IN THIS ISSUE

- **FLUID FLOW IN METAMORPHIC ROCKS, PART 3**
- **HANCOCKITE REINSTATED AS SPECIES NAME**
- **JOHN KOLIC: A KEEN EYE AND A GOOD HEART**
- **MINERAL SPECIES FOUND AT FRANKLIN AND OGDENSBURG, NJ**

THE FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY, INC.

OFFICERS AND STAFF

Two habits of Franklin bementite in one specimen: as plumose radiating aggregates of feathery crystals, and as fine-grained masses. Broken fragments of lean ore are present along the base. Earl R. Verbeek specimen and photo; 4.1 × 2.8 × 2.4 inches (10.5 × 7 × 6 cm).

THE
PICKING TABLE

ABOUT THE FRONT COVER

One of the "Parker shaft" rarities: charlesite (fl. blue) with clinohedrite (orange), roeblingite (dull red, upper left), calcite and/or roeblingite (red), and willemite (green), which together form a thick crust on altered hancockite. This specimen, which measures 2.6 × 2.0 × 1.6 inches (6.5 × 5 × 4 cm) and belongs to Richard Bostwick, is on display in one of the small cases in the fluorescent room of the Franklin Mineral Museum. *Earl R. Verbeek photo.*

FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY

FALL AND WINTER 2015 ACTIVITY SCHEDULE

SATURDAY, SEPTEMBER 19, 2015

9:00 AM – NOON
FOMS Field Trip
Collecting at the Taylor Road site.
Meet and park at the Franklin Mineral Museum, and walk
from there. **Do not park on Taylor Road!** Fee charged.

10:00 AM – NOON
FOMS Field Trip
Collecting at the Buckwheat Dump.

10:00 AM – NOON
FOMS Micro Group
Franklin Mineral Museum.
BYO microscope and minerals.
Call Ralph Thomas for information: 215-295-9730.

1:30 PM – 3:30 PM
FOMS Meeting
Franklin Mineral Museum.
Lecture: *Mining (Something Other Than Zinc)*
in Sussex County, by Bernard Kozykowski

SATURDAY AND SUNDAY, SEPTEMBER 26-27, 2015

**59TH ANNUAL FRANKLIN-STERLING
GEM & MINERAL SHOW
Sponsored by the Franklin Mineral Museum.
Franklin Middle School, Washington St., Franklin, New Jersey.
9:00 AM – 5:00 PM Saturday (indoors)
10:00 AM – 4:00 PM Sunday (indoors).
The ticket price covers the show, *The Pond* outdoor swap,
and admission to the Franklin Mineral Museum:
$7.00 per day for adults, $4.00 per day for children (6-16).

The Pond Swap-and-Sell, sponsored by the FOMS,
takes place outdoors on the school grounds
from 7:30 AM to 6:00 PM on Saturday, and from
9:00 AM to 5:00 PM on Sunday. Show admission required.

The FOMS Annual Banquet starts at 6:30 PM on Saturday
at the Lyceum Hall of the Immaculate Conception Church,
located at the south end of Franklin's Main Street.

Tickets may be obtained at the FOMS show table for $20.00.
The meal is an all-you-can-eat buffet;
soda, tea, and coffee are included.
♦BYOB♦
After the banquet there will be an auction
for the benefit of the FOMS.
Please plan on donating a good specimen, artifact, book, etc.!

** Saturday and Sunday:
Events at the Sterling Hill Mining Museum.
For more information, please call: **(973) 209-7212**.
Or you can visit the website at
www. sterlinghillminingmuseum.org

SATURDAY AND SUNDAY, OCTOBER 10-11, 2015

**9:00 AM – 5:00 PM
North Jersey Mineralogical Society Swap & Sell
Sterling Hill Mining Museum. Admission Free.

SATURDAY, OCTOBER 17, 2015

9:00 AM – NOON
FOMS Field Trip
Collecting at the Franklin Braen quarry
Cork Hill Road, Franklin N.J.
If gate is open, drive through and park to the left of the gate.
Please don't block the roadway.

10:00 AM – NOON
FOMS Micro Group
Franklin Mineral Museum.

1:30 PM – 3:30 PM
FOMS Meeting
Franklin Mineral Museum.
Lecture: *The Rogerley Mines*, by Alan Benson.

MINERAL OF THE MONTH – BEMENTITE
Bring your specimens of bementite for show-and-tell,
and a discussion led by Steven Kuitems.

6:00 PM – 10:00 PM
Nighttime Mineral Collecting
Sterling Hill Mining Museum.
Collecting permitted on the Mine Run Dump
and in the Passaic Pit and "saddle" areas.
For museum members only. $5.00 admission fee
plus $1.50 for each pound of material taken.

SATURDAY, OCTOBER 24, 2015

26TH ANNUAL *ULTRAVIOLATION*,
a Show-Swap-Sell Session featuring fluorescent minerals *only*.
First United Methodist Church, 840 Trenton Road,
Fairless Hills, Pennsylvania.
9:00 AM – 4:00 PM, $2 donation.
"If your rocks don't glow, you're at the wrong show."
Table space available. For information call, 856-663-1383
or e-mail ultraviolation@yahoo.com.

SATURDAY, NOVEMBER 7, 2015

7:00 PM – 10:00 PM
Night Dig on the Buckwheat Dump,
for the benefit of the Franklin Mineral Museum.
Doors open at 6:30 PM for check-in and mineral sales.
Admission $10.00 adult, $8.00 children 3-12 years of age.
Poundage fee charged. **Call for details: 973-827-3481.**

SATURDAY, NOVEMBER 21, 2015

9:00 AM – NOON
FOMS Field Trip
Collecting at the Balls Hill iron mines
(owned by Technology General Corporation).
Directions: From Franklin Avenue, take Cork Hill Road
500 ft. south to its junction with Maple Road on the right,
then park as directed and walk to collecting site.
**Members are cautioned to beware of old mine openings
and stay out of them; some are quite narrow and deep.**

10:00 AM – NOON
FOMS Micro Group
Franklin Mineral Museum.

1:30 PM – 3:30 PM
FOMS Meeting
Franklin Mineral Museum.
Lecture: *Processing Ogdensburg Ore, and Other
Historical Perspectives*, by Peter Kern.

SATURDAY, DECEMBER 5, 2015

9:30 AM – 4:00 PM
FLUORESCENT MINERAL SOCIETY MEETING
GeoTech Center, Sterling Hill Mining Museum.
Speakers include Donna Beaton, GG
(Determinants of color in natural and treated tanzanite)
and Shirley M. Mueller, MD
(Neurophysiology of why collectors collect).
Lunch will be served ($10.00 contribution).
♦BYOB♦
Reservations necessary! Please contact Howie Green:
royalp53@verizon.net.

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Scheduled activities of the FOMS include
meetings, field trips, and other events.
Regular meetings are held on the third Saturdays of
March, April, May, June, September, October, and
November, and generally comprise a business session
followed by a lecture. FOMS meetings are open to the
public and are held at 1:30 PM, usually in Kraissl Hall
at the Franklin Mineral Museum, 30 Evans St.,
Franklin, N.J. (check listings for exceptions).

Most FOMS field trips are open only to FOMS members
aged 13 or older. Proper field trip gear required:
hard hat, protective eyewear, gloves, sturdy shoes.

**Activities so marked are not FOMS functions but may
be of interest to its members. Fees, and memberships in
other organizations, may be required.
Any information in this schedule, including fees,
is subject to change without notice.

*Thanks go to Mark Dahlman, Bernard Kozykowski,
Pat Hintz, Richard Keller, Ralph Thomas, Howie Green,
the Franklin Mineral Museum, and the Sterling Hill
Mining Museum for this information.*

President's Message

MARK DAHLMAN
11906 SCOVELL TERRACE
GERMANTOWN, MD 20874

The fall Franklin show will be here soon, and as always the FOMS will be putting in displays, staffing our club table, and overseeing the outside dealer spaces. As a completely volunteer society, we rely on you to help carry on a successful show. A huge thanks to all of you who helped in the spring, and those of you who are taking part at the fall show. Of course the Edison show is just around the corner too. If you haven't volunteered before, now is the time to be part of the activities. Contact me at president@fomsnj.org or give me a call.

The fact that *The Picking Table* continues to be such an exceptional publication is due to the talent and determination of those people you see listed inside the front cover. This edition has had the challenge of being produced during the final phases of the Franklin Mineral Museum's *Mineralogy of Franklin and Ogdensburg, New Jersey: A Photographic Celebration*, which by all indications will be a tremendous book. Expertise is in high demand to create these works, and we're the lucky beneficiaries of it.

The new FOMS website (fomsnj.org) is soon to have its grand opening as of this writing. It is going to be a thing of beauty thanks to the work of our Web committee: Jim Van Fleet, Bernie Kozykowski, and especially our webmaster, Bill Pazik, and his son, John. They've done us a great service, and it's exciting to hear their ideas of how this site will grow. Watch the FOMS Facebook page for an announcement about the website this fall.

The FOMS *Mineral of the Month* sessions continue to be outstanding. Those of us who stay for them at the end of our meetings see outstanding specimens and hear information we probably won't get anywhere else. A recent session featured local apatites, including one from Sterling Hill that was surprisingly large, like a small child's head except hexagonal, green, and pointy.

As you will see from the list of FOMS activities in this issue, we have excellent speakers lined up thanks to Pat Hintz, and new field trips thanks to the continuing diligence of Rich Keller and Bernie Kozykowski, with special thanks to Mike Gunderman. Also note that the FOMS micromounters, a very friendly bunch by the way, gather in Kraissl Hall before our meetings. So come join us—there's a lot going on! ⚒

From the Editor's Desk

RICHARD J. KELLER, JR.
13 GREEN STREET
FRANKLIN, NJ 07416

Greetings, and welcome back for another exciting year of FOMS membership benefits such as field trips, a new website, and of course *The Picking Table*. I'm sure each member is aware by now that a top-quality color book on the minerals of Franklin and Sterling Hill is currently having the finishing touches applied to it. This book, commissioned by the Franklin Mineral Museum, will be a wonderful companion to the new FOMS website.

