FLUORSPAR

By M. Michael Miller

Domestic survey data and tables were prepared by Leola Bentley[1], statistical assistant, and the world production table was prepared by Regina R. Coleman, international data coordinator.

Traditionally, fluorspar has been considered vital to the Nation's national security and economy. It is used directly or indirectly to manufacture products such as aluminum, gasoline, insulating foams, refrigerants, steel, and uranium fuel. Most fluorspar consumption and trade involve either acid grade, which is greater than 97% calcium fluoride (CaF_2), or subacid grade, which is 97% or less CaF_2. The latter includes metallurgical and ceramic grades, and is commonly called metallurgical grade.

All domestic sources of fluorspar are derived from sales of material from the National Defense Stockpile (NDS) and from a small amount of synthetic fluorspar produced from industrial waste streams. Byproduct fluorosilicic acid production from some phosphoric acid producers supplements fluorspar as a domestic source of fluorine, but is not included in fluorspar production or consumption calculations. According to the Bureau of the Census and the U.S. Geological Survey (USGS), imports of fluorspar decreased by 6% compared with those of 1997. Hydrofluoric acid (HF) imports were nearly 14% higher than those reported in the previous year.

Legislation and Government Programs

The Defense Logistics Agency, Defense National Stockpile Center (DLA-DNSC), was authorized in accordance with the Strategic and Critical Materials Stockpiling Act as amended (50 U.S.C. section 98h-2) to sell about 45,000 metric tons (50,000 short dry tons) of metallurgical grade and about 163,000 tons (180,000 short dry tons) of acid grade during fiscal year 1998 (October 1, 1997 to September 30, 1998). During the 1998 calendar year, DLA-DNSC sold about 43,500 tons (48,000 short dry tons) of metallurgical grade and about 148,000 tons (163,000 short dry tons) of acid grade.

According to the DLA-DNSC's fiscal year 1999 (October 1, 1998 to September 30, 1999) Annual Materials Plan, total sales of about 45,400 tons (50,000 short dry tons) of metallurgical grade and about 109,000 tons (120,000 short dry tons) of acid grade were authorized for fiscal year 1999. In December 1998, the DLA-DNSC sold approximately 43,500 tons (48,000 short dry tons) of metallurgical grade, nearly meeting its fiscal year 1999 sales goal for metallurgical grade. Under current sales levels, the DLA-DNSC projects that the remaining acid-grade stockpiles will be sold during the second quarter of fiscal year 1999. The remaining metallurgical-grade stockpiles, totaling about 147,000 tons (162,000 short dry tons) are located in New Haven, IN; Warren, OH; Large and Marietta, PA; and Clearfield, UT. If current sales levels remain unchanged, it is likely the remaining metallurgical grade will be sold by 2003.

Production

There is currently (1998) no domestic mine production of fluorspar. Domestic production data for fluorosilicic acid were developed by the USGS from voluntary surveys of U.S. operations. Of the 11 fluorosilicic acid operations surveyed, 10 respondents reported production and 1 respondent reported zero production, representing 100% of the quantity reported.

The Hastie-Sogem Minerals partnership was dissolved, and Hastie Mining and Trucking Co. finalized the sole purchase (effective March 1) of the former Ozark-Mahoning Co. mill at Rosiclare, IL. Hastie Mining washed, screened, and dried metallurgical- and acid-grade fluorspar imported or purchased from the NDS. Seaforth Mineral & Ore Co., Inc., dried and screened imported or NDS fluorspar at its facilities at Cave-In-Rock, IL, and East Liverpool, OH, as did AIMCOR (Applied Industrial Materials Corp.) at its facility at Aurora, IN.

Five companies operating 10 plants processing phosphate rock for the production of phosphoric acid produced 67,900 tons of byproduct fluorosilicic acid and sold or used 67,300 tons of byproduct fluorosilicic acid at a value of about $8.64 million. This was equivalent to approximately 118,000 tons of fluorspar (grading 92% CaF_2) sold or used. The level of fluorosilicic acid output was essentially unchanged compared with that of the previous year. Because fluorosilicic acid is a byproduct of the phosphate fertilizer industry and is not manufactured for itself alone, shortages may occur when phosphate fertilizer production goes down.

Some synthetic fluorspar was recovered as a byproduct of uranium processing, petroleum alkylation, and stainless steel pickling. It is estimated that the majority of the marketable product comes from uranium processing. Greater restrictions on the disposal of industrial wastes and improvements in recovery processes may lead to greater recovery from non-uranium sources. At present, an estimated 10,000 tons of synthetic fluorspar is being produced annually in the United States.

Environment

Followup talks to the Kyoto conference of the United Nations Framework Convention on Climate Change (UNFCCC) were held in Buenos Aires, Argentina, in

[1]Deceased.

November to discuss procedures for reaching the targets for greenhouse-gas emission reductions agreed to in the terms of the Kyoto Protocol. These discussions included setting up an international emissions trading system and a clean development mechanism enabling industrialized countries to finance emissions-avoiding projects in developing countries and to receive credit for doing so (United Nations Climate Change Secretariat, 1998). A major U.S. concern was the unwillingness of many developing countries to agree to formal commitments that would put an upper limit on their emissions. Although no major decisions or proposals came out of the Buenos Aires meeting, with the inclusion of hydrofluorocarbons (HFC's), perfluorocarbons, and sulfur hexafluoride in the list of greenhouse gases, the activities of the UNFCCC are of great interest to producers of fluorspar, HF, and downstream fluorine chemicals.

