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# 2014 Minerals Yearbook

## FLUORSPAR [ADVANCE RELEASE]

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

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# Fluorspar

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In 2014, most of the fluorspar consumed in the United States was from imports and small amounts of byproduct synthetic fluorspar produced from industrial waste streams. Although not included in fluorspar production or consumption calculations, byproduct fluorosilicic acid (FSA) production from some phosphoric acid producers supplemented fluorspar as a domestic source of fluorine. Apparent consumption of fluorspar decreased by 5%. Despite falling prices, estimated world production remained relatively stable at 6.39 million metric tons (Mt) as compared with 6.38 Mt in 2013.

Fluorspar, the mineral form of calcium fluoride ($CaF_2$), also known as fluorite, is the primary source of fluorine in industrial applications. Globally, fluorspar is used directly as a flux in steelmaking and in the production of aluminum fluoride ($AlF_3$) and hydrofluoric acid (HF). HF may be used directly in manufacturing processes, such as cleaning of semiconductors and circuit boards, metal pickling, petroleum alkylation, and uranium processing, or as a precursor in the manufacture of a wide variety of fluorocarbons used as aerosols, insulating foams, plastics, and refrigerants. Most of the fluorspar consumed and traded is either acid grade (also called acidspar), which is greater than 97% $CaF_2$, 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 U.S. Environmental Protection Agency issued two notices of proposed rulemaking that would affect the status of various hydrofluorocarbons (HFCs) and HFC blends under its Significant New Alternatives Policy Program. The first rule would list four flammable refrigerants, one HFC, and three hydrocarbons as acceptable substitutes for ozone-depleting substances, subject to certain use limitations. The second rule would list as unacceptable or strictly limit the use of many HFCs and HFC blends previously listed as acceptable (U.S. Environmental Protection Agency, 2014a, b). Certain hydrochlorofluorocarbons (HCFCs) already being phased out under the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) would also be listed as unacceptable. The substances encompass a broad variety of end uses such as aerosols, foam-blowing agents, and refrigerants.

At a meeting sponsored by the White House, administration officials met with industry leaders and trade groups representing companies involved in the manufacture and use of refrigerant gases. The primary focus was to discuss reducing emissions from higher global warming potential (GWP) HFCs. There was broad support expressed for an amendment to the Montreal Protocol that was submitted by Canada, Mexico, and the United States, that would phase down production and consumption of HFCs (U.S. Department of State, 2014). In conjunction with the meeting, numerous companies announced voluntary initiatives to improve efficiencies in heating and refrigeration systems, reduce emissions, and invest in the manufacture and use of alternatives to HFCs, such as hydrofluoroolefin (HFO) and hydrocarbon refrigerants (Council on Environmental Quality, 2014).

The European Parliament adopted new regulations on fluorinated gases (f-gases), including HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride ($SF_6$). This measure superseded the original regulation passed in 2006. The measure's intent is to reduce the European Union's (EU's) f-gas emissions by two-thirds by 2030 compared with 2014 levels. The measure institutes a more aggressive phase-down schedule, increased restrictions on manufacture and use, and stringent reporting requirements for many higher GWP f-gases, including aerosols, foam-blowing agents, and refrigerants. The measure also seeks to reduce f-gas emissions by improving equipment servicing and maintenance and recovering f-gases at the end of the equipment's life cycle (European Commission, undated).

The EU's Joint Research Centre issued a report validating the safety of the HFO refrigerant R-1234yf in mobile air-conditioning systems. R-1234yf was originally developed under a joint agreement between E.I. du Pont de Nemours & Co. Inc. (DuPont) and Honeywell International Inc. (Honeywell) as a replacement for the higher GWP HFC R-134a. The review of scientific literature on safety of the refrigerant was undertaken after Daimler AG raised concerns over its flammability (European Commission, 2014b).

The EU notified DuPont and Honeywell that their cooperation on the development and manufacture of the HFO refrigerant R-1234yf may have violated antitrust rules (European Commission, 2014a). DuPont and Honeywell are currently the only two suppliers of the refrigerant. Both DuPont and Honeywell issued statements indicating that the collaboration on the new refrigerant was critical to timely compliance with the EU's Mobile Air-Conditioning Directive, was consistent with EU law, and that they expect to be fully exonerated (E.I. du Pont de Nemours & Co. Inc., 2014; Honeywell International Inc., 2014).

