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 (CaF_2) or metallurgical grade, which is 97% or less CaF_2.

With the closure of Ozark-Mahoning Company's operations in southern Illinois in late 1995, the United States ended 158 years of mining fluorspar. Remaining company stocks were shipped during the first quarter of 1996, but accounted for only an estimated 8,200 metric tons. Material from the National Defense Stockpile (NDS) made it into the U.S. supply through sales to consumers or distributors as did a small amount of synthetic fluorspar produced from industrial waste streams. 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 decreased by 8% compared with the 1995 figures. Hydrofluoric acid (HF) imports were 12% higher than those reported in 1995.

Legislation and Government Programs

The Defense Logistics Agency, Defense National Stockpile Center (DLA-DNSC), was authorized to sell about 136,000 metric tons (150,000 short dry tons [sdt]) of metallurgical grade and about 118,000 tons (130,000 sdt) of acid grade during fiscal year 1996 (October 1, 1995 to September 30, 1996). DLA-DNSC only sold about 15,500 tons (17,100 sdt) of metallurgical grade, but sold about 114,000 tons (125,000 sdt) of acid grade or nearly the maximum amount authorized. The DLA-DNSC sold an additional 32,700 tons (36,000 sdt) of acid grade during the fourth quarter of 1996, which falls under fiscal year 1997. Cumulative sales of fluorspar from the NDS, for calendar years 1992 through 1996, were about 89,000 tons (98,000 sdt) of metallurgical grade and about 490,000 tons (540,000 sdt) of acid grade. According to the DLA-DNSC's fiscal year 1997 Annual Materials Plan, total sales of about 45,400 tons (50,000 sdt) of metallurgical grade and about 163,000 tons (180,000 sdt) of acid grade were authorized for fiscal year 1997. Under current sales levels, the DLA-DNSC projects complete disposal of fluorspar stockpiles to be accomplished in 5 years for metallurgical-grade stocks and 2½ years for acid-grade stocks.

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. The last domestic fluorspar mining operation closed in December 1995, but a survey request was sent to this operation to collect final shipments data for 1996. Reported production from this Illinois producer has been traditionally withheld to protect company proprietary data, but was used to generate an estimate of total domestic shipments. Of the 11 fluorosilicic acid operations surveyed, 10 respondents reported production, representing 100% of the quantity reported.

In 1996, Elf Atochem North America, Inc., signed an agreement to sell its Ozark-Mahoning mill facilities to Sogem-Afrimet, Inc. and Hastie Mining Co. The sale agreement did not include the mines, mineral rights, or mining equipment. After due diligence, the deal was expected to be finalized during the third quarter of 1997. The partners have named their venture Hastie/Sogem Minerals and operated the facility under a lease agreement, pending finalization of the purchase. They are washing, screening, and drying metallurgical- and acid-grade fluorspar imported or purchased from the NDS. The information was confirmed by A. Marshall (Sogem- Afrimet, Inc., oral commun., 1997). Seaforth Mineral & Ore Co., Inc., dried and screened imported or NDS fluorspar at its facilities at Cave-In-Rock, IL, and East Liverpool, OH, as did Applied Industrial Materials Corp. (AIMCOR) at its facility at Aurora, IN.

Silverspar Minerals, Inc., signed an option and sales agreement to purchase the Babb-Barnes fluorspar mine and mill properties near Salem, KY, from USX Corp. Under the agreement Silverspar's subsidiary Orbex Resources, Inc., performed a test run of the mill for several months in the spring of the year. Silverspar was unable to finance the purchase and the option expired. The information was confirmed by M. Mews (Silverspar Minerals, Inc., oral commun., 1997). USX Corp. subsequently sold the mill to the Savage Zinc Co., which does not plan to utilize the mill for fluorspar processing. The information was confirmed by W. Mitchell (Savage Zinc Co., oral commun., 1997).

Six companies operating 10 plants processing phosphate rock for the production of phosphoric acid sold or used a reported 67,400 tons of byproduct fluorosilicic acid at a value of about $8.49 million. This was equal to approximately 119,000 tons of 92% fluorspar equivalent. Fluorosilicic acid output increased by about 20% compared with 1995. 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.

