GEM RHODOCHROSITE FROM THE SWEET HOME MINE, COLORADO

By Kimberly Knox and Bryan K. Lees

Massive banded rhodochrosite has long been used for carvings and other ornamental objects. Although intense red transparent rhodochrosite crystals of remarkable size have been known in Colorado since 1895, not until recently were mining techniques developed to recover them economically. These new mining techniques have combined state-of-the-art equipment and technology to detect and extract large, fine-quality rhodochrosite specimens and gem rough. Although rhodochrosite is a soft mineral, faceted rhodochrosite can be set into jewelry provided it receives special handling and consideration with respect to wear. Faceted rhodochrosite can be readily separated from possible imitations on the basis of standard gemological testing.

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Unusual gemstones have increased markedly in popularity over the last several years. This trend has been stimulated not only by the availability of these materials, but also by new cutting techniques and the creative efforts of innovative jewelry designers willing to integrate unusual materials into their works. Critical acknowledgment and distinction for such materials are earned through such venues as the AGTA Cutting Edge and Spectrum Awards. Faceted rhodochrosite, which was recognized at the 1996 Cutting Edge competition, is one of the most exciting new gem materials to appear as cut stones and in jewelry, following years as one of mineral collectors' most sought-after specimen materials (figure 1).

Although rhodochrosite is softer than almost all other gemstones (even opal), it is harder than some, such as pearl. Properly set and cared for, rhodochrosite can be made into outstanding pins, pendants, tie ornaments, and necklaces.

Until recently, rhodochrosite was primarily available as a pink opaque massive material, with the irregular curved or concentric pattern of gray or white banding that is characteristic of its stalactitic or nodular formation; typically, it is fashioned into cabochons, beads, or ornamental carvings (figure 2). With the recent redevelopment of the Sweet Home mine near Alma, Colorado, large (one over 14 cm, but averaging 2.5 cm), fine specimens of transparent-to-translucent rhodochrosite crystals, as well as small amounts of faceted rhodochrosite, have entered the gem and mineral trade. The faceted gems are usually deep, intense pink to red, typically modified by orange, and completely transparent.

Colorado has been known as a source of fine rhodochrosite since the 1800s, and the Sweet Home has been the most significant producer since 1895 (Jones, 1986). According to Sinkankas (1997, p. 408), the mine is "known worldwide for its unmatched crystals of transparent, vivid red rhodochrosite. . . ."

Although there have been and still are other sources of gem rhodochrosite—for example, South Africa's Kalahari Desert and the Pasto Bueno and other districts in Peru—

