AMAZONITE AND SMOKY QUARTZ

A Classic Mineral Composite from Colorado

Composite specimens—those in which two or more mineral species share the spotlight—are favorites among collectors because of the added interest of contrasting crystal forms and colors. Examples of collectible composite specimens that have great visual appeal are pink fluorite on dark-brown sphalerite; midnight-blue lazurite in white marble, the blue aquamarine variety of beryl with silvery sheets of muscovite, and the green amazonite variety of microcline in association with gray-brown smoky quartz.

The latter composite—amazonite and smoky quartz—is synonymous with the Pikes Peak region of Colorado. Colorado specimens typically, but not always, feature blocky crystals of green amazonite as the primary mineral, with smaller crystals of gray-brown smoky quartz that contrast in color and crystal structure. In quantity, quality, and intensity of color, Colorado is clearly the premier source of amazonite-smoky quartz specimens.

Amazonite, pronounced AM-ah-zahn-ite, is the green color variety of the mineral microcline, pronounced MY-crow-kline. Microcline is potassium aluminum silicate and has the chemical formula $KAlSi_30_8$. The word "microcline" combines the Greek words *mikros*, or "small," and *klinein*, meaning "to lean", the latter referring to the mineral's cleavage angles that are slightly inclined from 90 degrees. The molecular weight of microcline consists of 14.04 percent potassium, 9.69 percent aluminum, 30.28 percent silicon, and 45.99 percent oxygen.

Microcline is a tectosilicate and a member of the feldspar group. It crystallizes in the triclinic system, usually as single, equant prisms with generally square or rectangular cross sections, and also occurs as tabular crystals, in granular forms and cleavage masses, and as irregular, disseminated grains. Microcline has a specific gravity of 2.56, a Mohs hardness of 6.0-6.5, a vitreous luster, and is usually translucent to opaque. It has perfect cleavage in one direction and an uneven fracture.

Pure microcline is colorless or white, but traces of nonessential elements and the effects of geophysical radiation can combine to create a range of colors that include the pale-to-intense greens and blue-greens of amazonite. Amazonite colors are produced by a combination of trace amounts of lead and structural water together with the effects of geochemical radiation. The natural radioactive decay of the isotope potassium-40 oxidizes the divalent lead ion Pb^{2+} to trivalent lead Pb^{3+}; it also produces hydroxyl radicals $[(OH)^{1-}]$ that oxidize and displace oxygen ions to create vacant lattice positions. These vacant positions, called "color centers," then trap the trivalent lead ions, causing the microcline lattice to absorb the red end of the spectrum, while reflecting the greens and green-blues that we perceive in amazonite.

Microcline and other feldspars are essential components of virtually all silica-rich igneous and metamorphic rocks. Microcline is especially common in granite pegmatites and hornfels (fine-grained silicate rocks) of contact and regional metamorphic rocks. The amazonite variety of microcline occurs almost exclusively in granite pegmatites. Pegmatites, which are bodies of very coarse-grained granite, form when residual magma—the last magma to solidify—retains its heat and cools very slowly. Rather than quickly "freezing" into fine-grained granite, residual magma crystallizes on a fractional, or mineral-by-mineral, basis to form pods, lenses, pockets, and irregular dikes. As residual magma, which is often enriched with accessory or rare minerals, slowly solidifies, gases sometimes create vugs or mariolitic cavities that provide space for the

growth of large, well-developed crystals. Amazonite derives its color from traces of chromophoric lead from enriched, residual magma.

Microcline is polymorphic with the mineral orthoclase. Polymorphs are minerals that have the same chemical composition, but different crystal structures. Both microcline and orthoclase are potassium aluminum silicates with the formula $KAlSi_3O_8$. But because they form at different temperatures, orthoclase crystallizes in the monoclinic system and microcline in the triclinic system. The green and greenish-blue colors of amazonite occur only in microcline, apparently because the monoclinic structure of orthoclase does not accommodate lead ions.

While microcline is an abundant mineral, the amazonite variety is rare. Only a half-dozen localities worldwide yield fine amazonite specimens. Notable sources are in Russia, Namibia, Pakistan, Brazil, Madagascar, and the United States, where Colorado has the most important collecting localities. These include the Lake George-Crystal Peak-Florissant area of Teller and Park counties. Other notable Colorado sources are the Devil's Head, Pine Creek, Cheyenne, Pikes Peak, Crystal Park, and Harris Park areas. Amazonite specimens of lesser quality are also collected in Pennsylvania, Nevada, Massachusetts, and Virginia.

