Spring 2014

Hardystonite From the Desert View Mine, California

James A. Van Fleet
Bucknell University, vanfleet@bucknell.edu

Earl R. Verbeek
Sterling Hill Mining Museum

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EARL R. VERBEEK, PhD
RESIDENT GEOLOGIST, STERLING HILL MINING MUSEUM
30 PLANT STREET, OGDENSBURG, NJ 07439
everbeek@ptd.net

JAMES VAN FLEET
222 MARKET STREET
MIFFLINBURG, PA 17844
vanfleet@bucknell.edu

INTRODUCTION

In late December of 2012, Kevin Brady, an accomplished and knowledgeable field collector of minerals, sent to one of us (ERV) a specimen of an unknown mineral that he noted fluoresced deep violet under shortwave (SW) ultraviolet light and thus resembled hardystonite. Inasmuch as the locality for this specimen—the Desert View Mine, in California—has also produced several other minerals common at Franklin, N.J., but rare elsewhere, Mr. Brady's hopeful guess as to the mineral's identity had merit. Repeated X-ray scans and chemical analysis proved him correct. Hardystonite is thus removed from the list of minerals unique to Franklin.

LOCALITY DESCRIPTION

The Desert View Mine is in the San Bernardino Mountains of California, about 3 miles (5 km) northwest of the town of Fawnskin. Specimens from the locality often are labeled "Holcomb Valley" after the valley that drains the area about 1.25 miles (2 km) south of the mine site. The small mineral deposit exposed at the Desert View Mine site is hosted by Paleozoic marble that formed as Mesozoic granodiorites intruded the region and thermally metamorphosed the original sedimentary carbonate rocks (Miller et al., 2001). As described by Leavens and Patton (2008), the marble is part of a small roof pendant* only a few hundred yards across, both underlain and surrounded by granodiorite. The mine itself is a small one, consisting of an adit about 50 feet (15 m) long, small dumps, and minor surface workings.

The Desert View Mine has for years been popular among collectors of fluorescent minerals and has produced attractive specimens of willemite (fl. green), calcite (fl. red), and wollastonite (fl. yellow). In addition to these three minerals, franklinite, zincite, and hetaerolite also occur at the Desert View Mine and further strengthen its mineralogical similarities to Franklin. Although much of the original geology has been obliterated by intrusion of the granodiorite, Leavens and Patton (2008) provided mineralogical and geochemical evidence that the Desert View deposit, like that at Franklin, is exhalative, and that it is genetically intermediate between the Franklin-Sterling Hill deposits and those at Långban, Sweden.

SPECIMEN DESCRIPTION

The specimen sent to us for analysis is fine-grained, dark, and sawn on three sides (Fig. 1). Mr. Brady indicated that it is a trim piece from a much larger mass, collected many years ago, that was being prepared for grinding into a sphere. Visually the specimen is divisible into three parts: (1) a medium-gray mass of calcite (average grain size about 1 mm) and subordinate willemite, both obvious from their fluorescence; (2) a nearly black mass whose mineralogic composition is not visually evident owing to fine grain size; and (3) an irregular, dark brown contact zone between these two. The hardystonite (Fig. 2) occurs within the contact zone and appears on both a naturally broken and sawn surface of the specimen; on both surfaces it forms an elongated bleb about 0.7″ (2 cm) long and 0.2″ (0.5 cm) thick. Willemite in the calcite mass is concentrated near the contact zone. Both calcite and willemite occur in the black material as well, but only sparingly; within this material the fluorescence of the calcite is much subdued. Tiny (submillimeter) grains of native copper are evident in the black material upon magnification. Among the black minerals known from this deposit—including franklinite, magnetite, hetaerolite, and hematite—magnetite was eliminated from consideration because the specimen showed no perceptible magnetism even when tested with a powerful neodymium magnet.

* A roof pendant is a large mass of rock that sagged into the upper part of an intrusive body of igneous rock. Roof pendants are, in effect, gigantic xenoliths but are not wholly enclosed by the igneous magma that intruded them.

Figure 1. The Desert View Mine hardystonite specimen, showing the gray calcite layer (right) and the black oxide layer (left). The hardystonite bleb is along the contact zone, near the top-center of the specimen as photographed. The visible surface is sawn; specimen measures 2¾″ × 2¼″ × 1½″ (7 × 5.5 × 4 cm). *Earl R. Verbeek photo.*