The U.S. International Trade Commission ruled that U.S. industry has not been materially harmed by imports of the refrigerant R-134a from China. The original petition had been filed in October 2013 by Mexichem Fluor, Inc. of St. Gabriel, LA, one of three U.S. producers of the refrigerant. As a result of the ruling, no countervailing or antidumping duties will be imposed (U.S. International Trade Commission, 2014).

## Production

In 2014, small amounts of fluorspar may have been produced in Illinois by Hastie Mining & Trucking as a byproduct of limestone mining operations, but no data were collected on quantities produced. Synthetic fluorspar may have been produced as a byproduct of petroleum alkylation, stainless steel pickling, and uranium processing. However, 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 active FSA operations surveyed, responses were received from four, representing an estimated 97% of the total sold or used by producers. In 2014, 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 2014 was reported to be 70,100 metric tons (t) (equivalent to about 114,000 t of fluorspar grading 100% $CaF_2$).

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 continued stockpiling of ore from its Klondike II underground fluorspar mine in Livingston County, KY. The company has 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 HF consumption and five distributors that provide data on the merchant market (metallurgical and other uses). Responses were received by two of the seven companies and estimates were made for the five 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 97% or more $CaF_2$; ceramic grade, containing 85% to 97% $CaF_2$; 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.

Beginning in 2014, total reported U.S. fluorspar consumption was withheld to avoid disclosing company proprietary data (table 2). Apparent consumption (normally defined as production plus imports minus exports plus or minus changes in stocks) was estimated to have decreased by 5% to 518,000 t.

Acid-grade fluorspar, which accounted for approximately 77% of apparent consumption, was used primarily as a feedstock in the manufacture of HF. Two companies used fluorspar for the production of HF in 2014—DuPont and Honeywell. Fluorspar consumption for HF production decreased compared with that of 2013. 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 HCFCs, HFCs, HFOs, fluoroelastomers, and fluoropolymers. Major U.S. producers were Arkema Inc., DuPont, Honeywell, Mexichem Fluor, Inc., MDA Manufacturing Ltd., and Solvay Solexis Inc.

Internationally, acid-grade fluorspar was used in the production of $AlF_3$ and cryolite ($Na_3AlF_6$), which are essential 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, $AlF_3$ is also 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 $AlF_3$ requirements of the U.S. aluminum industry were met through imports in 2014 (table 8) because there are no active $AlF_3$ producers in the United States.

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 glass and steel 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 approximately 4% to 42,600 t compared with that of 2013.

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 2014, 70,100 t of byproduct FSA (equivalent to about 114,000 t of fluorspar grading 100% $CaF_2$) was produced, with the vast majority being sold for water fluoridation.

**Stocks**

Known consumer and distributor stocks at the end of 2013 totaled 313,000 t, the highest in the past 10 years. In 2014, reported stock data had to be withheld to avoid disclosing company proprietary data. However, reported data available through the third quarter showed that stocks had decreased to approximately 234,000 t, and were estimated to be 195,000 t at yearend 2014.

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 fluorspar is marketed in bags for small users and shipped by truck.

### Prices

In 2014, acidspar prices continued to decline (table 3). According to Industrial Minerals magazine, the yearend 2014 price range for acidspar filtercake from China, dry basis, cost, insurance, and freight Gulf port, decreased by nearly 30% to $340 to $370 per metric ton compared with that at yearend 2013. The price range for Mexican high-arsenic acidspar filtercake, free-on-board (f.o.b.) Tampico, decreased by approximately 11% to $290 to $330 per ton, and low arsenic acidspar from Mexico (arsenic less than 5 parts per million), f.o.b. Tampico, decreased by nearly 28% to $370 to $420 per ton.

### Foreign Trade

In 2014, U.S. exports of fluorspar decreased by 16% to 13,400 t compared with those of 2013 (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. More than 97% of exports went to Canada.