On a related issue, the U.S. Environmental Protection Agency issued proposed rules to extend the ban on venting chlorofluorocarbons (CFC's) and hydrochlorofluorocarbons (HCFC's) to include HFC's and perfluorocarbons because of their potential to contribute to global warming. The proposed rule was issued under authority of Title VI of the Clean Air Act Amendments of 1990, but chemical companies challenged the legal basis of the proposed rule, pointing out that Title VI only addresses the problem of stratospheric ozone depletion, not global warming (Hess, 1998).

Government representatives from more than 100 countries met in November in Cairo, Egypt, for the 10th annual meeting of the parties to the Montreal Protocol. The meeting reviewed the problem of noncompliance by Russia and seven other members of the former Soviet Union. In addition, the Montreal Protocol parties agreed on a process for coordinating their economic, scientific, and technology assessment panels with similar panels and committees linked to the Kyoto Protocol. The goal is to ensure that the scientific and policy responses underlying the two international agreements are mutually supportive and fully coordinated. This agreement is of concern to producers of HFC's, because HFC's, which were developed to replace CFC's phased out under the Montreal Protocol, are on the list of greenhouse gases being targeted by the Kyoto Protocol. Industry argues that countries would lose the choice of which greenhouse gases to control if the Montreal Protocol restricts the use of HFC's (Chemical Market Reporter, 1998).

Consumption

Domestic consumption data (table 2) for fluorspar were developed by the USGS from voluntary surveys of U.S. operations. The consumption survey was sent to 50 operations quarterly and to 3 small operations annually. In 1998, 35 responded to the consumption surveys, representing 66% of the operations surveyed. These 35 respondents are estimated to have accounted for 90% of total U.S. consumption. Estimates for nonrespondents were based on past consumption relationships, trends, and nonsurvey sources. A number of unidentified consumers are thought to have consumed small amounts that have not been included.

Traditionally, there have been three grades of fluorspar: acid grade, containing greater than 97% CaF_2; ceramic grade, containing 85% to 95% CaF_2; and metallurgical grade, containing 60% to 85% or more CaF_2. During the last several decades there has been a general movement toward the use of higher quality fluorspar by many of the consuming industries. For example, welding rod manufacturers may use acid-grade fluorspar rather than ceramic grade, and some steel mills use ceramic grade or acid grade rather than metallurgical grade. The following is a discussion of the general uses of fluorspar by grade, and, in the case of acid grade, the uses of some of its important downstream products.

Acid-grade fluorspar was used primarily as a feedstock in the manufacture of HF and in the production of aluminum fluoride (AlF_3). Two companies reported fluorspar consumption for the production of HF. The largest use of HF was for the production of a wide range of fluorocarbon chemicals, including HFC's, HCFC's, and fluoropolymers. HCFC's and HFC's were produced by the following seven companies: AlliedSignal Corp., Ausimont USA, Inc.; E. I. du Pont de Nemours & Co., Inc. (DuPont); Elf Atochem North America, Inc.; I.C.I. Americas, Inc.; La Roche Chemicals, Inc.; and MDA Manufacturing Ltd. The latter is a joint venture between Daikin America Inc. and 3M Corp. to produce HCFC 22 and hexafluoropropane for captive use in fluoropolymer manufacturing.

Some of the current or potential fluorocarbon replacements for the banned CFC's are HCFC's 22, 123, 124, 141b, 142b, and 225. These HCFC substitutes have ozone-depletion potentials that are much lower than those of CFC's 11, 12, and 113, which in total have accounted for more than 90% of CFC consumption. HCFC 22 has been used as a high-pressure refrigerant (e.g., home air conditioning) for years, HCFC 123 is being used as a replacement for CFC 11 in low-pressure centrifugal chillers, HCFC 124 is a potential replacement for CFC 114 in medium-pressure centrifugal chillers and may replace CFC 12 as a diluent in sterilizing gas, and HCFC's 141b and 142b have replaced most of the CFC 11 and 12 used in foam blowing. HCFC's 141b and 225, perfluorocarbons, and hydrofluoroethers have been introduced as replacements for CFC solvents. Unfortunately, because of the current phaseout schedule for HCFC's, the market for HCFC's will exist for only a short time, and perfluorocarbons are on the list of gases that contribute to global warming.

The HFC replacements have no ozone-depletion potential because they contain no chlorine atoms. The most successful HFC replacement compound is HFC 134a. It is the main replacement for CFC 12 in automobile air conditioners, is being used as the refrigerant in new commercial chillers and refrigerators, and is being used as the propellant in aerosols and tire inflators. HFC's 23, 32, 125, 143a, and 152a also are being produced domestically, but in much smaller quantities. These HFC's hold potential for use by themselves or more likely as blends for specific uses, such as the azeotropic mixture of HFC's 32 and 125 that is emerging as the replacement of choice for HCFC 22. HFC's 134a and 227 are being evaluated for use in medical aerosols. HFC 245fa may be a candidate for use as a low-pressure refrigerant to replace HCFC 123. HFC's 245 and 356 are being tested as potential replacements for HCFC 141b in blowing agents for thermosets, such as polyurethane. HFC 4310 has been developed as a replacement for CFC 113, HCFC's, and perfluorocarbons for use in drying fluids, cleaning and rinsing agents, defluxing agents, and heat transfer media. HCFC's 22, 123, and 124; HFC's 23, 125, 134a, and 227ce; and a number of other fluorine compounds have been approved by the EPA as acceptable substitutes (some subject to use restrictions) for halon streaming agents for fire suppression.

HF was also consumed to produce CFC 113, HCFC's 22 and 142b, and HFC 152a, which were produced as chemical intermediates in the production of fluoropolymers. Fluoropolymers have desirable physical and chemical properties that allow them to be used in products from pipes and valves to architectural coatings to cookware. These intermediate uses of CFC 113 and HCFC's 22 and 142b will not be subject to the production phaseouts mandated by the Montreal Protocol and the Clean Air Act Amendments of 1990, because these products are consumed in the manufacturing process.

