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FLUORSPAR [ADVANCE RELEASE]

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FLUORSPAR

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In 2021, most of the fluorspar consumed in the United States was from imports. Although not included in fluorspar production or consumption calculations, byproduct fluorosilicic acid (FSA) from some phosphoric acid producers, byproduct hydrofluoric acid from the U.S. Department of Energy's (DOE's) conversion of depleted uranium hexafluoride (DUF_6), and small amounts of byproduct synthetic fluorspar produced from industrial waste streams are other domestic sources of fluorine. Apparent consumption of fluorspar was 436,000 metric tons (t), 388,000 t of which was acid grade and 48,300 t of which was metallurgical grade. Total apparent consumption decreased by 10% compared with the amount in 2020. World fluorspar production was 8.68 million metric tons (Mt), a slight increase compared with that in 2020 (table 1).

Fluorspar is used for its fluorine content. Because of technical and practical considerations, fluorine is seldom consumed in elemental form, but rather as fluorspar, which is the commercial name that refers to crude or beneficiated material that is mined and (or) milled from the mineral fluorite (calcium fluoride, CaF_2). Elemental fluorine has unique properties including a small atomic radius, high electronegativity, lipophilicity (ability to mix with fats and nonpolar solvents), chemical reactivity, and low polarizability. These characteristics contribute to fluorine's ability to form a wide variety of stable compounds.

The processing of fluorspar is required to meet certain minimum CaF_2 percentage requirements and reduce undesirable impurities, both of which vary by application and consumer requirements. Generally, depending on the CaF_2 content, fluorspar is categorized into two main market grades: acid-grade fluorspar and metallurgical-grade fluorspar. Acid-grade fluorspar (also called acidspar) is a flotation concentrate typically with a CaF_2 content greater than 97% and it is primarily used in the manufacture of hydrogen fluoride (HF). The HF is dissolved in water to produce hydrofluoric acid, which is used as an intermediate in the production of fluorocarbons. Fluorspar with 97% or lower CaF_2 content is referred to commonly as metallurgical grade (also called metspar) because of its primary use as a steelmaking flux. In addition, in recent years numerous fluorspar producers have begun to develop and market products specifically for the cement industry. The CaF_2 content of these products is typically 40% to 50%, much lower than the CaF_2 content of metspar typically used as a steelmaking flux, which may be as low as 60%. Similarly, the Harmonized Tariff Schedule of the United States (HTS) differentiates acid- and metallurgical-grade fluorspar based on the 97% CaF_2 content threshold. Although CaF_2 content thresholds have been widely used for decades as a practical means to differentiate the grades of fluorspar, consumer specifications, such as allowable impurities, moisture content, and particle sizes can be equally important in determining their marketable uses (Roskill Information Services Ltd., 2020 p. 16–17, 113–114).

Government Actions and Legislation

Significant New Alternatives Policy Program.—The U.S. Environmental Protection Agency's (EPA's) Significant New Alternatives Policy (SNAP) program was established under section 612 of the Clean Air Act for the purpose of meeting the United States' obligations under the Montreal Protocol on Substances that Deplete the Ozone Layer, a global treaty adopted in 1987 that was ratified subsequently by all members of the United Nations. Because of the ozone-depleting potential of early generations of fluorocarbon gases [chlorofluorocarbons (CFCs) and later hydrochlorofluorocarbons (HCFCs)], many fluorinated substances used as foam-blowing agents, propellants, refrigerants, and solvents had been identified for reduction and eventual phase out under the SNAP program. In many cases, hydrofluorocarbons (HFCs), which are not ozone-depleting, were approved as acceptable alternatives. Although not ozone depleting, HFCs (as well as their predecessors) are in many cases potent greenhouse gases owing to their high global warming potential (GWP) and long atmospheric lifecycles. In a 2015 ruling, the EPA restricted certain HFCs. This ruling was challenged and vacated in a 2017 court case that established that the EPA did not have the statutory authority to restrict the use of HFCs on the basis of GWP (U.S. Court of Appeals for the District of Columbia Circuit, 2017, p. 25; Jones Day, 2023; U.S. Environmental Protection Agency, undated a, d).

In December 2020, the American Innovation and Manufacturing Act was enacted authorizing the EPA to address HFCs in three main areas, including a phasedown in the production and consumption of HFCs, facilitating the transition to next-generation technologies through sector-based restrictions, and the management of HFCs and their substitutes. In October 2021, the EPA finalized its ruling, which set baseline levels for production and consumption of HFCs and codified the phasedown schedule. The phasedown would decrease the production and import of HFCs in the United States by 85% during the next 15 years. Additionally, the rule established an initial approach for allocating HFC allowances in 2022 and 2023 and creating an enforcement system. Key components of the enforcement system include requiring the use of refillable containers, increased oversight of imports of HFCs, and allowance adjustments as an administrative consequence (U.S. Environmental Protection Agency, 2021b, c).

Per- and Polyfluoroalkyl Substances.—Per- and polyfluoroalkyl substances (PFAS) are a class of fluorinated chemicals with a wide range of uses. They are commonly used to make products that are resistant to grease, oil, and water. Of these substances, long-chain PFAS (PFAS molecules containing eight or more carbon atoms) have received the most attention owing to their association with adverse health effects. Perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are the two long-chain PFAS that have come under scrutiny during the past 15 years owing to their environmental persistence, prevalence in the bloodstream of humans, and widespread geographic distribution. As a result, several U.S. manufacturers have voluntarily reduced or completely phased out perfluorooctanyl chemistries, which included PFOA, PFOS, and their related precursors (Interstate Technology & Regulatory Council, 2022).

In October 2021, as part of the National PFAS Testing Strategy, the EPA required PFAS manufacturers to provide toxicity data and information on various categories of PFAS. Under section 4 of the Toxic Substances Control Act, PFAS manufacturers would have to conduct and fund the testing to determine if the substance or mixture presented an unreasonable risk to health or the environment. Owing to the large number of PFAS with limited or no toxicity data, the EPA developed an approach that would group the PFAS into smaller categories based on similar features and available data. As part of the initial phase of the EPA's strategy, 24 PFAS from different categories were strategically identified for testing. The gathered data were expected to address gaps in knowledge regarding the effects on human health and the environment and inform future regulatory efforts (U.S. Environmental Protection Agency, 2021a, undated b).

Production

In 2021, 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. Hastie Mining & Trucking also continued development of its Klondike II fluorspar mine in Livingston County, KY. 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) does not have a data survey for synthetic fluorspar produced in the United States.

