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 8.5% 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 (NDS) material. Additional NDS material entered the U.S. supply through direct sales to consumers and distributors. 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. Geological Survey (USGS), imports of fluorspar increased by more than 13% compared with the 1994 figures. Hydrofluoric acid (HF) imports were 3% higher than those reported in 1994.

Legislation and Government Programs

In 1995, the Defense Logistics Agency, Defense National Stockpile Center (DLA-DNSC) was authorized to sell about 72,600 metric tons (80,000 short dry tons [sdt]) of metallurgical grade and about 81,600 tons (90,000 sdt) of acid grade during fiscal year 1995 (October 1, 1994 to September 30, 1995). An additional disposal of nearly 32,600 tons (35,924 sdt) of acid grade was made under fiscal year 1996 disposal authority. DLA-DNSC met its sales goals for fiscal year 1995 with sales of metallurgical grade from stockpiles at Memphis, TN, and Pine Bluff, AR, and of acid grade from Northgate, CO. Cumulative sales of fluorspar from the NDS, from 1992 through 1995, were about 106,000 tons (116,000 sdt) of metallurgical grade and about 375,000 tons (413,000 sdt) of acid grade. According to the DLA-DNSC's fiscal year 1996 Annual Materials Plan, further sales of about 72,600 tons (80,000 sdt) of metallurgical grade and about 81,600 tons (90,000 sdt) of acid grade were planned for fiscal year 1996.

The Clean Air Act Amendments of 1990 included provisions for the phaseout of ozone-depleting substances, including chlorofluorocarbons (CFC's), as required by the Montreal Protocol. On February 11, 1992, the President announced that the United States would unilaterally accelerate the phaseout schedule for ozone-depleting substances, with most production of CFC's and halons to be terminated by December 31, 1995. U.S. producers terminated production of CFC's on schedule, and in the future all demand for CFC's will have to be met by material stockpiled prior to the phaseout or by recycled material.

Production

Domestic production data for fluorspar were developed by the USGS from voluntary surveys of U.S. operations. Surveys were conducted to obtain fluorspar mine production and shipments and fluorosilicic acid production. A survey request was sent to the only fluorspar mining operation active in 1995. Reported production from this Illinois producer was used to generate an estimate of total domestic shipments. Actual production quantities and values in table 1 are withheld to protect company proprietary data. Of the 11 fluorosilicic acid operations surveyed, 10 respondents reported production, representing 100% of the quantity reported.

Ozark-Mahoning Co., the Nation's only fluorspar producer and a subsidiary of Elf Atochem North America Inc., operated two mines and a flotation plant in Pope and Hardin Counties, IL. The company also processed some material from the NDS to supplement production and dried and sold imported material. In late November 1995, Elf Atochem announced the shutdown of the Ozark-Mahoning mine and mill operations effective January 31, 1996. After a period of about 6 months for reclamation, remediation, and equipment removal and repairs, 25 positions out of an original 127 were to remain. The company planned to continue to import and dry material for existing customers. The reason given for the shutdown was depletion of reserves at the active mines.[1] Ozark-Mahoning was the last active fluorspar mining company in the country, and had operated in southern Illinois since the late 1930's.

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 with material previously purchased from the NDS.

Silverspar Minerals, Inc., continued its attempts to enter the fluorspar business, but encountered internal problems. During 1995, the company replaced its board of directors after the Vancouver Stock Exchange (VSE) halted trading in the company's stock. The new board authorized a forensic accounting investigation and made attempts to satisfy questions raised by the VSE. The investigation revealed that most of the funds raised to purchase the Babb-Barnes Mine and mill and other mining properties were missing. While considering all available options to recover monies improperly paid to the former directors, Silverspar was left in the position of having to try to raise financing again for the purchases.[2]

Silverspar's subsidiary, Orbex Resources Inc., submitted

two successful bids for the purchase of about 73,000 tons (80,000 sdt) of metallurgical-grade from the NDS. The material was dried and screened for resale to U.S. customers. Under an agreement with USX Corp., the Salem flotation mill was being maintained by Orbex. Subject to some additional recommissioning work, the mill was ready to begin production.[3]

Six companies operating 10 plants processing phosphate rock for the production of phosphoric acid sold a reported 55,900 tons of byproduct fluorosilicic acid at a value of about $7.32 million. This was equal to 98,400 tons of 92% fluorspar equivalent. Since fluorosilicic acid is a byproduct of the phosphate fertilizer industry and is not manufactured for itself alone, shortages may occur when phosphate fertilizer production goes down.