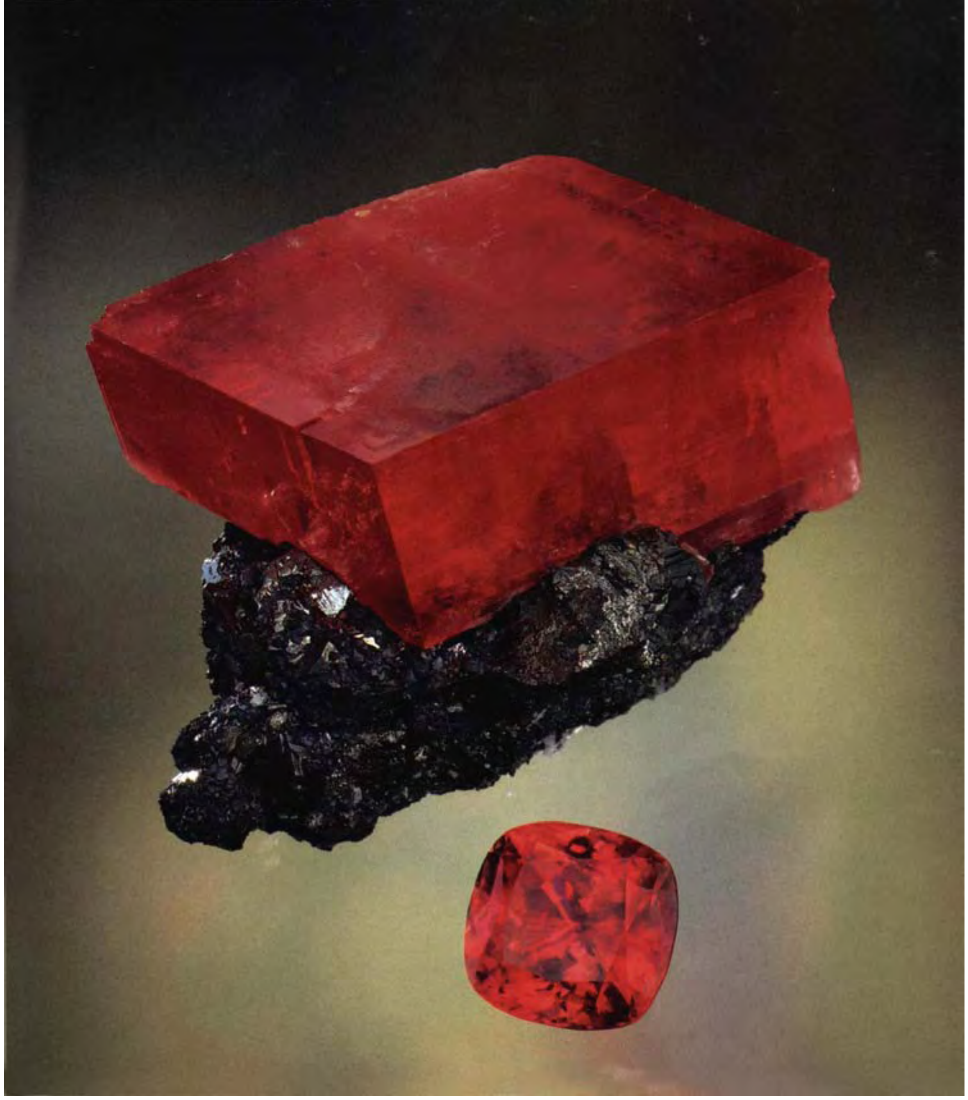


Figure 1. Long a favorite of mineral collectors worldwide, some rhodochrosite is now being faceted and even set in jewelry. This 5 × 6 cm rhodochrosite crystal on tetrahedrite and the 21.50 ct cushion-cut rhodochrosite are both from the Sweet Home mine, near Alma, Colorado. Courtesy of The Collector's Edge, Golden, Colorado. Photo © Harold & Erica Van Pelt.

their production has been irregular. The Sweet Home remains the single most important source of fine rhodochrosite specimens and faceted stones.

This article describes the history of rhodochrosite and the geology of the Sweet Home mine. Also discussed and illustrated are the novel, contemporary mining techniques developed by Sweet Home Rhodo, Inc. The results of a basic gemological analysis of eight Sweet Home faceted rhodochrosites are presented, along with identification criteria. Last, cutting and setting techniques specific to rhodochrosite are described in detail.

HISTORY

Rhodochrosite was first described in 1813 by J. F. L. Hausmann, using material from Kapnik, Transylvania. Dr. Franz Mansfeld is credited with introducing North America and Europe (around 1934) to "Inca Rose," the massive rhodochrosite found in abundance in Argentina's Catamarca Province (Shaub, 1972). Reportedly the mine was once worked by Incas for silver and copper (Webster, 1975). Dr. Mansfeld hoped to sell large quantities to institutions of applied arts as a carving material. Although his efforts to integrate rhodochrosite into the applied arts were unsuccessful, he did popularize the massive, opaque form of this stone (Shaub, 1972).

Massive rhodochrosite actually occurs in many localities in addition to Argentina. In Europe, it is found in Romania, Yugoslavia, and Germany; in Australia and its environs, it comes from New South Wales, Victoria, South Australia, and Tasmania (Clark, 1980); and in Mexico, it is known from the Cananea and Santa Eulalia mining districts (Jones, 1978).

However, the single-crystal form of this mineral is relatively rare. In 1887, Dr. George F. Kunz of Tiffany & Company reported finding gem-quality rhodochrosite in Colorado, "the first locality to yield crystals of such magnitude and transparency." A specimen of Sweet Home rhodochrosite that was acquired by the second author in 1987 bore a label from the American Museum of Natural History;

Figure 2. Traditionally, the rhodochrosite seen in the gem trade is the gray- or white-banded massive pink material that has been found in large quantities in Catamarca, Argentina. It is used primarily as beads and cabochons or for carvings. This photo shows some finer examples of this material. The two carvings are accompanied by slices of rhodochrosite taken from large stalactites (similar to the smaller stalactite section shown here). The faceted stones, (5.88 and 17.43 ct), which are from the Hotazel (South Africa) and Sweet Home mines, are included to give some idea of the differences in size between the massive opaque and transparent materials. From the collection of Michael M. Scott; photo © Harold & Erica Van Pelt.

this specimen was traced back to a donation by Tiffany and Company during the 1890s. In addition to the Sweet Home mine, the famous American Tunnel gold mining project of the 1950s in Silverton, the Climax molybdenum and John C. Reed (Alicante) mines (Jones, 1993), and the Moose (Pleasant Valley) and Mickey Breen (Uncompahgre Gorge) mines (Sinkankas, 1997) have also produced rhodochrosite in Colorado.

In 1974, gem-quality rhodochrosite was discovered at the N'Chwaning and Hotazel mines in South Africa's Kalahari manganese fields (Wight, 1985; figure 3). Around the same time, a few superb, large samples of gem-quality rhodochrosite emerged from the Huayllapon mine in the Pasto Bueno district, Pallasca Province, Peru (Clark, 1980; Crowley et al., 1997; figure 4). Since 1985, transparent "deep raspberry-pink to strawberry-red" crystals up to 2.5 cm have been produced from the Uchucchacua mine, in Peru's Oyon Province. However, production from the Kalahari region has been irregular and the crystals are small. Pasto Bueno produced fewer than two dozen "outstanding" rhodochrosite specimens, and the Uchucchacua crystals, like those from Kalahari, are small (Crowley et al., 1997).

