science for a changing world

2020 Minerals Yearbook

FLUORSPAR [ADVANCE RELEASE]

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

November 2024

Fluorspar

By Michele E. McRae

Domestic survey data and tables were prepared by Michelle B. Blackwell, statistical assistant.

In 2020, 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 (HF) 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 supplemented fluorspar as a domestic source of fluorine. Apparent consumption of fluorspar was 470,000 metric tons (t), 412,000 t of which was acid grade and 58,700 t of which was metallurgical grade. Total apparent consumption increased by 18% compared with that in 2019. World fluorspar production was 8.24 million metric tons (Mt), a decrease of 4% compared with that in 2019 (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 (the ability to dissolve in fats and non-polar solvents), chemical reactivity, and low polarizability. These characteristics contribute to fluorine's ability to form a wide variety of stable compounds. The term fluorine is derived from the Latin word fluere, which means to flow, and is a reference to the early use of fluorspar as a metallurgical flux (Jaccaud and others, 2012, p. 381; Dreveton, 2015).

Fluorspar needs to be processed to meet certain minimum CaF_2 percentage requirements and reduce undesirable impurities, both of which vary by application and consumer requirements. Acid-grade fluorspar (also called acidspar), so-called because of its primary use in the manufacture of HF, is a flotation concentrate with typically a CaF_2 content greater than 97%. Anything 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, but applications and specifications are more variable. Similar to the chemical industry, welding rods also use flotation concentrate, usually with a 92% CaF_2 content or more. In the United States and developed countries, fluorspar as a flux is used more commonly in stainless steel and alloys. The CaF_2 content in these applications usually exceeds 85%, which is typically higher than that used in crude steel, which may be as low as 60%. 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 about 40% to 50%, much lower than the CaF_2 content of metspar typically used as a steelmaking flux. The Harmonized Tariff Schedule of the United States (HTS) only differentiates acid- and metallurgical-grade fluorspar based on the 97% CaF_2 content threshold. The terms acidspar and metspar have been used widely for decades, as a convenient mechanism to differentiate differing forms of fluorspar. However, it should be understood that they are terms of convenience that can obscure important nuances in individual consumer specifications, such as CaF_2 content, impurity levels, and particle size.

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. Globally, the adoption of the Kigali Amendment to the Montreal Protocol in 2016 effectively expanded the scope of the treaty to phase down the use of many higher-GWP HFCs. As of yearend 2020, the United States had not ratified the Kigali Amendment, and a 2017 court case established that the EPA did not have the statutory authority to restrict the use HFCs on the basis of GWP (U.S. Court of Appeals for the District of Columbia Circuit, 2017, p. 25; Cooling Post Ltd., 2018; U.S. Environmental Protection Agency, undated b, c, d).

In December 2020, a bipartisan coalition of senators announced that they had reached an agreement to include the American Innovation and Manufacturing Act in an omnibus Government funding bill. Included in the bill was an amendment that directed the EPA to implement a phasedown in the production and use of HFCs to 15% of average annual levels in 2011–2013 by 2036. Certain uses for which there are currently no acceptable substitutes were exempted from the provisions of the phasedown, including those used as defense sprays, fire suppression chemicals in aircraft, medical propellants, semiconductor manufacturing, and other critical military uses. State and local governments were preempted from regulating congressionally mandated protected uses for a minimum of 5 years (Kennedy, 2020a, b).

Per- and Polyfluoroalkyl Substances.—Per- and polyfluoroalkyl substances (PFASs) 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. PFASs have been used in firefighting foams and as a processing aid in the manufacture of fluoropolymers. These substances, particularly long-chain PFASs (PFAS molecules containing eight or more carbon atoms, which are sometimes referred to as C-8), have come under scrutiny over the past 15 years owing to their environmental persistence, prevalence in the human bloodstream, and widespread geographic distribution. PFASs may enter the environment directly or through the degradation of other fluorinated telomers.

Of the thousands of unique PFASs, perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) are two types of long-chain PFASs that have received the most attention. Studies about their effects on human health have examined possible links between elevated blood levels of PFOA and PFOS and numerous adverse health conditions. A science panel established as part of a 2001 class action lawsuit that involved more than 3,500 personal injury claims related to PFOA determined probable links between PFOA exposure and six health conditions, including high cholesterol, kidney and testicular cancers, pregnancy-induced hypertension and preeclampsia, thyroid disease, and ulcerative colitis (Mancini, 2017; Interstate Technology & Regulatory Council, 2022; C8 Science Panel, undated).

PFOA, its salts, PFOA-related compounds, PFOS, its salts, and perfluorooctane sulfonyl fluoride were included on the list of chemicals covered by the Stockholm Convention on Persistent Organic Pollutants, a global treaty to protect human health and the environment from chemicals that persist in the environment for long periods, are widely dispersed geographically, accumulate in the fatty tissue of humans and wildlife, and are harmful to human health and (or) the environment (United Nations, undated a, b).

Domestically, PFOS was voluntarily phased out of production by 2002, and the EPA's voluntary 2010/2015 PFOA Stewardship Program likely reduced or eliminated the manufacture and import of PFOA and other long-chain PFASs. However, numerous communities and States across the United States have identified localized areas with PFOA and PFOS contamination, particularly those near industrial sites where the chemicals were manufactured or used or near airfields where the chemicals were used in firefighting foams (Interstate Technology & Regulatory Council, 2022; U.S. Environmental Protection Agency, undated a).

In 2020, the EPA released an update on its 2019 PFAS Action Plan. The agency highlighted several actions it had taken in the previous year to address PFAS contamination including issuing a preliminary determination to regulate PFOA and PFOS under the Safe Drinking Water Act; issuing a supplemental proposal to ensure that the manufacture or import of new uses of long-chain PFAS in surface coatings would require review under the Toxic Substances Control Act of 1976; validating new methods to accurately test for a total of 29 PFASs in drinking water; issuing interim guidance for addressing PFOA- and (or) PFOS-contaminated groundwater in Federal cleanup programs, including the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act; issuing an advanced notice of rulemaking that would allow public input on adding PFAS to the Toxic Release Inventory toxic chemicals list; and making available $4.8 million in funding for new research on managing PFAS in agriculture (U.S. Environmental Protection Agency, 2020).