There is some recovery of synthetic fluorspar at stainless steel pickling plants and at petroleum alkylation plants, but traditionally most of this product has been disposed of in landfills rather than reused as fluorspar. Greater restrictions on the disposal of industrial wastes and improvements in recovery processes may change this practice. At present, an estimated 10,000 tons of synthetic fluorspar is being produced annually in the United States.

Consumption

Domestic consumption data for fluorspar were developed by the USGS from voluntary surveys of U.S. operations. The consumption survey was sent to 60 operations quarterly and to 4 additional operations annually. Of the operations surveyed quarterly, 92% responded. Of the operations surveyed on an annual basis, 100% responded. Estimates were made for some of the operations surveyed quarterly. *(See table 1.)*

Acid-grade fluorspar, containing greater than 97% 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.

The level of total reported fluorspar consumption remained essentially unchanged in 1996. Reported consumption by the domestic HF industry in 1996 increased by nearly 4%, despite the closure of the Elf Atochem HF plant in early 1996. In order to conceal individual company proprietary data, fluorspar consumption data for HF are now being combined with consumption data for AlF_3 production. The reported consumption of fluorspar for non-HF/AlF_3 uses decreased by 19% compared with 1995. The data collected for these non-HF/AlF_3 markets do not accurately reflect the true size of these markets, which are larger than reported.

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 for at least part of the year. The largest use of HF was for the production of a wide range of fluorocarbon chemicals, including fluoropolymers, hydrochlorofluorocarbons (HCFC's), and hydrofluorocarbons (HFC'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.

Some of the replacements for chlorofluorocarbons (CFC's) will be HCFC's 22, 123, 124, 141b, 142b, and 225. 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, HCFC 141b and HCFC 142b have replaced most of the CFC 11 and CFC 12 used in foam blowing, and HCFC 225 has been introduced as a replacement for CFC solvents. 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 successful HFC replacement compound is HFC 134a, which is the main replacement for CFC 12 in auto air conditioners and in medium-temperature-range refrigeration systems. Demand for HFC 134a is growing, but will never achieve the market size that CFC 12 did, and at present HFC 134a production capacity is running far ahead of demand. 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 245ca is being tested in low pressure centrifugal compressor chillers, and HFC's 245 and 356 are being tested as potential replacements for HCFC 141b in blowing agents for thermosets such as polyurethane. DuPont has developed its proprietary HFC 4310 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. Hydrofluoroethers have been developed by 3M to replace CFC's in various solvent cleaning applications.

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. On average, worldwide the aluminum industry consumes about 21 kilograms (kg) of fluorides for each metric ton of aluminum produced. This ranges from 10 to 12 kg per ton in a modern prebaked aluminum smelter to 40 kg per ton in an older Soderberg smelter without scrubbers. AlF_3 was used by the ceramic industry to produce body and glaze mixtures and 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 sold or used for water fluoridation (48%), to make AlF_3 for the aluminum industry (27%), to make sodium silicofluoride (14%), and in other or unspecified uses (11%). *(See table 2.)*

Stocks

Consumer stocks at yearend were 117,000 tons, an increase of nearly 27% from the level reported in 1995. Consumer and distributor stocks contained an additional 234,000 tons purchased from the NDS, but still located at NDS depots. As of December 31, 1996, the NDS fluorspar inventory classified as excess (excluding material sold pending shipment) contained about 392,000 tons (432,000 sdt) of acid-grade material, about 187,000 tons (206,000 sdt) of metallurgical-grade material, about 677 tons (746 sdt) of nonstockpile, acid-grade material, and about 97,000 tons (107,000 sdt) of nonstockpile, metallurgical-grade material.

Transportation

The United States is import dependent for the majority of its fluorspar supply. Fluorspar is transported to customers by truck, rail, barge, and ship. Metspar is shipped routinely as lump or gravel, with the gravel passing a 75-millimeter sieve and not more than 10% by weight passing a 9.5-millimeter sieve. Acidspar is shipped routinely in the form of damp filtercake containing 7% to 10% moisture to facilitate handling and reduce dust.