Ares Strategic Mining Inc. (Canada) continued to develop its Lost Sheep fluorspar project in the Spor Mountain area in Juab County, UT. In July 2021, the company announced the acquisition of a processing plant from the Mujim Group (China), which would be built in Utah. The Mujim Group would assist in delivery, construction, and commissioning of the plant. The facility would be capable of producing high-grade metallurgical fluorspar lumps to be used in ceramic, fiberglass, glass, and metallurgy industries, and could produce 5,000 metric tons per month once fully operational. In November, Ares also increased its land holdings around the Lost Sheep property. Following geophysical investigation and geologic mapping of the area, 160 new drill targets were identified within the property outline. The past-producing Lost Sheep Mine, which historically produced metallurgical-grade fluorspar with 60% to 95% CaF_2 content, is located on the acquired property. According to a 2021 technical report, the estimated cumulative past production of the mine from 1948 to 2014 was about 170,000 t, with peak production taking place during the 1940s to 1950s (Ares Strategic Mining Inc., 2021a, b, c; P&E Mining Consultants Inc., 2021, p. 2–3).

In 2021, three companies—J.R. Simplot Co. (Boise, ID), Nutrien Ltd. (Saskatoon, Saskatchewan, Canada), and Univar Solutions Inc. (Downers Grove, IL)—produced marketable FSA, a byproduct from the processing of phosphate rock into phosphoric acid, at three plants in Wyoming, North Carolina, and Florida, respectively. Domestic production data for FSA were collected by the USGS from a voluntary canvass of U.S. phosphoric acid operations known to recover FSA. Responses were received from two, representing 97% of the total FSA sold or used by producers. In 2021, production was 39,800 t (equivalent to 64,700 t of fluorspar grading 100% CaF_2), an 82% increase compared with that in 2020 (table 1).

DOE's DUF_6 conversion project operated two plants—one in Paducah, KY, and the other near Portsmouth, OH. The goal of the project, which started production in 2011, was to convert the Government's inventory of DUF_6 into more stable forms, including uranium oxide and hydrofluoric acid. In 2021, both plants underwent several upgrades to improve worker safety and operational reliability following a production hiatus in 2020 that started because of the coronavirus disease 2019 (COVID-19) pandemic. In November, the Paducah facility was the first to restart conversion operations, and as of yearend 2021 the Portsmouth facility remained under a production hiatus (Office of Environmental Management 2021, 2022).

Consumption

In 2021, apparent consumption of fluorspar was 436,000 t, a 10% decrease compared with 483,000 t in 2020 (table 1). Apparent consumption of acid-grade fluorspar decreased by 9% to 388,000 t, and that of metallurgical-grade fluorspar decreased by 18% to 48,300 t. Globally, there are three leading fluorspar-consuming industries. The manufacture of HF, the leading source of fluorine in industrial applications and a precursor to the production of most other fluorine-containing chemicals, accounted for an estimated 49% of the global annual fluorspar consumption in 2021. The manufacture of aluminum fluoride (AlF_3) and cryolite (Na_3AlF_6), essential for primary aluminum smelting, accounted for an estimated 20% of global annual fluorspar consumption. (Although HF is produced as an intermediate in the manufacture of AlF_3, AlF_3 production typically has been discussed as a distinct use.) Both applications typically require acid-grade fluorspar, although FSA also can be used. Fluorspar used as a steelmaking flux accounted for an estimated 24% of global consumption. Metallurgical-grade fluorspar is used primarily in this application, although acid-grade material may also be used. Other applications of fluorspar accounted for the remaining 7% and included use in the manufacture of cement, ceramics, enamel, glass, and welding rod coatings (Roskill Information Services Ltd., 2020, p. 32, 86).

In 2021, the amount of FSA sold or used by producers in the United States was 39,700 t, an 81% increase compared with that in 2020, and was used primarily for water fluoridation (table 1). In general, FSA was used as an alternative to fluorspar in the production of AlF_3. However, because of differing physical properties, AlF_3 produced from FSA is not as readily substituted as is AlF_3 produced from acid-grade fluorspar. Consumption of FSA is low compared to production; the unused remainder is generally neutralized, discharged, ponded, or pumped to the sea. Since 2008, technology to produce anhydrous hydrogen fluoride (AHF) from FSA has existed but has only been implemented commercially at a few plants in China. In 2020, specialty materials manufacturer Arkema S.A. (France) signed a long-term supply agreement with phosphoric acid producer Nutrien to support current production of fluorogases and fluoropolymers at Arkema's Calvert City, KY, facility. As part of the agreement, Arkema invested $150 million for the construction of an AHF plant at Nutrien's site in Aurora, NC. The construction of the plant was completed in 2021, and production was expected to start in the first half of 2022, with a capacity of 40,000 metric tons per year (t/yr) of AHF (Roskill Information Services Ltd., 2020, p. 2, 110, 376; Arkema S.A., 2022, p. 65; Nutrien Ltd., 2022, p. 36).

Aluminum.—Internationally, acid-grade fluorspar was used in the production of AlF_3 and cryolite, which are essential in primary aluminum smelting. To recover aluminum through electrolytic processes, alumina (Al_2O_3) is dissolved in a bath that consists primarily of molten cryolite and small amounts of AlF_3 and fluorspar. 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 liquid form, allowed to cool and solidify, and then crushed and reused to start new smelter pots or compensate for electrolyte losses. This excess material is variously called crushed tapped bath, secondary cryolite, or bath cryolite. In the aluminum smelting process, AlF_3 also is used to replace fluorine losses (either absorbed by the smelter pot lining or released to the atmosphere as emissions). In 2021, the AlF_3 requirements of the U.S. aluminum industry were met through imports because there were no active AlF_3 producers in the United States (table 7; Roskill Information Services Ltd., 2020, p. 376).

Chemicals.—The United States was a leading producer of HF in 2021, with a capacity of 220,000 t/yr, second only to China. HF was used directly in a variety of industrial processes and as an intermediate in the production of organic and inorganic fluorine chemicals. Two companies in the United States used fluorspar to produce HF in 2021—The Chemours Co. and Honeywell International Inc. Major U.S. producers of downstream fluorochemicals that used HF as an intermediate were Arkema, Chemours, Daikin America, Inc., Honeywell, Mexichem Flúor, Inc. (known commercially as Koura), Solvay Fluorides, LLC, and Solvay Specialty Polymers USA, LLC. When used directly, HF is crucial in many manufacturing processes such as in the cleaning and etching of semiconductors and circuit boards, the enrichment of uranium, the production of low-octane fuels (petroleum alkylation), and the removal of impurities from metals (pickling). Fluorocarbons can be further subdivided into nonfeedstock uses (which are typically emissive) and feedstock uses (used captively in the manufacture of other chemicals such as fluoropolymers). This distinction is important because most nonfeedstock uses are subject to global regulation under the Montreal Protocol (Roskill Information Services Ltd., 2020, p. 24, 86, 243, 260).