An active silver mine since 1872, the Sweet Home (then known as the Home Sweet Home mine) holds one of the earliest U.S. mining patents, No. 106, granted under the General Mining Law of the same year ("Specimen mining," 1994). The mine was operated intermittently almost 90 years, until the 1960s, and extensive tunnels were driven to exploit the mine's silver reserves. During that period, rhodochrosite was regarded as a passing curiosity, and most was discarded on the dumps.

Leonard Beach, owner of the Sweet Home mine since about 1961, steadfastly maintained that many valuable rhodochrosite specimens were waiting to be retrieved. For over 25 years, through lectures and a circulating mining prospectus, he kept that idea alive. In 1966, following an unproductive silver-exploration effort, contractor John Soules decided to look for rhodochrosite crystals in one of the mine tunnels. A mine map from the 1920s showed a zone where a rich red seam of rhodochrosite had been uncovered but abandoned. This zone was opened and a superb specimen was uncovered (illustrated in Bancroft, 1984, pp. 60–61); it is now in the collection of the Houston Museum of Natural Science.

In 1977, Beach leased the mine to Richard Kosnar and John Saul, owners of the Intercontinental Mining Corporation (Sinkankas, 1997). They uncovered several productive pockets. However, better tools and collecting techniques had to be developed before major pieces could be recovered undamaged.

Most recently, in 1991, the Sweet Home Rhodo, Inc., mining company was founded by a group of investors who were intrigued by Leonard Beach's concept of a stand-alone specimen-mining effort. They spent a quarter of a million dollars to lease and rehabilitate the old mine in order to put it back into production—this time not for silver, but for rhodochrosite specimens. In 1992, the Sweet Home produced the largest specimen known from this locality, the Alma King (figure 5), which contains a rhodochrosite crystal measuring 14.25 cm on a side that sits on a matrix of quartz over 65 cm (more than 2 feet) long. The Alma King is now in the collection of the Denver Museum of Natural History ("Denver fax: Big crystal," 1994).

LOCATION AND ACCESS

The Sweet Home mine lies in the rugged Mosquito Range about 3.8 miles (6 km) northwest of Alma, Colorado, and 80 miles (128 km) southwest of Denver. The Sweet Home lies between two major mining districts: the silver-bearing mines flanking Mount Bross to the north and the gold district to the south (figure 6).

The entrance to the Sweet Home is at 11,600 feet (3,536 m) above sea level. The terrain is steep: Several mountain peaks as high as 14,000 feet (4,267 m) surround the mine. The mine is accessible only two to three months of the year. Mining usually begins in late May, after ice and snow drifts up to 6 m high have been cleared. The only truly snow-free period is between mid-July and mid-August.

Although the mine can be reached by automobile, the climate and the altitude are harsh. Neither the area nor the nature of the mine—an extensive underground operation with slippery, near-vertical tunnels—is suited for the general public.

Figure 3. Another source of fine transparent rhodochrosite crystals is the N'Chwaning mine in northern Cape Province, South Africa. This cluster of red scalenohedral rhodochrosite crystals from N'Chwaning measures 9.5 cm. However, crystals over 3 cm from this region are extremely rare. From the collection of the Houston Museum of Natural Science; photo © Harold & Erica Van Pelt.

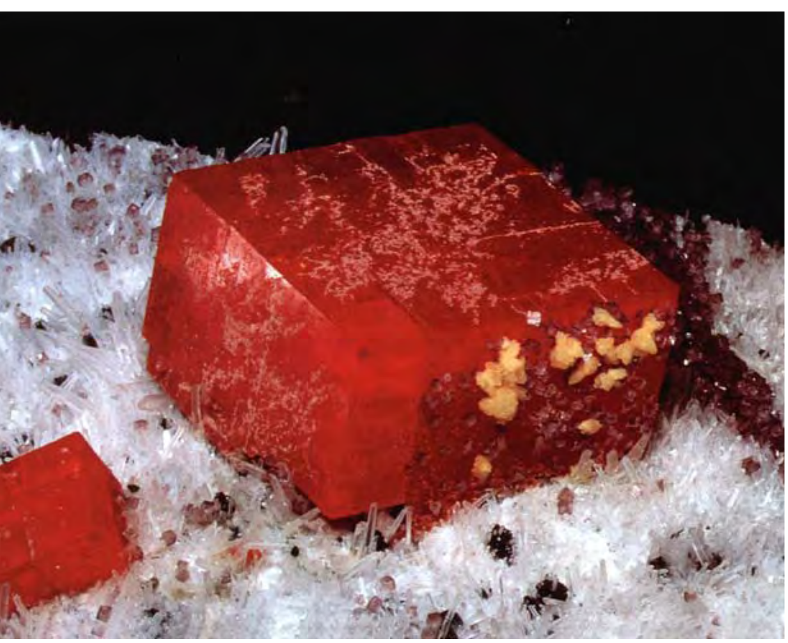
GEOLOGY

As noted earlier, gem-quality rhodochrosite has been found in many parts of Colorado (see, e.g., figure 6). Of these, the Climax-Alma area has been the most productive, both in quality and quantity. The region is made up of Precambrian granite and granitic gneiss. About 30 million years ago, this area was intruded by magmas, from which significant amounts of minerals and ore deposits—including the famous Climax porphyry-molybdenum system—formed (Moore et al., 1997).