Consumption

Domestic consumption data for fluorspar were developed by the USGS from voluntary surveys of U.S. operations. The consumption survey was sent to 54 operations quarterly and to 4 additional operations annually. Of the operations surveyed quarterly, 85% responded. Of the operations surveyed on an annual basis, 75% responded. Estimates were made for some of the operations surveyed quarterly and the one annual nonrespondent. *(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 (AlF_3). 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 1995 increased by more than 5%. Reported consumption by the steel industry in basic oxygen and electric arc furnaces decreased by about 4% in 1995, despite U.S. raw steel production in 1995 increasing by more than 4% compared with 1994. The reported consumption for steel making of 43,200 tons contrasts with the importation of 87,700 tons of metallurgical-grade fluorspar in 1995. Eliminating reported nonsteel uses of metallurgical-grade fluorspar, leaves 25,000 to 30,000 tons of consumption unaccounted for by the USGS consumption survey. The reported steel consumption numbers are either too low, the "other" uses numbers are too low, or it is a combination of both.

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 was for the production of a wide range of fluorocarbon chemicals, including fluoropolymers, CFC's, hydrochlorofluorocarbons (HCFC's), and hydrofluorocarbons (HFC's). CFC's, HCFC's and HFC's were produced by seven companies: AlliedSignal Corp., Ausimont USA Inc., E. I. du Pont de Nemours & Co. Inc. (DuPont), 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 1995 data from the U.S. International Trade Commission (USITC) quarterly report on U.S. Production of Selected Synthetic Organic Chemicals, production of CFC 11 decreased to 2,760 tons, production of CFC 12 decreased to 27,900 tons, and production of HCFC 22 increased to 151,000 tons. In 1995, the USITC started collecting production data on HFC 134a and HCFC 141b. HCFC 141b production was reported at 64,700 tons, but figures for HFC 134a were withheld to protect company proprietary data. Unfortunately, this is the only year the USITC will report production data on the new replacement fluorocarbons, because the agency will discontinue the synthetic organic chemicals report after the second quarter of 1996.

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 current 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. DuPont has developed HFC 43-10 as a replacement for CFC 113, HCFC's, and perfluorocarbon for use in drying fluids, cleaning and rinsing agents, defluxing agents, and in heat transfer media.[4]

One barrier to the acceptance of a fluorocarbon replacement for HCFC 22 used in home air conditioners was the existence of competing products from DuPont and AlliedSignal. An agreement has been reached where AlliedSignal would license its Genetron AZ-20 (R-410a) refrigerant (an azeotropic mixture of 50% HFC 32 and 50% HFC 125) to DuPont. This helps establish one product as a standard for home air conditioners, and will allow for a quicker phaseout of HCFC 22.[5] This market should grow more slowly than that for HFC 134a, because HCFC production currently is not due to be phased out until 2020. Equipment manufacturers will, however, eventually convert their products to R-410a, and likely sooner than later.

The manufacture of AlF_3 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, AlF_3, 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. AlF_3 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.

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 (45%), either directly or after processing to sodium silicofluoride, to make AlF_3 for the aluminum industry (34%), and in other uses (20%). *(See table 2.)*

Stocks

Consumer stocks at yearend were 92,400 tons, an increase of 83% from the level reported in 1994. Consumer and distributor stocks contained an additional 313,000 tons purchased from the NDS, but still located at NDS depots. As of December 31, 1995, the NDS fluorspar inventory (excluding material sold pending shipment) contained about 492,000 tons (542,000 sdt) of acid-grade material, about 166,000 tons (183,000 sdt) of metallurgical-grade material, about 1,180 tons (1,300 sdt) of nonstockpile, acid-grade material, and about 97,000 tons (107,000 sdt) of nonstockpile, metallurgical-grade material.

