# Western Cave Conservancy

## Protecting the West's Last Frontier

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### The Green Spot

By Bruce Rogers

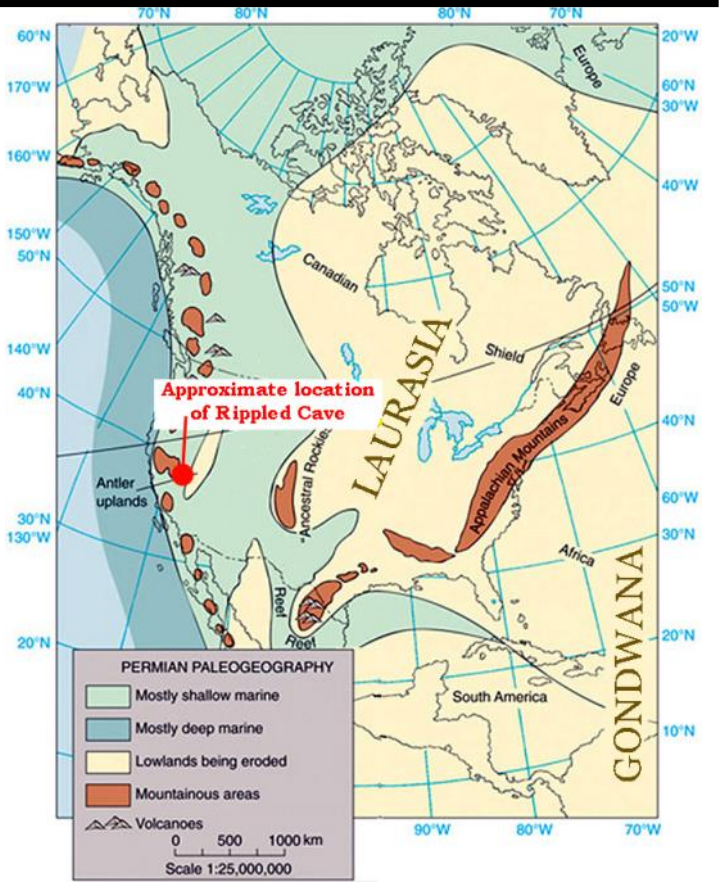
Unlike the Black Spot, a prominent element indicating a verdict of guilty featured in Robert Louis Stevenson's 1881 novel *Treasure Island*, Rippled Cave's spot is rich green. Tucked away on the wall adjacent to the archway between The Big Room and The Little Big Room in the cave is a very obscure, but interesting feature.

Among the rusty-colored, thin fins of quartz and small buttons of white gypsum, themselves of interest, is a small, rusty brown-colored bleb of iron oxide. Most probably made of the mineral goethite (a mineral we most often call "rust"), the BB-sized mass is surrounded by an intense green halo. This halo is a thin film of the copper mineral malachite. Composed of hydrous copper carbonate, its chemical formula is $Cu_2CO_3(OH)_2$.

Long ago and, most likely far away, a shallow tropical sea then off the western side of Laurasia (the central, western part of the super continent Gondwana) allowed enormous numbers of marine animals to build calcareous shells during their short lives and then die. This happened during the Permian Period, a time just before the start of the Age of Reptiles some 260 million years ago. The shells, or tests, then fell to the seabed, became compacted, and partly altered with the addition of magnesium precipitated from the warm seawater to form dolomitic limestone. Much later these limestone beds were whisked away, squeezed, bent, and finally ploughed up against the western shore of the nascent North American continent.

In the meantime, the remnants of the limestone and dolomite were swallowed up by rising masses of granitic rock. Those and other rocks of the old seabed were stuffed down into the crust,

Rippled Cave lies in a small lens of limestone, now metamorphosed to marble, that was deposited along the western edge of North America nearly a quarter-billion years ago during the Permian Period.




## IN THIS ISSUE

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*Editor* Mark Bowers



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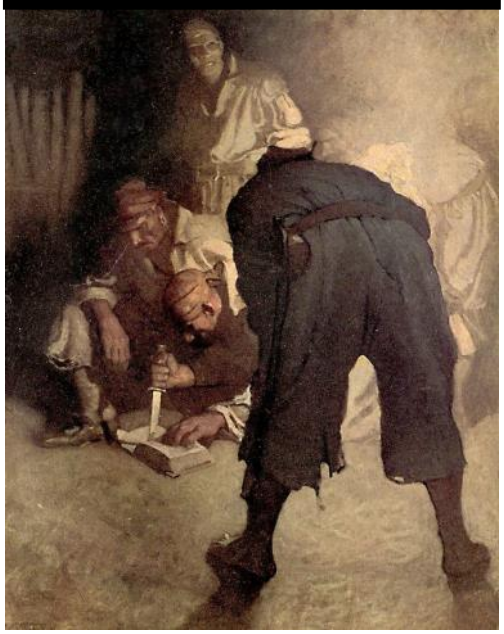
During the heyday of Caribbean piracy in the 1700's, pirates used a black spot crudely drawn on a Bible page to indicate a fellow pirate's days were numbered for some infraction of their informal rules. This illustration was made in 1911 by famous illustrator N.C. Wyeth for Robert Louis Stevenson's *Treasure Island*, 1911.