For the six years that I have been Managing Editor of the *PT*, I have encouraged members to submit articles for future issues. Although I have had only limited success increasing the author pool, I have an idea that might help those of you who want to write for us, but didn't think you could.

Many of our long-time members will recall the 40th Anniversary issue of the *PT*, for which members submitted their favorite collecting story. It was one of the more memorable issues (88 pages!), and copies are still available for those who do not yet own one. My idea is a variation on that theme.

It's obvious how people who live in the general vicinity of Franklin and Ogdensburg came to know of our hobby. I'd like to hear from those who do not, or did not, live in the area when they first became aware of the minerals…fluorescent or otherwise. Did you come here on a school field trip? Did you have a friend or relative who was involved and brought you here? What "set the hook" and led you to become a FOMS member? Tell us about it! If you want to add a favorite part of your visiting and collecting experiences, by all means include that. Now you know that you are as capable as anyone else to submit an article to *The Picking Table*. ⚒

Happenings at Sterling Hill

WILLIAM KROTH

PRESIDENT, STERLING HILL MINING MUSEUM

30 PLANT STREET

OGDENSBURG, NJ 07439

As 2015 winds down, we are again pleased to report record attendance and record sales. We feel that our increased degree of accommodation to our visitors and attention to detail are responsible for this good news.

We continue our "polishing program" with the following improvements to our facility. First, our many ore cars and locomotives have typically been set on bare ground and over the years have settled in a jumbled manner with many of the wheels being nearly fully buried. With the help of a small rail donation from the New York, Susquehanna and Western Railway, we were able to install stone ballast, concrete ties, and rail underneath the ore cars surrounding the employee parking lot. They have promised much more rail and we hope to have all of our rolling stock positioned straight and well above grade, thus giving a very tidy appearance. Additionally, we placed sheet plastic below the ballast to control the weeds. This along with a fresh paint job by Tom Hauck really make a big visual improvement and assure a much longer corrosion-free life for our important displays.

Our shaft station received several upgrades, with Safety Manager John Gumbs carefully scaling the high ceiling and then installing a chain-link mesh and cable system to assure that no rock fragments fall. Unlike other portions of the mine with much lower ceilings, this area located near the main shaft, has a ceiling over 20 feet high that could be a hazard if small pieces of rocks were to fall. We have never had any issues with falling rock fragments here, but safety cannot be overemphasized. We were able to do this work very economically (with in-house staff) since we already had enough chain-link fencing in stock. The cables that support the horizontal fencing are attached to the existing crane trolley rails. The system is barely noticeable but provides an important extra level of protection.

Our very popular periodic table of the elements received an upgrade with a new 22-inch touchscreen system that now allows visitors to further research each element. By simply touching any element on the touchscreen's table template, additional information is immediately presented. The screen replaces the old flip-card system and provides information on the ore source and uses for each element. We are testing this system to ascertain its durability and to see if such screens could be used for other displays within the Zobel Museum.

With more and more visitors, we need more samples of fluorescent minerals to hand out as part of the tour and to fill our carousel in the gift shop. Tom Hauck and his helper/nephew, Jonathan Krause, were able to restore the old crusher located just to the west of the pavilion. The 15-HP gasoline engine that sat unused for over 20 years was reconditioned in a matter of hours. It is connected with numerous "V" belts to several massive flywheels that then transmit their energy to two cams that are in turn linked to a corrugated plate system that can crush a basketball-sized boulder while barely slowing down. I was personally amazed how effortlessly (and surprisingly quietly) it crushes even the toughest of boulders. What once took hours to do by hand may now be done in a few minutes!

Our third cell tower tenant, Verizon, has just completed their installation of antennae on the existing headframe. They have also installed a backup generator and should be up and running by the time this article goes to print. Their long-term commitment will certainly ensure a steady and important cash flow to our foundation so that we may continue with our many programs. The headframe still has its iconic look, with very little distraction from the antennae.

On June 25, former Trustee and Montclair State University professor Jackie Willis brought over 50 international teachers to Sterling Hill for a combination advanced tour and dinner. These folks from the International Society for Teachers were given our in-depth tour by Dr. Earl Verbeek and myself in the early evening. Afterwards a wonderful dinner, catered by Dominick's Restaurant, was held in our pavilion. Folk music was played by several attendees and it was wonderful to see our facility in harmony with so many international guests.

I would like to personally thank all of our staff and friends who are making the Sterling Hill Mining Museum so successful! Again, please stop by to see our many upgrades. ⚒

Franklin Mineral Museum Report

MARK BOYER

PRESIDENT, FRANKLIN MINERAL MUSEUM
32 EVANS STREET
FRANKLIN, NJ 07416

This year marks 50 years of operation for the Franklin Mineral Museum. Opening its doors on October 9, 1965, the museum was a project of the local chapter of the Kiwanis, who wanted to preserve the rich mining and mineral heritage of Franklin, N.J. The museum celebrates its 50-year anniversary with confident prospects. Our value as a family-oriented attraction has not gone unnoticed, as we have had an increase in the number of visitors this year. Contributing to this success are the gem-panning and fossil dig areas, which have become great family favorites, along with the ever-popular Buckwheat Dump for both casual and serious rockhounding.

The museum is pleased to announce the hiring of Earl R. Verbeek, PhD, as part-time Curator. It has been 10 years since the death of our last official Curator, John Cianciulli, who passed away in January of 2005. In the interim, Lee Lowell has done yeoman's duty as Collections Manager, a position that covered the museum's basic curatorial needs except for the science. I should mention that the science needs were handled by Joe Orosz until his untimely passing in 2008. Now that Dr. Verbeek is on board, he will concentrate his energies on the science-related functions of the museum while Lee will continue his vital role as Collections Manager. Dr. Verbeek, who started with us in July, is in the museum at least once a week, and he has been busy writing interpretive labels for our exhibits as well as making great strides in our backlogged mineral research. Welcome aboard, Earl!

If you haven't visited the museum in a while, please make an effort to experience our ever-improving exhibits, family activities, well-stocked gift shop, and rock-collecting opportunities. And I thank all of you who have supported this museum over the years — it is the heart of the mineral heritage of the district, and its success is due to the interest and energies of those who love its minerals, geology, history, and science. I'm hopeful that our efforts will be appreciated by those who celebrate our 100th anniversary 50 years from now. ⚒

SCENES FROM THE GRAND OPENING OF THE FRANKLIN MINERAL MUSEUM, OCTOBER 9, 1965

Inside the museum's Local Species Room, in foreground left to right: John Bennett, Trotter Yard Boss, New Jersey Zinc Co.; Art Horr, Electrical Engineer, New Jersey Zinc Co.; Harry "Red" Renouf, Franklin businessman; in background: Perry Armagnac, Editor, *Popular Science Magazine* and FOMS Historian; Jack Baum, Resident Geologist, New Jersey Zinc Company. *Gardiner Gregory photo.*

Admiring the mineral exhibit, left to right: Richard Burham, President, American Federation of Mineralogical Societies Scholarship Foundation; Perry Armagnac, Editor, *Popular Science Magazine* and FOMS Historian; Jack Baum, Resident Geologist, New Jersey Zinc Company; unidentified visitor. *Gardiner Gregory photo.*

Left to right: Frederick Kraissl, Jr., President, FOMS; Walter Warren, President, Franklin Kiwanis Club; David Ackerman, Lieutenant Governor, 17th District, Kiwanis; Edward Selems, President, Franklin Mineral Museum; Jack Baum, Resident Geologist, New Jersey Zinc Company; Mervyn Haines, Governor, New Jersey District, Kiwanis; Alfred Littell, Secretary, Franklin Kiwanis and Franklin Mineral Museum. *Gardiner Gregory photo.*

Mineralogy of Franklin and Ogdensburg, New Jersey: A Photographic Celebration

The 50th anniversary of the Franklin Mineral Museum is coming in October, 2015. For the entire time of the Museum's existence, many have wished for an illustrated mineralogy of as many of the Franklin District's minerals in full color as could be recorded. During the last four years, photographers having been scouring the countryside for good specimens to photograph, both in white light and in ultraviolet light. Invitations have been sent out on the Internet, personal invitations have been extended, volunteers have come forward, and arms have been twisted. At this writing, the photos and accompanying text are being laid out in book format. The book should be for sale in mid-December, 2015. The luxury of the book will be that it isn't goi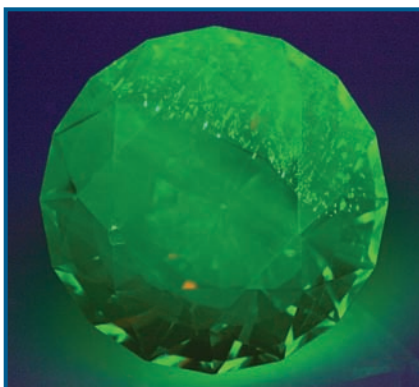ng to be rushed, and we know you will like what you see. The book will be hardcover, 8.5 x 11 inches (20.8 x 28 cm). The size will be a generous 500+ pages.
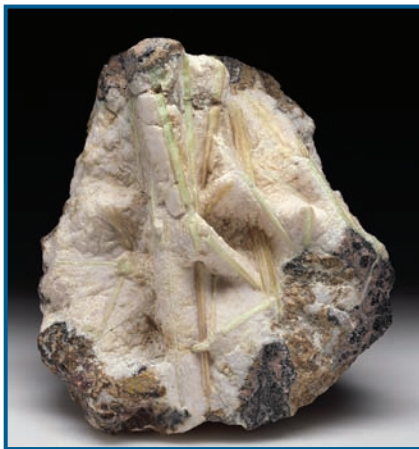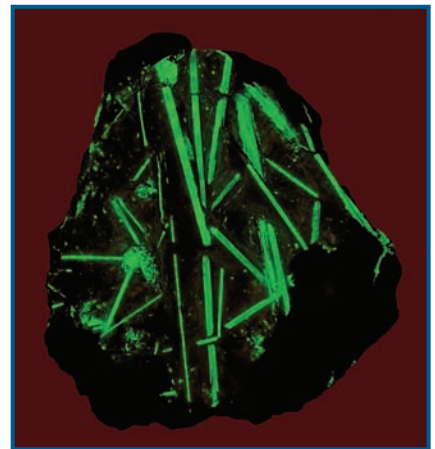
Collections to be represented include: Franklin Mineral Museum, Sterling Hill Mining Museum, Harvard University, Yale University, Smithsonian Institution, American Museum of Natural History, and others. Personal collections to be featured include specimens from: Philip Betancourt, Richard Bostwick, Peter Chin, George Elling, Elna Hauck, Richard Hauck, Vandall King, John Kolic, the Kuitems family, Fred Parker, Warren Miller, Steven Phillips, and Paul Shizume. Many additional collections, local as well as from across the USA and Europe, will be represented by individual photographs.