Prices

No domestic prices for fluorspar were available for 1995. Industrial Minerals (Metal Bulletin PLC) published yearend prices for Mexico increased to $115 to $120 per ton for acid grade and $85 to $95 per ton for metallurgical grade. South African prices for acid grade, f.o.b. Durban, increased to $100 to $115 per ton. 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 1995 to $142 to $152 per ton. This would be the average delivered price of Chinese, South African, Moroccan, and Mexican acid grade at Gulf ports. 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 mirror the increases in list prices reported at the end of 1995. *(See table 3.)*

Yearend price quotations from the Chemical Marketing Reporter (CMR) for anhydrous HF were unchanged at $0.6875 per pound. Aqueous HF, 70%, in drums, f.o.b., freight allowed was $62.00 per 100 pounds. These quotations were equivalent to about $1.52 per kilogram for anhydrous HF and $136.69 per 100 kilograms for aqueous HF, 70%, in drums. 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 78%. All U.S. exports were believed to be reexports of material imported into the United States or exports of material purchased from the NDS. *(See table 4.)*

In 1995, imports for consumption of fluorspar increased by more than 13% when compared with those of 1994, according to Bureau of the Census and USGS data. China was once again the largest supplier of fluorspar to the United States, followed by, in descending order, Mexico and South Africa. China accounted for nearly 60% of U.S. fluorspar imports. The average c.i.f. unit value, in dollars per metric ton, was $126 for acid grade and $94 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 of HF, excluding material from DuPont's foreign trade zone, increased by 3% to a quantity equivalent to approximately 105,000 tons of fluorspar. Imports of synthetic and natural cryolite increased 63% to a quantity equivalent to approximately 8,720 tons of fluorspar. Imports of AlF_3 decreased by 6% to a quantity equivalent to 33,300 tons of fluorspar. *(See tables 6, 7, and 8.)*

World Review

World fluorspar production increased in 1995, exceeding the 1994 production by more than 3%. In order of rank,

China, Mexico, Mongolia, and South Africa were the major producers. The international fluorspar industry enjoyed higher prices, especially for acid grade. *(See table 9.)*

Canada.—In 1995, Burin Minerals Ltd. conducted feasibility studies on reopening the fluorspar mines and mill at St. Lawrence, Newfoundland. The studies indicated that the project was viable, and the company was proceeding with efforts to arrange project financing. An environmental preview report on the Shoal Cove pond tailings disposal proposal was prepared and submitted to the Canadian Department of Environment. A mine planning study of the Tarefare and Blue Beach North Mines was prepared. An engineering study to evaluate options for product storage, logistics, and ship loading was also prepared. Acquisition of assets and mining leases on approximately 6,100 hectares (15,000 acres) was expected in the first quarter of 1996.[6]

China.—The export license and quota system instituted by the Chinese central Government in 1994 was restructured in 1995 but remained in effect. Overall prices for Chinese fluorspar continued to rise, but this was due more to rising production costs than to increases in the export licenses. The export license fee has stabilized, at least during the last 2 years. The license fee was about $21 to $25 per ton for 1995 exports and about $22 to $23 per ton for 1996 exports. Increases in wages, transportation costs, and raw material costs pushed acid-grade prices upward in 1995 to about $115 to $120 per ton, for filter cake, dry basis, f.o.b. China. During the contract negotiations for 1996 shipments, prices for acid grade appeared to stabilize at about the same level as for 1995 shipments. Additional upward price pressures will be generated by the new resource tax on the value of minerals mined from all mining operations, which is supposed to increase to 5% to 7% between 1996 and the year 2000.

Mongolia.—Mongolia reports total run-of-mine production in its official production statistics, but also reports concentrate production. Based on available information, the USGS has estimated the quantity of ore processed at the Bor-Undur flotation mill for concentrate production, and have subtracted it from the reported total production figures. The resulting 1995 figures and revised 1991-94 figures are shown in table 9. Most of the nonconcentrate production is minus-55% CaF_2 submetallurgical-grade material, most likely exported to Russia for further processing.