Fluorochemical Industry News.—In May, Solvay S.A. (Belgium), a leading producer of fluorochemicals, announced that it would no longer use fluorosurfactant process aids to produce polyvinylidene fluoride (PVDF) at its facility in West Deptford, NJ, by the end of June 2021. The new (nonfluorosurfactant) proprietary technology would replace those previously used that were within the family of PFAS and under scrutiny globally for their persistence in the environment and presence in the water, air, fish, and soil (Solvay S.A., 2021; U.S. Environmental Protection Agency, undated c).

In November, Koura signed a definitive agreement to acquire Wisconsin-based startup Silatronix Inc., which developed battery technology using fluorosilane additives for lithium-ion batteries. Koura also was awarded $3.1 million by the DOE to support the development of fluorinated electrolytes for lithium-ion batteries. The DOE research funding was part of a $60 million investment to support advancement in zero-emission vehicles. For this project, Koura would partner with researchers at newly acquired Silatronix and Argonne National Laboratory, which would assist Koura in the development and production of batteries and battery electrolytes (Mexichem Flúor S.A. de C.V., 2021a, b).

Steel and Other Uses.—The fluorspar market in the United States included sales of acid- and metallurgical-grade material mainly to steel mills, where it was used as a fluxing agent to increase slag fluidity. Sales also were made to smaller markets such as cement plants, foundries, glass and ceramics plants, and welding rod manufacturers. In the late 1970s, the United States used more than 500,000 t/yr of fluorspar for these applications. During the past 20 to 30 years, however, fluorspar use in such industries as steel and glass has declined because of product substitutions or changes in industry practices.

Prices

According to Fastmarkets IM (2022), the yearend price range of acid-grade fluorspar from all leading exporting countries except China decreased in 2021. The yearend price range of acid-grade fluorspar from China [free on board (f.o.b.) wet filtercake] in 2021 was $430 to $460 per metric ton compared with $380 to $430 per metric ton in 2020. The price range of acid-grade fluorspar from Mexico (f.o.b. Tampico filtercake) in 2021 was $320 to $350 per metric ton compared with $330 to $380 per metric ton in 2020. The price range of acid-grade fluorspar from South Africa (f.o.b. Durban filtercake) was $340 to $380 per metric ton compared with $340 to $390 per metric ton in 2020. In 2021, the yearend price range for metallurgical-grade fluorspar decreased from Mexico, the leading source of domestic metallurgical-grade imports, and was $280 to $300 per metric ton in 2021 compared with $280 to $320 per metric ton in 2020 (table 2).

Transportation

The United States depended on imports for most of its fluorspar supply. Metallurgical-grade fluorspar was 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 was shipped in the form of damp filtercake that contained 7% to 10% moisture to facilitate handling and reduce dust. This moisture was removed by heating the filtercake in rotary kilns or other dryers before treating with sulfuric acid to produce HF. Acid-grade imports usually were shipped by ocean freight using bulk carriers of

10,000- to 50,000-t deadweight capacity. Some fluorspar was marketed in bags for small users and shipped by truck.

Foreign Trade

In 2021, U.S. exports of fluorspar increased by 61% to 14,800 t compared with those in 2020 (table 3). With only a small amount of mined or byproduct fluorspar produced, exports were likely reexports of imported material. Approximately 69% of exports went to Canada. Combined acid- and metallurgical-grade fluorspar imports for consumption were 451,000 t in 2021, an 8% decrease compared with 492,000 t (revised) in 2020. The leading suppliers of total fluorspar imports to the United States were Mexico (71%), Vietnam (14%), Canada (9%), and South Africa (6%). Acid-grade imports were 391,000 t, an 8% decrease compared with 427,000 t (revised) in 2020. The leading sources of acid-grade imports were Mexico (66%), Vietnam (16%), and Canada (10%). Metallurgical-grade imports decreased by 9% to 59,200 t, 98% of which were from Mexico (table 4).

Imports of HF were 103,000 t in 2021, unchanged compared with those in 2020; most HF imports were from Mexico (91%). Imports of cryolite increased by 58% to 41,600 t; the leading suppliers were Canada (40%), Japan (27%), and France (14%). AlF_3 imports increased by 33% to 27,600 t; the leading suppliers of AlF_3 were Mexico (66%) and Italy (27%) (tables 5–7).

World Review

In 2021, total world production of fluorspar was 8.68 Mt, a slight increase from the revised total of 8.53 Mt in 2020. In descending order of tonnage, China, Mexico, Mongolia, and South Africa were the leading producers of fluorspar in 2021, accounting for 89% of total world production (table 8).

Canada.—In July, Canada Fluorspar (NL) Inc. (St. Lawrence, Newfoundland and Labrador) loaded its first shipment of fluorspar at the company's new marine shipping terminal in St. Lawrence. The plan for the construction of the new terminal located on Blue Beach Cove was approved in 2015, and construction was completed in 2021. Canada Fluorspar previously loaded its fluorspar shipments at the Kiewit Cow Head terminal in Marystown, which was 45 kilometers away from its fluorspar mine. The new terminal was closer to the St. Lawrence Mine and could accommodated larger ore carriers than the terminal at Marystown (SaltWire Network Inc., 2021).

China.—In February, Arkema announced an increase in its fluoropolymer production capacity at its site in Changshu scheduled by yearend 2022. The Changshu plant had produced PVDF and had been expanded several times during the past decade, with the latest expansion taking place in December 2020. The new scheduled expansion would increase its PVDF production capacity by an additional 35% to address the demand for use as a cathode binder and separator coating in lithium-ion batteries (Arkema S.A., 2021).

Italy.—In October, Fluorsid S.p.A. announced the sale of its subsidiary Alkeemia S.p.A. and its related assets, including the Porto Marghera plant, to Blantyre Capital Ltd., an investment management firm based in London, United Kingdom. The plant in Porto Marghera had a capacity of 51,000 t/yr of AHF produced from acid-grade fluorspar (Roskill Information Services Ltd., 2020, p. 188; Fluorsid S.p.A., 2021, p. 10–11).

