June 2004 Mineral of the Month: Rhodochrosite

Take a vote among mineral lovers to determine the most world's most beautiful minerals, and rhodochrosite would no doubt be in the top ten, perhaps even in the top five. What many consider to be the world's finest non-gem mineral specimen is a large rhodochrosite on matrix called the "Alma King" from the Sweet Home Mine, Alma, Colorado.

PHYSICAL PROPERTIES

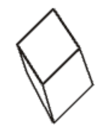

Figure 1 Rhombohedron

Chemistry: $MnCO_3$ Manganese Carbonate Often contains calcium, iron, magnesium, and zinc.
Class: Carbonates Group: Calcite
Crystal System: Hexagonal (Rhombohedral)
Crystal Habits: Well-formed, individual crystals, which are not common, occur most often as rhombohedrons and occasionally as scalenohedrons. Rhodochrosite also occurs as cleavage masses and as compact, granular, botryoidal, and incrusting forms, as well as in massive form in stalactites and stalagmites.
Color: Pure or nearly pure rhodochrosite is always pink or red, ranging from pale and deep pink to orange-red, rose-red and cherry-red. Even when impure or as an intermediate member of a solid-solution series, rhodochrosite usually retains a reddish or pinkish hue, but can also appear gray, brown, white, green, yellow, or nearly black.
Luster: Vitreous
Transparency: Translucent to transparent
Streak: White
Cleavage: Perfect in three directions, forming a rhombohedron.
Fracture: Uneven to subconchoidal, brittle
Hardness: Mohs 3.5-4.0
Specific Gravity: 3.4-3.6
Refractive Index: 1.59-1.81
Luminescence: None
Distinctive Features and Tests: The pink-red color and rhombohedral cleavage are diagnostic. Although sometimes similar in color to rhodonite, rhodonite is much harder at Mohs 5.5-6.5. Rhodochrosite often exhibits a thin, black surface film of pyrolusite (manganese dioxide, MnO_2). Rhodochrosite also effervesces slowly in cold hydrochloric acid and rapidly in warm hydrochloric acid. Differentiating rhodochrosite from pink calcite sometimes requires a fluorescence test. Rhodochrosite is distinctly non-fluorescent, while calcite usually fluoresces brightly.
Dana Classification Number: 14.1.1.4

NAME

Rhodochrosite is correctly pronounced road-oh-CROW-site. The name literally means "rose-colored," a reference to the mineral's characteristic color, and derives from the Greek *rhodon*, or "rose," and *crôma*, "color." Rhodochrosite's attractive color and broad range of forms and varieties have resulted in many names, including "manganese spar" (a name also applied to rhodonite), "Inca rose," "raspberry spar," "dialogite," "strömite," "himbeerspath," and "rothspatch." The cobalt-rich variety of rhodochrosite is known as "cobaltoan rhodochrosite," the iron-rich variety as "ponite" or "manganosiderite," and the calcium-rich variety as "kutnahorite." Tiny rhodochrosite spheroids that sometimes occur with manganese-oxide ores are called "sphaerodialogite." The banded, stalactitic and stalagmitic varieties are known as "rosinca," or "rhodochrosite onyx"; the yellow-gray banded variety is called "capillitite."

COMPOSITION

This month's gorgeous mineral is featured from three localities in Peter Bancroft's excellent book, *Gem & Crystal Treasures*. We are delighted to have specimens from the second of the three mentioned there. In October 1997, we were fortunate enough to secure 150 specimens from the Sweet Home Mine, Alma, Colorado, to send to Deluxe members, and now we have pieces from the region north of Lima, Peru. Perhaps in the future we will come across enough pieces from South Africa to complete the triumvirate!

Rhodochrosite's chemical formula, $MnCO_3$, indicates that it consists of the elements manganese (Mn), carbon (C), and oxygen (O). The total atomic weight of rhodochrosite is made up of 47.79 percent manganese, 10.45 percent carbon, and 41.76 percent oxygen. Within the rhodochrosite molecule, the +2 charge of the manganese cation (Mn^{+2}) balances the -2 charge of the carbonate (CO_3^{-2}) anion.