Morocco.—The Moroccan Government announced its intent to sell its stake in five of the country's mining operations, including the El Hammam fluorspar mine. The Government, through its parastatal Bureau de Recherches et de Participations Minières, owns 34% of Société Anonyme d'Enterprises Minières (SAMINE). SAMINE operates El Hammam and is 66% owned by Omnium Nord-Africain (ONA). ONA, a leading Moroccan holding company, was expected to make a strong bid for the remaining 34% of SAMINE when the Government officially announces the tender.[7]

United Kingdom.—In early 1995, Deepwood Mining Co., Ltd., reacquired the fluorspar mining leases it had sold to Swan Industrial Minerals Ltd. in 1992. Deepwood resumed production of fluorspar in 1995 from the Southern Pennine Orefield in Derbyshire and intends to increase production in 1996. The company received planning permission in October 1995 to develop a new deposit lying adjacent to its Ball Eye Quarry. A large vein has been identified grading 50% to 80% CaF_2 and 10% to 20% lead. Two other fluorspar companies are still operating: Laporte Minerals and Durham Industrial Minerals.[8] Total production for the country is estimated at 64,000 tons for 1995.

Current Research and Technology

Modular Environmental Technologies, Inc. (MET) has licensed or developed technologies and modularized them for the treatment and/or recovery of inorganic constituents from industrial blowdown and byproduct streams. In 1995, MET completed an exclusive licensing agreement with DuPont for the use its proprietary High Aspect Ratio Draft Tube Agitated Crystallizer (HARDTAC) technology. MET intends to apply the HARDTAC technology to the recovery of CaF_2 from major consumers of HF. Chemically, the HARDTAC process operates similarly to a conventional CaF_2 recovery process, i.e., mixing of spent HF in an agitated reactor tank with a calcium reagent, use of a clarifier to separate liquids and solids, and a system to dewater the solids. The HARDTAC process is much more efficient in its use of reagents, process control, and in generating a quality CaF_2 byproduct suitable for resale. The process is already suitable for recovery of CaF_2 from the petroleum refining alkylation process, and MET will be conducting tests on the treatability of spent fluorides from stainless steel mills, glass plants, electronic plants, and other waste streams.[9]

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% to 70% of HF demand and is thus the driving force in HF demand. Fluorspar consumption in the United States for HF production increased for the second straight year and reached its highest level since 1989.

Forecasting fluorocarbon demand is still a very uncertain endeavor. Although the replacement fluorocarbons use more HF per unit than the CFC's, representatives of the major North American fluorocarbon producers are divided in forecasting demand for the replacement fluorocarbons. The size of consumers' CFC stocks, the amount of CFC recycling that will occur, and the quantity of CFC's being illegally imported will affect the demand. The consumers' stocks and the illegal imports will eventually vanish, or in the case of the latter, at least drop to an acceptable level. The U.S. Government is making greater efforts to restrict the influx of illegal CFC imports. The Environmental Protection Agency and the U.S. Customs Service have signed a memorandum of understanding to increase their efforts to halt illegal imports of

CFC's. In 1995, the Customs Service seized over 450,000 kilograms (1,000,000 pounds) of CFC's.

AlliedSignal anticipates a global market for the new fluorocarbon products produced in the United States, and expects that demand will be driven not just by the North American market but also by the export market. With this export market in mind, AlliedSignal announced plans to reopen its mothballed HF plant in Amherstberg, Ontario, Canada. It is scheduled to reopen in late 1996, and be in full operation by the first quarter of 1997. With the closure of the Elf Atochem North America HF plant, the U.S. annual capacity for HF production drops to about 180,000 metric tons (100% basis).