The chapters will chronicle mine locations, history of mining, history of the Franklin Mineral Museum, history of "The Fluorescent Mineral Capital of the World," a detailed and expanded Franklin District mineral list, description of the District's rock types, Parker Shaft assemblages, a much expanded and detailed District fluorescent mineral list, A-Z gallery of fluorescent minerals, featured institutional collections, featured private collections, and an A-Z gallery of specimens in white light (the largest chapter). Particular attention has been addressed at having at least one photograph of each species. Surprisingly, at this writing it looks that only five species will not be represented, but we will continue to try for completion until the final tick of the clock. The total photo count is still increasing, but will certainly be over 1200. Images will include all of the various mineral types the District is famous for: cabinet sized specimens, micromounts, gems, fluorescent minerals, and rare species.

The book will be sold by the Franklin Mineral Museum.
Projected retail price: $125.00

Photos show willemite from Franklin as crystals in calcite (12 x 11 x 6.5 cm) and as a cut gemstone of 29.66 carats, under both visible and shortwave ultraviolet light.

Fluid Flow in Metamorphic Rocks, Part 3

EARL R. VERBEEK, PhD

RESIDENT GEOLOGIST, STERLING HILL MINING MUSEUM

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INTRODUCTION

This is the last of a three-part series of articles dealing with fluid flow in metamorphic rocks. Such rocks, though often thought of as being impermeable, or nearly so, nevertheless often show obvious signs that fluids have migrated through them at some time or times in the past. At both Franklin and Sterling Hill, for example, the ore layers, the calcium silicate layers associated with them, and the Franklin Marble enclosing them, all show signs of local alteration, replacement assemblages, and veins, which collectively provide evidence of a lengthy history of hydrothermal mineral activity. In similar manner, the presence of the "mud zone" at Sterling Hill, and of a smaller body of extensively weathered rock near the top of the northern part of the west limb of ore at Franklin, show that groundwater and descending rainwater have in places thoroughly altered the original rocks and resulted in the development of a wide variety of new minerals. Far from being impermeable, our local rocks have, in places, been markedly changed by fluid flow—and therein lies much of the mineralogical story of our two zinc deposits, and the reasons they are world-famous mineral localities.

Part 1 of this series, in the Fall 2012 issue of *The Picking Table*, dealt with the smallest but most numerous openings that pervade the local rocks: grain-boundary cracks and intragrain cleavage cracks. Though tiny—nearly all are of microscopic dimension—these cracks nevertheless provided permeability pathways for the flow of hydrothermal fluids and set the stage for the development of various alteration and replacement mineral assemblages. Part 2, which appeared one year later in the Fall 2013 issue, discussed the generally much larger openings that developed during multiple episodes of faulting of the rocks. In this, Part 3, we turn our attention to openings that formed by chemical breakdown of the rocks and the removal, in solution, of some of its components. The largest of such openings dwarf those formed by any of the means previously discussed.

This paper is largely geological in nature, but minerals of collector interest will be mentioned and illustrated where appropriate. It is important to keep in mind that the process of rock dissolution has taken place repeatedly, over a very long expanse of geologic time, and has acted in concert with other processes, such as faulting of the rocks, that created additional permeability pathways for hydrothermal fluids and groundwater to enter the rocks and react with them chemically.
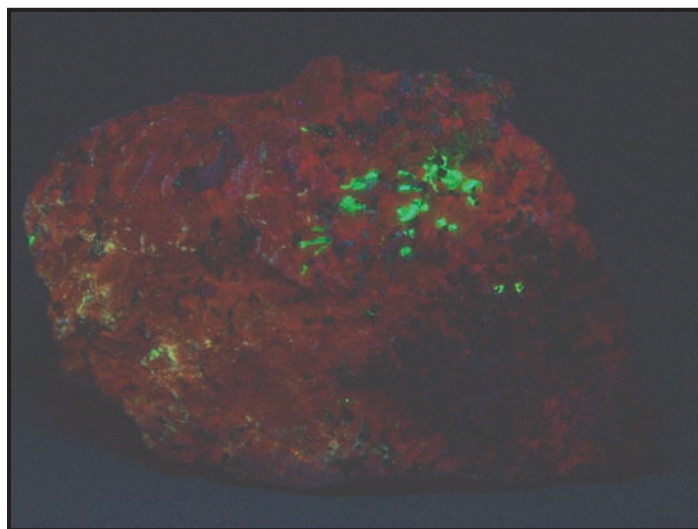

Figure 1. Tiny (2-3 mm) grains of chabazite in small vugs within wollastonite-bearing calcite marble from 1270 subdrift, 340 level, Sterling mine. The specimen measures 3.6 × 2.8 × 1.7 inches (9 × 7 × 4.5 cm) and is on display in the Franklin Mineral Museum. *Earl R. Verbeek photo.*

ALTERATION AND DISSOLUTION ALONG PERMEABILITY PATHWAYS

Fluids migrating along intragrain cleavage cracks, grain-boundary cracks, and faults do not simply deposit new minerals in the open spaces, as described before; they also interact with the wall rock. Sometimes this interaction takes the form of alteration, as when feldspars in gneissic rocks are hydrothermally altered to epidote, or when hardystonite alters to clinohedrite. But it can also lead to dissolution of some components of the wall rock, with the creation of additional open space for chemical reactions to occur and new minerals to form. Both can happen at the same time, and commonly do. The six specimens shown here are arranged in order of increasing size of the solution openings, from those barely visible to large openings apparent from across a room. Still larger solution openings are discussed in a following section.

Chabazite, 1270 subdrift, 340 level, Sterling Hill: Tiny crystals of green-fluorescent chabazite reside in vugs only 2 to 4 mm across in specimens from the wollastonite assemblage at this locality (Fig. 1). The geology of this area was studied in detail in 1990 by Steven Misiur and Robert Jenkins, who recovered an extensive suite of specimens for future research. During this same time period Marilyn Grout and I, both then

Figure 2. Chalcocite, partly altered to green, secondary copper minerals, in a vuggy mass of franklinite from which the calcite had previously been dissolved. Though both the franklinite and chalcocite are black, and thus not readily distinguished from each other in the photo, the franklinite has bright metallic luster and the chalcocite is dull. Originally in the John Kolic collection, this specimen is from Sterling Hill and measures 3 × 2¼ × 1½ inches (7.5 × 5.5 × 3.5 cm); it is now specimen no. SHMM-2254 of the Sterling Hill Mining Museum. *Liz Schneider photo.*

working for the U.S. Geological Survey, documented the fault network in this and nearby areas in considerable detail. Though numerous minor faults cut the rocks here, many of the tiny solution vugs in the marble peripheral to the wollastonite zone show no obvious connection to these faults. We concluded instead that the vugs probably reflect dissolution etching of the rock due to diffuse fluid flow along grain-boundary and cleavage cracks. The tiny size of the vugs and their irregular distribution within the rock are consistent with this interpretation.
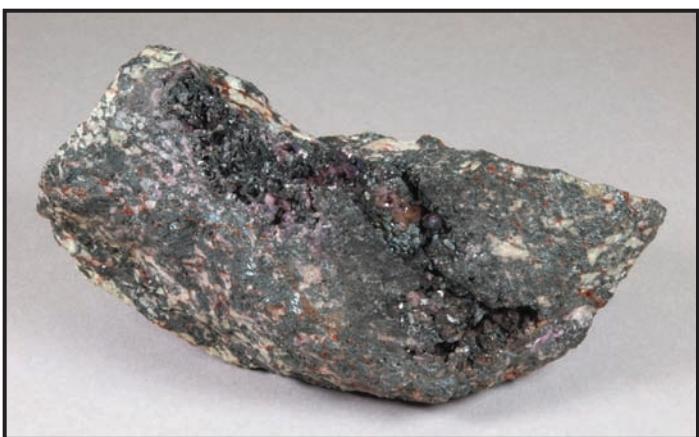

Figure 3. Tiny crystals of hodgkinsonite lining irregular vugs in high-grade franklinite-willemite-zincite ore. This specimen, once part of the SPEX/Gerstmann collection and now no. 1155 of the Franklin Mineral Museum, measures 4¾ × 2¼ × 1¾ inches (12 × 5.5 × 4.5 cm). *Earl R. Verbeek photo.*

Figure 4. Rhombohedral crystals of brown siderite in a shallow solution vug in ore from Sterling Hill. Bearing catalog no. 407, this specimen is on display in the Franklin Mineral Museum; it measures 4¼ × 2¾ × 2 inches (11 × 7 × 5 cm). *Earl R. Verbeek photo.*

Secondary copper minerals, Sterling Hill: The vuggy nature of this specimen (Fig. 2) is readily apparent in the photograph and resulted largely from dissolution of calcite from the original rock, leaving behind an open aggregate of franklinite grains. Chalcocite (Cu_2S, black, dull luster in photo) precipitated within these open spaces and was in turn altered by later solutions to secondary copper minerals. Specimens such as this, though largely ignored by collectors, nevertheless offer obvious testament to a lengthy record of fluid flow through the orebody at Sterling Hill.