Korea, Republic of.—Hyundai Steel Co., Ltd., Samsung Electronics Co., Ltd., and Pos Ceramics Co., Ltd. jointly developed new technology to reuse semiconductor manufacturing waste as a steelmaking additive. The sludge discharged from semiconductor plants is composed of 50% to 60% CaF_2, which can be used to filter out sulfur and phosphorus impurities during the steelmaking process. In August 2021, the group produced steelmaking materials from 30 t of fluorite substitutes and received verification from the National Institute of Environmental Research of the Republic of Korea. The recycled semiconductor waste was expected to replace nearly one-half of Hyundai Steel's fluorspar use, which had been about 20,000 t/yr of fluorspar in recent years (Hyundai Steel Co., Ltd., 2021).

Mexico.—Mexico was the second-ranked fluorspar producer globally, and the leading United States supplier of fluorspar imports in 2021. Total production in 2021 was 1,007,118 t, an increase of 10% compared with 914,597 t (revised) in 2020. Of the total production in 2021, 790,000 t was estimated to be acid grade, and 210,000 t was estimated to be metallurgical grade. The San Luis Potosi fluorspar mine, owned by Orbia Advance Corp., S.A.B. de C.V., accounted for 96% of the country's active production capacity in 2021. Orbia was a vertically integrated producer of AlF_3, fluorspar (acid and metallurgical grade), HF, medical propellants, and refrigerant gases through its fluorine business unit. According to the latest internal estimate, the mine had proven reserves of about 62 Mt (table 8; Orbia Advance Corp., S.A.B. de C.V., 2022, p. 68, 102).

Mongolia.—Mongolia was the third-ranked producer of fluorspar after China and Mexico. In 2021, total fluorspar production was estimated to be 650,000 t, a decrease of 10% compared with that in 2020. Of the 2021 production, 60,300 t was acid grade, and 590,000 t was estimated to be metallurgical grade. Gobishoo LLC operated the Shine Us Mine in Dundgovi Province located in south-central Mongolia, which mined fluorspar ore with grades of 18% to 40% CaF_2. The ore then was processed into both acid- and metallurgical-grade fluorspar and exported via rail to Inner Mongolia Autonomous Region (China) and Naushki (Russia). In September, Gobishoo announced that it had entered into an exclusive sales agent agreement with United Kingdom-based company Fluorspar Ltd., which would expand Gobishoo's market opportunities across Asia and Europe (table 8; O'Driscoll, 2021).

Morocco.—In December, Société Anonyme d'Entreprise Minière (SAMINE), a subsidiary of Managem S.A., closed its El Hammam underground fluorspar mine located in Khemisset. Historically, SAMINE was the main producer of fluorspar in the country, with most of the production exported from the Casablanca Port. The mine had a capacity to produce 80,000 t/yr of acid-grade fluorspar. However, by the end of 2019 the mine had only 205,000 t of proved and probable reserves (O'Driscoll, 2022; Taib, 2023).

Vietnam.—Nui Phao Mining Co. Ltd., a subsidiary of Masan High-Tech Materials Corp., produced 215,027 t of acid-grade fluorspar concentrate from its Nui Phao polymetallic mine in Thai Nguyen Province, which was a slight decrease compared with production in 2020. The decreased production was attributed to a mechanical failure that decreased plant throughput in the third quarter of 2021. The company also reported that there were freight disruptions in 2021, but the company was able to fulfill all of its contractual commitments and avoided many of the supply chain issues that affected other suppliers in the market (Masan High-Tech Materials Corp., 2022, p. 16–19, 22, 89).

Outlook

Because fluorspar is the basic material for almost all fluorochemicals, fluorspar consumption is influenced the by demand for products of the downstream industries. Fluorochemicals, particularly those containing carbon, are very stable and versatile, and new applications continue to be developed. However, numerous environmental, health, and safety issues constrain the use of fluorine, HF, and many other fluorinated substances. Despite these challenges, the demand for fluorspar products is anticipated to increase. Specifically, the consumption of feedstock fluorocarbons is projected to grow 3% to 5% between 2019 and 2025 in aerosol propellants and polymer feedstock end uses (Wietlisbach, 2021, p. 19).

References Cited

Ares Strategic Mining Inc., 2021a, Ares completes processing facility acquisition: Vancouver, British Columbia, Canada, Ares Strategic Mining Inc. press release, July 15. (Accessed March 28, 2024, at https://www.aresmining.com/post/ares-completes-processing-facility-acquisition.)

Ares Strategic Mining Inc., 2021b, Ares Strategic Mining completes purchase of lumps plant processing facility: Vancouver, British Columbia, Canada, Ares Strategic Mining Inc. press release, February 26. (Accessed March 28, 2024, at https://www.aresmining.com/post/ares-strategic-mining-completes-purchase-of-lumps-plant-processing-facility.)

Ares Strategic Mining Inc., 2021c, Ares Strategic Mining expands Utah fluorspar land holdings following mapping work: Vancouver, British Columbia, Canada, Ares Strategic Mining Inc. press release, November 23. (Accessed March 28, 2024, at https://www.aresmining.com/post/ares-strategic-mining-expands-utah-fluorspar-land-holdings-following-mapping-work.)

Arkema S.A., 2021, Arkema increases its Kynar® fluoropolymer capacities in China: Colombes, France, Arkema S.A. press release, February 23. (Accessed May 1, 2024, at https://www.arkema.com/global/en/media/newslist/news/global/corporate/2021/20210223-new-increase-kynar-fluoropolymer-capacities-china/.)

Arkema S.A., 2022, Universal registration document 2021: Colombes, France, Arkema S.A., March 29, 396 p. (Accessed May 1, 2024, at https://www.arkema.com/files/live/sites/shared_arkema/files/downloads/investorrelations/en/finance/ARK2021_ARKEMA_URD_EN_V4BAT_MEL_2022_03_29.pdf.)

Fastmarkets IM, 2022, Fastmarkets IM prices: Fastmarkets IM, November 11. (Accessed November 11, 2022, via http://indmin.com.)

Fluorsid S.p.A., 2021, Adieu Alkeemia SpA, *in* Life—The Fluorsid House Organ [Fluorsid S.p.A.], no. 4, October, p. 10–13. (Accessed May 1, 2024, at https://fluorsid.com/wp-content/uploads/2022/09/ENG-Fluorsid-Magazine-Issue-4-Oct21.pdf.)

Hyundai Steel Co., Ltd., 2021, New technology puts semiconductor sewage sludge to green use: Steel Talk [Hyundai Steel Co., Ltd.], v. 72, October 29. (Accessed May 1, 2024, at https://talk.hyundai-steel.com/global-english-post/new-technology-puts-semiconductor-sewage-sludge-to-green-use/.)