HF was consumed in the manufacture of uranium tetrafluoride that was used in the process of concentrating uranium isotope 235 for use as nuclear fuel and in fission explosives. It also was used in stainless steel pickling, petroleum alkylation, glass etching, treatment of oil and gas wells, and as a cleaner and etcher in the electronics industry. HF was used as the feedstock in the manufacture of a host of fluorine chemicals used in dielectrics, metallurgy, wood preservatives, herbicides, mouthwashes, decay-preventing dentifrices, and water fluoridation.

Currently the AlF_3 manufactured for use in aluminum reduction cells is produced directly from acid-grade fluorspar or byproduct fluorosilicic acid. In the Hall-Héroult process, alumina is dissolved in a bath of molten cryolite, AlF_3, and fluorspar to allow electrolytic recovery of aluminum. On average worldwide, the aluminum industry consumes about 21 kilograms of fluorides for each ton of aluminum produced. This ranges from 10 to 12 kilograms per ton in a modern prebaked aluminum smelter to 40 kilograms per ton in an older Soderberg smelter without scrubbers. AlF_3 is added to the electrolyte in reduction cells to improve the cell's electrical efficiency. AlF_3 was used by the ceramic industry for some body and glaze mixtures and in the production of specialty refractory products. It was used in the manufacture of aluminum silicates and in the glass industry as a filler.

Ceramic-grade fluorspar was used by the ceramic industry as a flux and an opacifier in the production of flint glass, white or opal glass, and enamels. Ceramic grade was also used to make welding rod coatings and as a flux in the steel industry.

Metallurgical-grade fluorspar was used primarily as a fluxing agent by the steel industry. Fluorspar is added to the slag to make it more reactive by increasing its fluidity (by reducing its melting point) and thus increasing the chemical reactivity of the slag. Reducing the melting point of the slag brings lime and other fluxes into solution to allow the absorption of impurities. Fluorspar of different grades was used in the manufacture of aluminum, brick, cement, and glass fibers and by the foundry industry in the melt shop.

The level of total reported fluorspar consumption increased by nearly 10% in 1998. This increase more than offset the decrease in acid-grade consumption reported in 1997 that was caused, in part, by rail freight problems in Texas that resulted from the Union Pacific Railroad takeover of Southern Pacific Railroad in 1996.

The data collected for non-HF/AlF_3 markets are believed to be underreported and may not accurately reflect the true size of these markets. Based on the data available, the reported consumption of fluorspar for non-HF/AlF_3 uses decreased by 17% compared with that of 1997. This was due primarily to the decrease in steel production caused by surge in cheap steel imports from Brazil, Japan, and Russia. Beginning in the second quarter of 1998, the effect on domestic steel producers was dramatic and resulted in complaints of foreign dumping by the U.S. steel industry and the steelworkers' union. Several small steel producers were forced to declare bankruptcy, and others were forced to cut prices and production because of the record amounts of imports, which were blamed for causing prices to plummet and demand to weaken (Kelly, 1998).

The increased levels of steel imports were the result of complex factors in international markets. With the onset of the recession in Asia, exports of Russian steel formerly directed to countries in the Far East were redirected to the United States. Brazil and Japan, each with sagging economies and sinking currencies, tried to improve their situations by exporting product to the largest, strongest market in the world. At the same time, ironically, U.S. steel producers were the recipients of much of the imported steel, which allowed them to meet increased demand from their customers.

About 35,200 tons of byproduct fluorosilicic acid valued at $4.96 million was sold for water fluoridation, about 14,800 tons of fluorosilicic acid valued at $1.73 million was sold to make AlF_3 for the aluminum industry, and about 17,300 tons valued at $1.95 million was sold or used for other uses, such as sodium silicofluoride production.

Stocks

Consumer stocks at yearend totaled 134,000 tons and were essentially unchanged from 1997 levels. Consumer and distributor stocks totaled of 468,000 tons, which included 334,000 tons purchased from the NDS but still located at NDS depots. As of December 31, 1998, the NDS fluorspar inventory classified as excess (excluding material sold pending shipment) contained about 95,200 tons (105,000 short dry tons) of acid-grade material and about 147,000 tons (162,000 short dry tons) of metallurgical-grade material. About 40% of the remaining metallurgical-grade material was classified as nonstockpile grade.

Transportation

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

Most acid-grade imports come from China and South Africa. Fluorspar is shipped by ocean freight using the “Tramp” market for ships. Bulk carriers of 10,000 to 50,000 tons deadweight normally are used. Participants negotiate freight levels, terms, and conditions. The main participants are (1) charterers, generally the buyers or sellers; (2) ship owners, who either own vessels or have them time chartered; (3) operators, traders normally taking positions on either cargo or ships; and (4) brokers, who generally represent ship owners or charterers and act as go-betweens. Ships are primarily owned by the following: privately held shipping companies, publicly held shipping companies, government-controlled companies, and groups of professionally managed fleets under varying ownership. This information was confirmed by R.C. Diamond (Mid-Ship Marine, Inc., written commun., 1993).

Owing to low interest rates and the easy availability of capital in the past few years, there has been a construction boom in new shipbuilding between 1996 and 1998. At the same time, the rate at which ships are retired and/or scrapped has been substantially lower than the rate of construction, despite the adoption of the new International Safety Management Code (ISMC), which went into effect on July 1, 1998. The ISMC was expected to cause the retirement of older ships by adding additional costs to ships already burdened by overage insurance and higher operating costs. This resulted in overcapacity at a time when, owing to weakness in Asian economies and the strength of the U.S. dollar, there was a shortage of cargoes bound from the United States to Asia. Meanwhile, cargoes to the United States were plentiful as the Asian countries tried to export their way out of the recession. This trade imbalance has depressed the shipping market and pushed shipping rates down to historic lows (adjusting for inflation). Low shipping rates benefitted customers, but the combination of low rates and lack of cargoes put a number of shipping companies out of business and created large operating losses for others (Kachmar, 1999).

