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2013 Minerals Yearbook

FLUORSPAR [ADVANCE RELEASE]

U.S. Department of the Interior
U.S. Geological Survey

April 2015

Fluorspar

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In 2013, mining began at Hastie Mining & Trucking Co.'s (Cave-in-Rock, IL) Klondike II fluorspar mine in western Kentucky, although at yearend no finished shipments had been made. This is the first fluorspar mine production in the United States since 1996. In addition, Hastie Mining & Trucking recovered a small amount of fluorspar as a byproduct of limestone quarrying in Illinois which was then screened and sold as metallurgical grade (Donald Hastie, Hastie Mining & Trucking Co., oral commun., May 12, 2014). The bulk of U.S. demand was supplied by imports and small amounts of byproduct synthetic fluorspar produced from industrial waste streams. Byproduct fluorosilicic acid (FSA) production from some phosphoric acid producers supplemented fluorspar as a domestic source of fluorine but was not included in fluorspar production or consumption calculations. Estimated world production decreased by about 6% to 6.77 million metric tons (Mt) compared with that of 2012, with most of the decrease accounted for by decreased production in Mongolia.

Fluorspar is predominately used to manufacture such products as aluminum, gasoline, insulating foams, plastics, refrigerants, steel, and uranium fuel. Most fluorspar consumption and trade involve either acid grade (also called acidspar), which is greater than 97% calcium fluoride (CaF_2), or subacid grade, which is 97% or less CaF_2. Subacid grade includes metallurgical and ceramic grades and is commonly called metallurgical grade or metspar.

Legislation and Government Programs

The European Union's (EU) mobile air-conditioning (MAC) directive became fully applicable on January 1, 2013. The MAC directive is part of the EU's F-Gas Regulation (842/2006) intended to reduce specific fluorinated greenhouse gas emissions from air-conditioning (A/C) systems in passenger cars and light commercial vehicles. The directive requires that A/C refrigerants in all new model vehicles sold after January 1, 2013, and all cars sold after 2017 have a global warming potential (GWP) of less than 150. The GWP represents how much a given mass of a chemical contributes to global warming during a given time period compared to the same mass of carbon dioxide (CO_2). The GWP of CO_2 is defined as 1.0. This regulation spurred the development of hydrofluoroolefin 1234yf (HFO-1234yf), which was developed to replace the current standard A/C refrigerant hydrofluorocarbon-134a (HFC-134a). The Society of Automotive Engineers' International Cooperative Research Project judged the new compound to be safe and effective in automotive applications (Honeywell International Inc., 2013b). HFO-1234yf could be a major downstream consumer use of acid-grade fluorspar if similar regulations were adopted globally.

Production

In 2013, small amounts of fluorspar were produced in Illinois by Hastie Mining & Trucking as a byproduct of limestone mining operations, but no attempt was made to collect data on quantities produced. The U.S. Geological Survey (USGS) has no data survey for synthetic fluorspar produced in the United States. FSA was produced as a byproduct from the processing of phosphate rock into phosphoric acid. Domestic production data for FSA were developed by the USGS from a voluntary canvass of U.S. phosphoric acid operations known to recover FSA. Of the five FSA operations surveyed, responses were received from all, representing 100% of the total sold or used by producers.

In 2013, three companies—J.R. Simplot Co., Mosaic Fertilizer LLC (a subsidiary of The Mosaic Co.), and PCS Phosphate Co., Inc.—produced marketable byproduct FSA at five phosphoric acid plants (part of phosphate fertilizer operations) in Florida, Louisiana, North Carolina, and Wyoming. Production in 2013 was reported to be 74,300 metric tons (t) (equivalent to about 131,000 t of fluorspar grading 92% CaF_2).

Some synthetic fluorspar was recovered as a byproduct of petroleum alkylation, stainless steel pickling, and uranium processing. The actual amount of synthetic fluorspar recovered was unknown. Uranium processing has the potential to generate significant amounts of byproduct fluorspar, but problems exist with respect to the grade, moisture content, and grain size. In 2013, only small amounts of byproduct fluorspar from this source were marketed.

