TASMANIAN CROCOITE

Few minerals command as much instant, visual recognition as crocoite. With their bright, orange-red color and complex clusters of elongated, needle-like prisms, it's no wonder that distinctive and eye-catching crocoite is a favorite among collectors and museum curators.

Crocoite is one of only 25 chromate minerals, all of which are rare. Of these, crocoite is the most common and familiar to collectors. Although crocoite has numerous occurrences, there are very few localities that produce fine specimens. The classic crocoite locality is the Zeehan Mining District in Tasmania, Australia. No other source approaches Zeehan when it comes to the color, size, and crystal complexity of crocoite specimens. And the story behind Tasmanian crocoite is as fascinating as the specimens.

Crocoite, pronounced CROAK-eh-ite, is the mineral form of lead chromate. Its chemical formula $PbCrO_4$ identifies its elemental components as lead, chromium, and oxygen. Lead comprises 64.11 percent of crocoite's molecular weight, chromium 16.09 percent, and oxygen 19.80 percent.

Crocoite crystallizes in the monoclinic system as elongated, thin, needle-like prisms with generally square cross sections and lengthwise striations. Crocoite crystals typically form reticulated aggregates, acicular ("jackstraw") clusters, radial sprays, and intricate, random groupings. Crystals are often partially hollow with poorly developed, uneven, or pitted terminations. Crocoite also occurs in granular, columnar, and incrusting forms.

Crocoite is translucent to transparent, with a Mohs hardness of 2.5-3.0, an adamantine luster, conchoidal to uneven fracture, distinct cleavage in one direction, and a yellow-orange streak.

With a specific gravity of 5.9-6.1, crocoite is among the densest of all translucent minerals. This unusual density is due to close atomic packing and to the high atomic weight (202.7) of lead, its primary elemental component. Because of its density, crocoite has an unusually high index of refraction of 2.31-2.66, which approximates that of diamond.

As an idiochromatic or "self-colored" mineral, crocoite derives its basic, orange-red color from its essential, elemental components and the nature of its crystal lattice. Chromium is a powerful chromophoric (color-causing) agent. In its hexavalent oxidation state (Cr^{6+}), chromium imparts orange-red colors; in crocoite, these diagnostic colors are caused by a metal-nonmetal charge transfer within its crystal lattice. Crocoite's chromate ions are covalently bonded by shared electrons which occupy "molecular orbitals" that range through the entire crystal lattice. When incident white light energizes these shared electrons, they are displaced from their normal molecular orbitals and migrate toward positive charges, which in crocoite are the hexavalent chromium ions. This electron migration causes the lattice to absorb the blue and green spectral wavelengths and to reflect and transmit the red wavelengths. Traces of sulfur and zinc can distort the lattice in a manner that causes it to reflect and transmit colors ranging from yellow-orange to pure red.

As a secondary mineral, crocoite occurs in the oxidation zones of massive hydrothermal replacement deposits. It most often forms in basic, chromium-rich chemical environments from the oxidation of galena. Crocoite is associated with such other secondary minerals as wulfenite, pyromorphite, cerussite, limonite (an indefinite mixture of basic hydrous iron oxides), vanadinite, and a number of rare chromates.

The German mineralogist Johann Gottlob Lehmann (1719-1767) identified crocoite as a new mineral after studying specimens from the type locality at the Tsvetnoi Mine near Sverdlowsk, Russia, in 1761. Suspecting that the new mineral contained lead, Lehmann named it "Siberian red lead." In 1770, the German scientist Peter Simon Pallas (1741-1811) ground specimens from the same site into a bright-yellow powder that made a superb paint pigment and fabric dye and quickly gained popularity throughout Russia and Europe.

But crocoite's true composition remained a mystery until 1797, when French chemist Louis-Nicolas Vauquelin (1763-1829) treated samples of "Siberian red lead" with acid to produce an oxide that contained a previously undiscovered element—a lustrous, hard, steel-gray metal with a high melting point and a density similar to that of iron. Vauquelin named this new element "chromium," after the Greek *chrōma*, meaning "color," and alluding to the bright hues of its compounds. He also demonstrated that "Siberian red lead" was actually lead chromate.