Hodgkinsonite, Franklin: Irregular solution cavities (Fig. 3) in this specimen of high-grade franklinite-willemite-zincite ore provided space for the growth of numerous small crystals of pink to nearly black (surficially oxidized) hodgkinsonite. Note the large size of the vugs relative to the previous two examples. The openings in the specimens of Figures 1 and 2 are on the scale of individual mineral grains, but in this example they are far larger. Parts of the ore adjacent to the vugs appear mildly brecciated, which probably explains the creation of the initial open space for the invasion of fluids to dissolve some of the nearby rock. Though it may seem surprising that high-grade zinc ore could be dissolved to create vugs of substantial size, both willemite and especially zincite (Laudise and Kolb, 1963; Brugger et al., 2003) are readily mobilized in hydrothermal solutions over a wide range of temperature.

Siderite, North Ore Body, Sterling Hill: In this specimen (Fig. 4), a druse of densely intergrown rhombohedra of medium-brown siderite lines a broad, shallow vug in altered, leached, locally hematite-stained, franklinite-calcite ore. The flat front face of the specimen is probably a solution-modified

Figure 5. Solution vugs lined with quartz in franklinite-willemite-calcite zinc ore from Sterling Hill. Specimen size is 4½ × 3¼ × 2 inches (11.5 × 8 × 5 cm). *Earl R. Verbeek photo.*

fault surface, to which the vug is parallel; the fault was thus the permeability conduit along which solutions migrated to dissolve part of the wall rock. Had the solution process proceeded much further, all hint of the fault morphology would have been lost at the hand-specimen scale. This specimen is on display in Case 13 of the Local Room of the Franklin Mineral Museum.

Quartz, Sterling Hill: Irregular solution vugs of all sizes pervade this specimen of franklinite-willemite-calcite ore from Sterling Hill (Fig. 5). The vugs are lined with small quartz crystals; compare to the specimen of hodgkinsonite (Fig. 3) from Franklin, discussed above. This specimen was acquired by John E. MacDonald in 1966 (his JEM 330) and is now no. ERV-490 in the author's collection.

Wurtzite, Sterling Hill: Botryoidal masses of black wurtzite ("voltzite") thickly line solution cavities in altered, coarse-grained, red-fluorescent calcite in this large specimen (Fig. 6) from the Franklin Mineral Museum. Specimens from this find, from the 1680 level of the Sterling mine, were described by miners as occurring along a "watercourse," implying the presence of large, interconnected solution openings over some appreciable distance. Frondel (1967) likewise described the openings as a "watercourse" and as a "cavernous zone," and Dunn (1995, p. 544) noted that it was 100 feet in vertical extent. Some specimens from other such "watercourses" deep underground at Sterling Hill contain multiple layers of loose mineral grains and broken calcite fragments that appear to have been deposited from running water, again implying the presence of large solution cavities through which fluids have flowed freely.

One could go on and on with dozens more examples. In some cases, the fluid flow appears to have been diffuse, as in the first example discussed above. In others (the siderite), there is evidence of a fluid-flow conduit that channeled the fluids and controlled where the vugs would develop. In still others, the conduit (generally a fault) and the vugs are preserved in the same specimen to give one a glimpse of the operative processes. In most cases, however, removal of the specimens from their geologic context, coupled with the fact that nearly all specimens are far too small to reveal that context, limits what can confidently be inferred about the mechanisms of vug formation.

The last specimen discussed above, of wurtzite from a "watercourse," hints at the presence of karst features (caves, collapse breccias, etc.) underground at Sterling Hill, and, by analogy, at Franklin. That is indeed the case. We turn now to some of the largest solution openings, those associated with cave formation in the Franklin Marble.

CAVES IN THE FRANKLIN MARBLE

Nearly everyone is familiar with caves in areas underlain by thick units of limestone, and many have ventured underground to experience caves directly. Caves can form in metamorphic as well as sedimentary rocks, and our own Franklin Marble is one example. Almost two dozen caves are known from the Franklin Marble in Sussex County (Dalton, 1976), and though all are small, they reveal intriguing clues to the history of fluid flow through that rock unit.

The general process of cave formation can be visualized as progressing in a series of steps. The first step involves fracturing of a soluble rock unit, most often a carbonate rock such as limestone or dolomite or their metamorphic equivalents, to


Figure 6. Botryoidal masses of wurtzite (principal component of "voltzite") lining solution cavities in coarse-grained calcite from the Sterling mine. Now on display in the Franklin Mineral Museum (catalog no. 118), this specimen was formerly part of the SPEX/Gerstmann collection and measures 8 × 4 × 2¾ inches (20 × 10 × 7 cm). *Earl R. Verbeek photo.*

create a three-dimensional network of fluid-flow pathways of sufficient permeability that large amounts of fluid can gain entry into the rock and begin to interact with it chemically. The fracture network can consist of faults, or joints, or both, as discussed in Part 2. Commonly, but not necessarily, the fractures form well before cave formation begins, and at greater depth. Eventually, however, as erosion progressively removes rock above the carbonate unit and brings it closer to the surface, part of the rock emerges above the water table, which separates the *zone of saturation* (where all rock openings are filled with water) from the *zone of aeration* above. This is the place where downward-percolating water that initiated as rain first becomes part of the groundwater system, and this is the place where many solution caves begin their formation. To understand why, one must first consider the chemistry of rainwater and its evolution as it descends into the rocks below.

Rainwater in much of the world is mildly acidic. This is because carbon dioxide, present naturally in our atmosphere, is readily soluble in cold water (thus the bubbles in our sodas and beer), so a raindrop that might have started out at a neutral pH of 7 becomes a dilute solution of carbonic acid by the time it reaches the Earth's surface:

$$H_2O(l) + CO_2(g) \rightarrow H_2CO_3(aq)$$
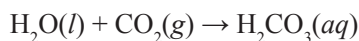
Rainwater here in New Jersey has a pH of about 5.5 to 5.6, a rather typical value for much of the United States. Now consider what happens to this rainwater as it soaks into the ground and percolates downward through the soil horizon. We live in a temperate climate zone, one long characterized by abundant vegetation. Our soils are rich in organic debris, which is continually being broken down by fungi and bacteria that live in the soil. Among the decomposition products of this process is a series of compounds called humic and fulvic acids, plus additional carbon dioxide, all of

Figure 7. Irregular pockets along a solution-widened fissure in the Sterling mine, Ogdensburg. *Earl R. Verbeek photo.*
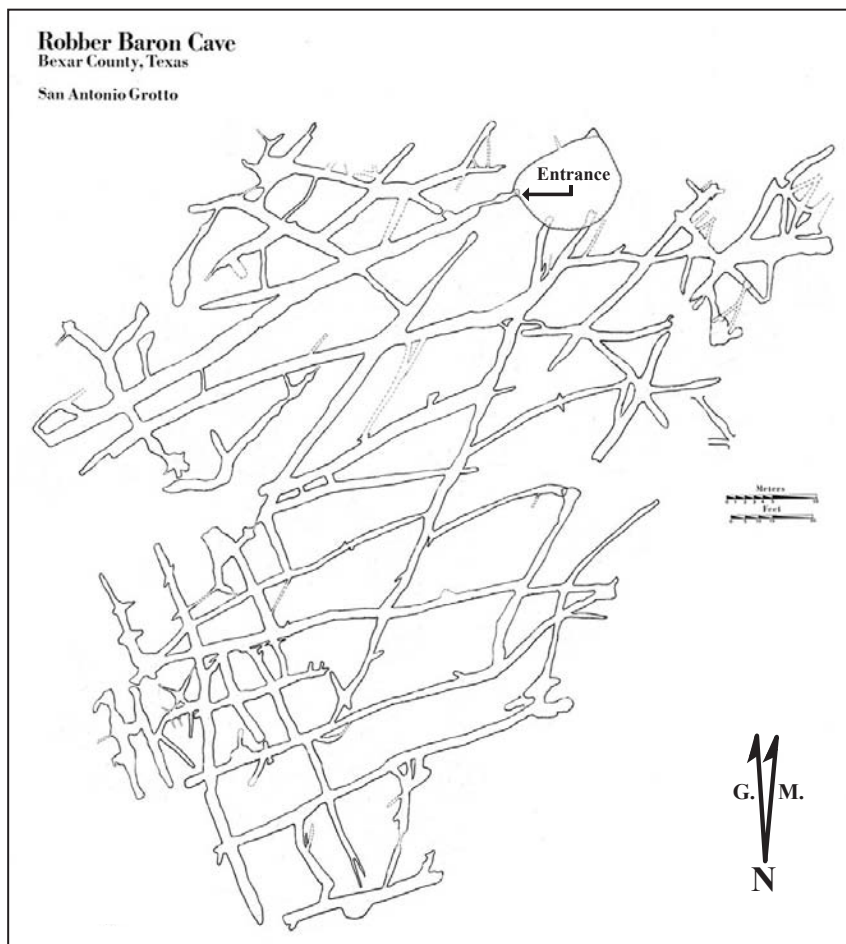

Figure 8. Map of the Robber Baron cave, Bexar County, Texas. The rectilinear passages in this cave reflect three sets of fractures, trending north-northwest to northwest, east-northeast, and northeast. Map drafted by Randy Waters from a 1976-1977 survey by Teeni Kern, Gary Poole, George Veni, and Randy Waters of the Bexar (San Antonio) Grotto.

which become incorporated in the rainwater as it percolates downward. By the time rainwater exits the bottom of the soil profile and first enters the rocks below, it is much more acidic than it started out.