Hastie Mining & Trucking, Core Metals Group (Aurora, IN), and Seaforth Mineral & Ore Co., Inc. (East Liverpool, OH) marketed screened and dried imported acid- and metallurgical-grade fluorspar. Hastie Mining & Trucking also screened and sold small amounts of byproduct fluorspar from the company's limestone quarry operation.

Hastie Mining & Trucking began fluorspar ore production from its Klondike II underground fluorspar mine in Livingston County, KY. Ore was stockpiled for future processing into metallurgical and acid grades (Donald Hastie, Hastie Mining & Trucking Co., oral commun., May 12, 2014). The ore is of relatively high grade (52% CaF_2 according to phase 1 drilling results) with few impurities. The company installed heavy media gravity separation and briquetting equipment for processing the ore. The company also owns a flotation plant which would require extensive renovation to become operational.

Consumption

Domestic consumption data were developed by the USGS from a quarterly survey of two large consumers that provide data on hydrofluoric acid (HF) consumption and five distributors that provide data on the merchant market (metallurgical and other uses). Responses were received by five of the seven companies and estimates were made for the two nonrespondents based on prior years' data and industry sources where available. These combined data comprise 100% of the reported consumption in table 2.

Industry practice has established three grades of fluorspar—acid grade, containing more than 97% CaF_2; ceramic grade, containing 85% to 95% CaF_2; and metallurgical grade, normally containing 60% to 85% CaF_2. Fluorspar grades are defined by the intended use, but these grades are essentially ranges derived from customer and supplier specifications. For reasons ranging from availability to economics to process changes, U.S. consumers have been moving toward the use of higher grade fluorspar. For example, welding rod manufacturers may use acid-grade rather than ceramic-grade fluorspar, and some steel mills use ceramic or acid grade rather than metallurgical grade.

Total reported U.S. fluorspar consumption was 441,000 t, a 6% increase compared with that of 2012 (table 2). Consumption data for the two HF producers has been combined with "Other" uses in table 2 to avoid disclosing company proprietary data. Apparent consumption (normally defined as production plus imports minus exports plus or minus changes in stocks) increased by 4% to 548,000 t. The large difference between the reported and apparent consumption totals was likely the result of incomplete reported consumption data and inaccurate import data. Uncertainty exists regarding the accuracy of some U.S. fluorspar import statistics during the past 3 years. It is possible that Mexican fluorspar is moving through ports in the United States for reexport but not being properly reported in the U.S. trade statistics.

Acid-grade fluorspar, which accounted for 93% of the total U.S. reported fluorspar consumption, was used primarily as a feedstock in the manufacture of HF. Two companies reported fluorspar consumption for the production of HF in 2013—E.I. du Pont de Nemours and Co., Inc. (DuPont) and Honeywell International Inc. Fluorspar consumption for HF production increased compared with that of 2012, although data for the 2 years may not be directly comparable because DuPont's HF plant was shut down for maintenance for much of the fourth quarter in 2012. Because most acid-grade fluorspar is converted to HF before consumption, HF uses and markets are key to analyzing fluorspar consumption.

The leading use of HF was for the production of a wide range of fluorocarbon chemicals, including hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs), fluoroelastomers, and fluoropolymers. Production of these compounds accounted for about 75% of domestic HF consumption and 40% of world HF consumption. Major U.S. producers were Arkema Inc., DuPont, Honeywell International, Mexichem Fluor, Inc., MDA Manufacturing Ltd., and Solvay Solexis Inc.

Internationally, acid-grade fluorspar was used in the production of aluminum fluoride (AlF_3) and cryolite (Na_3AlF_6), which are the main fluorine compounds used in primary aluminum smelting. Alumina (Al_2O_3) is dissolved in a bath that consists primarily of molten cryolite and small amounts of AlF_3 and fluorspar to allow electrolytic recovery of aluminum. During the aluminum smelting process, the amount of excess sodium in the bath (a result of impurities in the alumina) is controlled by the addition of AlF_3, which reacts with the sodium to form cryolite. This reaction results in excess bath material, which is drawn off in a liquid form, allowed to cool and solidify, and can then be crushed and reused to start up new pots or to compensate for electrolyte losses. This excess material is variously called crushed tapped bath, secondary cryolite, bath cryolite, as well as other terms. In the aluminum smelting process, AlF_3 also is used to replace fluorine losses (either absorbed by the bath walls or captured as emissions). Most AlF_3 is produced directly from acid-grade fluorspar or from byproduct FSA. The United States ceased production of AlF_3 in 2008 when Alcoa World Alumina LLC (a business unit of Alcoa Inc.) closed its Point Comfort, TX, production facility. The AlF_3 requirements of U.S. aluminum industry were met through imports in 2013 (table 8).