Beads and carvings fashioned from amazonite have been found in ancient tombs from Egypt to central Russia. In historical writings, amazonite was long confused with turquoise and jade. The mineralogical understanding of amazonite began in the 1790s, when feldspars were recognized as a mineral group. By 1830, increasing knowledge of chemistry and crystallography had enabled mineralogists to recognize orthoclase and microcline as separate feldspar-mineral species. A more complete understanding of the feldspars came in the 1920s with the introduction of X-ray diffraction and advanced spectrographic-analysis methods.

In the early 1800s, amazonite was known as "Amazon stone." The origin of the name is uncertain and may have stemmed from the reflection of jungle canopies in the Amazon River, an Amazon Basin native culture that traded green-blue beads, or a race of female warriors of Greek mythology who offered gifts of green stones. The name "amazonite" originated in 1879, when the trend at the time was to employ the new "-ite" mineralogical suffix as often as possible.

Various ancient cultures attributed talismanic values to amazonite pendants and carvings. Medieval physicians prescribed amazonite to alleviate skin and eye ailments and to enhance the condition of the skin. Modern metaphysical practitioners refer to amazonite as the "hope stone," reflecting the belief that it inspires hope and increases personal confidence. Amazonite is an alternative birthstone for December.

Microcline and other feldspar minerals have been mined for centuries, initially for use in glassmaking. Today, finely ground feldspar minerals are used in container glass, ceramics, and tiles, and also serve as filler materials in the manufacture of paper and glossy cardboards. In glassmaking, feldspar provides silica and serves as a flux to lower the melting point of the glass mix. Powdered feldspar is also the abrasive in household scouring powders. With a Mohs hardness less than that of glass, feldspar-based scouring powders clean, but do not abrade, glass and most ceramics. Because of its rarity and occurrence only in granite pegmatites, however, the amazonite variety of microcline is not a commercial mineral resource.

With its considerable hardness (Mohs 6.0-6.5) and pleasing range of green and greenish-blue colors, amazonite is a popular gemstone. Because it is opaque or semi-translucent, amazonite is cut into cabochons or flat inlay pieces, or it is fashioned into beads. Amazonite gems are mounted in silver for wear in pendants, necklaces, and bracelets. Amazonite also appears in southwestern-style silver jewelry as a substitute for turquoise, a gemstone that it closely resembles. And amazonite is also fashioned into spheres and small figurines. Most of

the gem-quality amazonite that is used in beads, inlay, and decorative objects comes from Colorado's Lake George-Crystal Peak-Florissant area or Russia's Irkustkaya district. Amazonite is not color-enhanced or otherwise treated.

Amazonite specimens, both as individual crystals and as composite specimens with smoky quartz, are very popular among mineral collectors. The most desirable amazonite specimens have blocky, prismatic crystals with intense green or greenish-blue colors, sharp crystal edges, and a satiny luster. Amazonite specimens from different localities vary widely in both appearance and mineralogical associations.

Colorado's most productive amazonite localities are in the Lake George-Crystal Peak-Florissant area. Lake George is located in northwest Teller County on U. S. Highway 24, about 16 miles northwest of 14,110-foot-high Pikes Peak, the main regional landmark, and 38 miles west of the city of Colorado Springs. This region is roughly 9,000 feet in elevation with rolling hills and pine forests interspersed with open meadows.

The center of the amazonite-collecting area is Crystal Peak, a steep hill at the western edge of the Pikes Peak Batholith, a 60-mile-long intrusion of coarse, pinkish Pikes Peak granite that covers 1,200 square miles. The Pikes Peak Batholith is famed for pegmatite pockets that are sometimes filled with crystals of amazonite, topaz, and smoky quartz. The batholith was formed one billion years ago as a deep granitic intrusion. Its very slow cooling is evident in its coarsely textured granite and numerous pegmatite dikes and pockets. Some 65 million years ago, the Laramide Orogeny, the mountain-forming event that created the Rocky Mountains, uplifted the entire region. This subsequently accelerated surface erosion, eventually reducing the upper part of the batholith to expose the pegmatites, many of which contained superb specimens of amazonite and smoky quartz.