Interstate Technology & Regulatory Council, 2022, History and use of per- and polyfluoroalkyl substances [PFAS] found in the environment: Washington, DC, Interstate Technology & Regulatory Council factsheet, August, 4 p. (Accessed May 2, 2024, at https://pfas-1.itrcweb.org/wp-content/uploads/2020/10/history_and_use_508_2020Aug_Final.pdf.)

Jones Day, 2023, D.C. Circuit vacates part of the EPA's HFCs phasedown rule: Sausalito, CA, JD Supra, LLC, August 16. (Accessed May 1, 2024, at https://www.jdsupra.com/legalnews/d-c-circuit-vacates-part-of-the-epa-s-6973527/.)

Masan High-Tech Materials Corp., 2022, Annual & sustainability report 2021: Ho Chi Minh City, Vietnam, Masan High-Tech Materials Corp., March 11, 305 p. (Accessed April 25, 2024, at https://masanhightechmaterials.com/wp-content/uploads/2022/04/Annual-Sustainability-Report-2021-5.pdf.)

Mexichem Flúor S.A. de C.V., 2021a, Koura acquires Silatronix—Koura acquires battery technology company Silatronix to meet growing global demand for energy storage: Boston, MA, Koura press release, November 1. (Accessed May 1, 2024, at https://www.kouraglobal.com/koura-acquires-silatronix/.)

Mexichem Flúor S.A. de C.V., 2021b, Koura awarded $3.1m research funding—U.S. Department of Energy selects Koura for development of fluorinated electrolytes to extend operating range and safety of Li-ion batteries: Boston, MA, Koura press release, November 23. (Accessed May 1, 2024, at https://www.kouraglobal.com/koura-awarded-3-1m-research-funding/.)

Nutrien Ltd., 2022, Annual report 2021: Saskatoon, Saskatchewan, Canada, Nutrien Ltd., February 17, 140 p. (Accessed May 1, 2024, at https://nutrien-prod-asset.s3.us-east-2.amazonaws.com/s3fs-public/uploads/2022-03/2021%20Nutrien_Annual%20Report_Enhanced_PDF.pdf.)

O'Driscoll, Mike, 2021, Fluorspar supply sources emerge—Mongolia–USA–Canada–Greenland: Wallington, United Kingdom, IMFORMED Industrial Mineral Forums & Research Ltd., October 13. (Accessed May 2, 2024, at https://imformed.com/fluorspar-supply-sources-emerge-mongolia-usa-canada-greenland/.)

O'Driscoll, Mike, 2022, Canada Fluorspar—New owner & restart on the cards?: Wallington, United Kingdom, IMFORMED Industrial Mineral Forums & Research Ltd., September 2. (Accessed May 2, 2024, at https://imformed.com/canada-fluorspar-new-owner-restart-on-the-cards/.)

Office of Environmental Management, 2021, DUF6 conversion project completes major safety upgrades: Lexington, KY, Office of Environmental Management press release, February 23. (Accessed March 28, 2024, at https://www.energy.gov/em/articles/duf6-conversion-project-completes-major-safety-upgrades.)

Office of Environmental Management, 2022, DUF6 facility returns to conversion operations at Paducah site: Paducah, KY, Office of Environmental Management press release, February 22. (Accessed March 28, 2024, at https://www.energy.gov/em/articles/duf6-facility-returns-conversion-operations-paducah-site.)

Orbia Advance Corp., S.A.B. de C.V., 2022, Annual report 2021: Mexico City, Mexico, Orbia Advance Corp., S.A.B. de C.V., April 29, 179 p. (Accessed May 1, 2024, at https://www.orbia.com/49c4eb/siteassets/5.-investor-relations/annual-reports/orbia-2021-annual-report-complete_en.pdf.)

P&E Mining Consultants Inc., 2021, Technical report on the Lost Sheep fluorspar property, Juab County, Utah, U.S.A.: Brampton, Ontario, Canada, P&E Mining Consultants Inc., September 17, 164 p. (Accessed March 28, 2024, at https://www.sedarplus.ca/csa-party/records/document.html?id=fe182c0ba52b92c3e1637735e818446984b6bd709de24f56a7a156f39679a041.)

Roskill Information Services Ltd., 2020, Fluorspar—Outlook to 2029, 14th ed.: London, United Kingdom, Roskill Information Services Ltd., 462 p.

SaltWire Network Inc., 2021, New Newfoundland terminal in St. Lawrence welcomes first fluorspar ship in 31 years: SaltWire Network Inc. [Halifax, Nova Scotia, Canada], July 30. (Accessed April 22, 2024, at https://www.saltwire.com/atlantic-canada/business/new-newfoundland-terminal-in-st-lawrence-welcomes-first-fluorspar-ship-in-31-years-100618342/.)

Solvay S.A., 2021, Solvay launches non-fluorosurfactant technologies in the U.S.: West Deptford, NJ, Solvay S.A. press release, May 5. (Accessed March 22, 2024, at https://www.solvay.com/en/press-release/solvay-launches-non-fluorosurfactant-technologies-in-us.)

Taib, Mowafa, 2023, The mineral industries of Morocco and Western Sahara [advance release], chap. 56 *of* Area reports—International—Africa and the Middle East: U.S. Geological Survey Minerals Yearbook 2019, v. III, p. 56.1–56.13. (Accessed May 1, 2024, at https://pubs.usgs.gov/myb/vol3/2019/myb3-2019-morocco-western-sahara.pdf.)

U.S. Court of Appeals for the District of Columbia Circuit, 2017, *Mexichem Fluor, Inc.* v. *[U.S.] Environmental Protection Agency*: U.S. Court of Appeals for the District of Columbia Circuit, August 8, [variously paged]. (Accessed May 1, 2024, at https://www.cadc.uscourts.gov/internet/opinions.nsf/3EDC3D4817D618CF8525817600508EF4/$file/15-1328-1687707.pdf.)