In 2019, the U.S. Department of Defense (DOD) established a PFAS Task Force in response to public concerns about PFAS contamination at military installations and surrounding communities, which was attributed to the military's use of fluorinated aqueous film forming foams (AFFFs) used to extinguish jet-fuel fires. The task force had several goals including (1) coordinating DOD's PFAS-related activities with other relevant Federal entities, (2) mitigating and eliminating the use of fluorinated AFFFs currently in use, (3) remediating PFAS-related contamination on military bases and surrounding communities, and (4) understanding the effects of PFAS on human health. By March 2020, the DOD had committed $49 million through fiscal year 2025 in research, development, and testing to find an effective AFFF alternative; develop a centralized database to manage water quality sampling data for all DOD-managed water systems; prepare to offer annual testing of DOD firefighters' blood; provide an additional $10 million to the Agency for Toxic Substances and Disease Registry to conduct exposure assessments in the communities around eight current and former military installations, and a multisite study to examine health outcomes; and work to ensure that users of DOD drinking water systems were provided with bottled water, filters, or other alternatives if the PFOA and PFOS limits exceeded the EPA's lifetime health advisory level of 70 parts per trillion (Paley, 2019; Vergun, 2020).

Production

In 2020, small amounts of fluorspar may have been produced in Illinois by Hastie Mining & Trucking (Cave-in-Rock, IL) 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) does not have a data survey for synthetic fluorspar produced in the United States.

Core Metals Group (Aurora, IN), Hastie Mining & Trucking, and Seaforth Mineral & Ore Co., Inc. (East Liverpool, OH) marketed screened and dried imported acid- and metallurgical-grade fluorspar. Hastie Mining & Trucking also continued development of the Klondike II fluorspar mine in Livingston County, KY.

In August 2020, Ares Strategic Mining Inc. (Canada) announced assay results from a drilling program at its Lost Sheep property located on Spor Mountain in Juab County, UT. According to a 2019 technical report on the property, historic fluorspar mining in the area dates to 1943. More than 350,000 t of fluorspar was shipped from 29 deposits, of which the Lost Sheep Mine contributed approximately 260,000 t. Most of the extraction occurred in high-grade brecciated volcanic pipes within or adjacent to faults and shear zones across Spor Mountain. The purpose of Ares' drilling program was to delineate the shape and grade distribution of fluorspar mineralization within and immediately adjacent to the pipes.

Based on the results, Ares began work on an economic model, mineral-resource estimate, and mine plan. By yearend 2020, the company announced that it had partnered with the Mujim Group (China) for technology to produce fluorspar lump for the ceramic, fiberglass, and glass industry, and that it had begun to evaluate proposals from equipment manufacturers for a facility to produce acid-grade fluorspar (Hughes, 2019, p. 2; Ares Strategic Mining Inc., 2020a–c).

In 2020, three companies—J.R. Simplot Co. (Boise, ID), Univar Solutions Inc. (Downers Grove, IL), and Nutrien Ltd. (Canada)—produced marketable FSA, a byproduct from the processing of phosphate rock into phosphoric acid, at three plants in Florida, North Carolina, and Wyoming. Domestic production data for FSA were collected by the USGS from a voluntary canvass of the three U.S. phosphoric acid operations known to recover FSA. Responses were received from all, representing 100% of the total FSA sold or used by producers. In 2020, FSA production was 21,900 t (equivalent to about 35,600 t of fluorspar grading 100% CaF_2), a 25% decrease compared with that in 2019 (table 1).

DOE's DUF_6 conversion project operated two facilities—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 aqueous HF. After conversion, the HF was sold in the commercial market.

Consumption

Apparent consumption of fluorspar was 470,000 t in 2020, an 18% increase compared with 398,000 t in 2019. Apparent consumption of acid-grade fluorspar increased by 20% to 412,000 t and that of metallurgical-grade fluorspar increased by 9% to 58,700 t (table 1). Globally, there were three leading fluorspar uses. 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 approximately 47% of global annual fluorspar consumption. The manufacture of aluminum fluoride (AlF_3) and cryolite (Na_3AlF_6), essential for primary aluminum smelting, accounted for approximately 20% of global annual fluorspar consumption. (Although HF is produced as an intermediate in the manufacture of AlF_3, AlF_3 production has typically been treated 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 approximately 26% 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 9% and included use in the manufacture of cement, ceramics, enamel, glass, and welding rod coatings (Roskill Information Services Ltd., 2020, p. 86).

In the United States, FSA was used primarily for water fluoridation, but it also was used as a treatment and cleaner for metal surfaces and for pH adjustment in industrial textile processing and laundries. FSA also was used in the processing of animal hides, for hardening masonry and ceramics, and in the manufacture of other chemicals. Internationally, FSA was used as an alternative to fluorspar in the production of AlF_3, accounting for an estimated 13% of global production. Because of differing physical properties, AlF_3 produced from FSA is not readily substituted for AlF_3 produced from fluorspar. Technology to produce HF from FSA also exists but has only been implemented commercially at a few plants in China. In 2020, the amount of FSA sold or used by producers in the United States was 22,000 t, a 32% decrease compared with that in 2019 and was used primarily for water fluoridation (table 1; Roskill Information Services Ltd., 2020, p. 2, 376).

In June 2020, fluorochemical producer Arkema S.A. (France) and phosphoric acid producer Nutrien Ltd. announced a partnership to construct a 40,000-metric-ton-per-year (t/yr) anhydrous HF plant in Aurora, NC, using FSA as feedstock. The new plant, expected to begin production in 2022, would be the first plant of its kind outside of China. The agreement established a long-term HF supply agreement that would support current production of fluorogases and fluoropolymers at Arkema's Calvert City, KY, facility. Arkema cited increasing concerns about the availability of mined fluorspar as an important factor in establishing the partnership (Arkema S.A., 2020).

Aluminum.—Internationally, acid-grade fluorspar was used in the production of AlF_3 and cryolite, 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 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). The AlF_3 requirements of the U.S. aluminum industry were met through imports in 2020 as there were no active AlF_3 producers in the United States (table 7).

Chemicals.—The United States was a leading producer of HF in 2020 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 used fluorspar for the production of HF in 2020—The Chemours Company and Honeywell. 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 (Roskill Information Services Ltd., 2020, p. 24, 243).