Prices

According to Industrial Minerals, yearend price ranges (table 3) for Mexican fluorspar, f.o.b. Tampico, were unchanged at $110 to $130 per ton for acid grade and $80 to $105 per ton for metallurgical grade. Industrial Minerals initiated a new price listing for Mexican acid grade, f.o.b. Mexico, less than 5 parts per million arsenic; the yearend price was $130 to $140 per ton. South African prices for acid grade, f.o.b. Durban, decreased to $110 to $120 per ton. No specific f.o.b. China or c.i.f. Gulf of Mexico prices were available for Chinese fluorspar. According to Industrial Minerals, the average U.S. Gulf port price, dry basis, for acid grade decreased to $122 to $135 per ton. This would be the average delivered price of Chinese, Mexican, and South African acid grade at Gulf port.

Prices of imported acid-grade fluorspar over the past 10 years (figure 1) have exhibited a roller coaster pattern of highs and lows. Prices have been affected by major factors, such as the severe drop in demand caused by the CFC phaseout, major increases in Chinese exports and the resulting cutthroat competition between Chinese exporters, and the introduction of Chinese export quotas and license fees. Lesser factors affecting prices were sales from the NDS, variations in shipping rates, and changes in import tariffs. The latter is not included in price data derived from trade statistics, which include only the additional costs of insurance and freight (See figure 1).

According to Chemical Market Reporter, the yearend price quotation for anhydrous HF was unchanged at $0.70 per pound ($1.55 per kilogram). It also quoted a price for chemically pure (99.0 weight percent) anhydrous HF, 1,300 pounds (590 kilograms), f.o.b., $2.96 per pound ($6.53 per kilogram). The quotation for aqueous HF, 70%, in drums, f.o.b., freight allowed, increased to $0.65 per pound ($1.44 per kilogram). The yearend price quotation for hydrofluosilicic acid (fluorosilicic acid), 23% basis, in tanks, Midwest and East Coast terminals, was unchanged at $165 per short ton (about $182 per ton).

Foreign Trade

According to the Bureau of the Census, U.S. exports of fluorspar (table 4) decreased by nearly 30%, to 43,600 tons. All U.S. exports were believed to be reexports of material imported into the United States or exports of material purchased from the NDS.

In 1998, imports for consumption of fluorspar (table 5) decreased by more than 6% when compared with those of the previous year, according to Bureau of the Census and USGS data. The largest suppliers of fluorspar to the United States were, in descending order, China, South Africa, and Mexico. China accounted for nearly 68% of U.S. fluorspar imports. The average c.i.f. unit value, in dollars per metric ton, was $128 for acid grade and $89 for metallurgical grade.

There is no tariff on subacid-grade (metallurgical-grade) fluorspar from normal trade relations (NTR) countries, and the tariff on acid grade from NTR countries was eliminated effective January 1, 1999. There are no tariffs on other major fluoride minerals and chemicals, such as natural or synthetic cryolite, hydrofluoric acid, and aluminum fluoride.

Imports of HF (table 6), excluding material from DuPont’s foreign trade zone, increased by nearly 14%, to a quantity equivalent to approximately 186,000 tons of fluorspar. Imports of synthetic and natural cryolite (table 7) increased by 64% to a quantity equivalent to approximately 18,200 tons of fluorspar. Imports of AlF_3 (table 8) increased by 75% to a quantity equivalent to 33,600 tons of fluorspar.

World Review

The most significant events affecting fluorspar supply and demand in 1998 were not the result of mine expansions or closures, but rather decisions made by governments. World production (table 9) increased by about 3.5% compared with the revised 1997 data.

Canada.—Since the reopening of the HF plant at Amherstburg, Ontario, in 1996, imports of acid-grade fluorspar have increased dramatically. From import levels of about 62,100 tons in 1995, Canada's acid-grade imports have increased to nearly 163,000 tons in 1998. In 1998, the major sources of supply were, in descending order, Mexico, Morocco, and China. Metallurgical-grade imports totaled 23,800 tons for 1998 (Marian Scollan, Natural Resources Canada, oral commun., 1999).

In the ongoing efforts by Burin Minerals Ltd. to reopen the St. Lawrence fluorspar mines, the Premier of Newfoundland and Labrador announced on July 24 that the Provincial Government had committed to provide funding assistance for the construction of a $10 million (Canadian dollars) deep-water-port facility at St. Lawrence. The investment was contingent on the results of feasibility studies and the securing of an adequate amount of private capital by Burin Minerals (Government of Newfoundland and Labrador, 1998). At the end of 1998, Burin Minerals was still in talks with financial institutions to arrange funding.

China.—Determining China's actual production data for acid- and metallurgical-grade fluorspar has always been difficult owing to the lack of official Government data and the complex nature of the network of producers, processors, exporters, and consumers in China. Problems range from an unreliable breakdown of export data by grade to the consumption in China of more than 300,000 tons per year of submetallurgical-grade fluorspar (less than 60% CaF_2) for cement manufacturing. For these reasons, the production estimates reported by grade in table 9 may be too high.

Effective July 20, the Chinese Government suspended the export quotas on fluorspar for the remainder of 1998. This allowed the unlimited export of fluorspar by any of the 200 to 300 authorized fluorspar traders for a flat rate export fee of about $27 per ton. This license fee was about $2 to $5 per ton higher than the original fees established in the initial bidding process for 1998 (Industrial Minerals, 1998).

