9
FLUORSPAR: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/ and grade 4/	1990	1991	1992	1993	1994 e/
Argentina	24,500 r/	16,500 r/	4,590 r/	4,610 r/	5,000
Brazil (marketable):					
Acid grade	47,700	52,400	61,400 r/	68,300 r/	65,000
Metallurgical grade	22,700	28,900	22,300 r/	24,600 r/	25,000
Total	70,400	81,300	83,700 r/	92,900 r/	90,000
Canada: Acid grade	21,400	--	--	--	--
China: e/					
Acid grade	700,000	700,000	700,000	800,000	800,000
Metallurgical grade	1,000,000	1,000,000	1,200,000	1,300,000	1,300,000
Total	1,700,000	1,700,000	1,900,000	2,100,000	2,100,000
Czech Republic	XX	XX	XX	22,100 r/	23,000
Czechoslovakia 5/	47,000	40,000 e/	40,000 e/	XX	XX
Egypt	1,250	1,790	1,700 e/	773 r/	700
France: e/					
Acid and ceramic grades	145,000	150,000	118,000 6/	100,000	100,000
Metallurgical grade	113,000	50,000	15,000 6/	25,000	25,000
Total	258,000 6/	200,000	133,000 6/	125,000	125,000
Germany:					
Eastern States	61,800	XX	XX	XX	XX
Western States (marketable)	85,300	XX	XX	XX	XX
Total	147,000	76,400 r/	53,100	40,000 r/	40,000
India:					
Acid grade	10,400	9,700	7,060 r/	7,800 r/	8,000
Metallurgical grade	13,000	14,400	13,600 r/	13,800 r/	14,000
Total	23,400	24,100	20,600 r/	21,600 r/	22,000
Iran 7/	4,770	12,300	9,180	10,000 e/	10,000
Italy:					
Acid grade	81,800	60,700	55,000 r/ e/	35,000 r/ e/	40,000
Metallurgical grade	40,700	37,900	25,000 e/	25,000 e/	--
Total	122,000	98,500	80,000 r/ e/	60,000 r/ e/	40,000
Kazakhstan e/	XX	XX	100,000	90,000	80,000
Kenya: Acid grade	112,000	77,400	80,600	78,700	64,000
Korea, North: Metallurgical grade e/	40,000	41,000	41,000	41,000	40,000
Korea, Republic of: Metallurgical grade	560	290	70	50 r/	50
Mexico: 8/					
Acid grade	428,000	277,000	189,000 r/	187,000 r/	221,000
Ceramic grade	11,000	--	--	--	--
Metallurgical grade	192,000	90,000	95,000 r/	93,000 r/	103,000
Submetallurgical grade e/	3,000	3,000	3,000	3,000	3,000
Total	634,000	370,000	287,000 r/ e/	283,000 r/ e/	327,000 6/
Mongolia:					
Acid grade	119,000	120,000	97,100 e/	80,000 e/	80,000
Other grades 9/	495,000	250,000	180,000 e/	100,000 e/	100,000
Total	614,000	370,000	277,000 e/	180,000 e/	180,000
Morocco: Acid grade	86,500	74,600	85,500	70,100 r/	85,000
Namibia: Acid grade 10/	27,100	34,600	37,200	43,500 r/	50,600 6/
Pakistan: Metallurgical grade e/	5,310 6/	5,300	5,000	5,100 r/	5,000
Romania: Metallurgical grade e/	12,000	12,000	15,000	15,000	15,000
Russia e/	XX	XX	100,000	70,000	60,000
South Africa, Republic of: 11/					
Acid grade e/	262,000	240,000	230,000	195,000	167,000 6/
Ceramic grade e/	7,500	6,000	5,500	3,800	--
Metallurgical grade e/	41,500	24,300	22,600	19,000	7,500 6/
Total	311,000	270,000	258,000	218,000	174,000 6/
Spain:					
Acid grade	144,000	107,000	91,000 r/	82,000 r/	90,000
Metallurgical grade e/	9,680 6/	5,000	5,000	5,000	5,000
Total e/	154,000 6/	112,000	96,000 r/	87,000 r/	95,000

See footnotes at end of table.

TABLE 9--Continued
 FLUORSPAR: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/ and grade 4/	1990	1991	1992	1993	1994 e/
Thailand:					
Acid grade	--	1,450	4,860	--	--
Metallurgical grade	94,800	60,600	51,600	48,400 r/	24,000
Total	94,800	62,100	56,500	48,400 r/	24,000
Tunisia: Acid grade	41,000	37,600	13,800	--	--
Turkey: Metallurgical grade e/	10,000	5,000	3,070 6/	4,000 r/	4,000
U.S.S.R. e/ 12/	380,000	350,000	XX	XX	XX
United Kingdom	118,000	77,900	76,100 r/	70,300 r/	59,000
United States (shipments) e/	63,500	58,000	51,000	60,000	49,000
Uzbekistan e/	XX	XX	100,000	90,000	80,000
Grand total	5,120,000	4,210,000 r/	4,010,000 r/	3,930,000 r/	3,850,000

e/ Estimated. r/ Revised. XX Not applicable.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Table includes data available through May 19, 1995.

3/ In addition to the countries listed, Bulgaria is believed to have produced fluor spar in the past, but production is not officially reported, and available information is inadequate for the formulation of reliable estimates of output levels.

4/ An effort has been made to subdivide production of all countries by grade (acid, ceramic, and metallurgical). Where this information is not available in official reports of the subject country, the data have been entered without qualifying notes.

5/ Dissolved Dec. 31, 1992.

6/ Reported figure.

7/ Year beginning Mar. 21 of that stated.

8/ Data are reported by Consejo de Recursos Minerales; but the production of submetallurgical grade and acid grade have been redistributed by the author based on industry data.

9/ Principally submetallurgical grade material.

10/ Data for 1993-94 are in wet tons.

11/ Data show estimated proportions of acid grade, ceramic grade, and metallurgical grade fluor spar within the reported totals.

12/ Dissolved in Dec. 1991.