The aluminum industry consumes most of its fluorides in the form of AlF_3. Aluminum fluoride is manufactured from fluorspar, HF, or fluorosilicic acid. Despite forecasts for growth in world aluminum production, the outlook for AlF_3 consumption is negative in the long term. The aluminum industry is eliminating the older inefficient Söderberg smelting technology (mainly in China and the former Soviet Union), introducing process improvements, and tightening raw material specifications. Increased U.S. fluorspar demand for AlF_3 production occurred in 1995, driven by increased export sales.

The following summarizes and quantifies U.S. demand. There are only a few markets for acid-grade fluorspar in the United States, which is primarily used to produce HF and AlF_3. With the closure of the Elf Atochem HF plant, the combined capacities of the two HF plants and the single AlF_3 plant allow for the annual consumption of less than 500,000 tons per year of acid grade. Consumption of acid grade for other uses is less than 20,000 tons per year and probably between 10,000 to 15,000 tons per year. The size of the metallurgical-grade market is more difficult to quantify. Reported consumption puts it at less than 50,000 tons per year, but imports were nearly 88,000 tons in 1995. The steel market is in decline due to continuing changes in technology, improvements in efficiencies, and tighter raw material specifications. Barring capacity increases at the HF plants or the development of new markets, U.S. consumption is unlikely to exceed 650,000 tons per year. Apparent consumption for 1995 was 599,000 tons.

Growth in demand is more likely to take place in Canada and Mexico, as demonstrated by the reopening of the Amherstberg HF plant in Canada and a capacity expansion planned for Norfluor's Ciudad Juarez plant in Mexico.

U.S. consumers have built up large stocks, primarily 313,000 tons of material purchased from the NDS in recent years but not yet shipped from Government depots. Including the previously sold NDS material and company stocks, U.S. industry fluorspar stocks totaled 405,000 tons at the end of 1995 or about 68% of annual consumption. The DLA-DNSC is continuing to sell fluorspar from the NDS, albeit at a lower rate than in earlier years. With continued NDS sales and the large industry stocks, U.S. imports may decline in the future.

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[1]Elf Atochem North America Inc. Elf Atochem North America Announces Partial Shutdown of the Ozark Mahoning Company Operations (news release). Nov. 29, 1995.

[2]Silverspar Minerals Inc. Results of Forensic Accounting Released (news release). Sept. 20, 1995.

[3]———. Status Report (news release). June 8, 1995.

[4]Chemical Marketing Reporter. V. 249, No. 22, May 27, 1996, p. 5.

[5]———. V. 249, No. 26, June 24, 1996, p. 21.

[6]Burin Minerals Ltd. Quarterly Progress Report, Mar. 31, 1996.

[7]Industrial Minerals (London). No. 332, May 1995, pp. 10-12.

[8]———. (London). No. 342, Mar. 1996, p. 19.

[9]LeFevre, C. G. Synthetic Fluorspar. (Pres. at International Fluorspar Conference 1996, Vail, CO, Mar. 3-6, 1996. 5 pp.)

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SRI International—Chemical Economics Handbook, Fluorine.

U.S. Department of Commerce Current Industrial Reports, Inorganic Chemicals, M28A.

TABLE 1
SALIENT FLUORSPAR STATISTICS 1/ 2/

		1991	1992	1993	1994	1995
United States:						
Production:						
Finished (shipments) e/	metric tons	58,000	51,000 3/	60,000 3/	49,000 3/	51,000 3/
Value, f.o.b. mine	thousands	W	W	W	W	W
Exports 4/	metric tons	73,900	13,600	12,700	23,500	41,800
Value 5/	thousands	$16,400	$1,980	$2,130	$3,690	$5,550
Imports 6/	metric tons	495,000	534,000	497,000	492,000	558,000
Value 7/	thousands	$59,200	$54,600	$47,000	$47,600	$67,400
Value per ton, acid grade 7/		$124.00	$107.00	$98.00	$98.00	$126.00
Value per ton, metallurgical grade 7/		$96.00	$85.00	$73.00	$75.00	$94.00
Consumption (reported)	metric tons	484,000	485,000	447,000	486,000	525,000
Consumption (apparent) 8/	do.	485,000	569,000	556,000 r/	563,000 r/	599,000
Stocks, December 31:						
Consumer and distributor	do.	69,000	75,400 r/ 9/	78,000 r/ 9/	284,000 r/ 9/	405,000 9/
Government stockpile	do.	1,180,000	1,180,000	1,160,000	909,000	756,000
World: Production	do.	4,300,000 r/	4,120,000 r/	4,100,000 r/	3,810,000 r/	3,940,000