In 1832, French mineralogist François-Sulpice Beaudant (1787-1850) gave "Siberian red lead" its first formal mineral name—"crocoise," from the Greek *krokos*, or "saffron," a reference to the color of its powder. This name was later changed to the present "crocoite."

Crocoite was initially the only known source of chromium. From 1780 until 1850, crocoite from Russia and Germany was the only source of chromium needed to manufacture yellow, lead-chromate pigments for paints and dyes. Crocoite's importance as a chromium ore ended in 1850 after the discovery of large deposits of chromite (iron chromium oxide) ores.

Crocoite-based yellow paints are thought to be the origin of today's yellow taxicabs. In the early 1800s, prosperous London citizens had their private carriages painted with bright-yellow, crocoite-based paints, a color that was subsequently copied by operators of carriages-for-hire. When taxis in the United States became motorized in the early 1900s, New York City cabbies painted their vehicles the same bright, highly visible, yellow color of the old London carriages-for-hire. By then, however, the yellow paint was being colored with a synthetic lead-chromate pigment.

Crocoite is too soft for jewelry use. Although difficult to cut and polish, large, transparent crystals are occasionally faceted into collectors' gems in elongated, rectangular styles that maximize cutting retention of the long crocoite prisms. Typically, one-carat crocoite gems, depending on cut, color, and degree of transparency, cost about $500. With their high index of refraction and bright, orange-red color, crocoite collectors' gems make beautiful display pieces.

Crocoite's only modern technological use is as "chrome-yellow" pigment for specialty oil paints used in graphic-arts applications.

According to modern metaphysical beliefs, crocoite enhances intuition, creativity, charisma, vitality, strength, and spirituality. It also helps one to adapt to changing situations and overcome emotional and mental distress.

The world's finest crocoite specimens come from the Zeehan Mining District in Tasmania, Australia, where a small group of mines has provided most of the world's crocoite specimens since the 1890s. Tasmania, Australia's "island state," is located 120 miles south of the mainland state of Victoria. With an area of 26,100 square miles, it is a bit smaller than West Virginia. Tasmania has a population of just 490,000, and much of the island is protected in its natural state as parks and wildlife refuges.

Tasmania was settled in the early 1800s as a British penal colony. In 1871, the discovery of tin ore lured miners into northwestern Tasmania's rugged hills. Although miners found little tin, they did discover rich silver-lead mineralization near the present town of Zeehan. Following a major silver rush, Zeehan, with a population of 10,000, became known as Tasmania's "Silver

City of the West." Tasmania's silver boom peaked in 1890 with 160 companies mining silver-lead ores that graded as high as 70 troy ounces of silver per ton. The value of the mines' output exceeded $1 million per year. With banks, theaters, dozens of saloons and hotels, and even a stock exchange, Zeehan was similar to the mining boomtowns that existed in America's western frontier during the same time period.

The geology of the Zeehan district is complex. Some 600 million years ago, olivine- and chromium-rich magma intruded existing formations of billion-year-old, Proterozoic schist. Then, 400 million years ago, tectonic collisions deformed, folded, and fractured the existing strata. Mineral-rich hydrothermal solutions surged into the fractures to form veins and replacement deposits. Subsequent erosion eventually exposed these mineralized veins that were rich in silver and lead.

Tasmanian silver-lead miners discovered crocoite in the late 1880s. According to the well-known Tasmanian amateur mineralogist William Frederick Petterd (1849-1910) wrote: "The first discovery of the mineral was made by Mssrs. Smith and Bell at the Heazlewood silver-lead mine. It occurs there in bright, shining hyacinth-red crystals, small as we now know them from other portions of the island, arranged in acicular bunches, penetrating and attached to a very friable clayey gossan, intermixed with a little cerussite, and more rarely pyromorphite." By the time mineralogists positively identified the orange-red mineral as crocoite in 1895, it had also been found in mines of the nearby Luina, Waratah, Whyte River, and Zeehan districts.