The Chinese Ministry of Foreign Trade and Economic Cooperation (MOFTEC) revised the export license system for 1999. Significant changes involved the mechanics of bidding for licenses and securing export quotas, and included the requirement that all bidding be done remotely via computer from company offices to reduce the possibility of collusion between bidders. The ratio of open (public) bidding to closed (agreement) bidding was changed; the amount available under open bidding was projected to be 55% to 60%, with the remaining available under closed bidding by the major producers and State-owned companies. The revised system called for four rounds of bidding per year to allow more flexibility in adjusting quantities and prices in response to market conditions. In an attempt to eliminate unsuitable bidders, the nonrefundable deposit required was increased from 10% to 50% of the total license fee. Another major modification was the proposal to accept the highest bid within preestablished limits, rather than using the average bid in determining the winning price and who receives licenses. (Mineral Price Watch, 1999a).

European Union.—The European Union's (EU) environmental ministers agreed to an accelerated phaseout of HCFC's, with a production freeze from 2000 to 2008 and a complete ban on their use by 2009. In addition, in keeping with the Kyoto Protocol, the EU agreed to cut its emissions of greenhouse gases by 8% from 1990 levels by 2010. With HFC's covered by the Kyoto Protocol, restrictions on their use were being considered by Denmark, the United Kingdom, and other EU nations. Ironically, the phaseout of HCFC's may actually accomplish the required reduction in HFC emissions, because a major source of HFC emissions is from the manufacture of HCFC 22. HFC emissions would be cut by the installation of HFC recovery equipment and the likely closure of some of the HCFC plants to comply with the HCFC phaseout. This would save the HFC producers from drastic cutbacks and could promote the use of HFC refrigerants as replacements for HCFC 22 (Milmo, 1999).

Mexico.—Cia. Minera Las Cuevas, S.A. de C.V., expanded its flotation mill, thus bringing capacity up to 320,000 metric tons per year, but its plans to build a fluorspar refinery to produce high-purity (low arsenic) acid grade were put on hold. Production costs for the refinery product were too high to be economic at current prices, but continued research is planned to develop a cost-effective solution.

Namibia.—Okorusu Fluorspar (Pty.) Ltd. completed major improvements to its mine and mill facilities. The company constructed a new flotation mill, workshop, and laboratory; purchased new mining equipment; and invested in housing and amenities for the employees. The company contracted out one of its open pits (Pit A), with a resulting waste push back of 3 million tons. This will allow Okorusu to access higher grade ore (60% CaF_2) by the spring of 2000. In 1998, the company mined a blend of low-grade ore from Pit A and ore from its Pit B. Projected output is 60,000 tons (wet) of acid grade for 1999 and 80,000 tons (wet) of acid grade for 2000. All production is intended for Okorusu's parent company, Solvay S.A., to supply its HF plant at Bad Wimpfen, Germany (Mark Dawe, Okorusu Fluorspar (Pty.) Ltd., oral commun., 1999).

Outlook

The long-awaited surge in demand for HF in North America appears to have finally arrived. Strong demand from fluorocarbon production plus the continued growth of the fluoropolymer markets resulted in North American supplies of HF being tight in the last half of 1998. The increase in fluorocarbon demand has been fueled by seasonal requirements and changes in the production of aerosols and tire inflators. Aerosol manufacturers are now required to use propellants with maximum volatile organic compound levels of 45% to 55%. HFC 152a and HFC 134a meet the requirement, but HFC 134a also has the advantage of being nonflammable. In early 1999, marketers of tire inflators started requiring the use of nonflammable material, which will create additional demand for HFC 134a. Fluorocarbon capacity appears to be sufficient, although the increased demand has caused producers to divert material from the export market. The increased demand for fluorocarbons has caused HFC 134a prices to increase, but not enough to warrant investment in new capacity. Fluorocarbon demand has picked up so strongly that AlliedSignal, which is the largest producer of HF in North America, is considering adding HF capacity to supply the increasing demand by fluorocarbon producers.

Because AlF_3 demand mirrors aluminum demand, the outlook for aluminum production is important. In recent years, increased domestic output of aluminum has been fueled by the strong U.S. economy and the recovery of world markets from the effects of the large quantities of Russian exports. This trend is expected to continue, with idle capacity expected to be back on-stream in the next few years as demand increases and prices strengthen. It is expected that fluorspar consumption in North America for AlF_3 production will increase as aluminum output increases.

The metallurgical-grade market may experience some lingering effects from the steel import problems in 1998. The conditions responsible for the decrease in domestic steel production still exist, although the imposition of antidumping duties could slow the flow of cheap imports. A better and longer term solution involves the recovery of the Asian economies, and there are some signs that the recovery has started.

Fluorspar prices are driven to the largest degree by the activities and policies of China. The revision of the export license system for 1999 is expected to impact prices. Initial rounds of bidding in early 1999 resulted in major increases in the export license fees to the $55- to $60-per-ton range, which is more than double the 1998 fees (Mineral Price Watch, 1999b). Exporters found it almost impossible to export fluorspar encumbered by such high license fees, and filed complaints with the Chinese Chamber of Commerce for Metals and Chemicals and MOFTEC. As a result, another 500,000 tons of fluorspar was authorized for bids, and the resulting license fee was announced at about $39 per ton (S.A. Humphrey, DuPont Fluoroproducts, oral commun., 1999). This is still $12 per ton higher than the flat rate established for the second half of 1998 when MOFTEC suspended the export quotas. Some exporters may attempt to find buyers at the earlier, higher license fees, but unless supplies get very tight, buyers are unlikely to accept such high prices. If exporters find it impossible to move material at the higher fee rates, MOFTEC will probably allow companies to turn in the unused licenses, and it will hold another round of bidding. Regardless, it appears that prices will increase by about $12 per ton to reflect the new $39 per ton license fee. Other fluorspar-producing countries will likely increase their prices in conjunction with the Chinese. In 1999, actual shipment prices for Chinese acid grade may fluctuate greatly, and will depend on the amount that was paid for the export license fee—$27 (carry over from 1998), $39, or $60 per ton.

