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Yellow-fluorescing calcite from Sterling Hill

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INTRODUCTION

In the mid-1990s, as the Edison Tunnel and Landmesser Decline were being developed by the Sterling Hill Mining Museum, collectors combing through the newly blasted rock began finding specimens of ore that showed not only the typical red to orange-red fluorescence of calcite under shortwave ultraviolet light, but also a patchy to streaky, pale yellow to cream-colored fluorescence under longwave ultraviolet light. Many such specimens contain sphalerite in tiny grains that fluoresce pinkish orange to blue, resulting in attractive multicolor pieces. Collectors soon began referring to the yellow-fluorescing mineral as "longwave barite," based, we assume, on the similarity of its color of fluorescence to that of barite specimens from the 600, 700, and 900 levels of the Sterling Hill mine. Although typical Sterling Hill barite fluoresces a cream to pale yellow color under shortwave ultraviolet light and shows only a weak response under a longwave lamp – the opposite of the new material – "longwave barite" quickly became part of the local folklore. Few seemed moved to question its identity, though some traded and marketed the material as "unidentified," "unknown," or simply "strange stuff." As reported here, however, the yellow-fluorescing mineral is not barite, but calcite.

SPECIMEN DESCRIPTION

The specimens we examined from the Edison Tunnel – Landmesser Decline area (Figs. 1-4) are lean ore consisting of franklinite, brown willemite, scattered and locally abundant grains of sphalerite, and much calcite. The longwave yellow fluorescence of the calcite does not occur throughout that material but is confined to thin, discontinuous planes parallel to cleavage surfaces within individual grains, thereby resulting in sets of short fluorescent "streaks" whose orientations differ from grain to grain. Because calcite has three directions of perfect cleavage, some individual grains also display fluorescent planes in more than one orientation (Fig. 4). Emission of light from cleavage surfaces of different orientation, combined with "bleeding" of some of the emitted light through the adjacent calcite, gives an overall impression of patchy fluorescence to parts of some specimens, but examination with a hand lens reveals that the yellow emission originates only from the planar areas. An obvious inference is that the yellow fluorescence is due to chemical alteration of pre-existing, red-fluorescent calcite by fluids infiltrating incipient cleavages, but the nature of those fluids and the chemical changes they produced have yet to be addressed.

During the course of this study we also briefly examined yellow-fluorescing calcite specimens from several other finds at Sterling Hill (Figs. 5 and 6) and Franklin, but no special study of these was undertaken, other than establishing their identity as calcite. Results are given on the following page.

Figure 1. Lean franklinite-calcite-sphalerite ore from the Edison Tunnel - Landmesser Decline area at Sterling Hill, daylight view. Specimen measures 9 x 5 x 5 cm. E.R. Verbeek specimen and photo.

Figure 2. Same specimen as Figure 1 shown under longwave ultraviolet light. E.R. Verbeek photo.

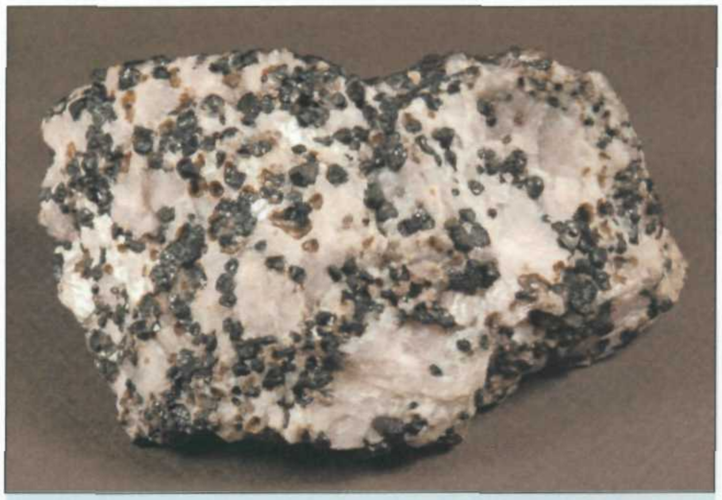

Figure 3. Lean franklinite-calcite-sphalerite ore from the Edison Tunnel - Landmesser Decline area at Sterling Hill, daylight view. Specimen measures 9 x 6 x 4 cm. Jim Van Fleet specimen; E.R. Verbeek photo.

Figure 4. Same specimen as Figure 3 shown under longwave ultraviolet light. E.R. Verbeek photo.