This month's mineral is classified in the anhydrous carbonate class of minerals, which includes compounds of carbon and oxygen bound together as carbonate anions, which in turn are bound to one or more metals. The term "anhydrous" means that this class of minerals contains no water (H_2O) molecules or hydroxyl (OH^-) ions. Of the approximately 70 anhydrous carbonates, only two, calcite (calcium carbonate, $CaCO_3$) and dolomite (calcium magnesium carbonate, $CaMg[CO_3]_2$), are abundant. Rhodochrosite is a member of the calcite group, along with such other minerals of similar chemistry and structure as magnesite (magnesium carbonate, $MgCO_3$), siderite (iron carbonate, $FeCO_3$), sphaerocobaltite (cobalt carbonate, $CoCO_3$), and smithsonite (zinc carbonate, $ZnCO_3$).

Carbonates, which are the inorganic salts of carbonic acid, generally form in relatively shallow or near-surface conditions when carbon dioxide (CO_2) in the air dissolves in water to form carbonic acid (H_2CO_3), which consists of hydrogen ions (H^+) and bicarbonate ions (HCO_3^-) in solution. Under proper conditions of temperature, pressure, and chemical concentration, metal ions will combine with the bicarbonate ions, freeing hydrogen ions and forming carbonates. The carbonate anions (CO_3^{-2}) are flat, triangular structures held together by strong covalent bonds with shared electrons. Within the rhodochrosite crystal lattice, the negatively charged carbonate ions are ionically bound to the positively charged manganese ions. This creates rows of alternating manganese and carbonate units, with each manganese atom surrounded by six oxygen atoms. Rhodochrosite's three planes of perfect cleavage occur along the planes of weak ionic bonding.

To visualize the rhodochrosite lattice, picture a cube that has been distorted into the shape of a rhombohedron. (See Figure 1.) This rhombohedral structure explains the shape of the rhodochrosite crystal and why its three planes of perfect cleavage never intersect at 90˚. The properties of the carbonate units prevent rhodochrosite from having a perfect cubic symmetry. The axes of the carbonate units can align with only one of the three axes of a cube, while the wide spacing of the carbonate units stretches the atomic planes to distort the lattice shape into a rhombohedron.

Rhodochrosite, while itself a relatively rare mineral, is a common constituent in small quantities in hypothermal, mesothermal, and epithermal (high-, medium-, and low-temperature) veins in association with such minerals as chalcopyrite (copper iron sulfide, $CuFeS_2$), galena (lead sulfide, PbS), sphalerite (zinc sulfide, ZnS); and with bornite (copper iron sulfide, Cu_5FeS_4), tetrahedrite (copper iron antimony sulfide $[Cu,Fe]_{12}As_{14}S_3$), and sphalerite in massive hydrothermal replacement deposits, most of which have been at least partially altered by the action of hot water and carbonic acid. Rhodochrosite also

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occurs in manganese-rich sedimentary deposits of marine origin in association with pyrolusite (manganese dioxide, MnO_2).

Rhodochrosite participates in a number of either partial or complete solid-solution series. It forms complete solid-solution series with the minerals siderite (iron carbonate, $FeCO_3$) and calcite (calcium carbonate, $CaCO_3$). Chemically related minerals can form solid-solution series through cationic or anionic substitution. Both the rhodochrosite-siderite series and the rhodochrosite-calcite series involve cationic substitution, meaning that iron cations and calcium cations substitute for manganese cations and vice versa. This results in graded series with the end members being pure (or nearly so) rhodochrosite and siderite, or rhodochrosite and calcite. The intermediate stages of the rhodochrosite-siderite series have the general formulas $(Mn,Fe)CO_3$ or $(Fe,Mn)CO_3$, while the intermediate stages of the rhodochrosite-calcite series have the formulas $(Mn,Ca)CO_3$ or $(Ca,Mn)CO_3$, depending upon the degrees of substitution. All members of the calcite group form at least partial solid-solution series with other members.