References Cited

Chemical Market Reporter, 1998, Montreal Protocol links efforts on climate change, ozone depletion: Chemical Market Reporter, v. 254, no. 23, December 7, p. 35.

Government of Newfoundland and Labrador, 1998, Government to partner with Burin Minerals in St. Lawrence: St. John's, NF, Canada, Government of Newfoundland and Labrador news release, July 24, 2 p.

Hess, Glenn, 1998, Industry challenges EPA under Clean Air Act Title VI: Chemical Market Reporter, v. 254, no. 16, p. 19.

Industrial Minerals, 1998, Fluorspar export quotas dropped: Industrial Minerals, no. 372, September, p. 17.

Kachmar, George, 1999, Asian flu effect on international shipping, *in* International Fluorspar Conference 1999, Vail, CO, March 9-10, Proceedings: Wilmington, DE, E.I. du Pont de Nemours & Co., Inc., [unpaginated].

Kelly, N.E., 1998, Commerce finds 'critical circumstances' vs. Japan, Russia: American Metal Market, v. 106, no. 227, November 25, p. 1.

Milmo, Sean, 1999, Producers raise alarms against efforts to restrict HFC uses: Chemical Market Reporter, v. 255, no. 3, January 18, p. 8.

Mineral Price Watch, 1999a, Chinese export licenses—A new twist for 1999: Mineral Price Watch, no. 50, February, p. 8-11.

———1999b, Round two for Chinese fluorspar bids: Mineral Price Watch, no. 52, April, p. 3.

United Nations Climate Change Secretariat, 1998, Kyoto Protocol talks in Buenos Aires to promote emissions cuts: Bonn, United Nations Climate Change Secretariat advance press release, 2 p.

SOURCES OF INFORMATION

U.S. Geological Survey Publications

Fluorspar. Ch. in Minerals Yearbook, annual.[2]
Fluorspar. Ch. in Mineral Commodity Summaries, annual.[2]
Fluorspar. Mineral Industry Surveys, quarterly.[2]
Geology and resources of fluorine in the United States, U.S. Geological Survey Professional Paper 933.

Other

Chemical and Engineering News.
Chemical Market Reporter.
Chemical Week.
European Chemical News.
Fluorspar. Ch. in Industrial Minerals and Rocks.
Fluorspar. Ch. in Mineral facts and problems, U.S. Bureau of Mines Bulletin 675.
Industrial Minerals (London).
North American Minerals News.
Roskill—The Economics of Fluorspar 1993.
SRI International—Chemical Economics Handbook, Fluorine.
U.S. Department of Commerce Current Industrial Reports, Inorganic Chemicals, M28A.

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

TABLE 1
SALIENT FLUORSPAR STATISTICS 1/ 2/

		1994	1995	1996	1997	1998
United States:						
Production:						
Finished (shipments) e/ 3/	metric tons	49,000	51,000	8,200	--	--
Value, f.o.b. mine	thousands	W	W	W	--	--
Exports 4/	metric tons	23,500	41,800	61,600	62,100	43,600
Value 5/	thousands	$3,690	$5,550	$8,110	$8,330	$6,800
Imports 6/	metric tons	492,000	558,000	513,000	536,000	503,000
Value 7/	thousands	$47,600	$67,400	$71,000	$69,500	$62,700
Value per ton, acid grade 7/		$97.70	$126.00	$142.00	$134.00	$128.00
Value per ton, metallurgical grade 7/		$74.90	$94.40	$103.00	$90.70	$89.20
Consumption (reported)	metric tons	486,000	534,000	527,000	491,000	538,000
Consumption (apparent) 8/	do.	556,000	599,000	719,000	551,000	572,000
Stocks, December 31:						
Consumer and distributor 9/	do.	284,000	405,000	234,000	375,000	468,000
Government stockpile	do.	909,000	756,000	667,000	448,000	243,000
World: Production	do.	3,750,000 r/	4,170,000 r/	4,240,000 r/	4,510,000 r/	4,670,000

e/ Estimated. Revised. W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits.
2/ Does not include fluorosilicic acid or imports of hydrofluoric acid and cryolite.
3/ May include fluorspar from the National Defense Stockpile beneficiated by Ozark-Mahoning Co., Illinois.
4/ Source: Bureau of the Census and the U.S. Geological Survey.
5/ F.a.s. values at U.S. ports.
6/ Source: Bureau of the Census and adjusted by the U.S. Geological Survey.
7/ C.i.f. values at U.S. ports.
8/ U.S. primary and secondary production plus imports minus exports plus adjustments for Government and industry stock changes.
9/ Includes fluorspar purchased from the National Defense Stockpile (NDS), but still located at NDS depots.