In 2014, imports for consumption of fluorspar were 414,000 t, a decrease of nearly 36% compared with those of 2013 (table 5). The leading suppliers of fluorspar to the United States were Mexico (77%), South Africa (9%), Mongolia (5%), and Vietnam (4%). Imports from China dropped to nearly zero, following a steady decline since 2007. From the mid-1990s to 2006, China's share of U.S. imports averaged approximately 60% annually.

The following imports are compared with those of 2013: imports of HF increased by about 5% to 125,000 t (table 6); the majority of HF imports were from Mexico (91%), with China (4%) and Canada (2%) supplying most of the balance. Imports of cryolite decreased by 14% to 16,200 t (table 7). $AlF_3$ imports decreased by 11% to 38,400 t (table 8), with almost all coming from three countries—Mexico (54%), China (36%), and Italy (8%).

### World Review

Production data for China for 2011 and 2012 were revised based on reports issued by the Government of China. For 2011, this revision increased China's previously reported production by 56%, which in turn affected total estimated world production, increasing it by more than 30% (table 9).

***China.***—Hunan Nonferrous Metals Corporation Ltd. and Hunan Nonferrous Metals Investment Ltd. established a joint venture, the Jinsha Fluorite Company, to recover fluorspar from tailings of the Huangshaping Mine. The mine processes lead, molybdenum, tungsten, and zinc. Although the mine had been estimated to contain a resource of approximately 9 Mt of fluorspar, it had been unable to process fluorspar owing to processing limitations. The company expects to produce 58,000 metric tons per year (t/yr) of acidspar and 38,000 t/yr of low-grade metspar through a two-stage flotation process (Hunan Nonferrous Metals Corporation Ltd., undated; Torrisi, 2014).

***Germany.***—Nickelhutte AUE GmbH commenced production at a new fluorspar mine in the Ore Mountains. The mine is expected to have a capacity of 40,000 t/yr of acid-grade fluorspar, which is expected to be sold in the domestic market (Miller, 2015).

***Kenya.***—The Government of Kenya revised the royalties levied on fluorspar products, increasing royalties in increments from 2% of gross sales value through the end of 2015 to 5% of gross sales value by July 2019 (Odongo, 2014).

***Namibia.***—Following 26 years of operation, Solvay S.A. announced it was indefinitely suspending operations at the Okorusu Fluorspar Mine due to the depletion of higher grade resources. The company had been unable to economically beneficiate the remaining ore owing to technical issues in the separation of gangue material and unfavorable market conditions. Although all 407 employees were slated to be terminated, 30 were to be rehired on a contractual basis to supervise care and maintenance and undertake a program of exploration and metallurgical testing on remaining resources (Solvay S.A., 2014).

***Spain.***—Arkema S.A. announced a plan to close its fluorochemical production plant in Zaramillo. The plant manufactures the HFC refrigerants R-32 and R-143a. In making the announcement, Arkema S.A. cited increased competition from China and the United States in the f-gas industry as well as the impending implementation of new European regulatory requirements in 2015 (Arkema S.A., 2014).

***United Kingdom.***—The Peak District National Park Authority granted British Fluorspar Ltd. permission to continue mining at the Milldam Mine until 2028. The mine, an underground operation near Great Hucklow and Eyam in Derbyshire County, currently produces about 65,000 t of acid-grade fluorspar and 10,000 t of barite annually. The company received permission to mine 2,000 hectares and approval to increase truck traffic to increase annual production to 150,000 t (British Fluorspar Ltd., 2014; Derbyshire Times, 2014).

## Outlook

The downturn in the global fluorspar market and downstream industries that began in 2012 continued throughout 2014. 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 and export of certain fluorocarbons resulted in a global surplus and depressed prices. This led to reduced fluorocarbon production in other countries and reduced demand for the acid-grade fluorspar required to produce the HF feedstock. 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.

Demand for refrigerants in developing countries such as China and India, as well as growth in highly specialized applications, such as anti-fingerprint coatings, fungicides, herbicides, insecticides, and pharmaceuticals, have been expected to lead market recovery. However, increased uses have been tempered by environmental and regulatory pressures on many fluorochemicals and emissions. Since the adoption of the Montreal Protocol in 1987, several classes of fluorocarbons including chlorofluorocarbons and HCFCs have been the subject of global reduction or phaseout owing to concerns over their ozone-depleting potential. These substances were largely replaced by HFCs, which, although not ozone depleting, in most cases are potent greenhouse gases owing to high GWP and long atmospheric life cycles. In 2014, developed countries, particularly in Europe and North America, not only introduced new measures to decrease domestic reliance on higher GWP HFCs, but also called for expanding the scope of the Montreal Protocol to address higher GWP substances as well.