The merchant fluorspar market in the United States included sales of metallurgical- and acid-grade material mainly to steel mills, where it was used primarily as a fluxing agent to increase the fluidity of the slag. Sales were also made to smaller markets such as cement plants, foundries, glass and ceramics plants, and welding rod manufacturers in railcar, truckload, and less-than-truckload quantities. Complete data on merchant fluorspar sales cannot be shown because consumption of acid-grade fluorspar for HF production has been combined with other uses in table 2 to prevent disclosure of company proprietary data. During the past 20 to 30 years, fluorspar usage in such industries as steel and glass has declined because of product substitutions or changes in industry practices. In the United States, reported consumption of fluorspar in metallurgical markets (mainly steel) decreased by 7% compared with that of 2012. Consumption in this sector was 73% metallurgical grade and 27% acid grade.

In the United States, FSA is used primarily for water fluoridation, but it also is used as a metal surface treatment and cleaner and for pH adjustment in industrial textile processing or laundries. It also can be used in the processing of animal hides, for hardening masonry and ceramics, and in the manufacture of other chemicals. In 2013, quantities of byproduct FSA sold or used totaled 73,900 t (equivalent to about 130,000 t of fluorspar grading 92% CaF_2), with the vast majority going for water fluoridation.

Fluorochemical news

Honeywell International announced that it was constructing an HFO-1234yf manufacturing plant at the company's existing HF and refrigerants manufacturing site in Geismar, LA. Plans called for the new plant to be fully operational in 2016. Global automobile manufacturers are adopting HFO-1234yf as the replacement for HFC-134a to comply with legislation and regulations designed to reduce greenhouse gas emissions by eliminating or reducing the use of high-GWP chemicals (Honeywell International Inc., 2013a). According to the news release, recent research has indicated that HFO-1234yf has a lower GWP than CO_2 making it an excellent replacement for HFC-134a, which in comparison has a GWP of 1,300 (Honeywell International Inc., 2013c).

Honeywell International also announced that it was suspending HF production at its plant in Amherstburg, Ontario, Canada, for at least 2 years. The company cited lower demand for HF as the reason for the suspension. At the time of the announcement (July), the plant was undergoing regularly scheduled maintenance. Once completed, the plant was to resume operations until it had depleted its current supply of raw materials (CBC News, 2013).

Babcock & Wilcox Conversion Services LLC announced that between October 1, 2011, and March 1, 2013, it shipped more than 7.6 million liters of HF. The company processed depleted uranium hexafluoride (DUF6) at special treatment facilities constructed at U.S. Government gaseous diffusion plants in Kentucky and Ohio. The process reduces the hazards associated with DUF6 by converting the DUF6 to depleted uranium dioxide (UO_2), depleted triuranium octoxide (U_3O_8), and HF. The UO_2 and U_3O_8 are more stable compared with DUF6 and are acceptable for near-surface disposal at low-level radioactive waste disposal sites. The DUF6 was a byproduct of uranium enrichment performed at the two gaseous diffusion facilities, which over decades had accumulated 700,000 t of the material. In 1998, Congress mandated (Public Law 105–204) that these materials be converted to a stable chemical form that was acceptable for transportation, beneficial reuse, or disposal. Both conversion plants went online in 2010, and the project was expected to take approximately 25 years (Babcock & Wilcox Conversion Services LLC, 2013; U.S. Department of Energy, [undated]).

Stocks

Data for stocks were available from some fluorspar distributors and the two large HF producers. Known consumer and distributor stocks at the end of 2013 totaled 313,000 t, an increase of nearly 34% compared with those at yearend 2012. Explanations for the large increase in stocks include reduced consumption caused by lower demand and the two major consumers (DuPont and Honeywell International) hedging against future fluorspar price increases by increasing stocks while prices are low.