TABLE 2
U.S. REPORTED CONSUMPTION OF FLUORSPAR, BY END USE 1/

(Metric tons)

	Containing more than 97% calcium fluoride		Containing not more than 97% calcium fluoride		Total	
End use or product	1997	1998	1997	1998	1997	1998
Hydrofluoric acid and aluminum fluoride	442,000	497,000	--	--	442,000	497,000
Basic oxygen furnaces	--	--	7,830	7,330	7,830	7,330
Electric furnaces	W	W	21,700	19,700	21,700	19,700
Other 2/	W	6,640	W	6,630	19,100	13,300
Total	W	504,000	W	33,700	491,000	538,000
Stocks (consumer), December 31	120,000	114,000	16,800	20,200	137,000	134,000

W Withheld to avoid disclosing company proprietary data.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes enamel, glass and fiberglass, iron and steel foundries, primary aluminum, primary magnesium, and welding rod coatings.

TABLE 3
PRICES OF IMPORTED FLUORSPAR

(Dollars per metric ton)

Source-grade	1997	1998
Mexican, f.o.b., Tampico:		
Acidspar filtercake	110-130	110-130
Metallurgical grade	80-105	80-105
Mexican, f.o.b., Mexico, acidspar filtercake, As <5 ppm	NA	130-140
South African, acidspar dry basis, f.o.b. Durban	125-135	110-120
U.S. Gulf port, dry basis, acidspar	130-137	122-135

NA Not available.

Source: Industrial Minerals, no. 363, p. 78, December 1997, and no. 375, p. 78, December 1998.

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

Country	1997 Quantity (metric tons)	1997 Value 2/	1998 Quantity (metric tons)	1998 Value 2/
Canada	19,200	$3,410,000	18,400	$3,130,000
Dominican Republic	19,700	2,860,000	20,100	2,910,000
Hong Kong	--	--	463	67,000
Korea, Republic of	5,190	739,000	284	56,400
Mexico	9,600	1,070,000	633	71,200
Taiwan	7,680	120,000	3,420	493,000
United Kingdom	303	51,500	59	14,000
Other 3/	390	73,600	334	57,800
Total	62,100	8,330,000	43,600	6,800,000

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ F.a.s. values at U.S. ports.
3/ Includes Australia, Bolivia, Brazil, Chile, Finland, France, Germany, Italy, Japan, Malaysia, the Netherlands, Panama, Spain and Venezuela.

Source: Bureau of the Census.

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

Country and customs district	1997 Quantity (metric tons)	1997 Value 2/ (thousands)	1998 Quantity (metric tons)	1998 Value 2/ (thousands)
Containing more than 97% calcium fluoride (CaF_2):				
Austria: Savannah	84	$71	8	$22
China:				
Baltimore	301	63	98	23
Houston 3/	142,000	28,000	207,000	25,600
New Orleans	209,000	19,100	134,000	17,800
Total	351,000	47,200	341,000	43,400
France: Philadelphia	334	131	508	188
Germany: Savannah	34	18	10	10
Mexico:				
El Paso	--	--	221	42
Laredo	9,740	1,350	3,080	438
New Orleans	4,800	712	1,550	148
Total	14,500	2,060	4,850	628
Morocco: Houston	--	--	4,730	693
South Africa:				
Houston	35,800	4,430	17,300	2,320
New Orleans	82,100	10,800	93,900	11,800
New York City	240	86	--	--
Total	118,000	15,300	111,000	14,100
Taiwan: Ogdensburg	9	4	--	--
United Kingdom: New York City	113	56	8	16
Grand total	485,000	64,800	462,000	59,100
Containing not more than 97% calcium fluoride (CaF_2):				
Canada: Buffalo	282	110	174	50
Germany: New Orleans	265	33	--	--
Mexico:				
Buffalo	239	29	--	--
El Paso	1,020	74	--	--
Laredo	6,300	484	7,390	556
New Orleans	43,200	3,920	33,200	3,030
Total	50,800	4,510	40,600	3,580
Grand total	51,300	4,650	40,700	3,630

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ C.i.f. values at U.S. ports.
3/ Includes data supplied by importer.

Source: Bureau of the Census and adjusted by the U.S. Geological Survey.

TABLE 6
U.S. IMPORTS FOR CONSUMPTION
OF HYDROFLUORIC ACID, BY COUNTRY 1/

Country	1997 Quantity (metric tons)	1997 Value 2/ (thousands)	1998 Quantity (metric tons)	1998 Value 2/ (thousands)
Canada	24,600	$27,700	33,500	$39,100
France	281	321	279	317
Germany	288	617	141	301
Greece	19	20	--	--
Japan	1,230	4,270	1,210	3,670
Mexico	82,800	77,100	89,000	70,100
United Kingdom	139	147	136	144
Total	109,000	110,000	124,000	114,000

1/ Data are rounded to three significant digits, may not add to totals shown.
2/ C.i.f. values at U.S. ports.

Source: Bureau of the Census and adjusted by the U.S. Geological Survey.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION
OF CRYOLITE, BY COUNTRY 1/

	1997		1998	
Country	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Australia	610	$256	969	$509
Austria	647	354	--	--
Canada	3,450	919	6,580	1,780
China	200	168	104	86
Denmark	502	708	324	497
Germany	2,180	2,650	3,310	3,580
Hungary	1,060	1,350	575	602
Japan	--	--	586	362
New Zealand	--	--	2,570	1,360
Switzerland	549	666	--	--
Other 3/	75	80	220	308
Total	9,270	7,150	15,200	9,080

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ C.i.f. values at U.S. ports.
3/ Includes data for the Czech Republic, India, Russia, and the United Kingdom.

Source: Bureau of the Census.

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

	1997		1998	
Country	Quantity (metric tons)	Value 2/ (thousands)	Quantity (metric tons)	Value 2/ (thousands)
Canada	2,140	$2,050	5,930	$5,490
Italy	--	--	4,290	3,110
Mexico	7,910	7,390	8,870	7,440
Norway	2,640	2,370	3,020	2,920
Other 3/	99	185	268	382
Total	12,800	12,000	22,400	19,300

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ C.i.f. values at U.S. ports.
3/ Includes data for Brazil, China, Germany, India, Japan, Sweden, and the United Kingdom.