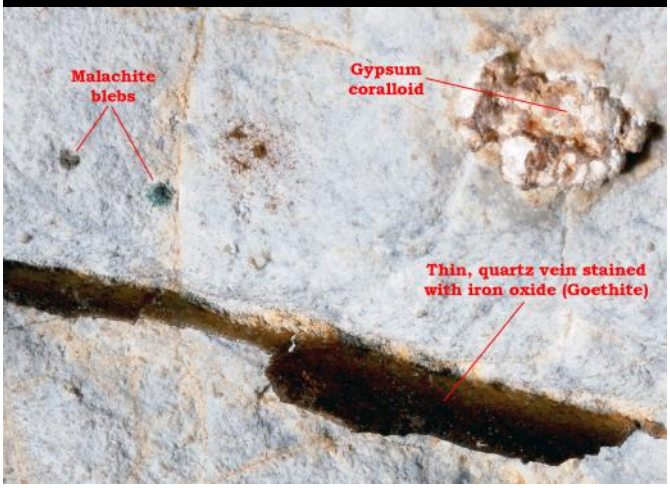
melted, and then rose as molten masses of granitic rock. The Sierra Nevada is made of these rocks and date to the Jurassic and Cretaceous Periods some 140 to 65 million years ago, the Age of Dinosaurs.

At about the same time, a huge slab of ocean floor now called the Farallon Plate was stuffed under North America. Unlike a "normal" plate, it refused to behave as one might expect it to and be pushed down (subducted) into the crust where it would melt and eventually become more continental granitic rocks. Instead, it ploughed east to about the western border of Colorado, partly peeling off the roots of the old continent as it went. In response, the North American crust stretched upwards to form the Great Basin and Rocky Mountains.

Time passed.

Most of the ancestral Sierra Nevada, some 10,000 feet high, was eroded away to fill California's Great Valley, leaving only scraps of the limestone and dolomite, now metamorphosed into marble, surrounded by a literal sea of granitic rock. These rocks then deeply weathered and were mostly swept away by the major rivers coursing down the Sierran slopes. A period of volcanism followed between about 20 and 5 million years ago, spewing lava and volcanic debris flows across the subdued Sierran landscape. During the past 2 million years or so, glaciers ground away the high Sierra and scoured the lower mountains to form deep canyons such as the Mokelumne River. The smaller feeder streams such as Sutter Creek also deepened their canyons, leaving remnants of much younger volcanic debris flows, now called the Mehrten Formation, as ridge top "islands" of

This photo shows the twin green spots (center left), a gypsum button (upper right), and a thin quartz vein coated with the iron oxide mineral goethite. The green spots are about 1/8-inch in diameter and one of only a few known malachite speleothems known in the US. 2015 photo by Mike Davies.



Malachite has a lovely green color and interesting fibrous structure in many mineral specimens. This material is part of a gold vermeil necklace shown with a malachite mineral specimen made by a real geologist/gemologist. 2016 photo by J. Fenton (she who assisted me in finding the Ice Age fossils in Sink Cave in 1996).

hard rock. Gopher Ridge Road east of Sutter Creek follows the edge of one of these flows.

The rain seasonally pelted down onto the landscape, adsorbed carbon dioxide from soil bacteria, and slowly dissolved the marble into the caves we now explore. Once inside the cave, the water also attacked any soluble minerals within the marble itself. One of these minerals was an easily altered compound of iron, copper, and sulfur called chalcopyrite, $CuFeS_2$. This suite of minerals and their weathering products can also be seen in Crystal Palace and in Lilburn cave. The extremely reactive oxygen in calcium carbonate stripped the iron from the chalcopyrite to form the iron oxide mineral goethite (also known as rust). The sulfur combined with calcium for the marble to form hydrous calcium sulfate or gypsum. The copper ions then combined with the stray carbonate molecules to form malachite.