Most acidspar imports come from China and South Africa. Fluorspar is shipped by ocean freight utilizing the "Tramp" market for ships. Bulk carriers of 10,000 to 50,000 tons deadweight normally are utilized. Participants negotiate freight levels, terms, and conditions. The main participants are *charterers*–generally the buyers or sellers, *ship owners*–who either own vessels or have them time chartered, *operators*–traders normally taking positions on either cargo or ships, and *brokers*–who generally represent ship owners or charterers and act as go betweens. Ships are primarily owned by the following: privately held shipping companies, publicly held shipping companies, government-controlled companies, and groups of professionally managed fleets under varying ownership. This information was confirmed by R.C. Diamond (Mid-Ship Marine, Inc., written commun., 1993). Until recently, the rate of new ship construction in the range of 10,000 to 50,000 tons had been very low, but during the 1996-97 period more than 300 new ships were due to be built. These new ships would drop the average age of the fleet to about 10 years.

This expansion of the smaller bulk carrier fleet would result in overcapacity and cause a likely decrease in shipping prices during the latter part of 1997. The new ships will make competition difficult for the older ships, which already may be burdened with the overage insurance frequently required on ships over 15 years in age. As a result, many of the older ships are expected to be scrapped. In addition, increased demand for grains and fertilizers in Asia, which are normally shipped on large bulk carriers, may affect the availability of the smaller bulk carriers favored by fluorspar shippers. These factors are expected to cause prices to rebound and to increase by 15% to 20%. This information was confirmed by Steven Rzehak (Mid-Ship Marine, Inc., oral commun., 1997).

Prices

Industrial Minerals (Metal Bulletin PLC) published yearend price ranges for Mexican fluorspar were $115 to $135 per ton for acid grade and $80 to $105 per ton for metallurgical grade. South African prices for acid grade, f.o.b. Durban, increased to $125 to $135 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 was unchanged at $142 to $152 per ton. This would be the average delivered price of Chinese, Mexican, and South African acid grade at Gulf ports. *(See table 3.)*

Yearend price quotations from the Chemical Market Reporter (CMR) for anhydrous HF increased to $0.70 per pound. Aqueous HF, 70%, in drums, f.o.b., freight allowed, was unchanged at $62.00 per 100 pounds. These quotations were equivalent to about $1.55 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 47%. 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 1996, imports for consumption of fluorspar decreased by 8% when compared with those of 1995, according to Bureau of the Census and USGS data. In descending order, China, South Africa, and Mexico were the largest suppliers of fluorspar to the United States. China accounted for more than 69% of U.S. fluorspar imports. The average c.i.f. unit value, in dollars per metric ton, was $142 for acid grade and $103 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 $1.24 per ton and for non-MFN countries

$5.51 per metric ton. The North American Free Trade Agreement eliminates these tariffs on any fluorspar imported from Canada or Mexico.

Imports of HF, excluding material from DuPont's foreign trade zone, increased by 12% to a quantity equivalent to approximately 118,000 tons of fluorspar. Imports of synthetic and natural cryolite decreased 10% to a quantity equivalent to approximately 7,810 tons of fluorspar. Imports of AlF_3 decreased by nearly 18% to a quantity equivalent to 25,200 tons of fluorspar. *(See tables 6, 7, and 8.)*

World Review

The industry experienced another mine closure, privatization of State-owned mining companies, continued attempts to restart mining operations, a new fluorspar discovery, and relatively stable prices. In order of rank, China, Mexico, Mongolia, and South Africa were the major producers. *(See table 9.)*

Canada.—Burin Minerals Ltd. continued its efforts to reopen the fluorspar mining operations at St. Lawrence, Newfoundland. The company completed a first-stage private financing effort, was proceeding with efforts to arrange additional public equity financing, filled staff positions, confirmed size and grade of ore deposits, continued working with the Government on environmental requirements, and appointed a marketing agent (Burin Minerals Ltd., 1996).