When used directly, HF was 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). HF's primary use, however, was as a chemical intermediate in the production of organic fluorocarbon chemicals, which accounted for approximately

49% of global annual acid-grade fluorspar consumption and an estimated one-third of global annual fluorspar consumption. 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. 86).

Historically, the leading nonfeedstock end uses of fluorocarbons have been as aerosols, foam-blowing agents, propellants, and refrigerant gases. Because of the ozone-depleting potential of early generation fluorocarbon gases (CFCs and later HCFCs), many of these substances were targeted for reduction and eventual phase out under the Montreal Protocol, which was adopted in 1987. In order to adapt to evolving regulatory requirements, nonfeedstock CFCs and HCFCs were replaced by HFCs.

Feedstock uses of fluorocarbons, including those used as intermediates in the manufacture of fluoropolymers and fluoroelastomers, have not been restricted by the provisions of the Montreal Protocol because chemicals used entirely as feedstock in the manufacture of other chemicals are excluded from production and consumption calculations. Fluoropolymers and fluoroelastomers are fluorine-containing plastics and rubbers that possess a wide range of advantageous properties including low adhesion; low index of refraction; low gas permeability; and chemical, electrical, oil, temperature, and water resistance, which make them invaluable for use in harsh and demanding environments. According to a report commissioned by the FluoroCouncil, an industry trade group, the United States was a leading producer and net exporter of fluoropolymers. Combined sales of fluoropolymers and fluoroelastomers were reported to be 85,000 t valued at $2 billion (Wood Environment & Infrastructure Solutions UK Ltd., 2020).

The electronics sector was the leading consumer of fluoropolymers, accounting for 31% of consumption in 2020. Primary applications of fluoropolymers in this sector were in the manufacture of semiconductors, because of their resistance to aggressive etchant chemicals, and in optical and data transmission cables, because of their dielectric properties, fire resistance, high transmission speed, and reliability. Consumption in the electronics sector was followed by the transportation sector (25%), in which fluoropolymers were typically used as fuel lines, hydraulic hoses, wire insulation, and as a variety of gaskets and seals. Fluoropolymers in the chemical and industrial processing sector (16%) were used for corrosion-resistant coatings, linings, piping, vessels, and fluid-handling components. Other important applications included architectural panels, fabrics, and coatings in building and construction; consumer products, such as nonstick cookware and waterproof textiles; electrode binder and separator coatings in lithium-ion batteries; films and coatings to protect solar photovoltaics in the energy sector; and as implantable devices, such as catheters, grafts, guidewires, ligaments, and pumps in the medical sector (Wood Environment & Infrastructure Solutions UK Ltd., 2020).

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 railcar, truckload, and less-than-truckload freight. In the late 1970s, the United States used more than 500,000 t/yr for fluxes and other 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 (2020, 2021), the yearend price of acid-grade fluorspar from all leading exporting countries decreased in 2020. The yearend price range of acid-grade fluorspar from China [free on board (f.o.b.) wet filtercake] was $380 to $430 per metric ton compared with $400 to $450 per metric ton in 2019. The price range of acid-grade fluorspar from Mexico (f.o.b. Tampico filtercake) was $330 to $380 per metric ton compared with $380 to $450 per metric ton in 2019. The price range of acid-grade fluorspar from South Africa (f.o.b. Durban filtercake) was $340 to $390 per metric ton compared with $400 to $450 per metric ton in 2019. The price range for metallurgical-grade fluorspar from Mexico, the leading source of domestic metallurgical-grade imports, was $280 to $320 per metric ton, unchanged compared with the yearend price range in 2019 (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 of the acid-grade and ceramic-grade fluorspar was marketed in bags for small users and shipped by truck.

Foreign Trade

In 2020, U.S. exports of fluorspar increased by 21% to 9,180 t compared with those in 2019. With only a small amount of mined or byproduct fluorspar produced, exports were likely reexports of imported material. Approximately 54% of exports went to Canada (table 3).

In 2020, combined acid- and metallurgical-grade fluorspar imports for consumption were 480,000 t, an 18% increase compared with those in 2019. The leading suppliers of total fluorspar imports to the United States were Mexico (60%), Vietnam (18%), South Africa (10%), and Canada (9%). Acid-grade imports were 414,000 t, a 20% increase compared with 346,000 t in 2019. Mexico was the leading source of acid-grade imports, accounting for 54%, followed by Vietnam, with 20%. Metallurgical-grade imports increased by 10%, to 65,400 t, and nearly 100% was from Mexico (table 4).

In 2020, imports of HF were 103,000 t, a decrease of 17% compared with 124,000 t in 2019; most HF imports were from Mexico (90%). Imports of cryolite increased by 27% to 26,400 t, with Japan (43%) and Canada (37%) being the leading suppliers. AlF_3 imports decreased by 46% to 20,700 t; the leading suppliers of AlF_3 were Mexico (87%) and Canada (8%) (tables 5–7).

World Review

The global coronavirus disease 2019 (COVID-19) pandemic likely contributed to both decreased production and consumption of fluorspar; however, the magnitude of the effect was difficult to characterize given that global supply and demand dynamics had already been turbulent in the years leading up to 2020. In 2018 and early 2019, the fluorspar market was characterized by tight supply and high prices, which were exacerbated by China's transition to become a net fluorspar importer in 2018. The situation had eased by late 2019, as new producers in Canada, Mongolia, and South Africa continued to ramp up production. Demand growth also was mitigated by a slowdown in the global economy. The global COVID-19 pandemic likely exacerbated existing trends in the fluorspar market; however, the effects were not distributed uniformly as some producers and consumers were affected more than others (Rhode, 2020, p. 3, 4).

World production of fluorspar in 2020 was 8.24 Mt, a decrease of 4% compared with that in 2019. However, production in South Africa and Canada increased by 57% and 25%, respectively, owing to the continuing rampup of new mines. Conversely, production in other leading exporting countries such as Mexico, Vietnam, and Mongolia decreased by 26%, 8%, and 4%, respectively (table 8).

Similarly, decreased global consumption may not have been evenly distributed geographically in 2020. Orbia Advance Corporation, S.A.B. de C.V., a vertically integrated producer of fluorspar and fluorochemicals based in Mexico, reported weak demand for most of its products in the fluorine value chain (including AlF_3, fluorspar, HF, and refrigerants, but excluding medical propellants) and that illegal imports of HFC in Europe adversely affected demand for fluorspar and refrigerants. By contrast, apparent consumption of fluorspar in the United States increased by 18%; apparent consumption of acid-grade fluorspar increased by 20%, and apparent consumption of metallurgical-grade fluorspar increased by 9% (table 1; Orbia Advance Corporation, S.A.B. de C.V., 2020, p. 5).