The Sweet Home deposit sits atop another porphyry-molybdenum system five miles (8 km) east of the Climax system, and the Sweet Home is slightly younger than Climax by one or two million years.

Figure 4. Recovered from Peru's Pasto Bueno district, this rhodochrosite crystal measures 9 cm high. From the Smithsonian Institution collection; photo © Harold & Erica Van Pelt.

Figure 5. The Alma King's largest crystal measures 5-5/8 inches (14.25 cm) on a side. It formed on a matrix of quartz sprinkled with purple fluorite and black sphalerite crystals. From the collection of the Denver Museum of Natural History; photo © Jeff Scovil.



The veins in the Sweet Home mine follow the northeasterly trends that are typical throughout much of the Colorado mineral belt. These veins are polymetallic, principally containing silver, lead, zinc, and copper. The primary ore mineral is silver-bearing tetrahedrite, and rhodochrosite occurs as a gangue (non-ore) mineral inside the ore veins. Other important minerals are galena, chalcopyrite, pyrite, and sphalerite. The ore veins are intersected by north- and east-trending faults.

Rhodochrosite ($MnCO_3$) is deposited from hydrothermal solutions containing metal ions (including manganese), sulfur, carbon, oxygen, and fluorine. These solutions work their way upward from the porphyry-molybdenum system through vertical fissures. When the temperature, pressure, and other conditions are correct, the solutions deposit their minerals along the cavity walls. The sequence of crystallization depends on the relative solubilities of the different mineral species at specific temperatures. For example, at the Sweet Home mine, quartz was the first species to crystallize, followed by tetrahedrite, huebnerite, topaz, and, finally, fluorite and rhodochrosite. As the system cools, for example, quartz will form at about 375°C, whereas rhodochrosite forms at about 300°C. These temperatures were determined by fluid-inclusion analysis of tiny liquid-and-gas inclusions inside crystals of the respective minerals (Moore et al., 1997).

MINING

When, in 1991, Sweet Home Rhodo launched an ambitious effort to uncover and extract fine rhodochrosite specimens, the accumulated debris of almost 100 years was cleaned out, the tunnel walls were widened to accommodate underground loaders, and a new portal (figure 7) was installed together with a high-volume ventilation system. Mine safety and rescue procedures were set up and maintained to code requirements (Lees, 1993, p. 30).

The first major question that needed to be addressed was where to look for the rhodochrosite. On the basis of extensive geologic mapping and target evaluation by Sweet Home Rhodo geologists, a theory was worked out that open spaces capable of containing rhodochrosite typically occurred where the main northeast-trending ore veins were intersected by the fault systems. These potential intersection sites were extrapolated from the mine maps and designated as primary targets. All of these data were assembled via computer-aided drafting to enable two- and three-dimensional analysis (again,