As an idiochromatic, or self-colored, mineral, rhodochrosite's basic red color is due to its inherent chemical and physical makeup, specifically the essential presence of manganese. Manganese creates a unique spacing within the crystal lattice which, when struck by white light, absorbs, or "traps," the blue spectral wavelengths, while reflecting or transmitting the red spectral wavelengths. The color variations in rhodochrosite can be caused by impurities, by the formation of solid-state solutions with other cations, or by a combination of the two.

COLLECTING LOCALITIES

Although rhodochrosite is relatively rare, it is also a gangue mineral common in hydrothermal veins of silver, copper, lead, and zinc ore minerals. Thanks to mining efforts, fine rhodochrosite specimens have been collected from a surprisingly large number of localities. Deep red, transparent crystals have come from Kuraman and Hotazel manganese deposits in South Africa. Fine crystals have been found at Kapnic (the type locality for rhodochrosite) and Nagyag, Romania; and from the Wolf Mine in Siegerland and several mines at Beiersdorf, Germany. In South America, Argentina's old silver mines at Catamarca are famed for their banded rhodochrosite stalagmites and stalactites– these were what we sent to Junior Club members back in October 1997. Peru has supplied fine, nicely colored rhodochrosite scalenohedrons from the Huallapon and Pachapaqui mines, Ancash Department; the Huaron Mine, Cerro de Pasco Department; and the Uchucchacua Mine in the Lima Department, where ours originated. In Mexico, rhodochrosite has been collected at mines in Magdalena and Cananea, Sonora.

The United States has produced many superb specimens of rhodochrosite. Large pink crystals and aggregates have been found in mines at Butte and Philipsburg, Montana. Rhodochrosite occurs with manganese-oxide minerals at Batesville, Arkansas, and at Poland, Maine. But the best American rhodochrosite source, in both quantity and quality, is Colorado. Fine specimens have been collected at the American Tunnel in the Silverton Mining District, San Juan County; the Mary Murphy Mine near St. Elmo, Chaffee County; the Leadville Mining District and the Climax Mine in Lake County; and the Eagle Mine at Gilman in Eagle County. Without question, the world's most spectacular rhodochrosite crystals have come from the Sweet Home Mine near Alma in Park County, Colorado.

JEWELRY & DECORATIVE USES

Transparent, deeply colored crystals of rhodochrosite can be faceted into stunning gems, but due to its relative softness (Mohs 3.5-4.0), such gems are not suitable for mounting in jewelry. Faceted rhodochrosite "collectors' gems," however, are quite popular for display purposes. Rhodochrosite collectors' gems range in size from 5 to as many as 50 carats. The largest on record is from Kuruman, South Africa, and weighs 59.65 carats. We have had the privilege to view many faceted rhodochrosite, and they are quite breathtaking! Transparent rhodochrosite crystals, sometimes cleaved into classic "rhomb" shapes, are sold in "cage" or "wrap" mounts for use as pendants. Cheryl has set several crystals in this fashion, and wears one that is watermelon-colored, that we obtained when visiting the mine in 1997.

Massive rhodochrosite, such as banded stalactitic and stalagmitic forms, are fashioned into cabochons and beads for jewelry use, as well as animal figures, eggs, spheres, boxes and other beautiful forms. It is also used in intarsias, inlay, and dioramas to supply an intensely pink color. Such pieces can be extraordinary and valuable. This material comes mainly from San Luis, Argentina, and is sometimes called "Inca Rose," because the Incas worked the deposits centuries ago.

Rhodochrosite, both as intensely colored transparent crystals and crystals on matrix, is among the most sought after of all mineral specimens among museums and collectors.