Although previous changes in regulation of fluorocarbons under the Montreal Protocol cast uncertainty over the fluorspar market, replacement substances often contained more fluorine than previous generations, and subsequently increased the amount of fluorspar required for their manufacture. In the current cycle, however, although fluorinated options such as HFOs and lower GWP HFC blends have gained acceptance, numerous not-in-kind replacements, such as hydrocarbon refrigerants, have also been introduced. Current industry trends suggest that the next generation of these substances will include a more diverse array of options that includes both fluorinated and nonfluorinated materials.

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TABLE 1
SALIENT FLUORSPAR STATISTICS[1, 2]

| | | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| United States: | | | | | | |
| Exports:[3] | | | | | | |
| Quantity | metric tons | 17,900 | 24,100 | 23,800 | 16,000 | 13,400 |
| Value[4] | thousands | $2,740 | $3,780 | $3,640 | $2,520 | $2,200 |
| Imports for consumption:[3] | | | | | | |
| Quantity | metric tons | 539,000 | 727,000 | 620,000 | 643,000 | 414,000 |
| Value[5] | thousands | $103,000 | $154,000 | $157,000 | $147,000 | $105,000 |
| Consumption: | | | | | | |
| Reported | metric tons | 503,000 | 456,000 | 416,000 | 441,000 | W |
| Apparent[6] | do. | 492,000 | 672,000 | 525,000 | 548,000 | 518,000 |
| Fluorosilicic acid: | | | | | | |
| Production | metric tons | 71,600 | 70,300 | 73,600 | 74,300 | 70,100 |
| Sold and used | do. | 72,600 | 70,200 | 73,600 | 73,900 | 70,600 |
| Value[5] | thousands | $10,400 | $13,400 | $12,100 | $21,800 | $19,800 |
| Stocks, December 31: | | | | | | |
| Consumer and distributor | metric tons | 131,000 | 162,000 | 234,000 | 313,000 | 195,000 e |
| World, production[e] | do. | 7,040,000 r | 9,080,000 r | 6,880,000 r | 6,380,000 r | 6,390,000 |

[e]Estimated. do. Ditto. [r]Revised. W Withheld to avoid disclosing company proprietary data.
[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)

| | Containing more than 97% calcium fluoride | | Containing not more than 97% calcium fluoride | | Total | |
|---|---|---|---|---|---|---|
| End use or product | 2013 | 2014 | 2013 | 2014 | 2013 | 2014 |
| Hydrofluoric acid | W | W | -- | -- | W | W |
| Metallurgical | 12,000 | 12,000 | 32,200 | 30,600 | 44,200 | 42,600 |
| Other[2] | 397,000 | W | -- | -- | 397,000 | W |
| Total | 409,000 | W | 32,200 | 30,600 | 441,000 | W |
| Stocks, consumer, December 31 | 293,000 | W | 19,800 | 20,000 | 313,000 | 195,000 e |

[e]Estimated. W Withheld to avoid disclosing company proprietary data. -- 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 | 2013 | 2014 |
|---|---|---|
| Acidspar: | | |
| Chinese, dry basis, cost, insurance, and freight (c.i.f.) Gulf port, filtercake | 480–530 | 340–370 |
| Chinese, free on board (f.o.b.) China, wet filtercake | 310–330 | 290–310 |
| Mexican, f.o.b. Tampico, filtercake | 350 | 290–330 |
| Mexican, f.o.b. Tampico, arsenic <5 parts per million | 540–550 | 370–420 |
| South African, f.o.b. Durban, filtercake | 380–450 | 300–330 |
| 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]