As this water flows through the rock, it comes into contact with grains of various sulfide minerals (pyrrhotite, pyrite, etc.) that are irregularly but widely disseminated in the Franklin Marble. Sulfide minerals are unstable in the presence of water and dissolved oxygen, as the numerous "rust stains" on long-exposed, sulfidic masses of rock amply show. In the case of pyrite, a general reaction can be written as follows:

$$2FeS_2(s) + 7O_2(g) + 2H_2O(l) \rightarrow 2Fe^{2+}(aq) + 4SO_4^{2-}(aq) + 4H^+(aq)$$
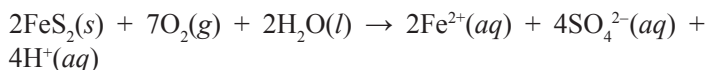
Note that this reaction increases the acidity of the water by producing hydrogen ions, and liberates the iron into solution. In effect, the breakdown of pyrite and other sulfides generates sulfuric acid. We now have three sources of acid in the water flowing through the Franklin Marble: carbonic acid in the original rain, humic and fulvic acids derived from the soil, and sulfuric acid derived from the breakdown of sulfide minerals in the rocks below.

Calcite, the main component of marble and limestones, is readily soluble in dilute acids. In the case of carbonic acid the reaction is:

$$CaCO_3(s) + H_2CO_3(aq) \rightarrow Ca^{2+}(aq) + 2HCO_3^-(aq)$$
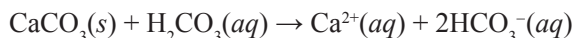
The obvious result is that rainwater, as it descends along fractures on its journey to the water table, dissolves some of the rock along the fracture walls, thereby widening them. An excellent example of this early stage in cave formation can be seen locally, on the adit level of the Sterling mine, a few dozen feet north of the timber sets. Here a large fracture, exposed on both ribs and across the back, shows a series of solution pockets (Fig. 7), the widest of which gapes open about 15 cm (6 inches). This solution-widened fracture is not yet wide enough to be called a cave, for part of the definition of "cave" is that it must be sufficiently large for human entry, but this is where the process begins.

This same process, continued, and operating within a large volume of rock pervaded by two or more sets of fractures, commonly gives rise to a *fissure cave system*, a rather good example of which is depicted in Figure 8. Fissure cave systems are characterized by narrow, rectilinear cave passages, many of which turn abruptly wherever one solution-widened fracture meets another. These are young caves, evolutionarily speaking. Referring again to Figure 8, note that the corners where two
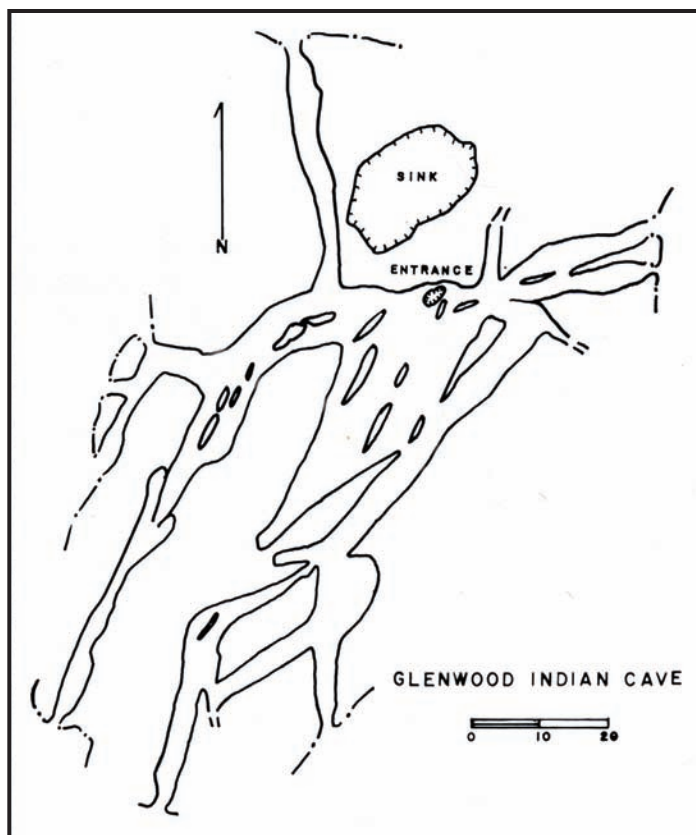

Figure 9. Map of Glenwood Indian Cave in the Franklin Marble, from Dalton (1976). This cave is near the village of Glenwood, Vernon Township, in Sussex County near the N.J.-N.Y. border. Note, in the largest room, the residual "ribs" of rock, reflecting progressive dissolution along a set of northeast-trending fractures.

cave passages meet are places where a small volume of rock is exposed over a large surface area, so this is where solution will preferentially occur, gradually rounding and eventually eliminating the corners to produce larger cave openings with curving walls. Similarly, narrow ribs of rock between closely spaced cave passages will gradually be removed by solution to create one opening where two had been before. The result will be a series of solution-widened, straight cave passages connecting larger, more irregular rooms. Most of the extant caves in the Franklin Marble are of this type. A map of one such cave is shown in Figure 9, and it is worth noting that four other caves were intersected during mining operations underground at Sterling Hill, and one at Franklin (Dalton, 1976). Collectors who visited the Lime Crest quarry before the lower levels were allowed to flood will also remember a prominent cave in the Franklin Marble there.

Caves in the Franklin Marble formed during at least two and perhaps three geologic periods, widely separated in time. The youngest caves are those most visible today, for most are exposed at the surface and are either empty (Fig. 10) or filled

Figure 10. A small, empty cave in the Franklin Marble, south of Route 517 in the McAfee gravel pit. Red pen at upper left for scale. Note the prominently solution-pitted walls. The cave extends farther than shown but is choked with rock and mud at the far end. *Earl R. Verbeek photo.*
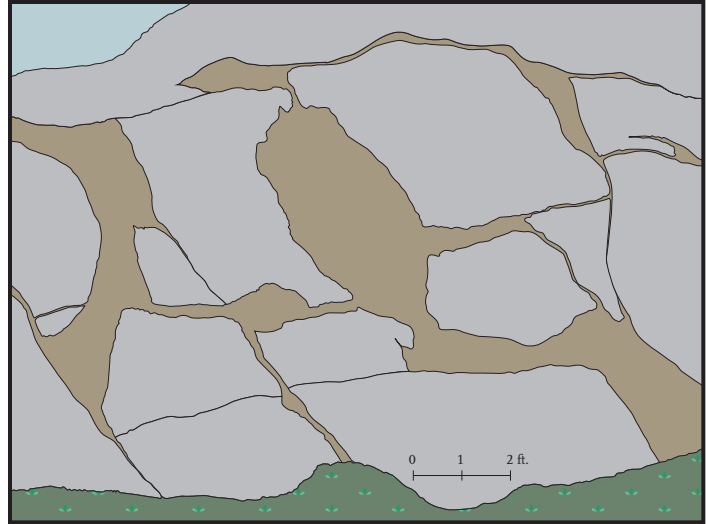
Figure 12. Map (vertical section) of an ancient cave and associated solution-widened fissures, all filled with Hardyston Quartzite, in the McAfee gravel pit (same locality as Figures 10 and 11). Traced from photograph of a nearly vertical, south-facing cut in the Franklin Marble. UTM coordinates for this locality: 18T, 0538676 E, 4558548 N, WGS 84.

Figure 11. Small cave in McAfee gravel pit, filled with glacial debris. Hammer at top center for scale; same locality as in Figure 10. *Earl R. Verbeek photo.*

Figure 13. Colorless, transparent quartz crystal in vug within a fragment of Franklin Marble included in the Hardyston Quartzite, McAfee gravel pit. Same locality as Figures 10-12. *Earl R. Verbeek photo.*

with glacial gravel and sand (Fig. 11). The two figured caves are near McAfee, about five miles north of Franklin, in an abandoned gravel pit where glacial debris had been stripped from the Franklin Marble. Three similar caves are exposed in the McAfee marble quarry across the road to the north. In this same gravel pit, however, is a much older cave, one that is filled not with unconsolidated glacial debris from the Pleistocene Epoch, but with firmly cemented sandstone—the Hardyston Quartzite—of Cambrian age. Richard Volkert of the New Jersey Geological Survey first pointed this feature out to me, and I thereupon set out to make a detailed drawing of it, using a photograph as a base. The result (Fig. 12) shows, in vertical section, two sets of nearly rectilinear, sandstone-filled, solution-widened fractures, in addition to the small ovoid cave that is visually the most evident feature. Fractures of the steeply dipping set are parallel to compositional layering in the Franklin Marble at this locality, and fractures of the other set probably correspond to a series of minor faults. Other than the abundant feldspar in the Hardyston Quartzite, which fluoresces deep red under shortwave ultraviolet light, there is little to tempt the average mineral collector at this locality. However, one occasionally finds well-developed quartz crystals in solution vugs within fragments of Franklin Marble that had fallen into the Hardyston sand before it was cemented (Fig. 13). These crystals are similar to those that have been recovered from vugs in the Buckwheat Dolomite in Franklin.