U.S. Government stocks of fluorspar are currently zero. Government stocks of fluorspar were, however, maintained from 1943 until 2006.

Transportation

The United States depends on imports for most of its fluorspar supply. Metallurgical-grade fluorspar is shipped routinely as lump or gravel, with the gravel passing a 75-millimeter (mm) sieve and not more than 10% by weight passing a 9.5-mm sieve. Acid-grade fluorspar is shipped in the form of damp filtercake that contains 7% to 10% moisture to facilitate handling and to reduce dust. This moisture is removed by heating the filtercake in rotary kilns or other dryers before treating with sulfuric acid to produce HF. Acid-grade imports from China and South Africa are usually shipped by ocean freight using bulk carriers of 10,000- to 50,000-t deadweight capacity; ships in this size range are termed “handymax.” Participants negotiate freight levels, terms, and conditions. Some of the acid grade and ceramic grade is marketed in bags for small users and shipped by truck.

Prices

In 2013, owing to reduced global demand, there were significant price decreases reported for Chinese acidspar and Mexican high-arsenic acidspar (table 3). According to Industrial Minerals magazine, the yearend 2013 price range for acidspar filtercake, free-on-board (f.o.b.) China, decreased by 21% compared with that of yearend 2012. The price range for Mexican high-arsenic acidspar, f.o.b. Tampico, decreased by nearly 18%.

Foreign Trade

In 2013, U.S. exports of fluorspar decreased 33% to 16,000 t compared with those of 2012 (table 4). With the absence of fluorspar stocks in the National Defense Stockpile and only a small amount of mined or byproduct fluorspar, exports are likely reexports of imported material. The leading recipients of U.S. exports were Canada (87%) and Brazil (8%).

In 2013, imports for consumption of fluorspar increased by nearly 4% compared with those of 2012 (table 5). The leading suppliers of fluorspar to the United States were Mexico (74%), China (11%), South Africa (8%), and Mongolia (7%).

The following imports are compared with those of 2012. Imports of HF decreased by about 11% to 119,000 t (table 6); the majority of HF imports were from Mexico (86%), with Canada (8%) and China (4%) supplying most of the balance. Imports of cryolite increased by 133% to 18,900 t (table 7). The large increase was mostly the result of increased imports of byproduct cryolite from aluminum smelting operations. AlF_3 imports decreased by 13% to 43,400 t (table 8), with almost all coming from three countries—Mexico (51%), China (26%), and Canada (23%).

World Review

The global fluorspar industry experienced a slow year as slumping prices resulted in reduced production by most exporting countries and scheduling delays for ongoing development projects. World fluorspar production decreased to 6.77 million metric tons; a substantial portion of the decrease was the result of a substantial decrease in Mongolia’s production (table 9).

Afghanistan.—Amania Mining Co. (Kabul) started production at its Bakhud fluorspar mine in Uruzgan Province in south-central Afghanistan. The Bakhud fluorite deposit was explored between 1969 and 1975 by Soviet geologists who conducted regional and geologic mapping, geochemical surveys, trenching, sampling, and exploratory drilling. The deposit consists of a number of tabular zones dipping 5° to 20° with estimated resources totaling 8.8 Mt averaging about 47% CaF_2. Initial operations involved surface mining of the deposit and production of metallurgical and ceramic grades for export. Future plans include construction of a flotation plant (Amania Mining Co., 2014).

Canada.—Canada Fluorspar Inc. reported new mineral resources for its Director Vein and AGS Vein (formerly the Grebes Nest Vein) deposits in the St. Lawrence area of Newfoundland and Labrador. The indicated resources were 2.1 Mt at an average grade of 51.0% CaF_2, and the inferred resources were 8.5 Mt at an average grade of 42.2% CaF_2. These new resource data were based on recent drilling at the down-dip and southern extensions of the Director Vein as well as the western part of the AGS Vein (Canada Fluorspar Inc., 2013). The Director Vein had been mined from 1936 to 1978 and from 1986 to 1991. Canada Fluorspar's Newspar fluorspar project (jointly owned with Arkema S.A.) in the same St. Lawrence area remained under review at yearend.

