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. Acicular fragments are desirable for filler and extender applications because the long, thin particles improve the flexural modulus, sag resistance, flexural and tensile strengths, and thixotropic properties of the paints, plastics, and rubber products in which they are used. Wollastonite is usually white but also may be gray, brown, or red depending on its composition. Most commercially mined wollastonite is white in color to meet customers' specifications.

Wollastonite forms when impure limestones are metamorphosed (subjected to heat and pressure) or silica-bearing fluids are introduced into calcareous sediments during metamorphism. In both cases, calcite reacts with silica to produce wollastonite and carbon dioxide. Wollastonite also can crystallize directly from a magma that has a high carbon content, but this is a less common 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. New York is the only State where large-scale wollastonite mining has taken place.

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 Canadian Coal Trust) operates mines 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 contain 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 R.T. Vanderbilt's Essex County plants where it is milled and air classified. R.T. Vanderbilt also produces some surface-treated products.

In 2003, domestic wollastonite production declined from that of 2002. Data collected by the U.S. Geological Survey are withheld to avoid revealing proprietary information. Hawley (2003) estimated U.S. crude ore production to be about 150,000 metric tons per year (t/yr) in 2002.

Consumption

NYCO indicated that sales from its operations in Mexico and the United States were 75,000 metric tons (t) in 2003, 11% less than in 2002. The company indicated that a global oversupply situation and competition from wollastonite suppliers in China and India affected its sales (Fording Canadian Coal Trust, 2004). Sales to U.S. ceramic markets have declined recently because some tile manufacturers are using locally produced alternatives to wollastonite, such as calcium carbonate, to save on transportation costs. Sales of wollastonite to the steel industry also have declined in recent years. Domestic production of steel has been lower, and steel companies, trying to reduce costs and be more competitive with steel imports, have reduced their consumption of wollastonite for flux applications. U.S. steel producers also are purchasing more imported wollastonite (Moore, 2003).

Annual end use data are not available. However, 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%) in 1999 (Industrial Minerals, 1999).

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 molten metal during the continuous casting of steel. As an additive in paint, it improves the durability of 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 improves flexural and tensile strength.

Prices

Prices for wollastonite ranged from $50 per metric ton (lump) to $1,700 per ton for ultrafine, surface-treated wollastonite (Hawley, 2003). Prices for domestically produced acicular wollastonite, ex works, were $190 per 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. Prices for wollastonite from China, free on board (f.o.b.), in bulk, were $80 to $100 per ton for 200-mesh and $90 to $110 per ton for 325-mesh (Industrial Minerals, 2003b). Prices for filler grades ranged from $89 to $473 per ton for wollastonite sourced from Asia and Africa. Prices for ceramic grades ranged from $58 to $137 per ton for wollastonite from Asia (Geo.net Commodities GmbH, 2004§[1]). 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. Imports were estimated to be between 3,000 and 4,000 t in 2003. The United States imported 1,990 t from China, 1,160 t from India, and about 250 t from Finland, based on data from the Journal of Commerce Port Import/Export Reporting Service. Small amounts of wollastonite probably were imported from or transshipped through Canada and Mexico. Imports from China and India were likely in the form of lower value wollastonite grades. Exports were estimated to be between 3,500 and 4,500 t in 2003.

World Review

World production of wollastonite ore was estimated to be between 550,000 and 600,000 t in 2003 (table 1). Sales of refined wollastonite product probably were between 500,000 and 525,000 t. China was the largest producer of wollastonite with an estimated production of 300,000 t (Moore, 2003). The next largest producer was India, followed by the United States and Mexico. Production in Finland was estimated to be slightly less than 20,000 t (Geological Survey of Finland, 2001§). Small amounts of wollastonite probably were produced in Morocco, Namibia, North Korea, Pakistan, and Turkey.

Joint State Company MKK-Seika (a subsidiary of HKK Holding) completed the first stage of construction of a wollastonite mill in Altai, western Serbia. The plant will have a capacity of 57,000 t/yr. Ore will be mined from the Sinyukhinshy deposit, which has reserves of more than 9 million metric tons (Industrial Minerals, 2003a).

Outlook

North American wollastonite producers appear to be changing their market strategies. Emphasis now is being placed on sales of higher value acicular products, giving up some of the lower value markets to imports. This trend probably will continue into the future as producers attempt to optimize returns from their wollastonite operations.

The most promising growth area for domestic producers continues to remain in the sale of acicular wollastonite for plastics. Demand for automobiles remains strong, so sales for friction products and automotive plastics may increase slightly. Sales to ceramics, paint, and steel markets probably will remain unchanged. The decline in value of the U.S. dollar relative to other currencies may result in a slight increase in exports and a decrease in imports in coming years. Worldwide consumption is not expected to increase significantly in the near future.

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[1]References that include a section mark (§) are found in the Internet References Cited section.

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TABLE 1

WOLLASTONITE: ESTIMATED WORLD PRODUCTION, BY COUNTRY[1]

(Metric tons)

Country	2002	2003
China	300,000	300,000
Finland	20,000	20,000
India, crude	125,000	177,000 [2]
Mexico	40,000 [2]	43,000
United States	W	W
Other[3]	10,000	10,000
Total	495,000	550,000

W Withheld to avoid disclosing company proprietary data.

[1]Estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Reported figure.

[3]Includes Morocco, Namibia, North Korea, Pakistan, and Turkey.