Possibly there are still older caves, ones that predate the Ottawa phase of the Grenville Orogeny (ca. 1.05 billion years ago; Volkert et al., 2010) and formed when the rock destined to become the Franklin Marble was still a limestone. The Franklin Marble is about 1.3 billion years old (Volkert et al., 2010), which means that about 250 million years elapsed between its initial accumulation as a sequence of carbonate muds and its eventual metamorphism to become the coarse-grained marble we see today. We know little of that long period of geologic time, but it would not be surprising if pre-Ottawa caves exist within the Franklin Marble but had not, until recently, been recognized for what they were. Two candidates exist at Sterling Hill, both adjacent to the East limb of ore. One of them, reasonably well exposed a few dozen yards south of the portal to the Edison adit, is a large mass of very coarse-grained, nearly black mica with subordinate reddish-brown garnet and dark green gahnite. This mica-rich body clearly cuts across the ore, in one place reducing it to a thickness of only two feet. The rest of the body extends into the footwall rocks below the ore and in those places is in contact with the Franklin Marble. For some years now, I have provisionally interpreted this feature as a cave that had become filled with mud and later—much later—subjected to high-grade metamorphism. The hydroxyl content of the original clays in the mud furnished the necessary water to form micas rather than pyroxenes, and the zinc content of

the ore layers is reflected in the presence of gahnite. Fragments of calcite embedded in the micaceous mass are suggestive of pieces of limestone that either fell or were washed into the mud as the cave was filling. A similar body was once present along the footwall of the East limb immediately north of the passage between the Fill quarry and the Passaic pit, but in recent years was destroyed by excavation. It too consisted dominantly of an irregular mass of coarse-grained black mica, boulders of which still remain scattered about, and it too contained gahnite and fragments of calcite. North of the main mass, thin layers of similar mica-rich rock extended parallel to compositional layering into the Franklin Marble. These probably reflect ancient dissolution of more soluble beds of the original limestone, similar to those found in many caves worldwide; these also became filled with mud and eventually were metamorphosed along with the enclosing limestone and ore layers. I stress that this interpretation is, at present, only an informed conjecture. Nevertheless, the prospect of mud-filled, pre-Ottawa caves is an intriguing one, deserving of careful mapping and mineralogical study of the mica-rich bodies to better establish their character.

Little has been said to this point about minerals of interest to collectors, other than the quartz crystals and large plates of mica mentioned above. Caves, after all, are erosional rather than depositional features, so their formation is more likely to result in the removal of minerals than their creation. All of that changes, however, if the water table drops to leave a cave, or extensive portions of it, above the water table. In that case, mineral-laden, downward percolating water can drip into the cave system and begin developing the large collection of features known collectively as cave *decorations* (or, technically, *speleothems*): stalactites, stalagmites, flowstone, curtains, cave pearls, etc. But how does this occur?

Most cave speleothems are composed of calcite, $CaCO_3$, the same mineral that was dissolved to form the caves in the first place. Calcite precipitates in caves as the water table drops to leave air-filled passages. As descending, carbonate-saturated water flows or drips into such passages, the chemical reactions shown previously are essentially reversed:

$$Ca^{2+}(aq) + 2HCO_3^-(aq) \rightarrow CO_2\uparrow(g) + H_2O(l) + CaCO_3\downarrow(s)$$

The degassing of carbon dioxide occurs because the partial pressure of carbon dioxide in air is much less than that in water, driving the reaction toward the right as written above, and resulting in the precipitation of calcite. An additional but generally minor factor resulting in calcite precipitation is the evaporation of some of the water. In both cases the reaction results in the growth of speleothems and the release of carbon dioxide gas into the cave atmosphere.

Although no large caves exist in the immediate area that we can enter to witness this process, and the caves once intersected by the mine workings are again underwater, a good proxy for a cave is the Sterling mine itself. Within it one can witness the various processes that lead to cave decoration and examine the deposits so formed. Water dripping from the back has in places formed small stalactites, the longest about five inches, and flowstone coating the mine ribs is seen in numerous areas. In a few areas, cave pearls (called "mine pearls" in this context, for obvious reasons) have started to form. An interesting property of nearly all of these deposits is their fluorescence, which under longwave UV is generally white, bluish white, or greenish white, but under shortwave

UV is decidedly more inclined toward blue. The longwave fluorescence is common to much cave calcite worldwide and is due to organic compounds present as molecular inclusions in the calcite. Mostly these are the aforementioned humic and fulvic acids derived from the overlying soils, carried downward in solution. The bluish shortwave fluorescence, however, is possibly due to hydrozincite, a weathering product of the zinc ores, deposited along with calcite in the flowstone and other cave decorations in those parts of the mine that lie in and near the orebody. Bluish-white-fluorescing flowstone (Fig. 14) and mine pearls, particularly pearls that have been cut open to reveal bits of fluorescent zinc ore within (Fig. 15), make attractive specimens and are popular collector items.
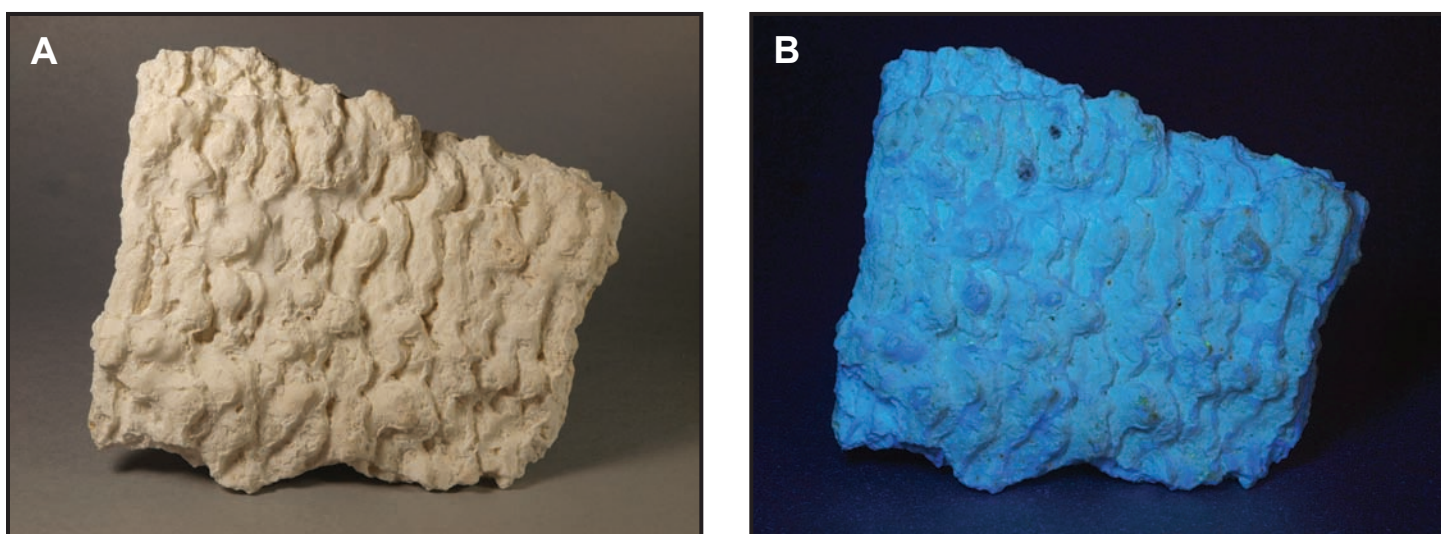

Figure 14. A lightweight, porous mass of postmining carbonate flowstone from Sterling Hill, shown under (A) white light and (B) shortwave (SW) ultraviolet light. The blue to blue-white fluorescence SW is probably due to hydrozincite intergrown with the calcite. Elna Hauck collection; specimen size is 7 × 6¼ × 1¼ inches (18 × 16 × 3 cm). *Earl R. Verbeek photo.*
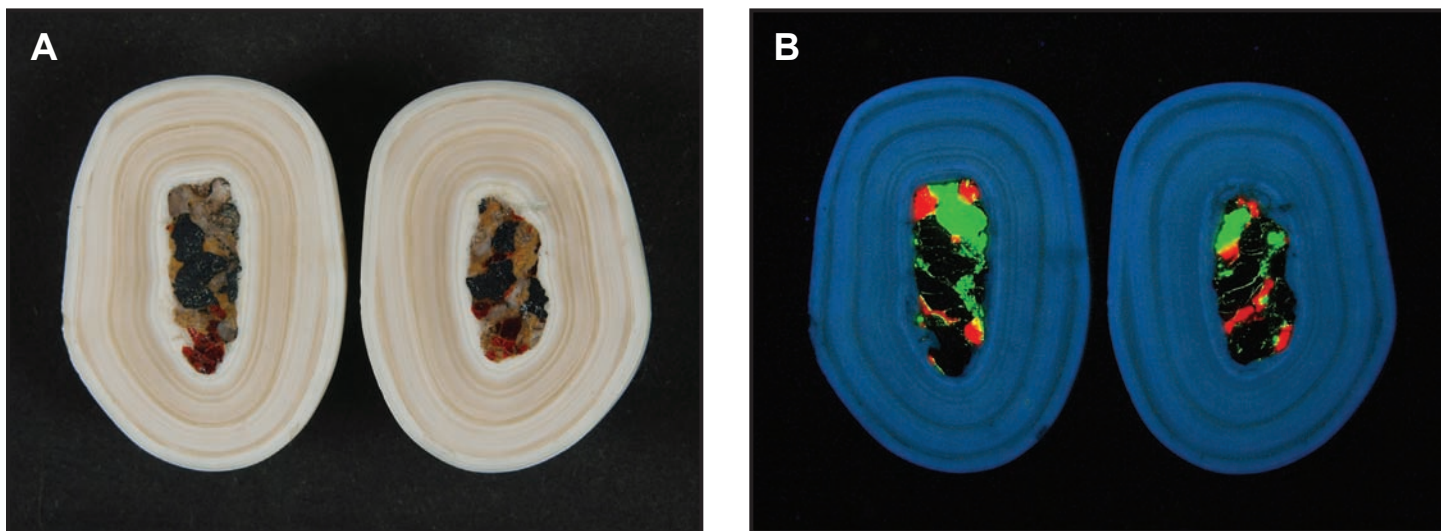

Figure 15. A Sterling Hill mine pearl, cut in half and polished to show the embedded ore fragment around which growth of the pearl began, photographed under (A) white light and (B) SW ultraviolet light. The photographed face measures 0.8 × 0.6 inch (2.1 × 1.5 cm). *Earl R. Verbeek specimen and photos.*

BRECCIA PIPES

Vertically extensive bodies of solution-collapse debris, described as "rubble breccia" by Metsger (1980, 2001), were found repeatedly during the course of mining operations at Sterling Hill. Most had vertical extents of tens to hundreds of feet, but Metsger (2001) described one example as a pipelike body extending from above the hanging wall of the orebody on 700 level through the footwall below 1850 level (thus a minimum vertical extent of 1,150 feet), with horizontal dimensions of roughly 300 feet × 100 feet. Metsger regarded these as karst features related to cave formation in the Franklin Marble and overlying Paleozoic rocks, a conclusion in full accordance with the known facts thus far.