Mongolia.—ARViN monspar, which holds a number of mining licenses in central and eastern Mongolia, explored fluorspar resources in the Choir area of central Mongolia with the goal of developing mining and mineral-processing facilities to produce acid-grade fluorspar. The company conducted a major exploration program between 2011–13, which involved analyzing previous geologic and drill-hole data, performing new drilling, and conducting beneficiation tests on process samples. Indications were that the company had discovered substantial fluorspar resources, although at relatively low ore grades, which would require upgrading prior to flotation. Project plans called for open pit mining followed by dense media separation to upgrade the ore followed by flotation. A statement announcing Joint Ore Reserves Committee-compliant resources on one of the company's project areas was expected in early 2014. Commissioning of the operation was projected to be in the 2015 to 2016 timeframe (ARViN monspar, 2013).

Russia.—United Company RUSAL (RUSAL) announced in September that it was mothballing its wholly owned fluorspar mining operation, JSC Yaroslavskaya Mining Co., located in Russia's far eastern Primorye territory, in order to modernize it and because of low ore quality. After modernization, the mining company expects to be able to produce higher grade fluorspar products and, as a result, attract regular purchase orders. RUSAL did not say when the enterprise would restart, although the territory's Federation of Trade Unions was told that the closure would extend until spring of 2016 (Interfax Information Services, B.V., 2013). JSC Yaroslavskaya was Russia's leading fluorspar producer and its closure will substantially increase Russia's fluorspar import dependence during the period of its shutdown.

South Africa.—Sephaku Fluoride Ltd. (SepFluor) issued contracts to install a fluorspar beneficiation plant (crushing and screening) and a flotation mill at SepFluor's Nokeng Mine project in Gauteng Province. Both plants were expected to be in operation by yearend 2017 (Hindu Business Line, The, 2013). SepFluor's plans call for production of up to 185,000 metric tons per year (t/yr) of acid-grade fluorspar and a maximum of 30,000 t/yr of metallurgical-grade fluorspar. An HF plant and an AlF_3 plant that would consume 130,000 t/yr of acidspar with the balance of the acidspar available for export also were planned. Original plans called for mine production to begin in late 2014 (Sephaku Fluoride Ltd., 2013).

Outlook

The outlook for fluorspar has some long-term concerns that include environmental pressures opposing the use of some fluorochemical products, safety concerns regarding the use of HF, availability of future fluorspar supplies, and a shift in fluorspar-consuming industries to Asia. The downturn in global fluorspar consumption that began in 2012 continued in 2013. This was precipitated by a slowdown in China's economy, resulting in low-capacity-utilization rates of China's AlF_3 and HF plants. In addition, China's production of certain fluorocarbons has resulted in a global surplus and depressed prices for these fluorocarbons. The circumstances in China led to reduced fluorocarbon production in other countries and reduced demand for the acid-grade fluorspar required to produce the HF feedstock.

Long-term demand for fluorspar may depend on the development and acceptance of alternatives to fluorocarbon refrigerants, which are likely to be phased out owing to high GWP. Strong replacement candidates are the hydrofluoroolefins HFO-1234yf, HFO-1234ze, and HFO-1233zd. These compounds all have low GWP and rapidly break down in the atmosphere. For the fluorspar industry, they also have the advantage of containing greater amounts of fluorine (thus requiring more fluorspar to manufacture) compared with some of the compounds they would replace.

Major markets for fluorspar in developed countries have been stagnant or have decreased as downstream production of HF and fluorocarbons have moved to China, and aluminum smelting capacity has moved to countries or regions with access to abundant, low-cost energy. This shift is evident in the increasing HF and fluorocarbon production capacity in China and the reduced production capacities in traditional production areas in Europe, Japan, and North America. China is already the world's leading fluorspar consumer, and its share of global consumption will likely continue to increase in the future.

