WULFENITE, MOLYBDENITE, AND MOLYBDENUM

Molybdenum-bearing minerals are not found in many collections. Collectors are most familiar with wulfenite [lead molybdate, PbMoO4] because of its bright colors and high levels of crystal development. It is a secondary mineral that crystallizes in the tetragonal system as square or tabular, yellow-to-orange crystals.

The molybdenum-bearing mineral of greatest importance is not wulfenite, but molybdenite [molybdenum disulfide, MoS_2]. Molybdenite, by far the most abundant molybdenum mineral, has a metallic luster. It usually forms opaque, bluish-gray scales and foliated masses, and occasionally distorted, hexagonal crystals. It is very soft at Mohs 1.0-1.5 and has a high density (specific gravity 4.8). It also has a diagnostic greasy feel.

Molybdenite is the only ore of molybdenum. One of the transition elements, molybdenum is a tough, malleable, silvery-gray metal with an atomic weight of 95.94. It is quite dense with a specific gravity of 10.2, roughly that of silver. Molybdenum ranks 56th among the elements in crustal abundance and is as common as tungsten. It is found in only about 20 minerals and does not occur free in nature. Its most notable property is its very high melting point of 4730°F (2610° C.), nearly twice that of iron.

Known since antiquity, molybdenite was long confused with both graphite [carbon, C, hexagonal] and galena [lead sulfide, PbS]. The early Greeks knew lead as *molybdos*, and used that term and *molybdaina* to describe all similar minerals. As late as the 16th century A.D., Georgius Agricola (Georg Bauer, 1494-1555), whose *de re Metallica* was the most enlightened mining treatise of its time, still referred to both metallic lead and galena as “molybdenum.”

Chemists finally distinguished graphite and lead from molybdenite in the mid-1700s. In 1778, Swedish chemist Carl Wilhelm Scheele (1742-1786) proved that molybdenite was the sulfide of a previously unknown element that he formally named “molybdenum.” Four years later, Peter Jacob Hjelm (1746-1813), another Swedish researcher, succeeded in isolating molybdenum in the form of a dark powder. Molybdenum was not only difficult to isolate, it was impossible to melt the metal powder into a mass suitable for metallurgical study. That was of little concern at the time, for molybdenum was thought to be rare and with no value or uses.

Confusion about molybdenite continued into the late 1800s. When a prospector discovered an enormous, low-grade mineral deposit at Climax, Colorado, in 1879, assayers and chemists were unable to correctly identify the samples as molybdenite until 1893. Then, in the late 1890s, French and German metallurgists began experimenting with molybdenum as an alloying agent to toughen steel. The world suddenly learned about molybdenum’s ability to greatly enhance the toughness, durability, and corrosion-resistance of steel at the outbreak of World War I, when Germany unexpectedly unveiled an arsenal of superior weaponry and armor, all of it made of molybdenum-steel alloys. The Germans had obtained their molybdenum from a very small, but high-grade deposit of molybdenite in Norway.

Knowledge of the German achievements with molybdenum-steel triggered a rush to the huge molybdenite deposit at Climax, Colorado, that resulted in development of the Climax Mine. The Climax ore is a light-colored, finely crystalline, silicified (altered) granite laced with networks of blue-gray molybdenite veinlets and flecked with bits of glittering pyrite [iron disulfide, FeS_2].

Only about four pounds of molybdenum are recovered from one ton of the low-grade Climax ore, but continuous mining from 1924 until 1982 produced nearly one million tons of elemental molybdenum with a year-mined value of $4 billion. In testimony to the size of its molybdenite ore body, the Climax Mine has recently been completely rebuilt and is again in production. Current reserves of molybdenite ore are sufficient for at least 20 more years of mining.

World molybdenum production now tops 200,000 tons per year and the price of molybdenum is about $14 per pound. Most production no longer comes from primary mines, such as Climax, but as by-product molybdenite recovery from copper mining and milling. About three-quarters of the molybdenum supply goes into molybdenum-steel alloys. The remainder is used in exotic molybdenum alloys, pigments, high-temperature lubricants, chemical catalysts, and an ever-widening array of specialized, high-tech applications.

Wulfenite will always be the most collectible molybdenum mineral for its rarity, excellent crystal development, and, most importantly, its bright yellow-orange colors. But when measured by economic and technological standards, the molybdenum mineral to remember is molybdenite.

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Steve has worked with the Mineral of the Month Club since 2002. As a former hardrock miner, he has mined Colorado molybdenum, Alaska gold, Arizona copper, and Wyoming uranium. Eight of his ten books deal with topics of minerals, mineral collecting, mining, and gemstones. He has written more than 1,000 articles and is a contributing editor and science columnist with *Rock & Gem* magazine. His work has also appeared in *The Mineralogical Record* and *Lapidary Journal*. He is a former member of the board of directors of the National Mining Hall of Fame & Museum