r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits.
2/ Does not include fluorosilicic acid (H2SiF6) or imports of hydrofluoric acid (HF) and cryolite.
3/ Includes fluorspar from the National Defense Stockpile beneficiated by Ozark-Mahoning Co., Illinois.
4/ Source: Bureau of the Census and the U.S. Geological Survey.
5/ F.a.s. values at U.S. ports.
6/ Source: U.S. Bureau of the Census as modified by the U.S. Geological Survey.
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, but still located at National Defense Stockpile depots.

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

(Metric tons)

	Containing more than 97% calcium fluoride (CaF_2)		Containing not more than 97% calcium fluoride (CaF_2)		Total	
End use or product	1994	1995	1994	1995	1994	1995
Hydrofluoric acid (HF)	356,000	375,000	--	--	356,000	375,000
Basic oxygen furnaces	--	--	29,500	21,700	29,500	21,700
Electric furnaces	1,320	W	14,100	21,500	15,400	21,500
Other 2/	W	W	W	W	85,100 r/	107,000
'Total	W	W	W	W	486,000	525,000
Stocks (Consumer), December 31	49,300 r/	89,900	1,100 r/	2,530	50,400 r/	92,400

r/ Revised. W Withheld to avoid disclosing company proprietary data; included in "Other" and "Total."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes aluminum fluoride, enamel, glass and fiberglass, iron and steel foundries, primary aluminum, primary magnesium, and welding rod coatings.

TABLE 3
PRICES OF IMPORTED FLUORSPAR

(Dollars per metric ton)

Source-grade	1994	1995
Mexican, f.o.b., Tampico:		
Acidspar filtercake	100-112	115-120
Metallurgical grade	80- 95	85- 95
South African, acidspar dry basis, f.o.b. Durban	88-100	100-115
U.S. Gulf port, dry basis, acidspar.	120-130	142-152

Source: Industrial Minerals (Metal Bulletin PLC), No. 327, p. 62, Dec. 1994 and No. 339, p. 64, Dec. 1995.

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

	1994		1995	
Country	Quantity (metric tons)	Value 2/	Quantity (metric tons)	Value 2/
Australia	189	$27,400	124	$22,300
Canada	16,300	2,650,000	21,900	3,230,000
Colombia	339	58,700	82	19,600
Korea, Republic of	1,360	198,000	1,830	204,000
Mexico	2,900	296,000	15,600	1,760,000
Taiwan	1,930	371,000	1,450	162,000
Venezuela	276	64,100	356	64,900
Other 3/	185	28,900	507	86,400
Total	23,500	3,690,000	41,800	5,550,000

1/ Data are rounded 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, Ecuador, Peru, and the United Kingdom.

Source: Bureau of the Census.

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

Country and customs district	1994 Quantity (metric tons)	1994 Value 2/ (thousands)	1995 Quantity (metric tons)	1995 Value 2/ (thousands)
Containing more than 97% calcium fluoride (CaF2):				
Canada: Detroit 3/	3,610	$216	19	$2
China:				
Houston 4/	153,000	14,600	170,000	22,400
New Orleans	129,000	11,900	149,000	18,000
Total	282,000	26,500	319,000	40,500
France:				
Philadelphia	18	9	182	96
Japan:				
Cleveland	--	--	88	11
Kenya:				
Houston 4/	3,050	274	--	--
Mexico:				
Laredo	9,390	1,130	20,400	2,720
New Orleans	1,020	98	10,700	957
Total	10,400	1,220	31,100	3,680
Morocco:				
Buffalo	--	--	114	32
Houston	7,250	910	5,940	731
New Orleans	8,180	856	18,000	2,590
Total	15,400	1,770	24,000	3,350
South Africa				
Houston	--	--	18,200	2,120
New Orleans	119,000	12,400	77,400	9,360
New York City	--	--	100	30
Ogdensburg	--	--	80	19
Total	119,000	12,400	95,800	11,500
Grand total	434,000 r/	42,300	470,000	59,100
Containing not more than 97% calcium fluoride (CaF2):				
China:				
Baltimore	4,040	299	--	--
New Orleans	12,300	865	15,100	1,570
Total	16,300	1,160	15,100	1,570
Mexico:				
Baltimore	--	--	3,890	494
Buffalo	--	--	1,620	191
El Paso	4,250	335	3,770	291
Laredo	2,350	103	4,160	328
New Orleans	35,800	2,800	59,100	5,410
Norfolk	--	--	46	3
Total	42,400	3,240	72,600	6,710
Grand total	58,800	4,400	87,700	8,280