Figure 5. Coarse-grained franklinite-willemite-sphalerite-calcite ore from the North Ore Body, Sterling Hill.. Specimen measures 7 x 5.5 x 5 cm. Jim Van Fleet specimen; E.R. Verbeek photo.

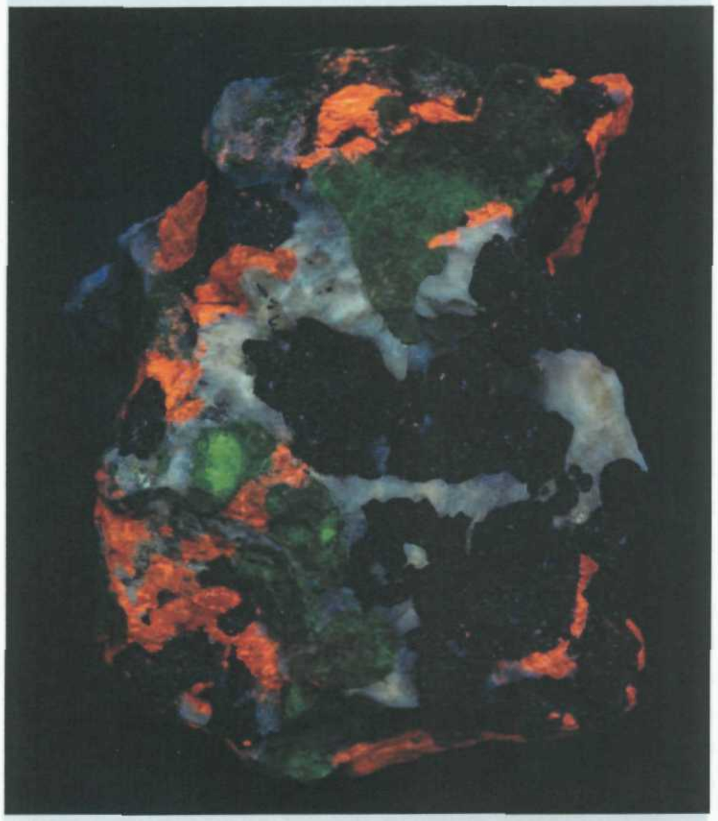

Figure 6. Same specimen as Figure 5 shown under longwave ultraviolet light. E.R. Verbeek photo.

IDENTIFICATION METHODS AND RESULTS

Among the numerous methods used to identify minerals, hardness, streak, luster, cleavage, and response to hydrochloric acid are easy to observe. The first three are of limited use in distinguishing calcite from barite, but the cleavage angles of barite are different from those of calcite, and of the two minerals, only calcite shows vigorous effervescence in dilute hydrochloric acid (HCl). These are techniques readily available to collectors. Among all specimens of purported "longwave barite" examined by us, all effervesce in dilute HCl. An attempt to prepare a sample for further testing, by immersing a chip in acid to remove the calcite and purify any barite present, resulted instead in the complete dissolution of the sample! Examination of yellow-fluorescing grains with a hand lens and binocular microscope revealed only the characteristic rhombohedral cleavages of calcite, and not the right-angle cleavage of the two best cleavage directions of barite. At this stage the evidence seemed clear that the longwave yellow-fluorescing mineral is calcite, not barite. To be certain, however, we turned to X-ray diffraction for further proof.

Samples for X-ray study were taken from five specimens, using a steel dental tool to remove material from the matrix. Three of the samples are from Sterling Hill, a fourth is labeled Franklin, and the fifth is unlabeled but is probably from Franklin. Sample purity was improved by crushing the yellow-fluorescing grains, separating franklinite grains with a magnet, and checking the samples with a longwave UV lamp. The purified samples were then X-rayed at Bucknell University, using a Philips (now PANalytical) X'Pert Pro MPD powder diffractometer with a Cu K-alpha radiation source. Settings were 45 kV and 40 mA. The scanner software ran a program that scanned for two seconds every 0.05 degrees, from 20 2-theta through 80o. The resultant data were analyzed by X'Pert Highscore, a software package that matches the resulting diffraction peaks to a digital library of known samples to identify the mineral(s) present.

