WOLLASTONITE

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Wollastonite, a calcium metasilicate ($CaSiO_3$), has a theoretical composition of 48.3% calcium oxide and 51.7% silicon dioxide but may contain trace to minor amounts of aluminum, iron, magnesium, manganese, potassium, and sodium. It occurs as prismatic crystals that break into massive-to-acicular fragments. It is usually white but also may be gray, brown, or red depending on its composition.

Wollastonite forms when impure limestones are metamorphosed (subjected to heat and pressure) or silica-bearing fluids are introduced into calcareous sediments during metamorphic processes. In both cases, calcite reacts with silica to produce wollastonite and carbon dioxide. Wollastonite also can crystallize directly from a magma that has an unusually high carbon content, but this is a more rare occurrence.

Deposits of wollastonite have been found in Arizona, California, Idaho, Nevada, New Mexico, New York, and Utah. These deposits also may contain calcite, diopside, garnet, idocrase, and quartz as minor components.

Wollastonite is used primarily in ceramics, friction products (brakes and clutches), metallurgy, paint, and plastics. Some of the properties that make it so useful are its high brightness and whiteness, low moisture and oil absorption, low volatile content, and the acicular nature of some wollastonite.

Production

Wollastonite has been mined commercially in California and New York. The California deposits, which are in Inyo, Kern, and Riverside Counties, were mined between 1930 and 1970. These operations were limited in size, producing only a few thousand metric tons per year for ceramics, decorative stone, paint, and mineral wool production.

Wollastonite deposits in New York have been mined for more than 50 years. Two companies currently are mining wollastonite—NYCO Minerals Inc. (a subsidiary of Fording Inc.) operates a mine in Essex County, and R.T. Vanderbilt Co. Inc. operates a mine in Lewis County. The NYCO deposit contains wollastonite, garnet, and diopside. Parts of the deposit are composed of up to 60% wollastonite. The ore is processed at the Willsboro plant where the garnet is removed by using high-intensity magnetic separators. NYCO also chemically modifies the surfaces of some of its wollastonite products to improve their performance. The R.T. Vanderbilt deposit in Lewis County consists primarily of wollastonite as well as minor amounts of calcite and prehnite and trace amounts of diopside. The ore is processed at its Balmat plant where it is milled and air classified.

In 2001, domestic wollastonite production decreased from that of 2000. Although data collected by the U.S. Geological Survey are withheld to avoid disclosing proprietary information, U.S. production was estimated to be on the order of 130,000 metric tons per year (t/yr) (Rieger, 2001). Contributing to the sales losses were the continued slow growth in the U.S. economy and increased foreign competition in some of the low-value markets. Fording indicated that its subsidiary in New York has begun to shift its focus on mid- to high-value markets, where sales and prices appear to be remaining fairly stable (Fording, 2001, p. 28).

Consumption

In 2001, the use of wollastonite in the United States declined from that of 2000, again reflecting the state of the U.S. economy and foreign competition in low-value markets. Sales for ceramic, metallurgy, and in general lower value products probably declined and those for plastics remained unchanged in 2001.

In 1999, plastics accounted for an estimated 37% of U.S. sales, followed by ceramics (28%), metallurgical applications (10%), paint (10%), friction products (9%), and miscellaneous (6%) (Industrial Minerals, 1999). Markets have declined since 1999, particularly with regard to sales for ceramics, metallurgy, and paint applications, so it is likely that plastics accounted for an even larger share of the market in 2001. Wollastonite also was used in adhesives, joint compounds, refractories, rubber, and wallboard applications.

In ceramics, wollastonite decreases shrinkage and gas evolution during firing, increases green and fired strength, maintains its brightness during firing, permits fast firing, and reduces crazing, cracking, and glaze defects. In metallurgical applications, wollastonite serves as a flux for welding, a source for calcium oxide, a slag conditioner, and to protect the surface of the molten metal during the continuous casting of steel. As a filler in paint, it reinforces the paint film, acts as a pH buffer, improves its resistance to weathering, reduces gloss, reduces pigment consumption, and acts as a flatting and suspending agent. In plastics, it improves tensile and flexural strength, reduces resin consumption, and improves thermal and dimensional stability at elevated temperatures. Surface treatments are used to improve the adhesion between the wollastonite and the polymers to which it is added. As a substitute for asbestos in floor tiles, friction products, insulating board and panels, paint, plastics, and roofing products, wollastonite is resistant to chemical attack, inert, stable at high temperatures, and a good reinforcer.