| | 2013 | | 2014 | |
|---|---|---|---|---|
| Country | Quantity (metric tons) | Value[2] | Quantity (metric tons) | Value[2] |
| Australia | 115 | $12,800 | 88 | $12,800 |
| Bahrain | 11 | 3,150 | -- | -- |
| Brazil | 1,350 | 198,000 | 170 | 24,700 |
| Canada | 13,900 | 2,180,000 | 13,000 | 2,150,000 |
| China | -- | -- | 128 | 14,300 |
| Dominican Republic | 396 | 89,000 | -- | -- |
| Malaysia | 35 | 5,050 | -- | -- |
| Mexico | 50 | 9,100 | -- | -- |
| Netherlands | 46 | 6,600 | -- | -- |
| Peru | 4 | 3,240 | -- | -- |
| Taiwan | 17 | 10,700 | -- | -- |
| Total | 16,000 | 2,520,000 | 13,400 | 2,200,000 |

-- 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 | 2013 Quantity (metric tons) | 2013 Value[2] (thousands) | 2014 Quantity (metric tons) | 2014 Value[2] (thousands) |
|---|---|---|---|---|
| Containing more than 97% calcium fluoride ($CaF_2$): | | | | |
| China: | | | | |
| Houston, TX | 49,000 | $20,000 | -- | -- |
| Mobile, AL | 597 | 340 | 801 | $520 |
| New Orleans, LA | 20,900 | 7,560 | -- | -- |
| New York, NY | 110 | 76 | -- | -- |
| Total | 70,600 | 28,000 | 801 | 520 |
| Germany: | | | | |
| Cleveland, OH | 26 | 16 | 27 | 18 |
| Savannah, GA | -- | -- | 20 | 16 |
| Total | 26 | 16 | 47 | 35 |
| Mexico: | | | | |
| Baltimore, MD | 1,380 | 854 | 1,050 | 692 |
| Houston, TX | 4,420 | 1,980 | -- | -- |
| Laredo, TX | 38,300 | 15,300 | 22,500 | 8,100 |
| New Orleans, LA | 308,000 | 52,900 | 187,000 | 45,500 |
| Total | 352,000 | 71,100 | 210,000 | 54,300 |
| Mongolia: | | | | |
| Houston, TX | 38,200 | 16,300 | 8,880 | 3,510 |
| New Orleans, LA | -- | -- | 5,280 | 1,820 |
| Total | 38,200 | 16,300 | 14,200 | 5,330 |
| Netherlands, Houston, TX | -- | -- | 5 | 4 |
| South Africa, Houston, TX | 51,300 | 18,900 | 38,000 | 11,700 |
| Spain, Houston, TX | -- | -- | 9,950 | 3,540 |
| Sweden, New York, NY | -- | -- | 1 | 2 |
| United Kingdom: | | | | |
| Houston, TX | 32 | 30 | 8,310 | 2,650 |
| Los Angeles, CA | 243 | 125 | 184 | 95 |
| Total | 275 | 156 | 8,490 | 2,740 |
| Vietnam: | | | | |
| Houston, TX | -- | -- | 8,460 | 3,770 |
| New Orleans, LA | -- | -- | 649 | 630 |
| Total | -- | -- | 9,110 | 4,400 |
| Grand total | 512,000 | 134,000 | 291,000 | 82,600 |
| Containing not more than 97% $CaF_2$: | | | | |
| China: | | | | |
| Mobile, AL | -- | -- | 295 | 172 |
| New York, NY | -- | -- | 412 | 111 |
| Total | -- | -- | 707 | 283 |
| Mexico: | | | | |
| Baltimore, MD | 14 | 6 | 91 | 39 |
| Cleveland, OH | 119 | 14 | -- | -- |
| Laredo, TX | 3,650 | 646 | 3,520 | 606 |
| New Orleans, LA | 122,000 | 11,800 | 106,000 | 19,600 |
| Total | 126,000 | 12,500 | 110,000 | 20,300 |
| Mongolia: | | | | |
| Cleveland, OH | 1,890 | 200 | 6,620 | 903 |
| Mobile, AL | 2,350 | 220 | -- | -- |
| New Orleans, LA | -- | -- | 300 | 192 |
| Total | 4,230 | 420 | 6,920 | 1,100 |
| Vietnam, New Orleans, LA | -- | -- | 5,470 | 745 |
| Grand total | 130,000 | 12,900 | 123,000 | 22,400 |
| Grand total, all grades | 643,000 | 147,000 | 414,000 | 105,000 |

