

WOLLASTONITE

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Wollastonite was mined by two companies in the United States in 2004. While mine production is withheld to avoid revealing company proprietary data, industry experts estimate U.S. production to be between 115,000 and 127,000 metric tons per year (t/yr). In 2004, exports of wollastonite were estimated to be in the range of 10,000 to 15,000 metric tons (t) and imports were estimated to be between 4,000 and 5,000 t.

Wollastonite, a calcium metasilicate (CaSiO_3), has an ideal 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 (primarily automobile brakes), 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 mined wollastonite in 2004—NYCO Minerals Inc. (a subsidiary of Fording Canadian Coal Trust), which operated mines in Essex County, and R.T. Vanderbilt Co. Inc., which operated 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 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 plant, where it is milled and air classified. R.T. Vanderbilt also produces some surface-treated products.

In 2004, domestic wollastonite production increased from that of 2003. Data collected by the U.S. Geological Survey (USGS) are withheld to avoid revealing proprietary information. Hawley (2004) estimated U.S. wollastonite production to be between 115,000 and 127,000 t in 2003.

Consumption

The USGS does not collect end use data on wollastonite, but market estimates occasionally are published in trade journals. Plastics were believed to have 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 2001, ceramic applications were thought to account for 40% to 50% of wollastonite sales worldwide, followed by polymers (20% to 25% of sales), and coatings (10% to 15% of sales). The remaining sales were for construction, friction products, and metallurgical applications (Kendall, 2001).

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 flattening 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.

There has been interest shown in using wollastonite for environmental applications. Tests have demonstrated that

wollastonite could be used to increase the pH of polluted streams. Limestone typically is used for this application, but its use can result in large fluctuations in water chemistry and its effects are short-lived. Wollastonite, however, dissolves slowly in the stream, resulting in smaller water chemistry fluctuations over longer periods of time (Institute of Ecosystem Studies, 2004).

NYCO indicated that sales in 2004 from its operations in Mexico and the United States were 82,000 t valued at \$34.8 million compared with 75,000 t valued at \$32.2 million in 2003 (Fording Canadian Coal Trust, 2004, p. 5).

Prices

Prices for wollastonite ranged from \$50 to \$60 per metric ton for Chinese powder to \$1,700 per ton for ultrafine surface-treated wollastonite (Hawley, 2004). Prices for domestically produced acicular wollastonite, ex works, were \$205 per ton for 200-mesh, \$248 per ton for 325-mesh, and \$275 per ton for 400-mesh. The price, ex works, for acicular, high-aspect-ratio wollastonite was \$345 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, 2004a). Prices for filler grades of wollastonite from Asia and Africa ranged from \$89 to \$510 per ton. Prices for ceramic grades from Asia ranged from \$58 to \$137 per ton (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.

Producers of wollastonite in China indicated that they would increase prices of their products. Increased production and transportation costs and higher electricity and gas prices were factors in the decision. Also influencing the pricing decision was the removal of a tax rebate of 10% on exported wollastonite by the Chinese Government (Golden Resources, Inc., 2004[§]).

Foreign Trade

Comprehensive trade data were not available for wollastonite. Exports were estimated to be in the range of 10,000 to 15,000 t in 2004. Imports were estimated to be between 4,000 and 5,000 t in 2004. The United States imported 2,900 t from China, 1,270 t from India, 57 t from Belgium, 57 t from Finland, 22 t from Mexico, and 21 t from Canada, based on data from the Journal of Commerce Port Import/Export Reporting Service. Additional amounts of wollastonite probably were imported from or transhipped through Canada and Mexico.

World Review

World production of wollastonite ore was estimated to be between 550,000 and 600,000 t in 2004. Sales of refined wollastonite product probably were between 500,000 and 525,000 t. China was the leading producer of wollastonite with an estimated production of 300,000 t (Moore, 2003). The next leading producer was India with 176,000 t of production in 2003

(Department of Mines and Geology, 2005[§]); India was followed by the United States (estimated to be 115,000 to 127,000 t), and Mexico (51,900 t in 2003). Production in Finland was 17,400 t in 2002 (Geological Survey of Finland, 2003[§]). Small amounts of wollastonite probably were produced in other countries.

Canada.—Sequoia Minerals Inc., acquired ownership of the wollastonite deposit in Orleans, Quebec, from Resources Orleans, Inc. The deposit, located in St. Onge township, contains more than 20 million metric tons (Mt) of ore reserves with an average wollastonite content of 36.6% (Industrial Minerals, 2004b).

China.—S&B Industrial Minerals S.A. (S&B) signed an agreement for a joint venture with Jilin Wollastonite Development Co. Ltd., subject to approval by the Chinese Government. S&B and Jilin will operate a wollastonite mine near Hulan, Jilin Province. In 2004, the mine capacity was 50,000 t/yr, and the mill capacity was 24,000 t/yr. Reserves were estimated to be 1.5 Mt. A subsidiary of S&B, Sibimin Overseas Ltd., will control 51% of the venture and manage the operation (S&B Industrial Minerals S.A., 2004).

Outlook

North American wollastonite producers continue to place greater emphasis on sales of higher value acicular and surface-treated products. The most promising growth area for domestic producers continues to be in plastics. Sales of wollastonite for friction product and automotive plastic applications probably will increase slightly based on the strength of the automobile sales. Sales to ceramics, paint, and steel markets are expected to remain unchanged. A continued decline in the value of the U.S. dollar relative to other currencies may result in a slight increase in exports and a decrease in imports. Imports of wollastonite also may decline slightly because of increased prices for Chinese wollastonite and the increased cost of transportation from China. China has been the major source of lower value wollastonite grades imported into the United States during the past few years. Worldwide consumption probably will increase at a low rate as consuming markets slowly expand in response to population growth.

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

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