The largest concentrations of crocoite occurred in Zeehan district, specifically in the Dundas subdistrict some five miles east of Zeehan at the Adelaide, Adelaide Proprietary, Comet Maestries, Dundas Extended (later renamed the Red Lead), West Comet, Platt, and Kosminsky mines. All of these mines are located along a mile-long, mineralized fault line. The size and quality of the crystals from the Dundas Subdistrict —as long as five inches with brilliant color, excellent transparency, and perfect terminations—far exceeded any crocoite specimens ever seen before. With their dazzling color and striking forms, Zeehan crocoite specimens amazed the mineralogical world.

Demand for these specimens soared and, in 1888, the Foote Mineral Company of New York City, then the world's leading commercial source of mineral specimens, sent a field collector to Tasmania. By the time the collector arrived, many mines had already driven through the shallow, crocoite-rich, oxidized zones into deeper, sulfide ore bodies. Other mines had shut down entirely and allowed their workings to flood. Nevertheless, the collector hired miners to drive new workings to expose many pockets of superb crystals.

The 1899 Foote Mineral Company catalogue, which was filled with spectacular Zeehan crocoite specimens, noted: "The discovery of new forms of this wonderful mineral is the result of over a year's work by our collector, in which the old Siberian specimens were totally outclassed. . . . our collector was fortunate to strike a patch of loose prisms 3 to 9 centimeters (1.2 to 3.6 inches) in length, superbly terminated, and of a most gorgeous translucent to transparent scarlet-red." The catalogue also pointed out that the collector's work, performed at a depth of 232 feet, was "the most extensive mining ever done solely for scientific mineral specimens."

The crocoite collected by the Foote Mineral Company represented only a small part of all the crystals that had actually been mined at Zeehan. Although crocoite was no longer valuable as a chromium ore, it nevertheless made an excellent flux for the Zeehan silver-lead smelters. Added to smelter mixes, it enhanced lead recovery and combined with impurities to form an easily separable slag. Accordingly, most of the Zeehan crocoite ever mined, including countless beautiful specimens, was destroyed in smelters.

When ore grades declined after 1900, most of Zeehan's silver-lead mines closed. Among them was the Adelaide Mine where, during the 1920s, miners had recovered an exceptional crocoite specimen which later earned a prestigious distinction. Its photograph appeared in Peter Bancroft's 1973 classic book *The World's Finest Minerals and Crystals,* a collection of 78 of the most remarkable mineral and gemstone specimens ever photographed.

The closing of the last of the Zeehan silver-lead mines in the early 1960s temporarily halted the supply of crocoite specimens. But growing interest in mineral collecting along with soaring prices for crocoite specimens soon lured miners back to the Zeehan mines to search for crocoite. At the old Adelaide Mine, miners opened a nine-foot-wide cavity filled with thousands of brilliant, terminated crocoite crystals as long as 3.5 inches. These specimens attracted great attention at gem-and-mineral shows in the mid-1970s. Since then, other Zeehan mines—including the Red Lead Mine, the source of our specimens—have reopened to provide a limited supply of crocoite specimens.

Although museums around the world exhibit Zeehan crocoite specimens, the premier display is appropriately located right in Zeehan. The old Zeehan School of Mines and Metallurgy building, constructed in 1892 during the Tasmanian silver-mining boom, is now the Zeehan Mining Museum. Its main attraction is the Mihajlowits Room, named in honor of long-time, crocoite-specimen miner Frank Mihajlowits. The room is filled with hundreds of fine specimens that represent the best of Zeehan crocoite.

In 2000, the Honorable John Bestwick, minister of mines of the Australian State of Tasmania, declared crocoite to be Tasmania's official mineral. That honor remains a fitting tribute to Tasmania, the Zeehan mines, and crocoite, a rare mineral that, with its rich orange-red color and distinctive, needle-like crystal shapes, is sought by collectors around the world.