Source: Bureau of the Census.

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

(Metric tons)

Country and grade 3/ 4/	1994	1995	1996	1997	1998 e/
Argentina	3,585	5,105	5,666	5,000 e/	5,000
Brazil (marketable):					
Acid grade	68,890	72,498	46,706	67,163 r/	67,100
Metallurgical grade	21,041	16,760	12,068	11,235 r/	11,300
Total	89,931	89,258	58,774	78,398 r/	78,400
China: e/					
Acid grade	1,200,000	1,200,000	1,250,000	1,300,000	1,400,000
Metallurgical grade	800,000	800,000	900,000	1,100,000	1,150,000
Total	2,000,000	2,000,000	2,150,000	2,400,000	2,550,000
Czech Republic	10,000	--	--	--	--
Egypt	514	551	700 e/	700 e/	700
France: e/					
Acid and ceramic grades	105,000	102,000	78,000 5/	80,000	80,000
Metallurgical grade	26,000	28,000	33,000 5/	30,000	30,000
Total	131,000	130,000	111,000 5/	110,000	110,000
Germany	35,641 r/	39,081 r/	32,448 r/	24,000 r/ e/	25,000
India:					
Acid grade	6,231	6,359	5,115	5,100 e/	5,200
Metallurgical grade	16,360	17,887	14,263	14,000 e/	14,100
Total	22,591	24,246	19,378	19,100 e/	19,300
Iran 6/	22,204 r/	20,163 r/	20,000 r/	20,000 r/ e/	20,000
Italy:					
Acid grade	52,630	91,529 r/	103,527 r/	105,800 r/ e/	105,000
Metallurgical grade	15,312	33,140	23,000	20,000 r/ e/	20,000
Total	67,942	124,669 r/	126,527 r/	125,800 r/ e/	125,000
Kenya: Acid grade	53,488	80,230	83,000	69,000 r/ e/	70,000
Korea, North: Metallurgical grade e/	40,000	40,000	39,000	39,000	30,000
Korea, Republic of: Metallurgical grade e/	50	50	--	617 5/	500
Kyrgyzstan	2,500 e/	2,500 e/	2,767	4,176	3,200 5/
Mexico: 7/					
Acid grade	129,000	270,000	279,033	290,580	267,331 8/
Metallurgical grade	103,000	252,000	244,938	262,260	330,711 8/
Submetallurgical grade	3,000 e/	--	--	--	--
Total	235,000	522,000	523,971	552,840	598,042 8/
Mongolia:					
Acid grade	88,000	120,300	128,000 r/	130,000	130,000
Other grades 9/	17,000 r/	13,000 r/	37,000 r/	41,000 r/	40,000
Total	105,000 r/	133,300 r/	165,000 r/	171,000 r/	170,000
Morocco: Acid grade	85,000	105,800	95,900	103,800 r/	110,000
Namibia: Acid grade 10/	52,226	36,889	32,285	23,208 r/	40,685 5/
Pakistan: Metallurgical grade	13,351	2,753	363	500 e/	400
Romania: Metallurgical grade e/	15,000	15,000	15,000	15,000	15,000
Russia e/	250,000 5/	250,000	250,000	250,000	220,000
South Africa: 11/					
Acid grade	166,761	177,000 e/	191,018	201,000 r/ e/	215,000
Ceramic grade	--	--	--	4,000 r/ e/	--
Metallurgical grade e/	7,497 5/	19,000	12,000	2,000 r/	11,000
Total	174,258	195,866	203,018	207,000 r/ e/	226,000
Spain:					
Acid grade	97,000 e/	108,205	109,085	110,000 e/	110,000
Metallurgical grade	10,000 e/	10,206	7,441	10,000 e/	10,000
Total	107,000 e/	118,411	116,526	120,000 e/	120,000
Tajikistan e/	10,000 5/	9,000	9,000	9,000	9,000
Thailand: Metallurgical grade	23,705	24,114	17,247	7,826	3,743 5/
Turkey: Metallurgical grade	6,671	8,873	4,828 r/	5,000 r/ e/	5,000
United Kingdom e/	58,000	55,000	65,000	64,000 r/ e/	65,000
United States (shipments) e/	49,000	51,000	8,200	--	--
Uzbekistan e/	90,000 5/	90,000	90,000	90,000	80,000
Grand total	3,750,000 r/	4,170,000 r/	4,240,000 r/	4,510,000 r/	4,670,000

See footnotes at end of table.

e/ Estimated. r/ Revised.
1/ This is the unrounded version of the table.
2/ Table includes data available through April 19, 1999.
3/ In addition to the countries listed, Bulgaria is believed to have produced fluorspar in the past, but production is not officially reported, and available information is inadequate for the formulation of reliable estimates of output levels.
4/ An effort has been made to subdivide production of all countries by grade (acid, ceramic, and metallurgical). Where this information is not available in official reports of the subject country, the data have been entered without qualifying notes.
5/ Reported figure.
6/ Year beginning March 21 of that stated.
7/ Data are reported by Consejo de Recursos Minerales; but the production of submetallurgical grade and acid grade have been redistributed based on industry data.
8/ Reported figure from Mexican Chamber of Mines.
9/ Principally submetallurgical grade material.
10/ Data are in wet tons.
11/ Data show estimated proportions of acid grade, ceramic grade, and metallurgical grade fluorspar within the reported totals.

FIGURE 1
QUARTERLY ACID-GRADE FLUORSPAR IMPORT PRICES

(Dollars per metric ton, c.i.f. port of entry)