Germany.—The Käfersteige fluorspar mine at Pforzheim and its flotation plant at Karlsruhe were closed down by Fluss-und-Schwerspatwerke Pforzheim GmbH, a subsidiary of Bayer AG. Mine production ceased at the end of September and mill production ceased at the end of October. Reasons given for the closure included competition from lower cost imports, the shrinking of the European fluorocarbon industry, and unfavorable currency exchange rates (Industrial Minerals, 1996a).

Kenya.—Kenya Fluorspar Co., Ltd., which has its mining operations in the Kerio Valley of Western Kenya, was privatized in 1996. The Kenyan Government, which owned 100% of Kenya Fluorspar, offered its entire stake in the company in a public tender. Nairobi-based Minerals and Chemicals Manufacturers Ltd. submitted the winning application (Industrial Minerals, 1996b).

Morocco.—As a result of a sales agreement with the Moroccan Government, Omnium Nord-Africain (ONA), through its holding company Managem, effectively increased its control of Société Anonyme d'Enterprises Minières (SAMINE) and its El Hammam fluorspar mine. The agreement called for ONA to increase to a majority stake its holdings in silver producer, SMI, which would then purchase the Government's 34% minority share in SAMINE (Industrial Minerals, 1996c).

Ukraine.—A new fluorspar deposit has reportedly been discovered in the Vinnitsa Region of Ukraine. Preliminary estimates of reserves put the deposit as second only to the Voskresenskoe deposit, largest in the Commonwealth of Independent States (Industrial Minerals in the CIS, 1996).

United Kingdom.—Production of acid-grade fluorspar increased by about 9% from 55,000 tons in 1995 to about 60,000 tons in 1996. Principal production came from Laporte Minerals with a smaller amount from Durham Industrial Minerals (formerly Weardale Fluorspar). The expected raw ore output from Deepwood Mining (as reported in the 1995 Annual Fluorspar Review) failed to materialize, but overall ore production from the Southern Pennine Orefield in Derbyshire did increase significantly with several new contributors in full production. This information was confirmed by P.L. Huxtable (Laporte Minerals, written commun., 1997).

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), which accounts for about 65% to 70% of HF demand. It appears that demand for replacement fluorocarbons is slowly increasing, aided by the depletion of stocks of banned CFC's and by the crackdown of CFC smuggling into the United States. Unfortunately, increases in HF and HFC 134a capacity have out paced the slowly rising demand. Protracted low prices may result, especially for HFC 134a. Fluorspar demand by the AlF_3, steel, and other assorted markets is expected to remain at about current levels. It is expected that overall fluorspar demand will exhibit only small increases over the next few years.

References Cited

Burin Minerals Ltd., 1996, Quarterly progress report: St. Lawrence, NF, Canada. Burin Minerals Ltd. press release, December 31, 1996, 2 p.

Industrial Minerals, 1996a, Germany—Bayer subsidiary exits fluorspar business: Industrial Minerals, no. 351, p. 17.

———1996b, Kenya—Kenya Fluorspar privatized: Industrial Minerals, no. 344, p. 13.

———1996c, Morocco—ONA increases stake in Samine Fluorspar: Industrial Minerals, no. 349, p. 13.

Industrial Minerals in the CIS, 1996, New fluorite deposit discovered in Ukraine: Industrial Minerals in the CIS, no. 2, p. 11.

SOURCES OF INFORMATION

U.S. Geological Survey Publications

Fluorspar. Ch. in Mineral Commodity Summaries, annual.[1]

Fluorspar. Ch. in Minerals Yearbook, annual.[1]

Fluorspar. Mineral Industry Surveys, quarterly.[1]

Geology and resources of fluorine in the United States, U.S. Geological Survey Professional Paper 933.

Other

Chemical and Engineering News.

Chemical Market Reporter.

Chemical Week.

European Chemical News.

Fluorspar. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675.
Industrial Minerals (London).
North American Minerals News.
Roskill—The Economics of Fluorspar 1993.
SRI International—Chemical Economics Handbook, Fluorine.
U.S. Department of Commerce Current Industrial Reports, Inorganic Chemicals, M28A.