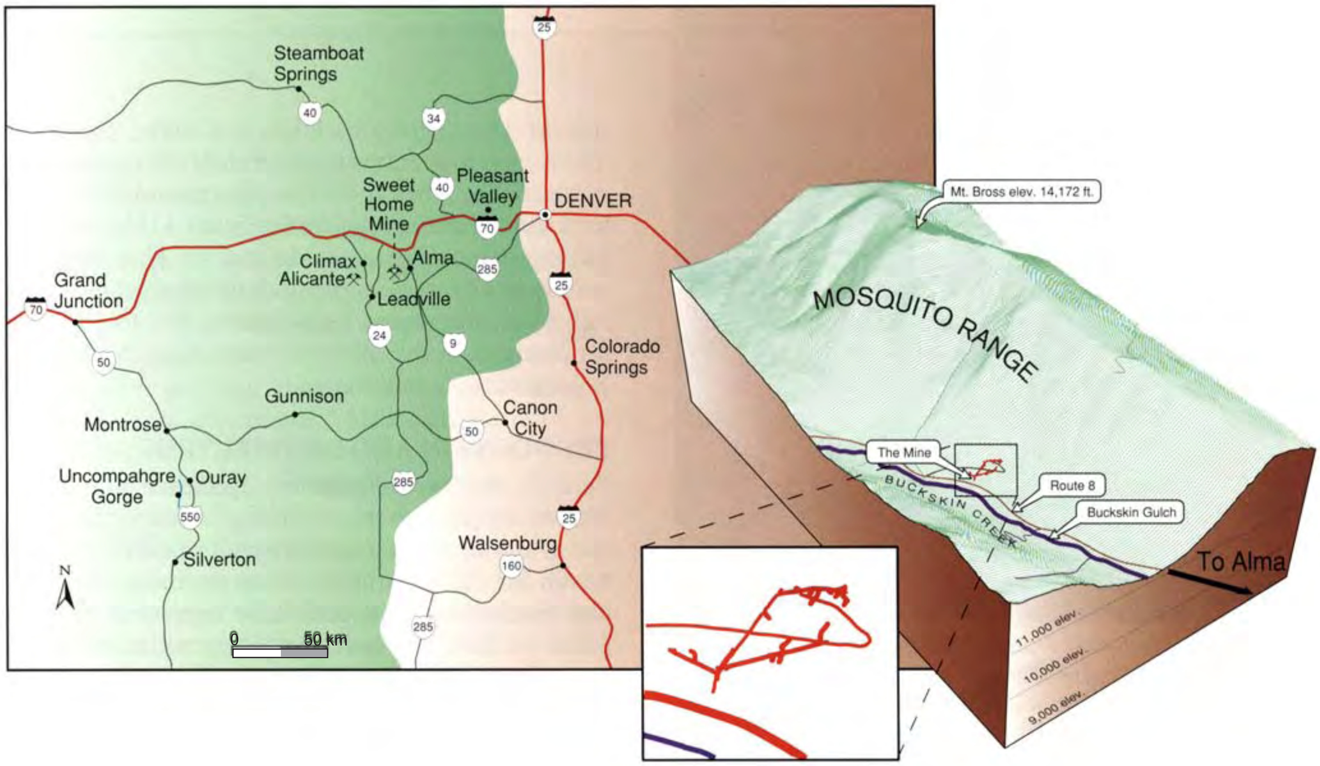


Figure 6. The Sweet Home mine is one of several rhodochrosite-producing localities in Colorado; the cities near which many of these are found are marked on this map of Colorado. The Sweet Home is only a few kilometers from Alma, which is southwest of Denver. In the perspective view looking north-northeast, it can be seen that the mine lies at an altitude above 11,000 feet (3,353 m). Shown in red are the potential intersection sites of the main north-east-trending rhodochrosite-bearing veins and north- or east-trending fault systems, which proved to be the most promising locations for rhodochrosite pockets. Locality map by Jenna MacFarlane. Digitizing and processing of the perspective view by Eugene Kooper; graphics by Bill Tanaka.

see figure 6). During the next few years, these sites turned out to be the primary sources for rhodochrosite pockets.

In addition to geologic mapping, a series of other geologic tools were used to help locate rhodochrosite pockets (Moore et al, 1997). These included:

1. Ground-penetrating radar (GPR) for void detection (see Cook, 1997, for additional information on this technique).
2. Geochemical and microprobe analysis of the host rock to look for trace-element clues that could lead to favorable deposition zones for rhodochrosite.
3. Surface electromagnetic surveys to search for unmapped veins (again, see Cook, 1997).
4. Fluid-inclusion work to identify the best zones for fine quality rhodochrosite and to help build an ore-deposition model.
5. Petrographic evaluation of the ore suite.

After the scientific studies were completed, mining began and continues to this day. At the Sweet Home, mining involves extensive drilling and blasting along the previously identified ore veins. When the miners near a vein intersection, drilling slows to a careful probing; when contact with a pocket is made, a medical endoscope is used for closer examination. A lens attached to a fiber-optic cable transmits the image of the pocket contents to the observer. To date, a discouraging 90% of the pockets examined have been empty or contained crystals of little value.

Since the veins are nearly vertical in orientation, their intersections with faults are likewise vertical, which has necessitated the development of a series of vertical tunnels called *raises*. These raises ultimately have produced the most value, but they are physically the most difficult to create. The raises progress upward, one blast at a time, from horizontal tunnels excavated into the side of the mountain. After each blast, all of the equipment has to be hauled up ladders to the working face by hand and then taken down again before the next blast. This

Figure 7. The Sweet Home mine is cold, wet, dark, at an extreme altitude, and absolutely inaccessible for all but a few months a year. This new portal leads to an extensive underground mine with slippery, vertical tunnels extending up sometimes 200 feet (61 m) high. Photo © Bryan Lees.

includes drills (approximately 125 pounds [57 kg]), wooden working platforms (several hundred kilograms), hoses, drill steels, and collecting equipment (about 50 kg). Each upward blast advances the face some 1.5 m. Some of the raises reach over 60 m.

When a pocket with top-quality material is identified (figure 8), careful rock removal is critical, as the fragility of rhodochrosite makes its extraction extremely difficult. Two new extraction techniques have shown extraordinary results in specimen recovery. These involve a combination of cutting with a hydraulic diamond chainsaw and hydraulic rock splitting.