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TABLE 1
SALIENT FLUORSPAR STATISTICS[1, 2]

		2009	2010	2011	2012	2013
United States:						
Exports:[3]						
Quantity	metric tons	14,100	17,900	24,100	23,800	16,000
Value[4]	thousands	$2,230	$2,740	$3,780	$3,640	$2,520
Imports for consumption:[3]						
Quantity	metric tons	475,000	539,000	727,000	620,000	643,000
Value[5]	thousands	$105,000	$103,000	$154,000	$157,000	$147,000
Consumption:						
Reported	metric tons	593,000 r	503,000 r	456,000	416,000	441,000
Apparent[6]	do.	473,000	492,000	672,000	525,000	548,000
Stocks, December 31:						
Consumer and distributor	do.	103,000	131,000	162,000	234,000	313,000
World, production[e]	do.	6,300,000 r	6,940,000 r	6,800,000 r	7,170,000 r	6,770,000

[e]Estimated. [r]Revised. do. Ditto
[1]Data are rounded to no more than three significant digits.
[2]Does not include byproduct or synthetic fluorspar production.
[3]Source: U.S. Census Bureau; data may be adjusted by the U.S. Geological Survey.
[4]Free alongside ship values at U.S. ports.
[5]Cost, insurance, and freight values at U.S. ports.
[6]Imports minus exports plus adjustments for changes in stocks.

TABLE 2

U.S. REPORTED CONSUMPTION OF FLUORSPAR, BY END USE[1]

(Metric tons)

End use or product	Containing more than 97% calcium fluoride 2012	Containing more than 97% calcium fluoride 2013	Containing not more than 97% calcium fluoride 2012	Containing not more than 97% calcium fluoride 2013	Total 2012	Total 2013
Hydrofluoric acid	W	W	--	--	W	W
Metallurgical	12,000	12,000	35,800	32,200	47,800	44,200
Other[2]	368,000	397,000	--	--	368,000	397,000
Total	380,000	409,000	35,800	32,200	416,000	441,000
Stocks, consumer, December 31	219,000	293,000	15,100	19,800	234,000	313,000

W Withheld to avoid disclosing company proprietary data; included in "Other." -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]May include cement, enamel, glass and fiberglass, hydrofluoric acid, steel castings, and welding rod coatings.

TABLE 3

PRICES OF IMPORTED FLUORSPAR

(Dollars per metric ton)

Source and grade	2012	2013
Acidspar:		
Chinese, dry basis, cost, insurance, and freight (c.i.f.) Gulf port, filtercake	480–600	480–530
Chinese, free on board (f.o.b.) China, wet filtercake	400–415	310–330
Mexican, f.o.b. Tampico, filtercake	400–450	350
Mexican, f.o.b. Tampico, arsenic <5 parts per million	540–550	540–550
South African, f.o.b. Durban, filtercake	380–450	380–450
Metspar, Mexican, f.o.b. Tampico	230–270	230–270

Source: Industrial Minerals magazine (London).

TABLE 4

U.S. EXPORTS OF FLUORSPAR, BY COUNTRY[1]

Country	2012 Quantity (metric tons)	2012 Value[2]	2013 Quantity (metric tons)	2013 Value[2]
Australia	88	$12,800	115	$12,800
Bahrain	--	--	11	3,150
Bolivia	27	3,900	--	--
Brazil	--	--	1,350	198,000
Canada	15,200	2,440,000	13,900	2,180,000
China	18	14,900	--	--
Dominican Republic	240	42,600	396	89,000
France	71	8,000	--	--
Germany	271	30,300	--	--
Indonesia	5	3,520	--	--
Israel	11	3,290	--	--
Malaysia	--	--	35	5,050
Mexico	512	60,700	50	9,100
Netherlands	--	--	46	6,600
Peru	--	--	4	3,240
Taiwan	5,360	780,000	17	10,700
Trinidad and Tobago	1,990	239,000	--	--
Venezuela	16	4,700	--	--
Total	23,800	3,640,000	16,000	2,520,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Free alongside ship values at U.S. ports.

Source: U.S. Census Bureau.

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF FLUORSPAR, BY COUNTRY AND CUSTOMS DISTRICT[1]