In the early 1800s, Native American Utes and Arapahos wore and traded small amazonite beads fashioned from material obtained from the Crystal Peak area. Anglo prospectors found amazonite at Crystal Peak during or immediately following the Pikes Peak gold rush of 1858-59, and commercial collecting of amazonite and smoky quartz crystals began about 1865. By the time amazonite was formally recognized as a Colorado mineral variety in 1867, the collecting area had become known variously as "Crystal Peak," "Crystal Butte," "Florissant Crystal Beds," and the "Lake George diggings."

In 1872, American mineralogist Dr. A. E. Foote (1846-1895), the head of the Philadelphia-based Foote Mineral Company, then the nation's largest distributor of mineral specimens, hired 20 men to dig amazonite and smoky quartz crystals near Crystal Peak. Their production enabled the United States to displace Russia as the world's leading amazonite source. By 1880, "crystal tours" had become an important part of the local economy. Large displays of "Pikes Peak Crystals" even greeted arriving passengers at the Colorado Springs railroad station. Soon, Colorado's first fee mineral-collecting venture was established. Just twenty dollars bought a three-day collecting expedition to Crystal Peak that included horses, tents, meals, and "knowledgeable guidance in the gem fields." Mineralogist George Frederick Kunz (1856-1932), America's first true gemologist, wrote extensively about Crystal Peak amazonite in his gemstone reports for the United States Geological Survey's *Mineral Resources* books in the early 1880s.

In the Lake George-Crystal Peak-Florissant area, amazonite occurs in both intact, in situ, subterranean pockets, and in partially exposed, collapsed pockets on the surface. The rare intact pockets are similar to geodes, with large, well-developed crystals of amazonite and smoky quartz protruding downward from the roofs. Wall crystals are smaller and less developed, while floor

crystals are usually broken and cemented together in a reddish clay of albite [sodium aluminum silicate, $NaAlSi_3O_8$] and hematite [iron oxide, Fe_2O_3].

Much-more-common collapsed pockets in decomposed surface or near-surface granite are sometimes filled with a jumble of broken crystals cemented together with albite-hematite clay. Amazonite is also occasionally found in alluvial concentrations that form after the surrounding granite has completely decomposed and the pocket contents have begun alluvial movement.

Colorado pegmatite pockets are rarely longer than four to six feet. The largest documented pocket, found in the early 1900s, was 15 feet long and contained $3,500 (in 1910 dollars) worth of amazonite and smoky quartz crystals. The largest single amazonite crystal ever found in Colorado measured 18 inches in length and was recovered during this period.

During the 1930s, commercial mining at Crystal Peak, utilizing mechanical equipment to trench into decomposed granite, became an important local industry and tourist attraction. Crystal Gem Mines, a popular fee-collecting attraction, opened in 1935 and operated continuously until 1968.

The Lake George-Crystal Peak-Florissant area is now classified as rural-residential. Most pegmatites are on private land that owners lease to collectors, mineral clubs, or commercial miners. More than 150 pegmatite claims are currently registered in the immediately adjacent Pike National Forest. A number of commercial collectors operate each summer, employing mechanical trenching equipment to expose pegmatite pockets.

In the Colorado pegmatites, amazonite is usually associated with smoky quartz, two minerals that form striking composite specimens. Smoky quartz is the brown, gray, or nearly black color variety of macrocrystalline quartz [silicon dioxide, SiO_2]. Like microcline, quartz is also a tectosilicate. It crystallizes in the hexagonal system, usually as short-to-long, six-sided prisms with pyramidal terminations. Macrocrystalline quartz has a Mohs hardness of 7.0, a conchoidal fracture, a specific gravity of 2.65, and a vitreous-to-greasy luster. Depending upon color intensity, smoky quartz is transparent to translucent. Its brown, gray, or nearly black colors are caused primarily by exposure to natural geophysical radiation, the same phenomenon that helps create the green-to-greenish-blue colors of amazonite.

In composite specimens of amazonite and smoky quartz, hexagonal prisms of gray-brown smoky quartz contrast nicely with the rich greens and greenish-blues of the blocky amazonite crystals. Such composites make eye-catching display pieces, and the best come from the pegmatites of Colorado.