-- 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]

| Country | 2013 Quantity (metric tons) | 2013 Value[2] (thousands) | 2014 Quantity (metric tons) | 2014 Value[2] (thousands) |
|---|---|---|---|---|
| Belgium | -- | -- | (3) | $7 |
| Canada | 9,430 | $26,400 | 2,620 | 10,700 |
| China | 5,320 | 6,880 | 5,280 | 5,850 |
| Colombia | -- | -- | 127 | 178 |
| Germany | 682 | 1,740 | 1,000 | 2,460 |
| India | 49 | 73 | 18 | 22 |
| Japan | 1,300 | 2,800 | 1,610 | 2,880 |
| Korea, Republic of | -- | -- | 336 | 1,030 |
| Mexico | 102,000 | 160,000 | 113,000 | 188,000 |
| Singapore | 97 | 348 | 81 | 223 |
| South Africa | 3 | 12 | -- | -- |
| Spain | 170 | 485 | 113 | 325 |
| Taiwan | 60 | 129 | 218 | 555 |
| Total | 119,000 | 199,000 | 125,000 | 213,000 |

-- 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, 2]

| Country | 2013 Quantity (metric tons) | 2013 Value[3] (thousands) | 2014 Quantity (metric tons) | 2014 Value[3] (thousands) |
|---|---|---|---|---|
| Canada | 3,970 | $1,900 | 6,550 | $2,850 |
| China | 1,320 | 812 | 1,250 | 1,240 |
| France | -- | -- | 165 | 114 |
| Germany | 1,800 | 2,260 | 1,580 | 2,470 |
| Hungary | 222 | 339 | 340 | 593 |
| Iceland | 973 | 575 | 453 | 293 |
| India | 28 | 18 | -- | -- |
| Italy | -- | -- | 141 | 197 |
| Japan | 3,800 | 5,020 | 3,650 | 4,450 |
| Slovakia | 6 | 7 | -- | -- |
| Spain | 231 | 84 | 1,290 | 476 |
| Switzerland | -- | -- | 38 | 32 |
| United Kingdom | 6,590 | 1540 | 761 | 1130 |
| Total | 18,900 | 12,600 | 16,200 | 13,800 |

-- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Includes natural and synthetic cryolite.
[3]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]

| Country | 2013 | | 2014 | |
|---|---|---|---|---|
| | Quantity (metric tons) | Value[2] (thousands) | Quantity (metric tons) | Value[2] (thousands) |
| Canada | 9,910 | $11,500 | 581 | $794 |
| China | 11,200 | 16,500 | 13,900 | 18,900 |
| Italy | -- | -- | 3,000 | 3,730 |
| Mexico | 22,200 | 30,000 | 20,900 | 27,100 |
| Other[3] | 5 | 27 | 85 | 129 |
| Total | 43,400 | 58,100 | 38,400 | 50,700 |