Prices

Prices for domestically produced acicular wollastonite, ex works, were $190 per metric ton for 200 mesh, $234 per ton for 325 mesh, and $258 per ton for 400 mesh. The price, ex works, for acicular, high-aspect-ratio wollastonite was $318 per ton and for ground (10-micrometer) wollastonite was $630 per ton. Prices for wollastonite, free on board, in bulk, were $209 per ton for 200 mesh and $253 per ton for 325 mesh (Industrial Minerals, 2001). Typical prices, free on board China, powder

grades, bulk or big bags, were $50 to $60 per ton for up to 9.8 inch (250 millimeter) lump, $65 to $80 per ton for 150 mesh, $70 to $85 per ton for 200 mesh, and $75 to $90 per ton for 325 mesh (Kendall, 2001). Quoted prices should be used only as a guideline because actual prices depend on the terms of the contract between the seller and the buyer.

Foreign Trade

Comprehensive foreign trade data were not available for wollastonite. However, imports probably declined from those of 2000 owing to the slow U.S. economy. Imports were estimated to be in the 4,000- to 6,000-metric-ton (t) range in 2001, with China, India, and Mexico being the major sources. Imports from China and Mexico probably were in the form of lower value wollastonite grades. A small amount of wollastonite also was imported from Finland. Exports were thought to be less than 3,000 t in 2001.

World Review

Worldwide production of wollastonite was estimated to be between 580,000 and 630,000 t in 2001. As with many industrial minerals, the structure of the wollastonite mining industry is such that it is difficult to accurately determine production. Production in China was estimated to be between 300,000 and 320,000 t. Lishu Wollastonite Mining Industry Co. was the largest producer in China, with 10 mines and plants in Liaoning Province. The company had a production capacity of 80,000 t/yr. Other major producers and their capacities were Xinyu South Wollastonite Industry Co. Ltd. (50,000 t/yr lump and 20,000 t/yr powder), Sanyi Mining Development Co. Ltd. (40,000 t/yr lump and 20,000 t/yr powder), Lianxian Wollastonite Mine (30,000 t/yr), Anhui Pioneer Mining Co. Ltd. (20,000 t/yr lump and 6,000 t/yr powder), Changxing Wollastonite Mine Co. Ltd. (25,000 t/yr total lump and ground), and Dayu Mineral Materials Co. Ltd. (20,000 t/yr total lump and ground). Exports from China were estimated to be 150,000 t/yr (Kendall, 2001).

In 2001, production for Finland, India, and Mexico was estimated to be 20,000 t (reported as 22,300 t in 1996), 100,000 t (reported as 95,700 t in 1998), and 30,000 t (reported as 30,800 t in 2000), respectively. Small tonnages probably also were produced in Morocco, Namibia (estimated to be 450 t in 2001 and reported as 441 t in 2000), North Korea, Pakistan, and Turkey (less than 5,000 t/yr). Chile, with a reported production of 270 t in 1996, and South Africa, with a reported production as 200 t in 1999, have not mined wollastonite since those times.

Following several attempts to produce wollastonite, Orleans Resources Inc. has awarded Les Services Environnementaux Delsan-A.I.M. the contract for dismantling the infrastructure of the Lac St.-Jean, Quebec, Canada, wollastonite operation, selling the equipment, and restoring the mine site. Orleans Resources will retain ownership of the 25-million-metric-ton (Mt) ore reserves (Orleans Resources Inc., 2001).

Bob Vasily & Associates Inc. continued with its plans to develop its Seeley's Bay, Ontario, Canada, wollastonite deposit. Reserves are estimated to be 9.6 Mt with the ore averaging 42% wollastonite. Resources are estimated to be 30 Mt. The company still needed to obtain the required permits for mining but hoped to begin stripping operations during 2002. A dry processing circuit will be used to process the wollastonite on start-up, but the company has plans for the installation of a wet processing mill in the future. The company will initially sell to concrete and agricultural markets (North American Minerals News, 2001).

Outlook

The growth in world production and sales of wollastonite has moderated since 1996, averaging about 2.1% per year. This contrasts sharply with the 24% growth between 1970 to 1995 and even the 18% growth between 1990 and 1995. Slow growth probably will be the trend for the future because the wollastonite industry appears to be approaching mature industry status.

The slow recovery of the U.S. economy probably will continue to hamper sales in the United States, causing a stagnation or possibly a slight decline. Domestic demand for automobiles remains strong, so sales for friction and automotive plastics markets should remain at current levels. Growth in ceramics and paint markets probably will remain slow. The most promising market continues to be plastics, with sales anticipated to increase slowly in the coming years.

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