For sample #1, the resulting peaks were a good match for calcite. Diagnostic peaks were seen at d-spacings of 3.032 Å (relative intensity 100%) and 1.911 Å (13%), with weaker peaks at 1.874 Å, 2.493 Å, and 2.283 Å, all important diagnostic peaks for calcite. No diffraction peaks that might be associated with barite were observed. Results for the other four samples were similar, with the X-ray diffraction data providing a match either for calcite (mineral ID# 86-2334) or magnesian calcite (mineral ID#s 86-2335 and 43-0697). Together with the optical examination and physical characteristics of these samples, the identity of the yellow-fluorescing mineral as calcite, and not barite, is now well established. Copies of the X-ray data for all five samples have been deposited with the Franklin Mineral Museum and Sterling Hill Mining Museum.

PRIOR EXAMPLES

The specimens recovered in the mid-1990s did not mark the first time that yellow-fluorescing calcite had been found at Sterling Hill – or, for that matter, at Franklin. Manuel Robbins, in his 1983 *The Collector's Book of Fluorescent Minerals*, wrote on p. 112:

> *We now consider what are undoubtedly some of the most interesting of mineral fluorescences – those in which the color differs depending upon whether short wave or long wave is used, as well as those in which the fluorescent and the phosphorescent colors differ. While such effects are found in many different mineral species the phenomenon finds its greatest expression in calcite.*

Robbins went on to cite a specific example of "a calcite from the ore body at Ogdensburg... which fluoresces a weak dark red under short wave. Under long wave, some portions continue to fluoresce red, but other segments now fluoresce a light yellow."

Our own *Picking Table* provides additional examples, from as far back as 1966, when Frank Edwards reported that "a cream or yellow calcite contains areas... that fluoresce a vivid yellow, short wave." Richard Bostwick (1977, p. 21) also reported "fine-grained ore bearing calcite, with weak conventional fluorescence and phosphorescence under SW, but showing an obvious moderate cream fluorescence LW." Similar unusual fluorescent responses in calcite were reported in *The Picking Table* six more times over the years, including by DeMenna (1984), Jenkins and Misiur (1994), and most recently by Grenier (2004). The literature on our local minerals thus includes ample references to yellow-fluorescing calcite, most of which show the yellow response most strongly, or only, under longwave ultraviolet light.

DISCUSSION

Yellow-fluorescent calcite is moderately common at Sterling Hill and is also known from Franklin. As noted above, calcite specimens showing yellow fluorescence, most commonly under longwave ultraviolet light, have been mentioned repeatedly in the local literature. In addition, longwave yellow-fluorescent calcite was found sparingly in "black ore" near the Buckwheat Dump in the early 1990s, around the piers of the Taylor Mine crusher. Specimens from the mid-1990s find at Sterling Hill are still fairly common on the market, and more recently, in 2002, longwave yellow-fluorescent calcite was again found at Sterling Hill, this time in the "genthelvite pit" near the entrance to the Passaic Pit from the Fill Quarry (Leavens et al., 2009). Specimens from other finds doubtless reside in systematic collections of the local minerals.

Specimens from the various finds of yellow-fluorescent calcite show significant differences in texture, mineralogy, and the character of the yellow fluorescence. Most specimens examined to date are of lean willemite-franklinite ore, generally containing sphalerite as an accessory mineral. Some are normal, fine- to medium-grained ore, but a few are quite coarse-grained. One anomalous Franklin specimen of fine-grained dolomite, coarse-grained calcite, and brown sphalerite contains, within a single large calcite grain, several tiny areas that fluoresce yellow. In this specimen the yellow fluorescence seems not to emanate from planar zones along the calcite cleavages, but instead from rhombohedral volumes *bounded* by cleavage surfaces. In still another specimen exhibiting mottled white to pale yellow fluorescence, the fluorescence appears throughout the entire extent of the calcite grains. No common factor has yet emerged as a "predictor" of yellow fluorescence, and clearly much remains to be learned. Similarly, the activator of yellow fluorescence in calcite from Sterling Hill and Franklin is unknown and remains a subject for future study.

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California FOMS member Gabe Reyna (right), representing the legend of the New Jersey Zinc Company to the Left Coast, with his yellow T-shirt.. He's a rocker...in more ways than one!

This post-mining stalagmite is one of the many pieces recently dispersed from the collection of Robert Hauck. Many such stalagmites were collected, but few were as brightly fluorescent as this one. Fewer still were "pulled out by the roots" to show a generous chunk of fluorescent calcite at the base. This specimen measures 23 cm in height. The blue shortwave fluorescence is probably due to hydrozincite as a component of the carbonate minerals that make up the stalagmite. Privately owned. E.R. Verbeek photo.