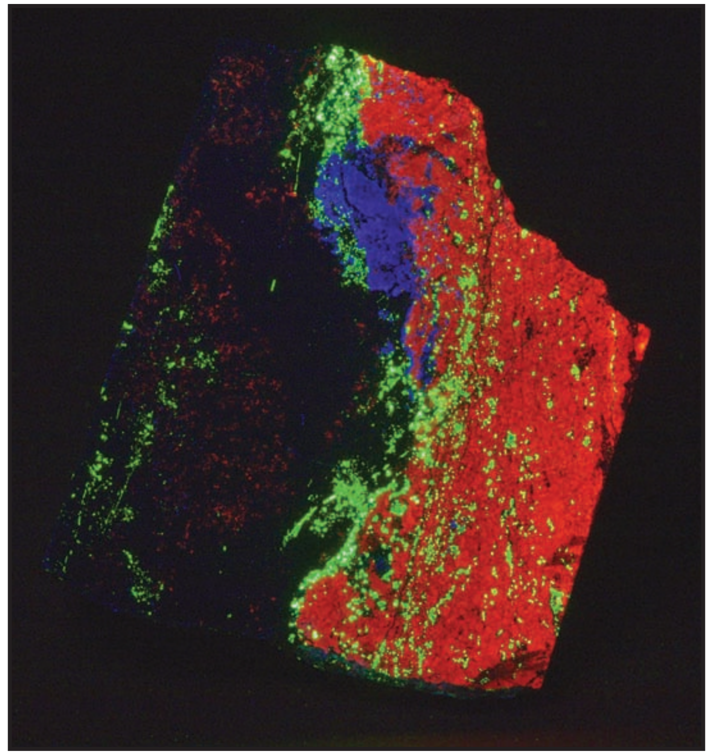

Figure 2. Same specimen as in Figure 1, here viewed under shortwave ultraviolet light. As at Franklin, hardystonite fluoresces violet, willemite green, and calcite red. *Earl R. Verbeek photo.*

ANALYTICAL RESULTS

A thin slab was sawn from the original specimen to facilitate extraction of samples for X-ray diffraction analysis. The instrument used was a Philips (now PANalytical) X'Pert Pro MPD powder diffractometer with a Cu K-alpha radiation source. X-ray settings were 45 kV and 40 mA. The analysis software used was X'Pert Highscore, which matches the resulting diffraction peaks to mineral IDs in an internal library.

The first sample run, a crushed powder derived from the hardystonite area and purified of other minerals as much as possible by sorting with a needle under a microscope, gave an initial X-ray scan strongly indicative of hardystonite. Because hardystonite was unknown from any locality on Earth other than Franklin, a much more careful scan (19 hours at very low scan speed) was run on this same material to strengthen and sharpen the X-ray peaks. Calcite had been removed from this sample by dissolution in dilute hydrochloric acid. The results again indicated hardystonite to a high degree of confidence; every major peak of the reference pattern for that mineral (00-012-0453) was matched in the measured scan. A third scan of equal duration yielded the same results.

Although the X-ray data already identified the violet-fluorescing mineral as hardystonite to a high degree of certainty, we nevertheless wished to acquire chemical data as an additional check on the results because a related mineral, akermanite, has a similar X-ray pattern. Hardystonite, $Ca_2Zn(Si_2O_7)$, and akermanite, $Ca_2Mg(Si_2O_7)$, are both members of the melilite group and have nearly identical unit cell parameters. Moreover, akermanite is known as a product of contact metamorphism of dolomitic rocks, which matches both the geologic setting of the Desert View Mine (in a roof pendant of a batholith) and the magnesium-rich character of the original host rock (the Bonanza King dolomite). The presence of akermanite in the Desert View deposit would thus hardly be surprising. To test this possibility, we submitted fragments of the violet-fluorescing mineral for energy-dispersive spectrometry. The results were gratifying: The analysis revealed calcium, zinc, and silicon as major components of the mineral but showed no detectable magnesium. The violet-fluorescing mineral is thus conclusively identified as hardystonite.

Additional samples were obtained from different portions of the sawn slab to identify other minerals present. Calcite and willemite, both evident from their fluorescence, were confirmed by X-ray diffraction from the gray area. Samples from the black material could not be separated into their component minerals due to the fine grain size of the minerals and their nonmagnetic character, but franklinite was confirmed near the contact zone, while hetaerolite appeared to be the dominant oxide mineral more distant from the contact. Additionally, the "leftover" peaks not assigned to hardystonite or franklinite in the slow X-ray scans best fit vesuvianite, which also has been reported from the Desert View locality (Leavens and Patton, 2008). Taken together, these results indicate a transition from (1) a calcium carbonate layer becoming progressively rich in zinc toward the contact zone as indicated by increasing content of willemite, to (2) an intermediate oxide-silicate layer rich in zinc and iron, but depleted in carbonate, to (3) an oxide layer rich in zinc and manganese. Visual examination also revealed the presence of native copper in this layer. The copper, like the hardystonite, is newly reported from the locality.

CONCLUSIONS

To the list of minerals common to the Desert View Mine in California and the Franklin Mine in New Jersey, we here add two more: hardystonite and native copper. Both species, the hardystonite especially, strengthen the notion advocated by Leavens and Patton (2008) that the Desert View deposit, like that at Franklin, is exhalative in origin. The discovery of hardystonite at the Desert View Mine removes that species from the list of minerals unique to the Franklin-Sterling Hill area—a distinction that hardystonite held for 115 years.

ACKNOWLEDGEMENTS

We are grateful to Kevin Brady for bringing the hardystonite specimen to our attention, and for subsequently donating it to the Sterling Hill Mining Museum for its reference collection. We also thank Lance Kearns of James Madison University for the EDS analysis that confirmed the unknown as hardystonite, Brad Jordan of Bucknell University for his assistance with the X-ray work, and Mark Boyer for his review of the original manuscript.

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