Country and customs district	2012 Quantity (metric tons)	2012 Value[2] (thousands)	2013 Quantity (metric tons)	2013 Value[2] (thousands)
Containing more than 97% calcium fluoride (CaF_2):				
China:				
Houston, TX	71,800	$38,800	49,000	$20,000
Mobile, AL	--	--	597	340
New Orleans, LA	8,960	4,440	20,900	7,560
New York, NY	44	25	110	76
Total	80,800	43,300	70,600	28,000
Germany, Cleveland, OH	17	18	26	16
Mexico:				
Baltimore, MD	1,380	850	1,380	854
Houston, TX	3,370	1,470	4,420	1,980
Laredo, TX	46,600	22,200	38,300	15,300
New Orleans, LA	252,000	46,200	308,000	52,900
Total	303,000	70,700	352,000	71,100
Mongolia, Houston, TX	9,910	4,890	38,200	16,300
South Africa:				
Houston, TX	52,300	16,000	51,300	18,900
New Orleans, LA	5,320	1,940	--	--
Total	57,600	17,900	51,300	18,900
Spain, Houston, TX	12,000	4,440	--	--
United Kingdom:				
Houston, TX	87	65	32	30
Los Angeles, CA	194	101	243	125
Total	281	166	275	156
Grand total	464,000	141,000	512,000	134,000
Containing not more than 97% CaF_2:				
China, Cleveland, OH	271	39	--	--
Mexico:				
Baltimore, MD	--	--	14	6
Cleveland, OH	238	26	119	14
Laredo, TX	5,190	713	3,650	646
New Orleans, LA	149,000	14,500	122,000	11,800
Total	155,000	15,200	126,000	12,500
Mongolia:				
Cleveland, OH	--	--	1,890	200
Mobile, AL	1,050	98	2,350	220
Total	1,050	98	4,230	420
Namibia, Houston, TX	419	37	--	--
Grand total	156,000	15,400	130,000	12,900
Grand total, all grades	620,000	157,000	643,000	147,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

Source: U.S. Census Bureau.

TABLE 6

U.S. IMPORTS FOR CONSUMPTION OF HYDROFLUORIC ACID, BY COUNTRY[1]

	2012		2013	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Belgium	(3)	$11	--	--
Canada	10,800	31,300	9,430	$26,400
China	5,890	8,260	5,320	6,880
Germany	233	608	682	1,740
Hong Kong	37	52	--	--
India	60	97	49	73
Japan	1,310	3,150	1,300	2,800
Korea, Republic of	21	24	--	--
Liechtenstein	2	104	--	--
Mexico	114,000	188,000	102,000	160,000
Singapore	113	425	97	348
South Africa	12	30	3	12
Spain	150	464	170	485
Taiwan	47	140	60	129
United Kingdom	1	138	--	--
Total	133,000	233,000	119,000	199,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF CRYOLITE, BY COUNTRY[1]

	2012		2013	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Canada	962	$425	3,970	$1,900
China	1,350	1,030	1,320	812
Croatia	20	31	--	--
Germany	2,190	3,110	1,800	2,260
Hungary	322	489	222	339
Iceland	--	--	973	575
India	--	--	28	18
Japan	2,760	4,170	3,800	5,020
Mozambique	81	74	--	--
Slovakia	--	--	6	7
Spain	2	6	231	84
United Kingdom	455	803	6,590	1540
Total	8,140	10,100	18,900	12,600

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Cost, insurance, and freight values at U.S. ports.

Source: U.S. Census Bureau.

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

	2012		2013	
Country	Quantity (metric tons)	Value[2] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Canada	16,800	$16,900	9,910	$11,500
China	10,800	17,800	11,200	16,500
Mexico	22,200	30,900	22,200	30,000
Other[3]	180	231	5	27
Total	50,000	65,900	43,400	58,100

[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Cost, insurance, and freight values at U.S. ports.
[3]Includes all countries with quantities less than 1,000 metric tons.

Source: U.S. Census Bureau.