HISTORY & LORE

Rhodochrosite has been known since antiquity, but its composition remained a mystery until 1813, when German mineralogist Johann Friedrich Ludwig Hausmann (1782-1859) formally identified its components and listed it as a separate mineral species based on study of specimens collected from the type locality at Kapnic, Romania. Because of its striking color, rhodochrosite has always been an eminently collectible mineral. In the 1870s and 1880s, before mineral collecting had even become popular in the United States, miners in western silver and base-metal mines collected rhodochrosite specimens for trade. Rhodochrosite was one of the first ore minerals valued solely for aesthetic reasons.

In testimony to the specimen value of rhodochrosite, commercial specimen miners reopened Colorado's 132-year-old Sweet Home silver mine in the early 1990s specifically to recover rhodochrosite crystals for the collectors' market. In 2002, the Colorado General Assembly honored the superb Sweet Home specimens by formally designated rhodochrosite as the official state mineral. Rhodochrosite has appeared on the United States' 10-cent stamp of 1974 and on Central Africa's 600-franc stamp of 1998.

According to modern metaphysical belief, rhodochrosite aids in achieving spiritual and emotional balance. It discourages avoidance and denial and makes its wearer receptive to new knowledge and experiences. Those who are drawn to rhodochrosite are thought to be ready to learn more about their personal spirituality.

TECHNOLOGICAL USES

Rhodochrosite found in hydrothermal veins of silver and base-metal ores has traditionally been considered as gangue (waste rock). Rhodochrosite that was not set aside as specimens was either discarded as mine waste or lost in the milling process. But when present in altered ore deposits of manganese oxides of sedimentary origin, rhodochrosite has served as a minor ore of manganese, with pyrolusite being the primary ore.

The element manganese was first isolated by in 1774 Swedish chemist Carl William Scheele (1742-1786), the discoverer of several elements, in whose honor the mineral named scheelite is named. Native manganese is a silver-white, brittle metal, found in its free state only in meteorites. Combined with other elements to form minerals, it ranks about twelfth in abundance among elements in the earth's crust, making up about 1/10 of 1% of the crust.

About 90 percent of all manganese mined today is used as sulfur-fixing and deoxidizing fluxes or as an alloying agent in the manufacture of steel. Extremely tough and durable, manganese-steel alloys are well-suited for use in steel products designed to endure high stresses, such as those used in making safes. Lesser amounts of manganese are alloyed with other metals such as aluminum, copper, tin, and zinc to create corrosion-resistant, specialized alloys or to improve metal workability. As an example, modern aluminum beverage cans are made of an aluminum-manganese alloy, in which the manganese enhances the extrusion properties of the aluminum. Other uses for manganese and its compounds include the manufacture of dry-cell batteries, inks, varnishes, dyes, chemical oxidizers, colorants for ceramics, fertilizers, and pharmaceuticals. Annual worldwide mine production of manganese metal is now about eight million metric tons per year. The top producers, in order, are China, South Africa, Ukraine, and Brazil. With no domestic manganese-mining industry, the United States must import all of the half-million tons of manganese it uses each year. The current price of refined manganese metal ready for alloy use is about 55 cents per pound.

ABOUT OUR SPECIMENS

The Peruvian mines mentioned under *Collecting Localities* as being famous for their fine rhodochrosite specimens all lie in an area north of Lima, the capital of Peru. This is the same area where our October 2003 pyrite specimens originated, the mountainous region where the Amazon River begins its long trek to the Atlantic Ocean. Mines producing copper, silver, lead, and zinc are located here, many at altitudes well over a mile high.

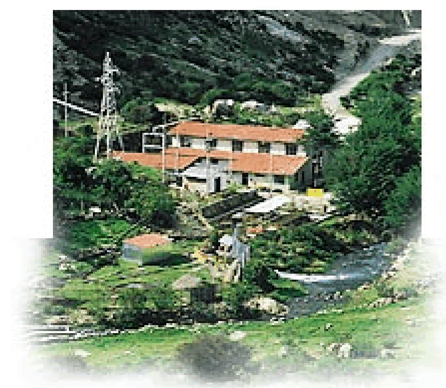

Figure 2
Ucchucchacua, Lima Department, Peru

Our wonderful specimens come from the Uchucchacua Mine, pronounced, as near as we can get to it, oo-choo-CHAK-wa. It is primarily a silver mine, producing about 16 ounces of silver per ton of rock mined, making it the third largest silver producer in Peru, at about three million ounces per year. Smaller but significant amounts of lead and zinc are also recovered here.

