

Industrial Minerals of the United States

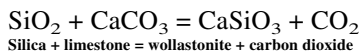
Wollastonite—A Versatile Industrial Mineral

What is Wollastonite?

Wollastonite is a chemically simple mineral named in honor of English mineralogist and chemist Sir W.H. Wollaston (1766–1828). It is composed of calcium (Ca) and silicon and oxygen (SiO₂, silica) with the chemical formula CaSiO₃. Although much wollastonite is relatively pure CaSiO₃, it can contain some iron, magnesium, manganese, aluminum, potassium, sodium, or strontium substituting for calcium in the mineral structure. Pure wollastonite is bright white; the type and amount of impurities can produce gray, cream, brown, pale-green, or red colors.

Geology of U.S. Wollastonite Deposits

Wollastonite is formed by two processes. The first occurs when silica and limestone are raised to a temperature of 400°–450°C, either because of deep burial (regional metamorphism) or by being baked because of their proximity to an igneous intrusion (skarn deposits), forming wollastonite and giving off carbon dioxide:



The second way wollastonite forms is by direct crystallization from molten rock (magma) that is unusually high in carbon content. The origin of these magmas is controversial, but current thinking is that they probably originate in the lower crust and upper mantle. The rocks they form, called carbonatites, are scattered throughout the U.S., but they have not been exploited for commercial wollastonite.

The only two currently commercial wollastonite deposits in the U.S. are in New York. These deposits differ in their basic mineralogy, reflecting both differences in

geologic conditions during formation and host rock composition. The Lewis Deposit, mined by NYCO Minerals, Inc., in the Adirondack Mountains in Essex County, was formed by the recrystallization of Precambrian carbonate rocks inter-layered with high-grade metamorphic rocks. Nearby reserves are contained in the Oak Hill and Deerhead deposits. The ore bodies consist of the minerals wollastonite, garnet, and diopside with as much as 60 percent of the bodies being wollastonite. The heat required to recrystallize the carbonate rocks has been attributed to either regional metamorphism accompanying deep burial or thermal metamorphism related to a nearby igneous intrusion. In either case, the recrystallization was primarily of thermal origin with only minor movement of material into or out of the system (metasomatism).

The other currently commercial wollastonite deposit is mined by the R.T. Vanderbilt Co. in the Gouverneur District, Lewis County, N.Y. The deposit was formed by the recrystallization of siliceous Precambrian carbonate rocks by the contact metamorphism and metasomatism accompanying an igneous intrusion. The ore bodies consist of large pods of wollastonite, calcite, and graphite with accessory prehnite, magnetite, and diopside.

What Makes Wollastonite Useful?

Wollastonite has several physical properties that make it useful as an industrial mineral:

Wollastonite is largely inert, although it will dissolve in concentrated hydrochloric acid. It will not react with other components of manufactured products either during or after the manufacturing process.

During crushing, wollastonite breaks into lath- or needle-shaped (acicular) particles because of its unique cleavage properties. This tendency is measured by the ratio of the length to diameter of the particles (aspect ratio). Small-aspect-ratio particles of wollastonite have ratios of around 3:1. High-aspect-ratio particles reach ratios of 20:1. Particles with different aspect ratios have different applications. Being acicular, wollastonite (1) acts to reinforce products such as plastics, paint films, and green ceramic bodies much like reinforcing rods do in concrete and (2) promotes early release of gases in ceramic production.

The brightness and whiteness of pure wollastonite are important for some applications. Commercial wollastonite has brightness (reflectance) values equal to 85–90 percent that of common reflectance standards like magnesium oxide and

barium sulfate. Being bright and white, wollastonite has a minimal effect on a product's color, but it can be used as a white pigment.

The amount of volatile material (gas) driven off when a material is heated to 1,000°C is called Loss on Ignition (LOI). The LOI of commercial wollastonite is very low, ranging between 0.5 and 2.0 percent. The low LOI reduces problems of gas bubble entrapment and gas dispersal during the firing of ceramics, lowers firing costs, and reduces firing time.

Wollastonite has a high pH of 9.9 in a 10 percent water slurry that can stabilize acidity and reduce the breakdown of polyvinyl acetate in paints.

The crystal structure and physical properties of wollastonite are stable to about 1,120°C, making wollastonite a substitute for asbestos in thermal insulation applications.

Wollastonite has a hardness of 4.5–5.5 on the Mohs scale.

Processing Wollastonite

To be useful for many different applications, wollastonite must be processed; the processing should produce concentrates that are 97–99 percent pure wollastonite. After drilling, blasting, and partial crushing at the mine site, the ore goes to a production plant for further crushing, beneficiation, and milling. Crushing and milling must produce a range of particle sizes having a range of aspect ratios. The commonly associated minerals garnet and diopside are removed by high-intensity magnetic separators. Some of the material may be chemically treated to improve binding in resin-based products. Four classes of final products are:

general grades - powders of < 400 mesh (38 micrometers)

fine grinds - > 400 mesh
high-aspect-ratio grades (15–20:1)

chemically modified grades

Wollastonite's Many Uses

Until the late 1970's, the primary use of wollastonite was as a decorative stone. Since the early 1980's, one of the uses has been as a

replacement for asbestos in products, including insulating board and panels, paint, plastics, roofing tiles, and in friction devices such as brakes and clutches. In ceramics, wollastonite reduces warping and cracking during firing and increases strength. Being a calcium silicate mineral, wollastonite contributes calcium in ceramic glaze mixes. Wollastonite is widely used as a flux in the casting of steel and in the production of paints and coatings. In paints, wollastonite provides reinforcement, hardening, low oil absorption, and other benefits. In textured coatings, like stucco, wollastonite provides crack resistance, reinforcement, and high brightness. Wollastonite is also used in the manufacture of adhesives, joint compounds, refractories, and rubber. All grades of wollastonite are used in the production of plastics, including nylons, phenolic molding compounds, polyesters, and polyurethanes and polyureas.

recognition in the 1970's of health issues associated with asbestos, wollastonite became a substitute for short-fiber asbestos in many applications, and the U.S. and worldwide markets have grown ever since. Another boost to the industry came with the increase in demand for wollastonite as a filler and extender for the rapidly growing plastics market. Today, plastics and ceramics are the leading markets, followed by paint and asbestos substitutes.

The United States is the second largest producer of wollastonite after People's Republic of China. The U.S. accounts for about 25 percent of the world's 600,000 metric tons of production. In general, domestic production grew steadily through the 1990's, although the rate of growth slowed toward the end of the decade due to competition from imports.

References

Consult these reports for more detailed information.

Bauer, R.R., Copeland, J.R., and Santini, Ken, 1994, Wollastonite, *in* Carr, D.D., ed., *Industrial minerals and rocks*, 6th Edition: Littleton, Colo., Society for Mining, Metallurgy, and Exploration, Inc., p. 1119–1128.

Virta, R.L., 2000, Wollastonite, *in* *Minerals Yearbook, metals and minerals 1998*, Volume I: U.S. Geological Survey, p. 83.1–83.2.

Information

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The U.S. Wollastonite Industry

Wollastonite has been mined in the U.S. for more than 70 years. The industry first started in California, where production continued until 1970. Production was only a few thousand metric tons per year for decorative stone, ceramics, mineral wool, and paint. Today, wollastonite is mined only in Essex and Lewis Counties, N.Y. Wollastonite has been produced in New York for more than 40 years.

Ceramic and paint markets traditionally were the mainstay of the wollastonite industry. With the

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