U.S. Environmental Protection Agency, 2021a, EPA grants petition to order testing on human health hazards of PFAS: Washington, DC, U.S. Environmental Protection Agency press release, December 28. (Accessed May 2, 2024, at https://www.epa.gov/newsreleases/epa-grants-petition-order-testing-human-health-hazards-pfas.)
U.S. Environmental Protection Agency, 2021b, EPA moves forward with phase down of climate-damaging hydrofluorocarbons: Washington, DC, U.S. Environmental Protection Agency press release, May 3. (Accessed April 30, 2024, at https://www.epa.gov/newsreleases/epa-moves-forward-phase-down-climate-damaging-hydrofluorocarbons.)
U.S. Environmental Protection Agency, 2021c, Phasedown of hydrofluorocarbons—Establishing the allowance allocation and trading program under the American Innovation and Manufacturing Act: Federal Register, v. 86, no. 190, October 5, p. 55116–55222. (Accessed May 1, 2024, at https://www.govinfo.gov/content/pkg/FR-2021-10-05/pdf/2021-21030.pdf.)
U.S. Environmental Protection Agency, [undated]a, Greenhouse gas emissions—Overview of greenhouse gases: U.S. Environmental Protection Agency. (Accessed May 1, 2024, at https://www.epa.gov/ghgemissions/overview-greenhouse-gases.)
U.S. Environmental Protection Agency, [undated]b, National PFAS testing strategy: U.S. Environmental Protection Agency. (Accessed May 21, 2024, at https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/national-pfas-testing-strategy.)
U.S. Environmental Protection Agency, [undated]c, PFAS explained: U.S. Environmental Protection Agency. (Accessed April 29, 2024, at https://www.epa.gov/pfas/pfas-explained.)
U.S. Environmental Protection Agency, [undated]d, Regulations, proposed rules and final rules determined by EPA: U.S. Environmental Protection Agency. (Accessed May 1, 2024, at https://www.epa.gov/snap/regulations-proposed-rules-and-final-rules-determined-epa.)
Wietlisbach, Samantha, 2021, Hydrofluoric acid—Downstream market outlook: IMFORMED Fluorine Forum 2021 ONLINE, October 20, presentation, 41 p.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Fluorine. Ch. in Critical Mineral Resources of the United States—Economic and Environmental Geology and Prospects for Future Supply, Professional Paper 1802, 2017.
Fluorspar. Ch. in Mineral Commodity Summaries, annual.
Fluorspar. Mineral Industry Surveys, quarterly.
Geology and Resources of Fluorine in the United States. Professional Paper 933, 1976.
Historical Statistics for Mineral and Material Commodities in the United States. Data Series 140.

Other

Fluorocarbons. Chemical Economics Handbook Marketing Research Report, IHS Chemical, 2011.
Fluorspar. Ch. in Industrial Minerals and Rocks (7th ed.), Society for Mining, Metallurgy, and Exploration, Inc., 2006.
Fluorspar. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
Fluorspar—Global Industry Markets & Outlook, 11th edition. Roskill Information Services Ltd., 2013.
Fluorspar and Inorganic Fluorine Compounds. Chemical Economics Handbook Marketing Research Report, IHS Chemical, 2012.
ICIS Chemical Business Americas.
Industrial Minerals.
United Nations Commodity Trade Statistics Database.
United States International Trade Commission, Interactive Tariff and Trade DataWeb.
World Fluorochemicals to 2016. The Freedonia Group, 2012.

TABLE 1
SALIENT FLUORSPAR STATISTICS[1, 2]

(Metric tons and dollars per metric ton, unless otherwise specified)

		2017	2018	2019	2020	2021
United States:						
Exports:[3]						
Quantity:						
Acid grade, containing more than 97% calcium fluoride		5,180	2,720	1,880	2,440	3,860
Metallurgical grade, containing not more than 97% calcium fluoride		5,760	6,250	5,720	6,750	10,900
Total		10,900	8,970	7,600	9,180	14,800
Average unit value:[4]						
Acid grade, containing more than 97% calcium fluoride		172	137	120	113	115
Metallurgical grade, containing not more than 97% calcium fluoride		183	156	156	154	149
Imports for consumption:[5]						
Quantity:						
Acid grade, containing more than 97% calcium fluoride		331,000	381,000	346,000	427,000 r	391,000
Metallurgical grade, containing not more than 97% calcium fluoride		70,400	77,600	59,500	65,400	59,200
Total		401,000	459,000	405,000	492,000 r	451,000
Average unit value:[6]						
Acid grade, containing more than 97% calcium fluoride		267	276	304	309 r	322
Metallurgical grade, containing not more than 97% calcium fluoride		237	258	292	149	151
Reported consumption		W	W	W	W	W
Apparent consumption:[7]						
Acid grade, containing more than 97% calcium fluoride		326,000	378,000	344,000	424,000 r	388,000
Metallurgical grade, containing not more than 97% calcium fluoride		64,700	71,300	53,800	58,700	48,300
Total		390,000	450,000	398,000	483,000 r	436,000
Fluorosilicic acid:						
Production		39,500	32,500	29,400	21,900	39,800
Sold or used		39,000	32,100	32,300	22,000	39,700
Value	thousands	$13,500	$8,680	$6,960	$4,070	$4,970
World, production[8]		6,690,000 r	7,850,000 r	8,610,000 r	8,530,000 r	8,680,000

[r]Revised. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through September 27, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Does not include byproduct or synthetic fluorspar production.
[3]Source: U.S. Census Bureau.
[4]Free alongside ship values at U.S. ports.
[5]Sources: U.S. Census Bureau and Trade Mining LLC; data adjusted by the U.S. Geological Survey.
[6]Cost, insurance, and freight value at U.S. ports.
[7]Defined as imports minus exports.
[8]May include estimated data.

TABLE 2
PRICES OF IMPORTED FLUORSPAR[1, 2]

(Dollars per metric ton)

Grade and source	2020	2021
Acid grade:		
Chinese, free on board (f.o.b.) China, wet filtercake	380–430	430–460
Mexican, f.o.b. Tampico, filtercake	330–380	320–350
South African, f.o.b. Durban, filtercake	340–390	340–380
Metallurgical grade, Mexican, f.o.b. Tampico	280–320	280–300

[1]Table includes data available through September 27, 2022.
[2]Represents yearend price offerings, not transaction values. Chinese prices are based on weekly price quotations; all others are monthly.

Source: Fastmarkets IM (London).

TABLE 3
U.S. EXPORTS OF FLUORSPAR, BY COUNTRY OR LOCALITY[1, 2]

	2020		2021	
Country or locality	Quantity (metric tons)	Value[3]	Quantity (metric tons)	Value[3]
Australia	54	$4,600	18	$13,900
Brazil	4	2,500	--	--
Canada	4,980	730,000	10,200	1,390,000
Chile	504	56,500	--	--
Dominican Republic	1,010	165,000	1,670	242,000
Germany	--	--	40	10,200
India	--	--	27	3,040
Indonesia	53	7,720	--	--
Japan	23	3,400	--	--
Korea, Republic of	740	93,300	169	19,000
Mexico	1,750	238,000	2,510	350,000
Nicaragua	--	--	45	12,100
Taiwan	6	4,920	12	10,100
Turkey	--	--	40	5,840
Uruguay	60	10,500	60	10,500
Total	9,180	1,320,000	14,800	2,070,000

-- Zero.
[1]Table includes data available through July 21, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Exports include domestic exports only for Schedule B numbers 2529.21.0000 and 2529.22.0000.
[3]Free alongside ship value at U.S. ports.