China.—China was the world's leading producer and consumer of AlF_3, fluorspar, fluorocarbons (feedstock and nonfeedstock), and HF. Throughout the 1990s, China was also the leading global fluorspar exporter. Since 2018, China has been a net importer of metallurgical-grade fluorspar and, in 2020, became a net importer of acid-grade fluorspar as well. This trend was mostly attributed to Government policy, which for the past two decades had evolved to discourage exports in favor of development of downstream consuming industries and increased vertical integration. In 2017, the Government declared fluorspar to be a strategic mineral. Key priorities included establishing stricter controls on the use of mineral resources and targets for financial investment, and increased monitoring to support Government initiatives. In December 2018, the Fluorite Industry Development Association of China was established in Beijing to facilitate development and standardization within the fluorspar industry (Rhode, 2019, p. 21, 23; Roskill Information Services Ltd., 2020, p. 140, 141).

The China Nonmetallic Minerals Industry Association (CNMIA) estimated fluorspar consumption to be approximately 6 Mt in 2018 and likely to increase. More than three-quarters of this was used for the production of AlF_3 and HF; approximately 10% to 15% was used a flux in steelmaking; and less than 10% was for other uses such as cement, ceramics, glass, and welding rods (Liao, 2019).

China's progressive transition to a net fluorspar importer, coupled with CNMIA's reports of extensive mine disruptions and closures owing to environmental inspections and industry consolidation and depletion of some higher grade deposits in some of the leading-producing Provinces, exacerbated consumers' concerns about the global availability of fluorspar. There was considerable uncertainty about actual production levels and the potential for further exploration and development within the country. The USGS's fluorspar production series for China is based on reporting by the Ministry of Land and Resources (MLR). According to that data series, China's production of fluorspar increased from 3.47 Mt in 2016 to 5.447 Mt in 2019 (table 8), and production in 2020 was estimated to have been essentially unchanged compared with that in 2019. In 2018 specifically, the MLR reported Chinese production to be 4.98 Mt, which stands in contrast to CNMIA's estimate of 6.02 Mt based on Provincial production data. The leading Provinces in terms of production quantity were Hunan Province, Inner Mongolia Autonomous Region, Jiangxi Province, and Zhejiang Province based on the CNMIA's estimate in 2018. A 2020 report on fluorspar deposits in China indicated that the country would likely continue to be a leading producer, which was attributed to an abundance of higher grade deposits that were easy to exploit. The ore grade of deposits exploited solely for fluorspar averaged 54% CaF_2 content. Rich deposits (defined as those with an ore grade of more than 65% CaF_2 content), accounted for 27% of resources and were located primarily in Inner Mongolia, Jiangxi, and Zhejiang. Newly identified resources were concentrated in the leading-producing Provinces, although continued identification of prospective deposits took place in all regions of China, including eastern China, where multiple large deposits have been discovered in the past 10 years. This stands in contrast to reports that opportunities to replace resources from depleted mid- and large-sized mines would mostly need to come from southwestern and northwestern China where production and transportation costs were higher (Liao, 2019; Han and others, 2020, p. 473–474, 483).

Republic of Korea.—The Ministry of Trade, Industry, and Energy announced that Soulbrain Co., Ltd., a chemical company based in Gyeonggi Province, had developed the capability to manufacture enough high-purity HF to meet most of the needs of its domestic semiconductor manufacturing industry. The country had been working to reduce its dependence on imported materials needed for the manufacture of semiconductors and displays after Japan imposed export restrictions on high-purity HF, fluorinated polyimides, and photoresists in 2019 (Kyoung-son, 2020).

Mexico.—Mexico was the second-ranked fluorspar producer globally and the leading exporter. Total production in 2020 was 915,000 t, a decrease of 26% compared with that in 2019. Of the 2020 production, 665,000 t was estimated to be acid grade and 250,000 t was estimated to be metallurgical grade. San Luis Potosi, the site of Orbia's primary mine, accounted for 97% of the country's production. 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 (table 8).

Mongolia.—Mongolia was the third-ranked producer of fluorspar after China and Mexico, and the second-ranked fluorspar exporter. There are more than 600 deposits located in the eastern and southeastern parts of the country, occurring in zones up to 300 kilometers (km) wide and more than 1,000 km long (Khashbat and Jargalan, 2016, p. 95). However, as a landlocked country, Mongolia has limited channels to the export market, so that its two main trading partners have been primarily China and Russia. Although Mongolia has been known to produce acid-grade fluorspar, many plants produced lower grade flotation concentrate that did not meet the specifications required by most leading acid-grade consumers. The vast majority of exports were of metallurgical-grade fluorspar; however, some analysts believed that a significant portion may have been used for the production of HF, either directly or after upgrading. Others have suggested that the material was more likely used as metallurgical grade particularly in China, owing to the increasing difficulty of sourcing high-grade metallurgical lump domestically. Total fluorspar production in Mongolia was estimated to be 685,000 t, a decrease of 4% compared with that in 2019. Of the 2020 production, 95,300 t was acid grade and 590,000 t was metallurgical grade (table 8).

Outlook

Because of fluorspar's role as the basic material for almost all fluorochemicals, fluorspar consumption is driven primarily by factors affecting 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. These conflicting factors complicate an assessment of the outlook for fluorspar. The following discussion examines fluorspar consumption within three leading industrial sectors.

Aluminum.—Because aluminum produced from scrap does not require either AlF_3 or cryolite, demand for fluorspar is expected to move in tandem with primary aluminum production. Aluminum fluoride produced from FSA may displace some AlF_3 produced from fluorspar. However, because of differing physical properties, the two products are not readily interchangeable.

Chemicals.—Consumption of HF is expected to have an average annual growth rate of approximately 3% to 4%, with fluorocarbon production accounting for 60% of demand. Global demand for refrigeration and air conditioning, particularly in developing countries, continues to increase, driving continued demand for fluorocarbon gases. However, because of increased regulation of fluorinated gases with high GWP, a portion of the refrigerant market is expected to transition to nonfluorinated alternatives, which could temper increased consumption of fluorspar in this sector. Total fluorocarbon consumption, including feedstock and nonfeedstock end uses, is expected to increase by 100,000 t between 2019 and 2025, with an increasing proportion being used for fluoropolymer feedstock, which is important in the land transportation and aerospace sectors (Wietlisbach, 2021, p. 15, 19, 38).