Similar pipelike bodies of breccia are known in many other parts of the world and are intimately related to cave systems. To understand their genesis in general terms, envision a large cavern underground. Rainwater percolating downward through fractures progressively weakens the rock above the cavern, eventually leading to collapse of the cavern roof. After the collapse, the cavern roof is higher than it was before, and a pile of collapse debris lies on the cavern floor. Meanwhile, downward-percolating rainwater will continue to alter, dissolve, and generally weaken the overlying rocks, leading to another collapse event, then another, and so on. The same rainwater, flowing through whatever collapse breccias have already formed, commonly dissolves carbonate minerals from those rock units that contain them, thereby freeing grains of insoluble minerals to accumulate as a sandy to muddy matrix between the rock fragments. Some of this sand and mud sifts downward through the breccia, eventually to be redistributed through the underlying cave system by subterranean streams. The end result of such successive solution-collapse events is a pipelike structure rooted in a pre-existing cavern and filled with solution-collapse debris derived from all of the rocks overlying the original cave system. Breccia pipes typically have diameters of 100 to 300 feet and vertical extents of 1000 feet or more; some breach the land surface and are exposed as deep pits with rubble floors. Because such breccia pipes transect multiple rock units, and allow fluid flow through them virtually unimpeded, they are frequently mineralized and, in some areas, constitute low-tonnage but high-grade ore deposits. The uranium-mineralized breccia pipes of the Grand Canyon area in Arizona are a prominent example (Wenrich, 1985; Verbeek et al., 1988). Some of the larger breccia pipes documented in the Sterling mine probably formed in similar manner.

Other breccia bodies in the Sterling mine formed along faults, which provided effective conduits for fluid flow and dissolution to occur. Fault breccias were discussed in Part 2 of this series and formed in brittle rocks during several episodes of fault movement; examples from both Sterling Hill and Franklin are abundant. Fluids migrating through such fault breccias often modify them by solution, resulting in rounding of the original breccia clasts, progressive accumulation of insoluble mineral grains within the fault zone, and production of additional void space as the dissolved components of the rock are carried away. Weakening of the wall rock by alteration and dissolution can lead to further breccia production as portions of the wall rock collapse. As noted before, faulting, dissolution, alteration of existing minerals, and formation of new ones are processes that have often acted repeatedly, and in concert, during the course of the lengthy geologic history of our two zinc deposits. Specimens abound to prove the point.

Collectors of our local minerals are already familiar with several products of such breccia bodies. The character of the breccia differs markedly from place to place, depending on (a) the nature of the broken rock fragments constituting the breccia *clasts*; (b) the identity of the insoluble mineral grains that accumulated between the rock fragments, which collectively constitute the breccia *matrix*; and (c) the character of whatever later minerals precipitated in remaining open space and turned the loose mass into a rock (the *cement*). A few of the many variants are listed here:

1. Clasts of Franklin Marble in a matrix of insoluble mineral grains from that unit (diopside, norbergite, phlogopite, etc., but mostly graphite), cemented by calcite (Fig. 16).

Figure 16. Solution-collapse breccia from 700 level, Sterling mine, consisting of clasts of Franklin Marble in graphitic matrix, cemented by later carbonate. The graphite explains the dark matrix color of most solution-collapse breccia derived from the Franklin Marble. Specimen size is 5 × 4.9 × 2.8 inches (13 × 12.5 × 7 cm). *Earl R. Verbeek specimen and photo.*

2. Similar to (1), but with much fine-grained sphalerite cement, inconspicuous in daylight, that replaced some of the original calcite and precipitated in whatever open space remained between the mineral grains of the matrix and within the clasts themselves. Such specimens under ultraviolet light are texturally interesting; a fine example from Franklin, part of a much larger mass, is shown in Figure 17.

3. Fragments of red-fluorescent calcite, along with fragments of granular zinc ore containing variable proportions of calcite and willemite, in a sandy, carbonate-cemented matrix consisting of individual grains of willemite and franklinite (Fig. 18). The willemite and franklinite grains represent the insoluble residue of ore from which calcite had been removed by solution; later carbonate minerals recemented those grains into a coherent mass. Note the shape of the clasts: Some remain sharply angular, but others show variable degrees of rounding by solution.
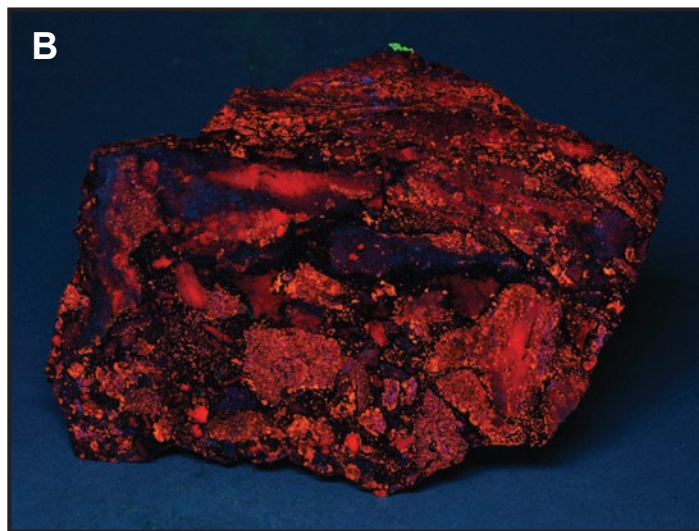

Figure 17. A specimen of probable solution-collapse breccia from Franklin. The clasts are dominantly Franklin Marble, but the whole has been mineralized with sphalerite, which lends to the specimen a sparkly appearance in daylight and a mottled orange fluorescence under longwave and medium-wave ultraviolet light. The red fluorescence of the calcite clasts suggests derivation from within the "manganese halo" of the Franklin orebody. (A), white light; (B) SW ultraviolet light. The specimen measures 6 × 4¼ × 2 inches (15 × 11 × 5 cm). *Earl R. Verbeek specimen and photos.*

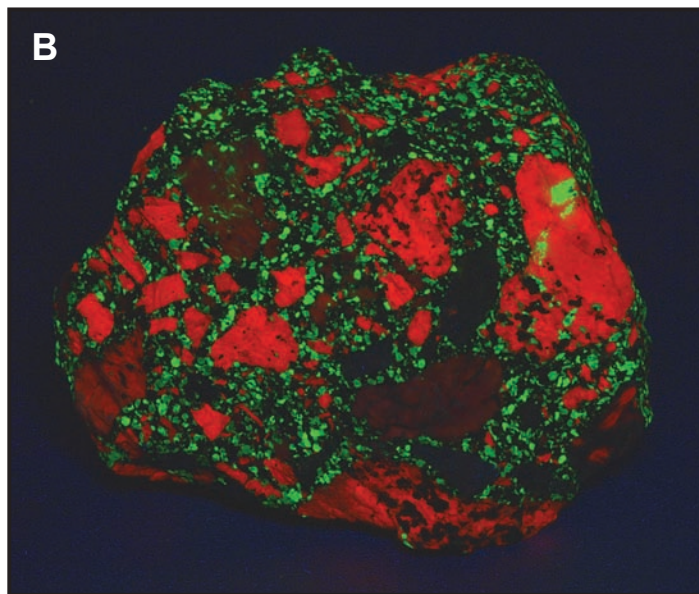**Figure 18.** A polymictic (mixed rock types) solution-collapse breccia containing clasts of red-fluorescent calcite marble and lean zinc ore in a matrix consisting of individual grains of franklinite and willemite cemented by later carbonate. This specimen, 5¾ × 4¼ × 3¾ inches (14.5 × 11 × 9.5 cm), is shown under (A) white light and (B) SW ultraviolet light. *Earl R. Verbeek specimen and photos.*

Figure 19. Solution-collapse breccia consisting of large fragments of zinc ore (right and top) and coarse-grained marble (left) cemented by fine-grained sphalerite. Specimen size is 10½ × 6¾ × 4 inches (27 × 17 × 10 cm). *Earl R. Verbeek specimen and photo.*

4. Mixed, altered clasts of Franklin Marble and zinc ore in a matrix of massive, reddish-brown, very fine-grained sphalerite (Fig. 19). Note the extreme rounding by solution of some of the clasts and the pinkish-orange alteration rind along the margins of the marble clast (left).