First, a chainsaw cut is made along a line around the pocket wall (figure 9). Then, split holes are drilled outside the cut lines, and a hydraulic splitter is inserted into the holes, one at a time, carefully breaking and removing the rock up to the saw cut (figure 10). Once most of the wall rock is removed, the contents of the pocket are carefully removed with the chainsaw. Using this new extraction technique, Sweet Home miners can recover specimens that otherwise would not be viable. Notably, breakage is minimal and few crystals require repair after extraction.

The specimens recovered are indexed, wrapped, and boxed before they are sent to the mine's laboratory at The Collector's Edge, in Golden, Colorado. There, each specimen is carefully trimmed and cleaned. The silica that typically coats this material as it emerges from the mine (figure 11) is removed by a combination of acids and air abrasion that avoids any damage to the underlying crystals (figure 12). Most specimens require from five to 10 hours for cleaning; some, like the Alma King, have taken as long as three months.

PRODUCTION AND DISTRIBUTION

Because the Sweet Home is a specimen mine, only broken crystals or those otherwise not suitable for use as mineral specimens are submitted for cutting. Given the current mining methods, easily 100 mineral specimens are successfully recovered for each piece of faceting material. Approximately 100 faceted gems greater than one-half carat have been produced annually since 1992. Over 75% of cut production is represented by stones between 1 and 3 ct. In an average year, fewer than 10 eye-clean stones over 10 ct are produced (P. Cory, pers. comm., 1997). The largest faceted rhodochrosite from North America on record is a 61 ct Sweet Home mine stone (Sinkankas, 1997).

Figure 8. The tiniest evidence of red at the end of the tunnel is the prize at the Sweet Home rhodochrosite mine. Bryan Lees (sitting) and Scott Betz discuss the strategy for extracting the pocket shown here. Photo © Jeff Scovil.

Since 1989, a register of specimens and cut stones from the Sweet Home mine has been maintained by cutter and archivist Paul Cory as a historic record of the rhodochrosites taken from that location. Each crystal specimen and cut stone carries a registration number, the name of the pocket from which it was recovered and approximate date of recovery, the name of the cutter (if appropriate), all pertinent physical characteristics, and, in some cases, specific comments. Although some of the crystals recorded may eventually be faceted, such a record is invaluable to potential collectors.

Approximately 70% of the faceted stones are sold to dealers. The other 30% are sold retail to amateur collectors and retail jewelry buyers. About 80% of those sold to dealers are subsequently purchased by collectors of rare stones or set into jewelry for resale (P. Cory, pers. comm., 1997).

Figure 9. At Sweet Home, a miner used a hydraulic diamond-impregnated chainsaw to make the initial cut around a pocket. This pocket, recovered in 1994, was named the Corner Pocket, the source of many fine rhodochrosite specimens. Photo © Bryan Lees.

SWEET HOME MINE RHODOCHROSITE

Materials and Methods. Eight faceted rhodochrosites (5.09–26.68 ct) from the Sweet Home mine were examined by Shane McClure of the GIA Gem Trade Laboratory in Carlsbad. A Duplex II refractometer with a near-sodium equivalent light source was used to take the refractive index readings. Specific gravity was determined by the hydrostatic weighing method. On all stones, a desk-model spectroscope was used to examine the absorption spectra. The reaction to ultraviolet radiation was viewed with four-watt long- and short-wave lamps. The internal features in each stone were examined with a standard binocular microscope. The results are given in table 1 and discussed below.

Description of the Material. Rhodochrosite, a trigonal carbonate of manganese, derives its name from the Greek words *rhodon* (rose) and *chrosis* (color; Dana and Ford, 1932). Gem-quality rhodochrosite usually occurs as rhombohedral crystals and occasionally as scalenohedral crystals, with perfect cleavage in three directions. At the Sweet Home mine, the crystals only occur as rhombohedra. These crystals are often accompanied by quartz, fluorite, tetrahedrite, and sphalerite (again, see figures 1, 5, and 12). The translucent-to-opaque banded variety of rhodochrosite is an aggregate, and it is usually found in stalactitic or nodular masses. Massive material has been recovered from veins of the Sweet Home mine, but to date none has been found in any of the pockets.

Gemological Characteristics. The eight faceted stones, all of medium quality, ranged from pinkish orange to pink-orange (figure 13). The physical properties of all the samples were remarkably similar: Refractive indices of four stones were 1.600 and over-the-limits of the refractometer, and the other four were 1.599 and over-the-limits. The specific gravity was 3.71 for seven stones and 3.70 for the eighth. Pleochroism was light yellowish orange and orange-pink. The spectrum seen in all eight specimens consisted of a strong narrow band centered at 415 nm and two broader bands from approximately 440 to 470 nm and 540 to 560 nm. There was no fluorescence to either long- or short-wave UV.