Although representing only a small fraction of downstream consumption, one of the fastest growing uses of fluorspar is expected to be in lithium-ion battery electrolytes, which typically use fluorine-containing lithium salts combined with solvents and other additives. The electrolyte salt industry is based in the fluorochemical industry, and often production is partially integrated with the downstream production of electrolyte solutions (Roskill Information Services Ltd., 2020, p. 343, 344). The primary salt used in battery electrolytes is lithium hexafluorophosphate ($LiPF_6$). Production of $LiPF_6$ was reported to be 28,700 t in 2018, which was expected to more than quintuple by 2025 with increased adoption of battery-powered electric vehicles (Shang, 2019).

Fluxes in Steelmaking.—Metallurgical-grade fluorspar consumption varies significantly by geographic region. In Europe and North America, consumption decreased dramatically in the 1990s with decreasing use of open-hearth steelmaking furnaces that used large quantities of fluorspar as a flux. Improvements in steelmaking technology also have reduced the rate of consumption of fluorspar per ton of steel produced. In developing countries, however, the quantity of fluorspar used as a flux in steelmaking continues to be much higher, but further efficiency improvements are expected to moderate growth.

References Cited

Ares Strategic Mining Inc., 2020a, Ares completes delineation drilling assaying & confirms high grades of naturally occurring fluorspar: Vancouver, British Columbia, Canada, Ares Strategic Mining Inc. press release, August 31. (Accessed May 11, 2023, at https://www.aresmining.com/post/ares-completes-delineation-drilling-assaying-confirms-high-grades-of-naturally-occurring-fluorspar-1.)

Ares Strategic Mining Inc., 2020b, Ares Strategic Mining Inc. completes plant design and begins tendering process: Vancouver, British Columbia, Canada, Ares Strategic Mining Inc. press release, December 22. (Accessed May 11, 2023, at https://www.aresmining.com/post/ares-strategic-mining-inc-completes-plant-design-and-begins-tendering-process.)

Ares Strategic Mining Inc., 2020c, Ares Strategic Mining Inc. receives breakthrough fluorspar technology sharing commitment: Vancouver, British Columbia, Canada, Ares Strategic Mining Inc. press release, December 29. (Accessed May 11, 2023, at https://www.aresmining.com/post/ares-strategic-mining-inc-receives-breakthroughfluorspar-technology-sharing-commitment.)

Arkema S.A., 2020, Arkema announces an innovative partnership in the United States for the supply of anhydrous hydrogen fluoride, the main raw material for fluoropolymers and fluorogases: Colombes, France, Arkema S.A. press release, June 3. (Accessed May 11, 2023, at https://www.arkema.com/global/en/media/newslist/news/global/corporate/2020/20200603-arkema-signe-un-a/.)

C8 Science Panel, [undated], C8 Science Panel—C8 probable link reports: C8 Science Panel. (Accessed May 10, 2023, at http://www.c8sciencepanel.org/prob_link.html.)

Cooling Post Ltd., 2018, Court rejects petition to retain HFC ban: Kent, United Kingdom, Cooling Post Ltd., January 27. (Accessed May 10, 2023, at https://www.coolingpost.com/world-news/court-rejects-petition-retain-hfc-bans/.)

Dreveton, Alain, 2015, Overview fluorochemicals industrial sectors: 3d International Symposium on Innovation and Technology in the Phosphate Industry, Marrakesh, Morocco, May 18–20, presentation, [unpaginated].

Fastmarkets IM, 2020, Fastmarkets IM December 2019 price movements: Fastmarkets IM, January 10. (Accessed March 19, 2020, via http://indmin.com.)

Fastmarkets IM, 2021, Fastmarkets IM December 2020 price movements: Fastmarkets IM, January 6. (Accessed March 1, 2021, via http://indmin.com.)

Han, Bei-bei; Shang, Peng-qiang; Gao, Yong-zhang; Jiao, Sen; Yao, Chao-mei; Zou, Hao; Li, Min; Wang, Liang; and Zheng, Hou-yi, 2020, Fluorite deposits in China—Geological features, metallogenic regularity, and research progress: China Geology, v. 3, September, p. 473–489. (Accessed September 22, 2023, via https://www.sciencedirect.com/science/article/pii/S2096519220301816.)

Hughes, T.N.J., 2019, Technical report on the Lost Sheep property: Vancouver, British Columbia, Canada, Antediluvial Consulting Inc., June 30, 118 p. (Accessed May 11, 2023, at https://c2789c21-62f1-4082-847ed877f86d2499.filesusr.com/ugd/f57d32_873e912dde574e6cb1805b289fbc58ff.pdf.)

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 11, 2023, at https://pfas-1.itrcweb.org/wp-content/uploads/2020/10/history_and_use_508_2020Aug_Final.pdf.)

Jaccaud, Michel, Faron, Robert, Devilliers, Didier, and Romano, René, 2012, Fluorine—Ullmann's encyclopedia of industrial chemistry, v. 15: Wienheim, Germany, Wiley-VCH Verlag GmbH & Co. KGaA, p. 381–395.

Kennedy, John, 2020a, Kennedy, Barrasso, Carper announce agreement on HFCs amendment to energy bill: Washington, DC, John Kennedy, Senator for Louisiana press release, September 10. (Accessed May 10, 2023, at https://www.kennedy.senate.gov/public/press-releases?ID=74F0C92B-A687-48A8-90CA-EECDA5318826.)

Kennedy, John, 2020b, Kennedy, senators announce historic bipartisan agreement on American Innovation and Manufacturing Act: Washington, DC, John Kennedy, Senator for Louisiana press release, December 21. (Accessed May 10, 2023, at https://www.kennedy.senate.gov/public/2020/12/kennedy-senators-announce-historic-bipartisan-agreement-on-american-innovation-and-manufacturing-act.)

Khashbat, D., and Jargalan, S., 2016, Fluorite resources of Mongolia: Resource Geology [Japan], v. 66, no. 2, p. 95–102. (Accessed September 22, 2023, at https://www.jstage.jst.go.jp/article/shigenchishitsu/66/2/66_95/_pdf/-char/ja.)