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ C.i.f. values at U.S. ports.
3/ Data for 1994 supplied by importer.
4/ Data for 1994 contain fluorspar equivalent, back-calculated from imported HF produced in LaPorte, TX, Foreign Trade Zone; data for 1995 includes data supplied by importer.

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

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

Country	1994 Quantity (metric tons)	1994 Value 2/ (thousands)	1995 Quantity (metric tons)	1995 Value 2/ (thousands)
Brazil	16	$16	36	$35
Canada	100	270	112	269
France	359	392	57	58
Germany	116	233	113	279
Japan	582	1,850	596	2,200
Mexico	67,000	60,200	69,400	63,100
United Kingdom	38	39	--	--
Total	68,200	63,000	70,300	65,900

1/ Data are rounded 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. Geological Survey.

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

Country	1994 Quantity (metric tons)	1994 Value 2/ (thousands)	1995 Quantity (metric tons)	1995 Value 2/ (thousands)
Australia	--	--	514	$129
Canada	1,310	$415	2,600	965
China	117	84	261	201
Denmark	143	135	205	230
Germany	1,660	1,480	2,190	2,220
Hungary	48	40	743	900
India	--	--	600	529
Italy	688	768	--	--
Japan	311	395	53	55
Other 3/	170	136	114	104
Total	4,450	3,460	7,270	5,330

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ C.i.f. values at U.S. ports.
3/ Includes data for the Czech Republic, France, Mexico, Russia, Switzerland, and the United Kingdom.

Source: Bureau of the Census.

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

Country	1994 Quantity (metric tons)	1994 Value 2/ (thousands)	1995 Quantity (metric tons)	1995 Value 2/ (thousands)
Canada	2,730	$1,740	2,660	$1,800
China	21	14	--	--
Italy	1,990	7,770	2,430	1,830
Japan	17	37	(3/)	11
Mexico	14,300	9,300	13,000	8,950
Norway	3,980	3,350	3,940	4,340
United Kingdom	429	261	140	72
Other 4/	263	250	96	183
Total	23,700	22,700	22,200	17,200

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ C.i.f. values at U.S. ports.
3/ Less than 1/2 unit.
4/ Includes data for Belgium, Finland, Germany, and Sweden.

Source: Bureau of the Census.

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

(Metric tons)