Figure 10. Two miners press upward with a splitter, a device similar to the "Jaws of Life," into holes drilled just outside the sawcut made around the Corner Pocket. Photo © Bryan Lees.

Figure 11. When a specimen is first removed from the pocket, it is difficult to know what to expect. While it is clear that a large crystal has been uncovered, its muddy color and the silica coating say little about the gem beneath. Photo © Bryan Lees.

Figure 12. Cleaned of silica and mud by a combination of acids and air abrasion, the specimen in figure 11 emerges as a fine, 16-cm-high, rhodochrosite crystal on snowy white quartz and dark sphalerite crystals. Courtesy of the Collector's Edge; photo © Jeff Scovil.

TABLE 1. Gemological properties of transparent rhodochrosite from the Sweet Home (Colorado) and Hotazel (South Africa) mines.

Characteristic	Sweet Home[a]	Hotazel[b]
Color	Pinkish orange to pink-orange[c]	Pinkish to deep red, with orange, brown, and black secondary colors
Hardness	Not tested	4
Cleavage	Not tested	Easy, perfect rhombohedral
Specific gravity	3.70 – 3.71	3.64
Refractive indices	1.600 – OTL[d] 1.599 – OTL	1.597 – 1.812
Pleochroism	Light yellowish orange and orange-pink	Red and brownish red
UV fluorescence		
Long-wave	Inert	Inert – dull red
Short-wave	Inert	Inert
Absorption spectra	Strong band at 415 nm, two broader bands at 440–470 and 540–560 nm	Band at 535–565 nm, lines at 551 and 410 nm

[a]Information provided by S. F. McClure (pers. comm., 1997) on the basis of eight study stones.
[b]As published in "Rhodochrosite" (1987).
[c]These colors are for the eight stones studied only.
[d]OTL = over the limit of a standard refractometer.

With magnification, it was evident that all stones contained planes of liquid and two-phase (liquid and gas) inclusions; some of the two-phase inclusions were quite large (figure 14). Several stones contained irregular to plate-like transparent dark brown crystals; one had a triangular opaque platelet, and several had straight internal growth striations in two or more directions (again, see figure 14). Note also in figure 14 (right, without a polarizing filter) the strong doubling caused by the high birefringence characteristic of rhodochrosite.

In reviewing the literature for analytical work on rhodochrosite, we examined the results of an informative work published on Hotazel rhodochrosite ("Rhodochrosite," 1987) and compared them to the results for the Sweet Home mine stones (table 1). While there are differences between the Sweet Home and Hotazel rhodochrosites, they are small enough only to indicate (not prove) differences in geographic origin. Because the Catamarcan material is an aggregate—composed also of other distinctly different minerals—and not a crystal, its properties deviate from those of the single-crystal material (see, e.g., Galloni, 1950).

Identification. The identification of single-crystal rhodochrosite from similar-appearing gem materials, such as rhodonite and some Mexican opal, is not difficult because of rhodochrosite's distinctive gemological properties. These include its high birefringence,

Figure 13. Illustrated here are seven of the eight faceted Sweet Home mine rhodochrosites (5.09–26.68 ct) that were tested for this study. Courtesy of the Collector's Edge; photo © Harold & Erica Van Pelt.

characteristic color, and low hardness (for further information, see the *Gem Reference Guide*, 1992).

CUTTING AND SETTING

The Cutting Process. Faceting rhodochrosite requires a great deal of skill and experience. Not only is rhodochrosite very soft, but it also has perfect cleavage in three directions—planes that must be avoided completely during cutting. Following is the technique used by those who cut for the Sweet Home Rhodo mining group.

The material is preformed by hand, slowly and with minimal force, on a 360 grit, continuously wetted grinding wheel. Some of the grinding is accomplished simply by rubbing the stone on a stationary grinding wheel.

The stones are then dopped. The first adhesion of the table to a standard dop is made with ordinary white glue. Once the placement is judged satisfactory, the joint between the dop and the stone is reinforced (surrounded) with a "five-minute" epoxy that is allowed to cure for one to two hours. Facets are placed first with a 1200 grit flat lap, and then with a tin lap, wax lap, or "Final Lap" (from Diamond Pacific Co.), as the stone requires. Occasionally, as difficulties are encountered, better results are obtained by reversing the rotation of the lap.

Because rhodochrosite is sensitive to heat, the cutter unmounts the stones from the dopstick by immersing the dop and stone together in a bath of methylene chloride (a toxic and flammable substance) at room temperature until the adhesive is completely dissolved and the gem may be removed without any force.

The cutter redops the stone by packing a standard dop with clay, positioning the stone, and surrounding the joined area with five-minute epoxy. The rest of the stone is then faceted, and it is removed from the dop as before (E. Gray, pers. comm., 1997). Occasionally cutters use a wooden dop to reduce the potential for vibrational damage associated with metal dops.

It is critical when working with rhodochrosite

Figure 14. Two-phase inclusions were present in all the rhodochrosites examined. Use of a polarizing filter (left) eliminated the strong doubling (right), which results from the high birefringence of the host material. Photomicrographs by Shane F. McClure; magnified 18×.