Kyoung-son, Song, 2020, Soulbrain is able to make super pure etching gas: Seoul, Korea JoongAng Daily, January 3. (Accessed May 11, 2023, at https://koreajoongangdaily.joins.com/news/article/article.aspx?aid=3072206.)

Liao, Xinhua, 2019, Chinese fluorspar update: IMFORMED Fluorine Forum 2019, Prague, Czechia, October 21–23, presentation, [unpaginated].

Mancini, Jess, 2017, DuPont reaches C8 settlement agreement for $670M: The Parkersburg [OH] News and Sentinel, February 14. (Accessed May 10, 2023, at http://www.newsandsentinel.com/news/localnews/2017/02/dupont-reaches-c8-settlement-agreement-for-670m/.)

Orbia Advance Corporation, S.A.B. de C.V., 2020, Orbia announces second quarter 2020 financial results: Mexico City, Mexico, Orbia Advance Corporation, S.A.B. de C.V. press release, July 28, 11 p. (Accessed September 20, 2023, at https://www.orbia.com/4a1f23/siteassets/5.-investor-relations/quarterly-earnings/2020/q2/pr-eng-fv.pdf.)

Paley, Miranda, 2019, DOD moving forward with task force to address PFAS: Arlington, VA, U.S. Department of Defense, August 9. (Accessed May 12, 2021, at https://www.defense.gov/Explore/News/Article/Article/1930618/dod-moving-forward-with-task-force-to-address-pfas/.)

Rhode, Oliver, 2019, Key trends and outlook for the fluorspar market: IMFORMED Fluorine Forum 2019, Prague, Czechia, October 21–23, presentation, 51 p.

Rhode, Oliver, 2020, Fluorspar supply & demand overview: IMFORMED Fluorine Forum 2020 ONLINE, October 13, presentation, 21 p.

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

Shang, Cindy, 2019, Fluorine application for fluorochemical and battery industry: Industrial Minerals Fluorspar 2019, London, United Kingdom, presentation, September 25–27, [unpaginated].

United Nations, [undated]a, PFASs listed under the Stockholm Convention—Overview: Geneva, Switzerland, United Nations Environment Programme, Secretariat of the Stockholm Convention. (Accessed May 11, 2023, at http://chm.pops.int/Implementation/IndustrialPOPs/PFOS/Overview/tabid/5221/Default.aspx.)

United Nations, [undated]b, The Convention—Overview: Geneva, Switzerland, United Nations Environment Programme, Secretariat of the Stockholm Convention. (Accessed May 11, 2023, at http://chm.pops.int/TheConvention/Overview/tabid/3351/Default.aspx.)

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. (Accessed May 10, 2023, at https://www.cadc.uscourts.gov/internet/opinions.nsf/3EDC3D4817D618CF8525817600508EF4/$file/15-1328-1687707.pdf.)

U.S. Environmental Protection Agency, 2020, EPA releases PFAS action plan—Program update: U.S. Environmental Protection Agency press release, February 20. (Accessed May 11, 2023, at https://www.epa.gov/newsreleases/epa-releases-pfas-action-plan-program-update-0.)

U.S. Environmental Protection Agency, [undated]a, Assessing and managing chemicals under TSCA: U.S. Environmental Protection Agency fact sheet. (Accessed May 11, 2023, at https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/fact-sheet-20102015-pfoa-stewardship-program.)

U.S. Environmental Protection Agency, [undated]b, Greenhouse gas emissions—Overview of greenhouse gases: U.S. Environmental Protection Agency. (Accessed May 10, 2023, at https://www.epa.gov/ghgemissions/overview-greenhouse-gases.)

U.S. Environmental Protection Agency, [undated]c, Recent international developments under the Montreal Protocol: U.S. Environmental Protection Agency. (Accessed January 16, 2024, at https://www.epa.gov/ozone-layer-protection/recent-international-developments-under-montreal-protocol.)

U.S. Environmental Protection Agency, [undated]d, Significant New Alternatives Policy (SNAP) program: U.S. Environmental Protection Agency. (Accessed May 10, 2023, at https://www.epa.gov/snap.)

Vergun, David, 2020, DOD releases PFAS Task Force progress report: Arlington, VA, U.S. Department of Defense, March 13. (Accessed May 11, 2023, at https://www.defense.gov/News/News-Stories/Article/Article/2111631/dod-releases-pfas-task-force-progress-report/.)

Wietlisbach, Samantha, 2021, Hydrofluoric acid—Downstream market outlook: IMFORMED Fluorine Forum 2021 ONLINE, October 20, presentation, 41 p.

Wood Environment & Infrastructure Solutions UK Ltd., 2020, Socio-economic assessment of the US Fluoropolymer Industry—Executive summary: London, United Kingdom, Wood Environment & Infrastructure Solutions UK Ltd., February, 5 p. (Accessed January 29, 2021, at https://fluoropolymerpartnership.com/wp-content/uploads/2020/03/Socio-Economic-Assessment-of-the-US-Fluoropolymer-Industry-Executive-Summary.pdf.)

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 and Inorganic Fluorine Compounds. Chemical Economics Handbook Marketing Research Report, IHS Chemical, 2012.

Fluorspar—Global Industry Markets & Outlook, 11th edition. Roskill Information Services Ltd., 2013.
ICIS Chemical Business Americas.
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]