TABLE 9
FLUORSPAR: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country[3, 4]	2009	2010	2011	2012	2013[e]
Argentina	13,424	17,657	25,099	18,000 [e]	18,000
Brazil, marketable:					
Acid grade	28,803	6,295	6,197	5,768 [r]	6,200
Metallurgical grade	15,161	18,152	18,843	18,380 [r]	18,900
Total	44,000	24,400	25,000	24,100 [r]	25,100
Bulgaria	--	--	31,800 [r, 5]	69,700 [r, 5]	60,000
China:[e]					
Acid grade	1,600,000	2,100,000	2,000,000	2,100,000 [r]	2,000,000
Metallurgical grade[6]	2,200,000	2,500,000	2,200,000	2,300,000 [r]	2,400,000
Total	3,800,000	4,600,000	4,200,000	4,400,000 [r]	4,400,000
Egypt	500	500	500	500	500
Germany, acid grade	49,962	59,086	65,619	54,202 [r]	55,000
India:[7]					
Acid grade	8,786	8,400	8,500	8,600	8,700
Metallurgical grade	4,996	4,600	4,800	5,000	5,100
Total	13,800	13,000	13,300	13,600	13,800
Iran[8]	71,409 [9]	72,000	55,976 [r, 9]	60,000 [r, e]	70,000
Kazakhstan[e]	65,000	65,000	65,000	65,000	65,000
Kenya, acid grade	15,667	44,500	117,420	110,000	48,500
Kyrgyzstan[e]	1,600	500	550	500	500
Mexico:					
Acid grade	640,676	719,122	731,456	749,608 [r]	739,000
Metallurgical grade	405,264	348,264	475,451	487,483 [r]	493,000
Total	1,050,000	1,070,000	1,210,000	1,240,000 [r]	1,230,000 [10]
Mongolia:[11]					
Acid grade[12]	115,300	140,700	116,400	157,200	76,400
Other grades	344,200	259,000 [e]	232,000 [e]	314,000	150,000
Total	460,000	400,000 [e]	348,000 [e]	471,000	226,000
Morocco, acid grade	69,091	75,380	79,207	80,000	76,000
Namibia, acid grade[13, 14]	73,580	95,092	84,480 [r]	67,500 [r]	50,000
Pakistan, metallurgical grade[e]	1,400	1,500	3,156 [r, 9]	6,866 [r, 9]	6,000
Romania, metallurgical grade[e]	15,000	15,000	--	--	--
Russia[e]	127,300 [r, 9]	67,000 [r, 9]	119,800 [r, 9]	129,000 [r, 9]	80,000
South Africa:[e, 15]					
Acid grade	196,000	150,000	225,000	210,000	160,000
Metallurgical grade	8,000	10,000	15,000	15,000	15,000
Total	204,000	160,000	240,000	225,000	175,000

See footnotes at end of table.

TABLE 9—Continued

FLUORSPAR: WORLD PRODUCTION, BY COUNTRY[1, 2]

(Metric tons)

Country[3, 4]	2009	2010	2011	2012	2013[e]
Spain:					
Acid grade	111,810	126,730	109,284	120,000	109,000
Ceramic grade	6,485	1,824	2,639	2,640	2,600
Metallurgical grade	4,238	3,787	5,410	5,450	5,400
Total	123,000	132,000	117,000	128,000	117,000
Thailand[16]	86,365	2,222	5,093	9,602 [r]	9,000
United Kingdom	18,536	26,420	--	--	45,000
Vietnam[e]	NA [r]	NA [r]	NA [r]	NA [r]	NA
Grand total[e]	6,300,000 [r]	6,940,000 [r]	6,800,000 [r]	7,170,000 [r]	6,770,000

[e]Estimated. [r]Revised. NA Not available. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes data available through May 16, 2014.

[3]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.

[4]In addition to the countries listed, Afghanistan, North Korea, Vietnam, and some other nations may produce fluorspar, but output data are not reported; available general information is inadequate to formulate reliable estimates of output levels.

[5]Data were provided by British Geological Survey.

[6]Includes submetallurgical-grade fluorspar used primarily in cement that may account for 33% to 50% of the quantity.

[7]Year beginning April 1 of that stated.

[8]Year beginning March 21 of that stated.

[9]Reported figure.

[10]Reported figure is rounded. Quantities by grade are estimated.

[11]Data are reported by the Mineral Resource Authority of Mongolia.

[12]Flotation concentrate, including less than 97% CaF_2 material.

[13]Data were in wet tons, but have been converted to dry tons to agree with other data in the table.

[14]Prior to 2011 all production was acid grade, but beginning in 2011 data also included an unspecified amount of metallurgical grade.

[15]Data for 2009 to 2012 based on data from the South African Minerals Bureau; data show estimated proportions of acid-grade and metallurgical-grade fluorspar within the reported totals.

[16]Data for 2009 to 2012 are as reported by the Thailand Bureau of Economics and International Cooperation, Department of Primary Industries and Mines.