Country 3/ and grade 4/	1991	1992	1993	1994	1995 e/
Argentina	16,500	4,590	4,610	4,000 r/ e/	5,000
Brazil (marketable):					
Acid grade	52,400	61,400	68,300	55,200 r/	54,000
Metallurgical grade	28,900	22,300	26,000 r/	21,000 r/	26,000
Total	81,300	83,700	94,400 r/	76,200 r/	80,000
China: e/					
Acid grade	700,000	700,000	800,000	800,000	700,000
Metallurgical grade	1,000,000	1,200,000	1,300,000	1,300,000	1,200,000
Total	1,700,000	1,900,000	2,100,000	2,100,000	1,900,000
Czech Republic	XX	XX	22,100	10,000 r/ e/	15,000
Czechoslovakia 5/	40,000 e/	40,000 e/	XX	XX	XX
Egypt	1,790	1,700 e/	773	700 e/	700
France: e/					
Acid and ceramic grades	150,000	118,000 6/	96,000 r/	105,000 r/	100,000
Metallurgical grade	50,000	15,000 6/	20,000 r/	26,000 r/	25,000
Total	200,000	133,000 6/	116,000 r/	131,000 r/	125,000
Germany	60,900 r/	53,100	40,000	37,000 r/	39,000
India:					
Acid grade	9,700	7,060	7,800	6,110 r/	8,000
Metallurgical grade	14,400	13,600	13,800	15,800 r/	15,000
Total	24,100	20,600	21,600	21,900 r/	23,000
Iran 7/	12,300	9,180	10,000 e/	10,000 e/	10,000
Italy: e/					
Acid grade	60,700 6/	55,000	35,000	25,000 r/	25,000
Metallurgical grade	37,900 6/	25,000	25,000	10,000 r/	10,000
Total	98,500 6/	80,000	60,000	35,000 r/	35,000
Kazakstan e/	XX	100,000	90,000	80,000	80,000
Kenya: Acid grade	77,400	80,600	78,700	64,000 e/	91,200
Korea, North: Metallurgical grade e/	41,000	41,000	41,000	40,000	40,000
Korea, Republic of: Metallurgical grade	290	70	50	50 e/	50
Mexico: 8/					
Acid grade	277,000	189,000	187,000	221,000 e/	270,000
Metallurgical grade	90,000	95,000	93,000	103,000 e/	252,000
Submetallurgical grade e/	3,000	3,000	3,000	3,000	--
Total	370,000	287,000 e/	283,000 e/	327,000	523,000
Mongolia:					
Acid grade	120,000	97,000 r/	77,000 r/	88,000 r/	120,000
Other grades 9/	355,000 r/	287,000 r/	276,000 r/	85,000 r/	120,000
Total	475,000 r/	384,000 r/	353,000 r/	173,000 r/	240,000
Morocco: Acid grade	74,600	85,500	70,100	85,000 e/	105,000
Namibia: Acid grade 10/	34,600	37,200	43,500	52,200 r/	37,000 6/
Pakistan: Metallurgical grade e/	5,300	5,000	5,100	5,000	3,000
Romania: Metallurgical grade e/	12,000	15,000	15,000	15,000	15,000
Russia e/	XX	100,000	70,000	60,000	60,000
South Africa: 11/					
Acid grade e/	240,000	230,000	195,000	167,000 6/	177,000
Ceramic grade e/	6,000	5,500	3,800	--	--
Metallurgical grade e/	24,300	22,600	19,000	7,500 6/	19,000
Total	270,000	258,000	218,000	174,000	196,000
Spain:					
Acid grade	107,000	94,000 r/	82,000	90,000 e/	97,000
Metallurgical grade e/	5,000	2,960 r/ 6/	5,000	5,000	--
Total e/	112,000	97,000 r/ 6/	87,000	95,000	97,000

See footnotes at end of table.

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

(Metric tons)

Country 3/ and grade 4/	1991	1992	1993	1994	1995 e/
Thailand:					
Acid grade	1,450	4,860	--	--	--
Metallurgical grade	60,600	51,600	48,400	23,700 r/	24,000
Total	62,100	56,500	48,400	23,700 r/	24,000
Tunisia: Acid grade	37,600	13,800	--	--	--
Turkey: Metallurgical grade e/	5,000	3,070 6/	4,000	4,000	4,000
U.S.S.R. e/ 12/	350,000	XX	XX	XX	XX
United Kingdom	77,900	76,100	70,300	58,000 r/ e/	64,000
United States (shipments) e/	58,000	51,000	60,000	49,000	51,000
Uzbekistan e/	XX	100,000	90,000	80,000	80,000
Grand total	4,300,000 r/	4,120,000 r/	4,100,000 r/	3,810,000 r/	3,940,000

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

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through May 23, 1996.

3/ In addition to the countries listed, Bulgaria is believed to have produced fluorspar 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 1993-95 are in wet tons.

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

12/ Dissolved in Dec. 1991.