———

[1]Prior to January 1996, published by U.S. Bureau of Mines.

TABLE 1
SALIENT FLUORSPAR STATISTICS 1/ 2/

		1992	1993	1994	1995	1996
United States:						
Production:						
Finished (shipments) e/ 3/	metric tons	51,000	60,000 r/	49,000	51,000	8,200
Value, f.o.b. mine	thousands	W	W	W	W	W
Exports 4/	metric tons	13,600	12,700	23,500	41,800	61,600
Value 5/	thousands	$1,980	$2,130	$3,690	$5,550	$8,110
Imports 6/	metric tons	534,000	497,000	492,000	558,000	513,000
Value 7/	thousands	$54,600	$47,000	$47,600	$67,400	$71,000
Value per ton, acid grade 7/		$106.71	$97.60	$97.66	$125.74	$141.56
Value per ton, metallurgical grade 7/		$84.72	$73.43	$74.88	$94.41	$103.00
Consumption (reported)	metric tons	485,000	447,000	486,000	534,000 r/	527,000
Consumption (apparent) 8/	do.	569,000	556,000	311,000 r/	446,000 r/	730,000
Stocks, December 31:						
Consumer and distributor	do.	75,400	78,000	284,000	405,000	234,000
Government stockpile	do.	1,180,000	1,160,000	909,000	756,000	667,000
World: Production	do.	4,120,000	4,090,000 r/	3,680,000 r/	4,050,000 r/	4,140,000 e/

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/ May include fluorspar from the National Defense Stockpile beneficiated by Ozark-Mahoning Co., IL.
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	1995	1996	1995	1996	1995	1996
Hydrofluoric acid and aluminum fluoride	472,000 r/	477,000	--	--	472,000 r/	477,000
Basic oxygen furnaces	--	--	21,700	11,900	21,700	11,900
Electric furnaces	W	W	21,500	19,200	21,500	19,200
Other 2/	W	W	W	W	9,890 r/	18,800
Total	W	W	W	W	525,000	527,000
Stocks (consumer), December 31	89,900	106,000	2,530	11,100	92,400	17,500

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other" and/or in "Total."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes 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	1995	1996
Mexican, f.o.b., Tampico:		
Acidspar filtercake	115-120	115-135
Metallurgical grade	85-95	80-105
South African, acidspar dry basis, F.o.b. Durban	100-115	125-135
U.S. Gulf port, dry basis, acidspar	142-152	142-152

Source: Industrial Minerals (Metal Bulletin PLC), No. 339, p. 64, Dec. 1995 and No. 351, p. 72, Dec. 1996.

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

Country	1995 Quantity (metric tons)	1995 Value 2/	1996 Quantity (metric tons)	1996 Value 2/
Bolivia	--	--	234	$33,900
Canada	21,900	$3,230,000	37,400	5,480,000
Dominican Republic	--	--	4,340	595,000
Italy	--	--	10,300	851,000
Korea, Republic of	1,830	204,000	540	84,800
Mexico	15,600	1,760,000	6,000	669,000
Taiwan	1,450	162,000	2,340	298,000
Venezuela	356	64,900	336	59,100
Other 3/	713 r/	128,000 r/	130	37,100
Total	41,800	5,550,000	61,600	8,110,000

r/ Revised.
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 Australia, Chile, Ecuador, France, Hong Kong, 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	1995 Quantity (metric tons)	1995 Value 2/ (thousands)	1996 Quantity (metric tons)	1996 Value 2/ (thousands)
Containing more than 97% calcium fluoride (CaF2):				
Austria: Charleston	--	--	348	$97
Canada: Detroit	19	$2	--	--
China:				
Houston 3/	170,000	22,400	212,000	29,300
New Orleans	149,000	18,000	144,000	21,900
Total	319,000	40,500	356,000	51,200
France: Philadelphia	182	96	54	28
Japan: Cleveland	88	11	--	--
Mexico:				
Laredo	20,400	2,720	18,100	2,530
New Orleans	10,700	957	--	--
Total	31,100	3,680	18,100	2,530
Morocco:				
Buffalo	114	32	--	--
Houston	5,940	731	--	--
New Orleans	18,000	2,590	--	--
Total	24,000	3,350	--	--
South Africa				
Houston	18,200	2,120	17,900	2,400
New Orleans	77,400	9,360	81,500	10,800
New York City	100	30	240	88
Ogdensburg	80	19	--	--
Total	95,800	11,500	99,600	13,300
Grand total	470,000	59,100	474,000	67,100
Containing not more than 97% calcium fluoride (CaF2):				
Canada:				
Buffalo	--	--	354	118
Ogdensburg	--	--	9	4
Total	--	--	363	122
China: New Orleans	15,100	1,570	--	--
Germany: New Orleans	--	--	194	20