		2016	2017	2018	2019	2020
United States:						
Exports:[3]						
Quantity:						
Acid grade, containing more than 97% calcium fluoride	metric tons	6,930	5,180	2,720	1,880	2,440
Metallurgical grade, containing not more than 97% calcium fluoride	do.	5,000	5,760	6,250	5,720	6,750
Total	do.	11,900	10,900	8,970	7,600	9,180
Average unit value:[4]						
Acid grade, containing more than 97% calcium fluoride	dollars per metric ton	$159	$172	$137	$120	$113
Metallurgical grade, containing not more than 97% calcium fluoride	do.	160	183	156	156	154
Imports for consumption:[3]						
Quantity:						
Acid grade, containing more than 97% calcium fluoride	metric tons	328,000	331,000	381,000	346,000	414,000
Metallurgical grade, containing not more than 97% calcium fluoride	do.	55,200	70,400	77,600	59,500	65,400
Total	do.	383,000	401,000	459,000	405,000	480,000
Average unit value:[5]						
Acid grade, containing more than 97% calcium fluoride	dollars per metric ton	273	267	276	304	288 e
Metallurgical grade, containing not more than 97% calcium fluoride	do.	233	237	258	292	149
Reported consumption	metric tons	W	W	W	W	W
Apparent consumption:[6]						
Acid grade, containing more than 97% calcium fluoride	metric tons	321,000	326,000	378,000	344,000	412,000
Metallurgical grade, containing not more than 97% calcium fluoride	do.	50,200	64,700	71,300	53,800	58,700
Total	do.	371,000	390,000	450,000	398,000	470,000
Fluorosilicic acid:						
Production	metric tons	44,200	39,500	32,500	29,400	21,900
Sold or used	do.	43,200	39,000	32,100	32,300	22,000
Value	thousands	$14,300	$13,500	8,680	$6,960	$4,070
Stocks, December 31, consumer and distributor	metric tons	147,000 e	NA	NA	NA	NA
World, production[7]	do.	5,640,000	6,710,000 r	7,890,000 r	8,580,000 r	8,240,000

[e]Estimated. [r]Revised. do. Ditto. NA Not available. W Withheld to avoid disclosing company proprietary data.
[1]Table includes data available through August 12, 2021. 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; data 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.
[7]May include estimated data.

TABLE 2
PRICES OF IMPORTED FLUORSPAR[1]

(Dollars per metric ton)

Source and grade	2019	2020
Acidspar:		
Chinese, free on board (f.o.b.) China, wet filtercake	400–450	380–430
Mexican, f.o.b. Tampico, filtercake	380–450	330–380
South African, f.o.b. Durban, filtercake	400–450	340–390
Metspar, Mexican, f.o.b. Tampico	280–320	280–320

[1]Table includes data available through August 12, 2021.

Source: Fastmarkets IM (London).

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

	2019		2020	
Country or locality	Quantity (metric tons)	Value[3]	Quantity (metric tons)	Value[3]
Australia	101	$14,600	54	$4,600
Brazil	4	2,720	4	2,500
Canada	5,330	771,000	4,980	730,000
Chile	60	18,500	504	56,500
Dominican Republic	861	147,000	1,010	165,000
Indonesia	--	--	53	7,720
Japan	--	--	23	3,400
Korea, Republic of	63	10,200	740	93,300
Mexico	1,170	150,000	1,750	238,000
Taiwan	10	6,130	6	4,920
Uruguay	--	--	60	10,500
Total	7,600	1,120,000	9,180	1,320,000

-- Zero.
[1]Table includes data available through July 19, 2021. 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 2829.22.0000.
[3]Free alongside ship values 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	2019 Quantity (metric tons)	2019 Value[3] (thousands)	2020 Quantity (metric tons)	2020 Value[3] (thousands)
Acid grade containing more than 97% calcium fluoride (CaF_2):				
Canada:				
Buffalo, NY	--	--	3	$5
Houston, TX	4,810	$1,250	22,300	5,900
Mobile, AL	--	--	6,030	1,660
New Orleans, LA	6,560	2,600	16,700	5,970
Total	11,400	3,850	45,000	13,500
China:				
Charleston, SC	--	--	70	38
Houston, TX	12,700	6,020	--	--
Total	12,700	6,020	70	38
France, Savannah, GA	38	21	1	4
Germany:				
Baltimore, MD	--	--	152	111
Charleston, SC	8	5	--	--
Houston, TX	444	73	274	147
New York, NY	38	30	38	30
Total	490	107	464	288
Japan, New York, NY	882	476	1,120	590
Mexico:				
Laredo, TX	10,000	3,120	24,600	9,360
New Orleans, LA	221,000	61,500	197,000	60,500
Total	231,000	64,600	222,000	69,800
Mongolia, Baltimore, MD	799	484	1,380	824
South Africa:				
Houston, TX	9,990	4,500	23,200	7,820
New Orleans, LA	--	--	23,800	5,540
Total	9,990	4,500	47,000	13,400
Spain:				
Houston, TX	10,100	4,640	9,940	3,930
Nogales, AZ	1	6	--	--
Total	10,100	4,640	9,940	3,930
United Kingdom, Houston, TX	86	23	8	36
Vietnam:				
Houston, TX	63,600	18,900	82,800	24,700 [e]
New Orleans, LA	5,030	1,520	4,300	1,290 [e]
Total	68,600	20,400	87,100	26,000 [e]
Grand total	346,000	105,000	414,000	128,000 [e]
Metallurgical grade containing not more than 97% CaF_2:				
Canada, Houston, TX	4,110	1,890	--	--
China:				
Cleveland, OH	81	56	74	52
Los Angeles, CA	416	240	20	10
New Orleans, LA	75	50	--	--
New York, NY	--	--	15	10
Seattle, WA	158	103	--	--
Total	730	449	109	72
Germany, Great Falls, MT	6	4	--	--
India, Los Angeles, CA	93	54	2	10
Mexico:				
Laredo, TX	2,100	354	5,390	1,270
New Orleans, LA	52,100	14,400	59,900	8,370
Total	54,200	14,800	65,300	9,640
Mongolia, New Orleans, LA	336	198	--	--
Netherlands, Los Angeles, CA	1	4	1	2
United Kingdom, Chicago, IL	--	--	2	7
Grand total	59,500	17,400	65,400	9,730
Grand total, all grades	405,000	123,000	480,000	138,000

See footnotes at end of table.

TABLE 4—Continued

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

[e]Estimated. -- Zero.

[1]Table includes data available through July 19, 2021. 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 values at U.S. ports.

Source: U.S. Census Bureau; data adjusted by U.S. Geological Survey.

TABLE 5

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

	2019		2020	
Country or locality	Quantity (metric tons)	Value[3] (thousands)	Quantity (metric tons)	Value[3] (thousands)
Belgium	18	$42	--	--
Canada	309	771	252	$635
China	2,520	3,080	1,470	1,680
Germany	1,190	2,820	1,430	3,450
India	536	648	736	886
Ireland	--	--	88	120
Israel	15	17	--	--
Japan	2,110	5,210	2,080	4,810
Korea, Republic of	1,900	4,270	1,200	3,830
Mexico	113,000	179,000	93,000	143,000
Netherlands	18	23	--	--
Singapore	290	920	514	1,100
Spain	1,870	2,930	1,030	1,680
Taiwan	640	1,710	1,680	4,120
Total	124,000	202,000	103,000	166,000

-- Zero.