Source: U.S. Census Bureau.

TABLE 4
U.S. IMPORTS FOR CONSUMPTION OF FLUORSPAR, BY COUNTRY AND CUSTOMS DISTRICT[1, 2]

Country and customs district	2020 Quantity (metric tons)	2020 Value[3] (thousands)	2021 Quantity (metric tons)	2021 Value[3] (thousands)
Acid grade containing more than 97% calcium fluoride (CaF_2):				
Canada:				
Buffalo, NY	3	$5	3	$9
Houston, TX	34,900 r	9,300 r	39,400	11,300
Mobile, AL	6,030	1,660	--	--
New Orleans, LA	16,700	5,970	--	--
Total	57,600 r	16,900 r	39,400	11,300
China, Charleston, SC	70	38	--	--
France, Philadelphia, PA	1	4	--	--
Germany:				
Baltimore, MD	152	111	--	--
Houston, TX	274	147	304	164
New Orleans, LA	--	--	1	2
New York, NY	38	30	164	95
Philadelphia, PA	--	--	43	26
Total	464	288	512	288
Japan:				
Cleveland, OH	--	--	1	9
Los Angeles, CA	--	--	1,380	712
New York, NY	1,120	590	999	663
Total	1,120	590	2,380	1,380
Mexico:				
Laredo, TX	24,600	9,360	48,900	18,400
New Orleans, LA	197,000	60,500	211,000	67,700
Total	222,000	69,800	260,000	86,100
Mongolia:				
Baltimore, MD	1,380	824	658	399
New York, NY	--	--	532	350
Total	1,380	824	1,190	750
South Africa:				
Houston, TX	23,200	7,820	24,800	9,940
New Orleans, LA	23,800	5,540	--	--
Total	47,000	13,400	24,800	9,940
Spain:				
Cleveland, OH	--	--	7	5
Houston, TX	9,940	3,930	--	--
Total	9,940	3,930	7	5
United Kingdom, Houston, TX	8	36	10	32
Vietnam:				
Houston, TX	82,800	24,700 e	63,000	16,200 e
New Orleans, LA	4,300	1,290 e	--	--
Total	87,100	26,000 e	63,000	16,200 e
Grand total	427,000 r	132,000 r, e	391,000	126,000 e
Metallurgical grade containing not more than 97% CaF_2:				
Canada, Portland, ME	--	--	6	4
China:				
Cleveland, OH	74	52	58	45
Los Angeles, CA	20	10	--	--
New Orleans, LA	--	--	397	218
New York, NY	15	10	--	--
Total	109	72	455	263
India, Los Angeles, CA	2	10	--	--
Mexico:				
Laredo, TX	5,390	1,270	9,360	1,820
New Orleans, LA	59,900	8,370	48,500	6,330
Nogales, AZ	--	--	103	9
Total	65,300	9,640	57,900	8,160
Mongolia, New Orleans, LA	--	--	743	439
Netherlands, Los Angeles, CA	1	2	37	28
South Africa, Baltimore, MD	--	--	29	15

See footnotes at end of table.

TABLE 4—Continued

U.S. IMPORTS FOR CONSUMPTION OF FLUORSPAR, BY COUNTRY AND CUSTOMS DISTRICT[1, 2]

	2020		2021	
Country and customs district	Quantity (metric tons)	Value[3] (thousands)	Quantity (metric tons)	Value[3] (thousands)
Metallurgical grade containing not more than 97% CaF_2:—Continued				
United Kingdom:				
Chicago, IL	2	7	7	21
Houston, TX	--	--	3	10
Total	2	7	10	31
Grand total	65,400	9,730	59,200	8,940
Grand total, all grades	492,000 r	142,000 r	451,000	135,000

[e]Estimated. [r]Revised. -- Zero.

[1]Table includes data available through July 21, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes acid- and metallurgical-grade fluorspar as reported by Harmonized Tariff Schedule of the United States codes 2529.22.0000 and 2529.21.0000, respectively.

[3]Cost, insurance, and freight value at U.S. ports.

Sources: U.S. Census Bureau and Trade Mining, LLC; data adjusted by the U.S. Geological Survey.

TABLE 5

U.S. IMPORTS FOR CONSUMPTION OF HYDROFLUORIC ACID, BY COUNTRY OR LOCALITY[1, 2]

	2020		2021	
Country or locality	Quantity (metric tons)	Value[3] (thousands)	Quantity (metric tons)	Value[3] (thousands)
Canada	252	$635	325	$679
China	1,470	1,680	329	464
Germany	1,430	3,450	884	1,810
India	736	886	430	656
Ireland	88	120	--	--
Japan	2,080	4,810	2,280	5,040
Korea, Republic of	1,200	3,830	1,020	3,190
Mexico	93,000	143,000	93,800	150,000
Mongolia	--	--	17	39
Singapore	514	1,100	417	1,430
Spain	1,030	1,680	1,830	2,660
Taiwan	1,680	4,120	1,940	4,870
United Kingdom	--	--	(4)	3
Total	103,000	166,000	103,000	171,000

-- Zero.

[1]Table includes data available through July 21, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Import information for hydrofluoric acid is reported by Harmonized Tariff Schedule of the United States code 2811.11.0000.

[3]Cost, insurance, and freight value at U.S. ports.

[4]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 6

U.S. IMPORTS FOR CONSUMPTION OF CRYOLITE, BY COUNTRY OR LOCALITY[1, 2]

	2020		2021	
Country or locality	Quantity (metric tons)	Value[3] (thousands)	Quantity (metric tons)	Value[3] (thousands)
Argentina	1,270	$987	631	$467
Australia	--	--	363	239
Bahrain	67	43	30	25
Canada	9,720	4,130	16,800	5,970
China	80	87	60	66
Croatia	1	10	--	--
Denmark	672	1,290	786	1,470
France	149	132	5,980	3,800
Germany	1,280	1,840	1,680	2,320
Hungary	179	308	236	409
Iceland	803	844	2,040	1,550
India	38	42	--	--
Ireland	299	298	--	--
Japan	11,200	14,800	11,200	14,300
Mexico	--	--	3	3
Mozambique	320	235	1,160	869
Netherlands	24	20	--	--
Norway	--	--	487	437
Switzerland	165	112	131	114
United Kingdom	51	102	67	66
Total	26,400	25,300	41,600	32,100

-- Zero.