See footnotes at end of table.

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

Country and customs district	1995 Quantity (metric tons)	1995 Value 2/ (thousands)	1996 Quantity (metric tons)	1996 Value 2/ (thousands)
Containing not more than 97% calcium fluoride (CaF2)--Continued:				
Mexico:				
Baltimore	3,890	$494	--	--
Buffalo	1,620	191	--	--
El Paso	3,770	291	3,120	$238
Laredo	4,160	328	6,180	494
New Orleans	59,100	5,410	29,000	2,930
Norfolk	46	3	--	--
Total	72,600	6,710	38,300	3,660
Grand total	87,700	8,280	38,900	3,810

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 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	1995 Quantity (metric tons)	1995 Value 2/ (thousands)	1996 Quantity (metric tons)	1996 Value 2/ (thousands)
Brazil	36	$35	--	--
Canada	112	269	105	$338
France	57	58	272	304
Germany	113	279	164	332
Japan	596	2,200	589	2,160
Mexico	69,400	63,100	81,200	75,700
Total	70,300	65,900	82,300	78,800

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	1995 Quantity (metric tons)	1995 Value 2/ (thousands)	1996 Quantity (metric tons)	1996 Value 2/ (thousands)
Australia	514	$129	--	--
Bahrain	--	--	1,010	$674
Canada	2,600	965	594	155
China	261	201	77	67
Denmark	205	230	296	427
Germany	2,190	2,220	2,070	2,400
Hungary	743	900	565	833
India	600	529	1,020	1,030
Italy	--	--	505	642
Other 3/	167 r/	159 r/	270	283
Total	7,270	5,330	6,400	6,510

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/ Includes data for the Czech Republic, France, Japan, 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	1995 Quantity (metric tons)	1995 Value 2/ (thousands)	1996 Quantity (metric tons)	1996 Value 2/ (thousands)
Canada	2,660	$1,800	2,510	$2,410
France	--	--	900	1,030
India	--	--	309	312
Indonesia	--	--	1,500	1,510
Italy	2,430	1,830	129	96
Mexico	13,000	8,950	8,520	7,890
Norway	3,940	4,340	4,230	3,360
Other 3/	236 r/	266 r/	242	250
Total	22,200	17,200	18,300	16,800

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/ Includes data for Belgium, Germany, Japan, Sweden, and the United Kingdom.

Source: Bureau of the Census.

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

(Metric tons)