-- 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]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] | 2010 | 2011 | 2012 | 2013 | 2014[e] |
|---|---|---|---|---|---|
| Afghanistan | -- | -- | -- | -- | 2,000 |
| Argentina | 17,657 | 25,099 | 35,874 [r] | 37,967 [r] | 37,000 |
| Brazil, marketable: | | | | | |
| Acid grade | 6,295 | 6,197 | 5,768 | 6,835 [r] | 6,000 |
| Metallurgical grade | 18,152 | 18,843 | 18,380 | 20,886 [r] | 20,000 |
| Total | 24,400 | 25,000 | 24,100 | 27,700 [r] | 26,000 |
| Bulgaria[e, 5] | -- | -- [r] | 12,000 [r] | 12,000 [r] | 20,000 |
| China:[e] | | | | | |
| Acid grade | 2,100,000 | 3,800,000 [r] | 2,400,000 [r] | 2,300,000 [r] | 2,200,000 |
| Metallurgical grade[6] | 2,500,000 | 2,750,000 [r] | 1,800,000 [r] | 1,700,000 [r] | 1,600,000 |
| Total | 4,600,000 | 6,550,000 [r, 7] | 4,200,000 [r, 7] | 4,000,000 [r] | 3,800,000 |
| Egypt[e] | 500 | 500 | 500 | 500 | 500 |
| Germany, acid grade | 59,086 | 65,619 | 54,202 | 48,744 [r] | 60,000 |
| India[8] | 59,954 [r] | 5,010 [r] | 3,107 [r] | 3,000 [r] | 3,000 |
| Iran[9] | 76,000 [r] | 58,000 [r] | 80,000 [r, e] | 85,000 [r, e] | 90,000 |
| Kazakhstan[e] | 65,000 | 65,000 | 65,000 | 108,000 [r, 10] | 110,000 |
| Kenya, acid grade | 44,500 | 117,420 | 91,000 [r] | 71,987 [r] | 70,000 |
| Kyrgyzstan[e] | 500 | 550 | 500 | 500 | 500 |
| Mexico: | | | | | |
| Acid grade | 719,122 | 731,456 | 749,608 | 700,000 [r] | 688,000 |
| Metallurgical grade | 348,264 | 475,451 | 487,483 | 510,477 [r] | 422,000 |
| Total | 1,070,000 | 1,210,000 | 1,240,000 | 1,210,000 [r] | 1,110,000 [7] |
| Mongolia: | | | | | |
| Acid grade[11] | 140,700 | 116,400 | 157,200 | 76,400 | 71,900 |
| Other grades | 259,000 | 232,000 | 327,200 [r] | 161,700 [r] | 303,000 |
| Total | 400,000 | 350,000 | 480,000 [r] | 240,000 [r] | 370,000 |
| Morocco, acid grade | 89,700 [r] | 79,207 | 79,300 [r] | 81,250 [r] | 74,854 [10] |
| Namibia, acid grade[12, 13] | 97,179 [r] | 84,484 [r] | 68,966 [r] | 60,774 [r] | 65,485 [10] |
| Pakistan, metallurgical grade | 1,500 [e] | 3,156 | 6,859 [r] | 13,344 [r] | 7,469 [10] |
| Romania, metallurgical grade[e] | 15,000 | -- | -- | -- | -- |
| Russia | 67,000 | 119,800 | 129,000 | 59,000 [r] | 3,000 [10] |
| South Africa:[7] | | | | | |
| Acid grade | 147,000 [r] | 186,000 [r] | 160,000 [r] | 148,000 [r] | 275,000 |
| Metallurgical grade | 10,000 | 10,000 [r] | 10,000 [r] | 10,000 [r] | 10,000 |
| Total | 157,000 [r] | 196,000 [r] | 170,000 [r] | 158,000 [r] | 285,000 |
| Spain: | | | | | |
| Acid grade | 123,562 [r] | 106,294 [r] | 98,374 [r] | 94,000 [r] | 90,000 |
| Ceramic grade | 1,213 [r] | 1,599 [r] | 6,699 [r] | 5,000 [r] | 5,000 |
| Metallurgical grade | 2,873 [r] | 4,275 [r] | 2,250 [r] | 4,000 [r] | 3,000 |
| Total | 128,000 [r] | 112,000 [r] | 107,000 [r] | 103,000 [r] | 98,000 [e] |
| Thailand[e, 5] | 23,000 [r] | 12,000 [r] | 21,000 [r] | 24,000 [r] | 35,000 |
| Turkey | 25,189 | 4,524 | 5,197 | 3,874 | 4,000 |
| United Kingdom | 26,420 | -- | -- | 30,000 [r] | 77,000 [10] |
| Vietnam[e, 5] | NA | NA | NA | NA | 38,000 |
| Grand total[e] | 7,040,000 [r] | 9,080,000 [r] | 6,880,000 [r] | 6,380,000 [r] | 6,390,000 |

[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 October 15, 2015.

[3]An effort has been made to subdivide production of all countries by grade (acid, ceramic, and metallurgical). Where this information is not available the data have been entered without qualifying notes.

[4]In addition to the countries listed, the Republic of Korea 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]Estimate based on export data.

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

[7]Reported figure, quantities by grade are estimated.

[8]Year beginning April 1 of that stated.

[9]Year beginning March 21 of that stated.

[10]Reported figure.

[11]Flotation concentrate, includes some material less than 97%.

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

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