Geologists have divided the mineral formation here into three stages, with the metals manganese and iron introduced in Stage I, that of skarn formation (skarn is defined as rocks composed mainly of lime-bearing silicates, derived from nearly pure limestones and dolomites into which large amounts of silicon, aluminum, iron, and manganese have been introduced); in Stage II, the metals zinc, lead, iron, copper, boron, and manganese were introduced, as the main orebody mineralization occurred; and in Stage III, more metals were emplaced, including silver, arsenic, antimony, manganese, zinc, lead, and iron. As you may have noticed, manganese was emplaced during all three stages, so a number of minerals containing it are found here, including benavidesite [$Pb_4(Mn,Fe)Sb_6S_{14}$], bustamite [$(Mn^{2+},Ca)_3Si_3O_9$], friedelite [$Mn^{2+}{}_8Si_6O_{15}(OH,Cl)_{10}$], johannsenite [$CaMn^{2+}Si_2O_6$], manganaxinite [$Ca_2Mn^{2+}Al_2BSi_4O_{15}(OH)$], manganpyrosmalite [$(Mn^{2+}Fe^{2+})_8Si_6O_{15}(OH,Cl)_{10}$], manganoan calcite [$CaCO_3$], rhodonite [$(Mn^{2+},Fe^{2+},Mg,Ca)SiO_3$], and of course, rhodochrosite. The rare silver-lead-manganese antimony sulfide mineral aptly named uchucchacuaite [$AgPb_3MnSb_5S_{12}$] was discovered here in the 1980's. In addition, collector-quality specimens of acanthite, fluorite, kutnohorite, pyrrhotite, proustite, pyrargyrite, pyrite, and

Figure 3 Tunnel at Uchucchacua

native silver, are found at Uchucchacua. The rare silver form called "bird's-nest" is found here, so exceptional as to command extremely high prices. One was featured in the Connoisseur's Choice column in Rocks & Minerals magazine in January-February 2003.

In fact, the mineral magazines regularly remark on exceptional specimens from Uchucchaqua, such as the May-June 1991 Mineralogical Record, which call them "excellent, deep red, partially gemmy, scalenohedral crystals" in its "What's New in Minerals." The May-June 1999 issue contains a photo of a gorgeous gemmy rhodochrosite group with wire silver above it, and perched on top, a perfect little doubly terminated rhodochrosite crystal! And the report on new finds at the Denver Show 2000 in the January-February 2001 MR mentions that "a few lovely thumbnails from this locality bristle with thin, spiky scalenohedrons of rhodochrosite all over black matrix, the crystals brilliantly lustrous, rose-pink, and totally gemmy." The book *Rare and Beautiful Minerals* has on its cover a lovely rhodochrosite and quartz specimen from Romania, while the book *Minerals* by George Robinson sports a lovely banded rose-red slice of Argentinian rhodochrosite among the photos on its cover.

The aforementioned "Alma King" rhodochrosite from the Sweet Home Mine is now on permanent display in the Denver Museum of Nature and Science. It consists of a large, perfect, five inch plus crystal of rhodochrosite perfectly perched on a bed of needle quartz crystals, with a smaller rhodochrosite crystal sitting off to its side. The extraction of this magnificent piece was recorded on video, and plays continuously at the museum. Also on display is a crystal-lined wall from the mine, carefully removed, cleaned, and reconstructed on a steel frame. Definitely a museum to visit when in Denver!

Perhaps the day will come when we find sufficient pieces from South Africa in order to feature this gorgeous mineral from the third of its three most famous localities– or better yet, to go out and personally collect some! In the meantime, how happy we are add these wonderful specimens to our collections! We hope you feel the same way.

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