Country 3/ and grade 4/	1992	1993	1994	1995	1996 e/
Argentina	4,587	4,611	3,585 r/	5,071 r/	5,000
Brazil (marketable):					
Acid grade	61,432	68,325	68,890 r/	72,498 r/	36,000
Metallurgical grade	22,264	24,566 r/	21,041	16,860 r/	16,000
Total	83,696	92,891 r/	89,931 r/	89,358 r/	52,000
China: e/					
Acid grade	700,000	800,000	1,200,000 r/	1,200,000 r/	1,250,000
Metallurgical grade	1,200,000	1,300,000	800,000 r/	800,000 r/	900,000
Total	1,900,000	2,100,000	2,000,000 r/	2,000,000 r/	2,150,000
Czech Republic e/ 5/	XX	22,100 6/	10,000	15,000	15,000
Czechoslovakia 7/	40,000 e/	XX	XX	XX	XX
Egypt e/	1,700	773 6/	700	700	700
France: e/					
Acid and ceramic grades	118,000 6/	96,000	105,000	102,000 r/	80,000
Metallurgical grade	15,000 6/	20,000	26,000	28,000 r/	25,000
Total	133,000 6/	116,000	131,000	130,000 r/	105,000
Germany	53,100	40,000	37,000	39,000 e/	39,000
India:					
Acid grade	7,062	7,798	6,231 r/	4,875 r/	6,000
Metallurgical grade	13,572	13,846	16,360 r/	17,604 r/	17,000
Total	20,634	21,644	22,591 r/	22,479 r/	23,000
Iran e/ 8/	9,182 6/	10,000	10,000	10,000	10,000
Italy: e/					
Acid grade	55,000	35,000	52,630 r/ 6/	25,000	30,000
Metallurgical grade	25,000	25,000	15,312 r/ 6/	10,000	15,000
Total	80,000	60,000	67,942 r/ 6/	35,000	45,000
Kazakstan e/	100,000	90,000	80,000	80,000	80,000
Kenya: Acid grade	80,630	78,725	53,488 r/	80,230 r/	80,000
Korea, North: Metallurgical grade e/	41,000	41,000	40,000	40,000	40,000
Korea, Republic of: Metallurgical grade	70	50	50 e/	50 e/	50
Mexico: 9/					
Acid grade	189,000	187,000	129,000 r/	270,000	280,000
Metallurgical grade	95,000	93,000	103,000	252,000	260,000
Submetallurgical grade e/	3,000	3,000	3,000	--	--
Total	287,000 e/	283,000 e/	235,000 r/	522,000 r/	540,000
Mongolia:					
Acid grade	97,000	77,000	88,000	120,300	130,000 6/
Other grades 10/	287,000	276,000	85,000	119,000 r/ e/	124,000
Total	384,000	353,000	173,000	239,000 r/ e/	254,000
Morocco: Acid grade	85,500	70,050	85,000	105,800 r/	100,000
Namibia: Acid grade 11/	37,176	43,466	52,226	37,076 r/	20,000
Pakistan: Metallurgical grade	5,000 e/	5,100 e/	13,351 r/	2,753 r/	3,000
Romania: Metallurgical grade e/	15,000	15,000	15,000	15,000	15,000
Russia e/	100,000	70,000	60,000	60,000	60,000
South Africa: 12/					
Acid grade e/	230,000	195,000	166,761 6/	177,000	197,000
Ceramic grade e/	5,500	3,800	--	--	--
Metallurgical grade e/	22,600	19,000	7,497 6/	19,000	20,000
Total	258,105	217,778	174,258	195,866	217,000
Spain:					
Acid grade	94,000	82,000	97,000 r/ e/	96,000 r/ e/	95,000
Metallurgical grade e/	2,960 6/	5,000	10,000 r/	15,000 r/	10,000
Total e/	97,000 6/	87,000	107,000 r/	111,000 r/	105,000
Thailand:					
Acid grade	4,863	--	--	--	--
Metallurgical grade	51,597	48,387	23,705	24,114 r/	24,000
Total	56,460	48,387	23,705	24,114 r/	24,000
Tunisia: Acid grade	13,800	--	--	--	--
Turkey: Metallurgical grade	3,074	4,000 e/	6,671 r/	6,700 r/ e/	7,000
United Kingdom	76,100	70,300	58,000 e/	55,000 r/ e/	60,000
United States (shipments) e/	51,000	60,000	49,000	51,000	8,200
Uzbekistan e/	100,000	90,000	80,000	80,000	80,000
Grand total	4,120,000	4,090,000 r/	3,680,000 r/	4,050,000 r/	4,140,000

See footnotes at end of table.

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

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

1/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.

2/ Table includes data available through Apr. 21, 1997.

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/ Formerly part of Czechoslovakia; data were not reported separately until 1993.

6/ Reported figure.

7/ Dissolved Dec. 31, 1992.

8/ Year beginning Mar. 21 of that stated.

9/ 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.

10/ Principally submetallurgical grade material.

11/ Data for 1993-96 are in wet tons.

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