Figure 15. The Denver Necklace was designed and created to preserve a suite of fine gem rhodochrosites for public display. The center stone is 14.06 ct, with the stones on either side of it about 5.5 ct each, 3 ct each, and 1.5 ct each (moving up the necklace). Designed by Kimberly Knox; created by Knox and Zane A. Gillum of Golden Pacific Arts. Photo © Harold & Erica Van Pelt.

to ensure that the work area is always clean and that all surfaces are soft and nonabrasive. No stone is placed on any surface that has a greater hardness than the gem, and each gem is moved from one pad of clean cotton or felt to another with clean, soft, steady hands; fingers replace metal tweezers.

Setting Techniques. As of March 1997, we knew of at least 35 faceted rhodochrosites from the Sweet Home mine that had been prong-set successfully in gold mountings (P. Cory, pers. comm., 1997).

The setting process for any rhodochrosite first involves a thorough initial cleaning of the entire work area. The stones must be placed safely on a soft cloth when they are not being handled, and any handling should be done only with fingers or soft beeswax. Careful attention must be paid to the angle cut into the prongs, the seat onto which the stone will rest, and to the bearing surface of the upper portion of the prong. Matching these bearing angles exactly to each stone's profile—without any bulges or gaps between the metal and any of the surfaces of the stone—is much more important with rhodochrosite than with gemstones that have greater hardness and toughness profiles. Also uncharacteristic for other faceted gem materials, mountings destined to be set with rhodochrosite must be completely polished and cleaned prior to setting. When fitting the stone into the setting, the jeweler must take care to ensure that the stone barely touches any surface of the setting. A careless bump can cause damage.

The Denver Necklace (cover and figure 15) is an example of the challenges faced when setting rhodochrosite. The necklace was designed and created by the first author to preserve an unusual suite of gem rhodochrosites for public view. It is now on loan to the Los Angeles County Museum of Natural History. The necklace contains complex and unusually shaped stones, which range from about 1.50 to 14.06 ct, all matched to one another in shape and color. The necklace was designed to mirror the strong shapes and emphasize the rich color of this rare suite of rhodochrosites.

Construction in 20k or 22k gold would have made the setting process possible by more conventional methods, but because of the intricate hinging mechanisms and the additional complication of glass enamel adjacent to every setting junction, we chose the more durable 18k gold. The design called for double-bearing surfaces (i.e., two adjacent surfaces bearing on the stone) at each angle, and even the most painstaking setting methods proved too severe. After several unproductive experiments, and trying also to protect the gems against any possible damage from vibration or thermal shock (as had previously been experienced with specimens), we researched adhesive polymer compounds used by the aerospace industries that (1) maintained long-term elasticity, (2) were good adhesives, (3) had little potential to discolor, and (4) would create a cushion to dampen the effects of both vibration and the differential thermal coefficients of the metal and stone. A polystyrene-based adhesive was selected and chemically modified. Once each stone was fixed in its mounting, we carefully bent the gold over the top.

Care of Rhodochrosite Jewelry. To clean jewelry set with rhodochrosite, soak it in room-temperature soapy water. Rinse the jewelry lightly, rubbing slightly with your fingers, and then dry it with a very soft cloth. Solvents such as methylene chloride or acetone may also be used. Traditional methods, such as the ultrasonic, steamer, buffing wheel, and mechanical cleaning, must never be employed.

SUMMARY

Although massive rhodochrosite is readily available, transparent gem-quality crystals are relatively rare. Such crystals have been found in few localities: Peru, South Africa, and, most notably, Colorado. In recent years, new exploration and extraction techniques at the Sweet Home mine near Alma, Colorado, have greatly increased the number of fine crystals that are recovered each year.

Because of their rarity and attractiveness, most gem-quality rhodochrosite crystals are preserved as specimens and not submitted to the lapidary. Nevertheless, approximately a hundred 0.5+ ct stones a year are cut from crystals that had been damaged or were otherwise inappropriate for specimen use. Because of its cleavage and softness, faceted rhodochrosite is quite fragile and requires special setting techniques. However, it can be set in jewels such as necklaces and pins that are typically not subjected to direct contact with other surfaces. Extreme care must be taken in cleaning and otherwise handling rhodochrosite jewelry. Because of its distinctive gemological properties, rhodochrosite is readily identified from any similar-appearing materials.

Predicting future potential at the Sweet Home mine is difficult. Because gem-quality rhodochrosite occurs in pockets and not in veins, formulas that are generally used for ore mining are not appropriate. While detection methods continue to improve, nature's code may never be broken: There is still a significant probability of discovering yet another unproductive pocket. Since 1992, the mine has had alternating years of success and disappointment; its continued operation is carefully evaluated annually. Ultimately, the future of the Sweet Home mine depends on advances in the methods used for geophysical exploration.

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