In Rippled Cave, Mike Davies of the SFBC took several random photos for me of small, but interesting, deposits in November of 2015. Upon viewing them, I immediately saw the green halo surrounding the gypsum bud. While the malachite is a small halo about a quarter-inch in diameter surrounding the white-colored gypsum coralloid, the color is a pale, but unmistakable, green. While none of the malachite is outstanding in size or beauty, it is one of only three localities known in California and one of six localities in the US. In Lilburn Cave in Sequoia-Kings Canyon National Parks it forms stalactites, crusts, angel hair, microhelictites, and coralloids, and it partly colors calcite and aragonite flowstone. These deposits are considered some of the best displays of malachite in the world. In Malachite Arch in Sunol Regional Park east of Fremont, there is a small sheet of pale greenish-blue calcite flowstone tinted by malachite. In Lilburn and Malachite Arch the source for the malachite is, as in Rippled Cave, chalcopyrite.

Malachite is colored a very vivid green. Its name comes from the ancient Greek Molochites, or "the color of the mallow plant leaves." Initially it was mined as a gemstone and as ornamental stone; only later did early blacksmiths, metallurgists, and alchemists realize it could be smelted to make copper. This mineral was also used for eye shadow such as that used by Cleopatra nearly 5,000 years ago and as high-end art paint pigment. The Pharaohs lined their crowns with malachite, thinking it promoted clear vision and wise thinking. Also in the Near East, malachite was mined and smelted into copper in the Timoa Valley in Israel since about 3,000 years ago. Indeed, Michelangelo's deep azure blue sky in the Sistine Chapel and other paintings is ground up azurite while some of the green

Chalcopyrite, composed of copper, iron sulfate, has a bronzy luster. When weathered, it releases the iron (that usually forms the iron oxide mineral goethite or "rust"); the copper (which usually forms malachite or azurite); and sulfate (which usually combines with the calcium of the marble to form gypsum). This chalcopyrite formed off the Washington coast several tens of millions of years ago. This eight-inch-long specimen was collected during the RS Alvin deep-sea submersible dive in 1978, and now resides in my collection courtesy of Randi Koski, USGS

trees were painted with powdered malachite pigment. Malachite and azurite have been used as carvings such as the extensive Russian Czarist room paneling and as jewelry and sculpture, but because the mineral is relatively soft, care much be taken not to scratch it.

The mineral's metaphysical and spiritual uses are legion and it is associated with the Egyptian goddesses Hathor (Joy and Fertility) and Isis (Life) as well as the Greek goddess Persephone, all associated with spring and new beginnings. Those born under the sign of Taurus may benefit from its zodiacal power by being down to earth in their view of life; the practical ones. Malachite is also reputed to align with the Feng Shui associations of beneficial eating spaces and vitality. Its other supposed values include protection from the Evil Eye; assuaging fear of flying; promoting health; and aiding in healing cold sweats, malaria, epilepsy, tumors, broken bones, trembling, kidney stones, torn muscles, gall stones, "women's problems," rheumatic pain, spinal osteoarthritis, psychological depression, memory loss, gaining physical strength, and assists gaining insights from the subconscious and finding one's place in the Universe. Indeed, some say that wearing amulets carved with St. Francis of Assisi images may enable mere mortals to understand and even talk to animals. It may also assist in lining the pockets of charlatans with gold coin for espousing such wonders.

In most deposits the banded patterns of coralloid or "reniform" masses are unique and mesmerizing, looking like deep green masses of cauliflower or kidneys (indeed, "reniform" means kidney-like in shape). The mineral often forms excellent small crystals as well as coralloids, flowstone, and stubby stalactites. Many metal ore deposits are marked with thin films of malachite and its deep blue-colored first cousin, azurite (hydrous copper double carbonate). Huge deposits of malachite are present in southern Arizona surrounding the town of Bisbee and decorate large deep limestone caves accidentally opened within the mines. Other major malachite deposits are found in The Congo, Tsumeb, and Namibia in Africa; the Ural Mountains in Russia; near Lyon, France; and Broken Hill, New South Wales in Australia. In Amador County, malachite and azurite were both part of the ore and accessory or "gangue" minerals found at Copper Hill/Tiger copper-gold-zinc-silver mine a few miles northwest of Drytown and Sutter Creek. In that mine, chalcopyrite was also one of the ore minerals.

So once again, Rippled Cave has shown us a miniature edition of mineral development little known to many visitors.

Several excellent, if weighty, references for your inquisitive minds include:

Gaines, R.V., H.C. Skinner, E.E. Ford, B. Mason, A. Rosenzwig, V.T. Kingand E. Dowty, 1997, Dana's New Mineralogy, 8th ed.: New York, John Wiley & Sons, 1,819 p.

Hill, C., and Forti, P., 1997, Cave minerals of the world, 2nd ed.: Huntsville, AL, National Speleological Society, 463 p.

Hurlbut, Cornelius S., and Cornelius Klein, 1985, Manual of Mineralogy, 20th ed.: New York, John Wiley & Sons, 596 p.