[1]Table includes data available through July 21, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes natural and synthetic cryolite as reported by Harmonized Tariff Schedule of the United States codes 2530.90.1000 and 2826.30.0000, respectively.

[3]Cost, insurance, and freight value at U.S. ports.

Source: U.S. Census Bureau.

TABLE 7

U.S. IMPORTS FOR CONSUMPTION OF ALUMINUM FLUORIDE, BY COUNTRY OR LOCALITY[1, 2]

	2020		2021	
Country or locality	Quantity (metric tons)	Value[3] (thousands)	Quantity (metric tons)	Value[3] (thousands)
Canada	1,740	$2,550	1,350	$1,990
China	174	226	243	392
Italy	351	483	7,510	18,800
Jordan	315	501	323	508
Mexico	18,100	26,100	18,100	23,900
Other[4]	12	32	32	125
Total	20,700	29,900	27,600	45,800

[1]Table includes data available through July 21, 2022. Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Import information for aluminum fluoride is reported by Harmonized Tariff Schedule of the United States code 2826.12.0000.

[3]Cost, insurance, and freight value at U.S. ports.

[4]Includes all countries with quantities less than 100 metric tons.

Source: U.S. Census Bureau.

TABLE 8

FLUORSPAR: WORLD MINE PRODUCTION, BY COUNTRY OR LOCALITY[1]

(Metric tons)

Country or locality[2]	2017	2018	2019	2020	2021
Afghanistan	7,500 [e]	11 [e]	10,812	6,000 [r, e]	7,000 [e]
Argentina	13,696	7,924	1,500 [r]	NA	NA
Burma:[e]					
Acid grade	--	20,000	36,000	6,000	2,000
Metallurgical grade	3,000	50,000	17,000	10,000	9,000
Total	3,000	70,000	53,000	16,000	11,000
Canada	NA	35,000 [e]	90,000 [r, e]	140,000 [r, e]	140,000 [e]
China	4,380,000 [3]	4,980,000 [3]	5,447,000	5,650,800 [r]	5,700,000
Germany, acid grade	45,375	49,197	79,959	64,933 [r]	65,000 [e]
India, metallurgical grade	1,120	1,270	1,424	917 [r]	1,500 [e]
Iran[4]	36,511 [r]	89,102 [r]	49,705 [r]	50,000 [r, e]	50,000 [e]
Kazakhstan[5]	80,000 [e]	80,000 [e]	87,800	74,500 [r]	67,000
Mexico:[6]					
Acid grade	692,125	800,000 [e]	940,000 [r, e]	680,000 [r, e]	790,000 [e]
Metallurgical grade[e]	325,000	380,000 [r]	290,000 [r]	230,000 [r]	210,000
Total	1,020,000 [e]	1,182,058	1,231,465	914,597	1,007,118
Mongolia:					
Acid grade[7]	55,200	80,700	47,500	85,000 [r]	60,300
Metallurgical grade[e]	300,000 [r]	470,000 [r]	650,000 [r]	640,000 [r]	590,000
Total[e]	355,000 [r]	551,000 [r]	698,000 [r]	725,000 [r]	650,000
Morocco:					
Acid grade	56,395	60,000 [e]	65,000 [e]	54,000 [e]	49,000 [e]
Metallurgical grade	19,105	27,874 [r]	28,000 [e]	28,000 [e]	28,000 [e]
Total	75,500	87,900	93,000 [e]	82,000 [e]	77,000 [e]
Namibia, acid grade, 97% calcium fluoride (CaF_2)	--	11 [8]	--	--	--
Nigeria, metallurgical grade	--	--	7,200 [e]	29,000 [e]	31,000 [e]
Pakistan[e]	21,000	25,000	50,000	52,000 [r]	65,000
Russia, unspecified, 55% to 96.4% CaF_2	2,700	6,000	4,200 [r]	2,800 [r]	2,800 [e]
South Africa:[6]					
Acid grade[e]	206,000	198,000 [r]	236,000 [r]	240,000 [r]	360,000
Metallurgical grade[e]	12,000	14,000	17,000 [r]	47,000 [r]	43,000
Total	218,399	211,542 [r]	252,974 [r]	287,000 [r, e]	403,000 [e]
Spain:					
Acid grade	125,870	145,428	130,988	142,256 [r]	142,000 [e]
Metallurgical grade[9]	12,622	19,009	5,533 [r]	13,173 [r]	13,000 [e]
Total	138,492	164,437	136,521 [r]	155,429 [r]	155,000 [e]
Thailand:					
Acid grade[e]	25,000	36,000	28,000	14,000	--
Metallurgical grade	5,500	16,700	17,747	9,807 [r]	10,000 [e]
Total[e]	30,500	52,700	45,700	23,800 [r]	10,000
Turkey	20,150	6,200	14,400	19,896 [r]	10,348
United Kingdom, all grades	11,000	11,000	14,000 [r]	15,000 [r]	15,000 [e]
Vietnam	234,905	238,702	238,003	219,920	215,027
Zambia, metallurgical grade	--	--	4,000 [e]	4,000 [e]	4,000 [e]
Grand total	6,690,000 [r]	7,850,000 [r]	8,610,000 [r]	8,530,000 [r]	8,680,000
Of which:					
Acid grade	1,210,000	1,390,000 [r]	1,560,000 [r]	1,290,000 [r]	1,470,000
Metallurgical grade	678,000 [r]	979,000 [r]	1,040,000 [r]	1,010,000 [r]	940,000
Other and unspecified	4,810,000 [r]	5,480,000 [r]	6,010,000 [r]	6,230,000 [r]	6,270,000

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

[1]Table includes data available through August 15, 2022. All data are reported unless otherwise noted; grand totals and totals may include estimated data. Grand totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]In addition to the countries and (or) localities listed, Brazil and Egypt may have produced fluorspar, but available information was inadequate to make reliable estimates of output.

[3]As reported by China's Ministry of Natural Resources. May not include production from operations that did not meet the Government's minimum mining and processing requirements. The China Non-Metallic Minerals Industry Association estimated that actual production in 2018 was approximately 6 million metric tons.

[4]Production is based on fiscal year, with a starting date of March 20 of the year shown.

[5]Production likely included a significant quantity of unbeneficiated material.

[6]Quantities by grade are estimated. Total production was reported as shown in the table.

[7]Flotation concentrate; likely includes some material less than 97% CaF_2 content.

[8]Production was reported as semiprecious fluorite crystals.

[9]As reported by the Geological and Mining Institute of Spain, metallurgical grade fluorspar typically contains 70% to 97% CaF_2.