[1]Table includes data available through July 19, 2021. 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 values at U.S. ports.

Source: U.S. Census Bureau.

TABLE 6

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

Country or locality	2019 Quantity (metric tons)	2019 Value[3] (thousands)	2020 Quantity (metric tons)	2020 Value[3] (thousands)
Argentina	394	$269	1,270	$987
Bahrain	65	45	67	43
Belgium	158	132	--	--
Brazil	207	131	--	--
Canada	5,460	2,420	9,720	4,130
China	115	180	80	87
Côte d'Ivoire	17	24	--	--
Croatia	--	--	1	10
Denmark	748	1,380	672	1,290
France	841	628	149	132
Germany	1,370	1,930	1,280	1,840
Hungary	691	1,130	179	308
Iceland	1,160	854	803	844
India	39	59	38	42
Ireland	--	--	299	298
Japan	7,280	8,990	11,200	14,800
Mexico	21	9	--	--
Mozambique	1,550	1,180	320	235
Netherlands	--	--	24	20
Norway	33	21	--	--
Spain	25	21	--	--
Switzerland	538	432	165	112
United Arab Emirates	32	21	--	--
United Kingdom	--	--	51	102
Total	20,700	19,900	26,400	25,300

-- Zero.

[1]Table includes data available through July 19, 2021. 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 values 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]

Country or locality	2019 Quantity (metric tons)	2019 Value[3] (thousands)	2020 Quantity (metric tons)	2020 Value[3] (thousands)
Canada	14,400	$10,400	1,740	$2,550
China	911 r	1,590 r	174	226
Italy	3,010	5,800	351	483
Jordan	1,140	1,800	315	501
Mexico	18,400	30,500	18,100	26,100
Other[4]	99	254	12	32
Total	38,000 r	50,400 r	20,700	29,900

[r]Revised.

[1]Table includes data available through July 19, 2021. 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 values 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	2016	2017	2018	2019	2020
Afghanistan	7,600 e	7,500 e	11 e	10,812 r	10,000 e
Argentina	14,222	13,696	7,924	1,226 r	1,200 e
Brazil:					
Acid grade	6,290	6,300 e	6,300 e	6,300 e	6,300 e
Metallurgical grade	11,970	12,000 e	12,000 e	12,000 e	12,000 e
Total	18,260	18,300	18,300	18,300	18,300
Bulgaria	2,000 e	--	--	--	--
Burma:[e]					
Acid grade	--	--	20,000	36,000	6,000
Metallurgical grade	7,000	3,000	50,000	17,000	10,000
Total	7,000	3,000	70,000	53,000	16,000
Canada	--	NA	35,000 e	80,000 e	100,000 e
China[2]	3,470,000	4,380,000	4,980,000 r	5,447,000 r	5,400,000 e
Egypt	1,000	1,000 e	1,000 e	1,000 e	1,000 e
Germany, acid grade	52,552	45,375	49,197	79,959 r	80,000 e
India, metallurgical grade	1,920	1,120	1,270	1,424	1,400 e
Iran	70,820	55,297	55,000	54,824 r	56,000 e
Kazakhstan	80,000 e	80,000 e	80,000 e	87,800	77,000 e
Kenya, acid grade	42,656	--	--	--	--
Mexico:					
Acid grade	649,361	692,125	800,000 r, e	840,000 r, e	665,000 e
Metallurgical grade[e]	250,000	325,000	382,000 r	391,000 r	250,000
Total	899,000	1,020,000	1,182,058	1,231,465	914,597
Mongolia:					
Acid grade[3]	34,100	55,200	80,700	47,500	95,300
Metallurgical grade[e]	240,000	280,000	480,000	670,000	590,000
Total[e]	274,000	335,000	561,000	718,000	685,000
Morocco:					
Acid grade	66,584	56,395	60,000 r, e	65,000 r, e	54,000 e
Metallurgical grade	7,336	19,105	27,900 r	28,000 r, e	28,000 e
Total	73,920	75,500	87,900	93,000 r	82,000
Namibia, acid grade, 97% calcium fluoride (CaF_2)	1,495 [4]	--	11 [5]	--	--
Pakistan	6,625	21,000 r, e	25,000 r, e	50,000 r, e	55,000 e
Russia, unspecified, 55% to 96.4% CaF_2	3,000	2,700	6,000	4,000 r	4,000 e
South Africa:					
Acid grade[e]	146,000	206,000	240,000	190,000	280,000
Metallurgical grade[e]	31,000	12,000	14,000 r	20,000	50,000
Total	177,280	218,399	254,000 r	210,000	330,000
Spain:					
Acid grade	130,131	125,870	145,428	130,988 r	131,000 e
Metallurgical grade[6]	11,997	12,622	19,009	-- r	--
Total	142,128	138,492	164,437	130,988 r	131,000
Thailand:					
Acid grade[e]	37,000	25,000	36,000	28,000	14,000
Metallurgical grade	20,100	5,500	16,700	17,747	18,000 e
Total	57,100	30,500	52,700	45,700	32,000
Turkey	10,339	20,150	6,200	14,400 r	14,000 e
United Kingdom, all grades	12,000	11,000	11,000	12,000 r	12,000 e
Vietnam	218,876	234,905	238,702	238,003	219,920
Grand total	5,640,000	6,710,000 r	7,890,000 r	8,580,000 r	8,240,000
Of which:					
Acid grade	1,170,000	1,210,000	1,440,000 r	1,420,000 r	1,330,000
Metallurgical grade	581,000	670,000	1,000,000 r	1,160,000 r	959,000
Other and unspecified	3,900,000	4,830,000 r	5,450,000 r	6,000,000 r	5,950,000

See footnotes at end of table.

TABLE 8—Continued

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

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

[1]Table includes data available through August 2, 2021. All data are reported unless otherwise noted; 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]As reported by China's Ministry of Natural Resources. May not include production from operations that do 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.

[3]Flotation concentrate, likely includes some material less than 97% CaF_2 content.

[4]Likely metallurgical grade.

[5]Production was reported as semiprecious fluorite crystals.

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