Pemberton, H.E., 1983, Minerals of California: New York, Van Nostrad Reinhold, 591 p.

## The Gating of Cave of the Catacombs and Sink Cave in California

By Chuck Chavdarian

In September of 2015, WCC signed a lease for our second Mountain Ranch cave, Sink Cave, located about 200 yards from Cave of the Catacombs, which was leased in January of 2015. Now having both caves under lease, the next task was obtaining a quotation from Tom Gilleland of MineGates, Arizona, for the professional installation of four gates for the two caves. With gates installed on these caves, the WCC could better protect and manage the caves, and still allow controlled access to the caves for responsible cavers and researchers.

Early in 2016 we obtained the final quotation from

COTC -Skylight Gate - Photo by C. Chavdarian

Tom for the gating of Cave of the Catacombs and ink Cave. After unanimous approval by the WCC Directors, we scheduled the installation of the gates for Tuesday-Thursday, April 12 – 14.

Bruce Rogers and I planned to meet Tom and Bruce, from MineGates, at the cave property on April 12.

**COTC - Main Gate** - Photo by C. Chavdarian

We were surprised to hear from Tom that they would be arriving late that day. The unfortunate reason was that they had some of their equipment stolen while staying overnight in Merced. Fortunately, after finding and purchasing replacement equipment, Tom and Bruce arrived in Mountain Ranch in the late afternoon. As a result, it appeared that they would require an extra day (April 15) on-site to complete the work. Bruce Rogers was only able to be there on Tuesday due to other commitments, but I remained for three days and assisted Tom and Bruce with their work, and also took the opportunity to take photos and videos of the installations.

Three gates were planned for Cave of the Catacombs, and one gate for Sink Cave. The gates were initially constructed at the MineGates facility in Arizona, and then modified and installed, with additional side-bars, on-site.

On Tuesday evening, we took the pre-fashioned gate (for the skylight) and necessary equipment to the top of Cave of the Catacombs, in preparation for the installation the next day. On Wednesday morning, the gate for the slotted skylight above Cave of the Catacombs was installed. There was extensive welding involved to construct the vertical side bars for the gate. Following the welding and drilling, the gate was secured in place. On Wednesday afternoon, installation began on the large, locking steel gate for the main entrance to Cave of the Catacombs. After the heavy lifting was completed - by carrying the very heavy, swinging steel door to the entrance and then positioning it – the steel side-bars were cut to size with the electric saw and then welded to the door frame. Finally, the side-bars were secured to the rock walls of the cave entrance, following drilling and the pounding in of steel pins. The side bars were installed to the left, right, and top side of the steel door frame. By Wednesday evening, the installation of the gate on the main entrance was completed, and the door was locked. The third gate – for the historical entrance to Cave of the Catacombs – was postponed until after the gate to Sink Cave was installed.

On Thursday, we took the equipment and the other pre-built heavy, swinging steel door to Sink Cave. It was quite a challenge bringing all the equipment and the large, locking steel door to, or near, the main entrance, as we had to also negotiate carefully over the karst terrain. After running the electrical cabling from the gasoline generator to the entrance, the work began. As with the gate on Cave of the Catacombs, this Sink Cave gate was also carried by us into place, measurements taken to cut the steel side-bars to size, and then

**MineGates Personnel - Tom and Bruce**

Photo by C. Chavdarian

the bars were sequentially welded to the door frame. The bars were next secured to the walls of the entrance in the same fashion as was done for the other cave. The gating of Sink Cave was completed by Thursday evening, and the door was locked.

On Friday morning, the gate for the historical entrance to Cave of the Catacombs was installed. The entrance is a small crawl-through passage. The gate was installed with a removable, locking steel bar. Once the bar is unlocked and removed, a caver has ample space to crawl through. At the end of Friday morning, all work was completed by MineGates.

It should be noted that all the gates are bat-friendly.

We thank Tom and Bruce of MineGates for their hard work, and the professional design, manufacture, and installation of the locking steel gates on Cave of the Catacombs and Sink Cave.

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**COTC - Main Gate Finished**

Photo by C. Chavdarian


**WCC in Ely**

The WCC has been actively working multiple projects over the past few years, including multiple cave management, gating, landowner relations, and other work to help protect all of our caves. Please take time to visit us at the convention and support us with your donations or time and help. We have free popcorn, various accessories to sell to help the cave conservation cause. We would like to share our progress with you. If you won't be at the convention you can visit us at www.westerncaves.org. We gladly accept donations online or in person.

As the public relations director and acting newsletter editor, I would personally appreciate anyone who would be willing and able to act as the newsletter editor.

**Sink Cave** - Photo by C. Chavdarian