CONCLUDING REMARKS

As originally formed, at great depth (15-18 km) and high temperatures (769º ± 43º C; Peck et al., 2006) during the Ottawan phase of the Grenville Orogeny, the metamorphic rocks that now underlie the Franklin-Sterling Hill area would have contained only microscopic voids at best. Under such conditions, the rocks would have been ductile rather than brittle and could not have supported the large openings we see in them today. Any fluids present in the original, premetamorphic rocks would have long since been expelled, as would new fluids generated through chemical reactions as old minerals broke down and new ones formed through (in part) dehydration, dihydroxylation, and decarbonation reactions. During the roughly billion years that have elapsed since then, however, voids both large and small have formed in these rocks through various processes, including postmetamorphic cooling, depressurization as overlying rocks were gradually eroded, faulting, jointing, hydrothermal alteration and dissolution, cave formation, and weathering and continued dissolution of the rocks by groundwater flow. The legacy of these events is preserved in our local mineral collections, most notably in the many dozens of vein and cavity minerals for which this area

is so deservedly famous. Consider, for a moment, what our mineral list, now more than 365 species strong, might look like if these events hadn't taken place: no manganberzeliite, no schallerite or friedelite, no barysilite, no arsenate minerals from either locality, no radiating willemite…one could go on and on, listing more than 300 mineral species that might never have been found here, had open space not been available for their formation.

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Mineral Species Found At Franklin And Ogdensburg, NJ

REVISED BY THE FMM MINERAL LIST COMMITTEE, AUGUST 2015

The Franklin Mineral Museum (FMM) is responsible for publishing an annual list of mineral species known to occur in the Franklin Mining District. This list has traditionally appeared every fall in the show booklet for the Franklin-Sterling Gem and Mineral Show, an event sponsored by the FMM and now in its 59th year, and is also published on occasion in *The Picking Table*. A museum-appointed Species List Committee prepares this list in consultation with various subject-matter experts. Members of the current committee are Richard Bostwick, Dr. Steven Kuitems, Lee Lowell, Tony Nikischer, and Dr. Earl Verbeek. Vandall King provided extensive technical assistance and advice regarding the current list in preparation for a soon-to-appear book on the local minerals.

The Species List Committee holds to strict standards of identification. Before the advent of this committee and involvement of the Franklin Mineral Museum, some previous lists were flawed by incorrect sight identifications (often of minerals that were not inherently sight-identifiable), insufficient data to uphold a claimed identification, or claims of positive identifications based on unknown or unrevealed sources. In addition, problems of fabricated species identifications occurred on occasion, especially when such claims would result in financial gains through increased mineral sales. To hold such problems to a minimum, it is the policy of the Committee to accept only well verified species to its lists. To validate a claim of a mineral new to the area, the Committee requests copies of the original data and specification of the analytical methods used. The discoverer is further requested to submit a descriptive article to *The Picking Table*, the journal of the Franklin-Ogdensburg Mineralogical Society, for the benefit of the society's members.

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This list conforms to the nomenclature of the International Mineralogical Association (IMA) except where noted. Comments, questions, and suggested revisions should be directed to: fmm1954@earthlink.net.

In list below, F = Franklin, O = Ogdensburg, (TL) = type locality, **bold type** = mineral unique to the Franklin-Ogdensburg area. Superscript numbers refer to footnotes at end of list.

Acanthite – F,O

Actinolite – F,O

Adamite – F,O

Adelite – F,O

Aegirine – F,O

Aegirine-augite – F

Akrochordite – O

Albite – F,O

   var. oligoclase – F

Allactite – F,O

Allanite-(Ce) – F

Alleghanyite – F,O

Almandine – F?

Analcime – F

Anandite[1] – O

Anatase – F

Andradite – F,O

Anglesite – F,O

Anhydrite – F,O

Annabergite – F

Annite – O

Anorthite – F,O

Anorthoclase[2] – F

Antigorite – F

Antlerite – F

Aragonite – F,O

Arakiite – F

Arsenic – O

Arseniosiderite – O

Arsenolite – O

Arsenopyrite – F,O

Atacamite – F

Augite – F,O

Aurichalcite – F,O

Aurorite – O

Austinite – F,O

Axinite-(Fe) – F

Axinite-(Mn) – F (TL), O

Azurite – F,O

Bakerite – F

Bannisterite – F (TL)

Bariopharmacosiderite – O

Barite (IMA = baryte) – F,O

Barylite – F

Barysilite – F

Bassanite – O

Baumhauerite – O

Bementite – F (TL), O

Berthierite – O

Bianchite – O

Birnessite – O

Bornite – F,O

Bostwickite – F (TL)

Brandtite – O

Breithauptite – F

Brochantite – F,O

Brookite – F

Brucite – F,O

Bultfonteinite – F

Bustamite – F (TL), O

Cahnite – F (TL)

Calcite – F,O

Canavesite – O

Carrollite[3] – F

Caryopilite – F,O

Celestine – F,O

Celsian – F

Cerussite – F,O

Chabazite-Ca – F,O

Chalcocite – F,O

Chalcophanite – F,O (TL)

Chalcopyrite – F,O

Chamosite – F

Charlesite – F (TL)

Chloritoid – F

Chlorophoenicite – F (TL)

Chondrodite – F

Chrysocolla – F,O

Chrysotile – F,O

   var. clinochrysotile – F

   var. orthochrysotile – F

   var. parachrysotile – O

Cianciulliite – F (TL)

Clinochlore – F,O

Clinoclase – O

Clinohedrite – F (TL)

Clinohumite – O

Clinozoisite – O

Clintonite[4] – F

Conichalcite – O

Connellite – O

Copper – F,O

Corundum – F,O

Covellite – O

Cryptomelane – O

Cummingtonite – O

Cuprite – F,O

Cuprostibite – F

Cuspidine – F

Cyanotrichite – O

Datolite – F

Descloizite – O

Devilline – O

Digenite – O

Diopside – F,O

Djurleite – F,O

Dolomite – F,O

Domeykite – F

Dravite – F,O

Duftite – O

Dundasite – O

Dypingite – F,O

Edenite[5] – F,O

Epidote – F,O

Epsomite – O

Erythrite – F,O

Esperite – F (TL)

Euchroite – O

Eveite – O

Fayalite – F,O

Feitknechtite – F (TL)

Ferrimolybdite – O

Ferro-actinolite – F

Ferrohornblende – O

Flinkite – F

Fluckite – O

Fluoborite – F,O

Fluorapatite – F,O

Fluorapophyllite-(K) – F,O

Fluorapophyllite-(Na) – F

Fluorite – F,O

Fluorophlogopite – F,O

Fluor-uvite – F (TL), O

Forsterite – O

Fraipontite[6] – O

Franklinfurnaceite – F (TL)

Franklinite – F (TL), O

Franklinphilite – F (TL)

Friedelite – F,O

Gageite – F (TL)

Gahnite – F,O

Galena – F,O

Ganomalite – F

Ganophyllite – F

Genthelvite – F,O

Gersdorffite – F

Gerstmannite – O (TL)

Glaucochroite – F (TL)

Glaucodot – F

Goethite – F,O

Gold – O

Goldmanite – O

Graeserite – O

Graphite – F,O

Greenockite – F,O

Grossular – F,O

Groutite – F

Grunerite – F

Guérinite – O

Gypsum – F,O

Haidingerite[7] – O

Halotrichite – O

Hancockite – F (TL)

Hardystonite – F (TL)

Hastingsite – F,O

Hauckite – O (TL), F

Hausmannite – F

Hawleyite – F,O

Hedenbergite – F

Hedyphane – F

Hellandite-(Y) – F

Hematite – F,O

Hemimorphite – F,O

Hendricksite – F (TL), O

Hercynite – F,O

Hetaerolite – O (TL), F

Heulandite-Na – O

Hexahydrite – O

Hodgkinsonite – F (TL), O

Holdenite – F (TL), O
Hübnerite – F
Humite – F,O
Hydrohetaerolite – O (TL)
Hydrotalcite – F,O
Hydroxyapophyllite-(K) – F
Hydrozincite – F,O

Ilmenite – F

Jacobsite – F
Jarosewichite – F (TL)
Jarosite – F
Jerrygibbsite – F (TL)
Johannsenite – F (TL)
Johnbaumite – F (TL), O
Junitoite – F

Kaolinite – O
Kentrolite – F
Kittatinnyite – F (TL)
Kolicite – F,O (TL)
Köttigite – O
Kraisslite – O (TL)
Kutnohorite – F,O

Larsenite – F (TL)
Laumontite – O
Lavendulan – O
Lawsonbauerite – O (TL)
Lead – F
Legrandite – O
Lennilenapeite – F (TL)
Leucophoenicite – F (TL)
Linarite – O
Liroconite – O
Lizardite – F
Löllingite – F,O
Loseyite – F (TL)

Magnesiochlorophoenicite – F (TL)
Magnesio-hornblende – F,O
Magnesio-riebeckite – F
Magnetite – F,O

Magnussonite – O
Malachite – F,O
Manganberzeliite – F
Manganhumite – F
Manganite – F
Manganocummingtonite[8] – F,O
Manganohörnesite – O
Manganosite – F
Manjiroite – O
Marcasite – F
Margarite – F,O
Margarosanite – F (TL)
Marialite – F
Marsturite – F (TL)
Mcallisterite – O
Mcgovernite – O (TL)
Meionite – F,O
Meta-ankoleite – O
Metalodèvite – O
Metazeunerite – O
Microcline – F,O
Miguelromeroite[9] – O (TL)
Mimetite – F,O
Minehillite – F (TL)
Molybdenite – F,O
Monazite-(Ce) – F
Monohydrocalcite – O
Mooreite – O (TL)
Muscovite – F,O

Nasonite – F (TL)
Natrolite – O
Nelenite – F (TL)
Neotocite – F,O
Newberyite – O
Niahite – O
Nickeline – F
Nontronite – O
Norbergite – F,O

Ogdensburgite – O (TL)
Ojuelaite – O
Opal – F,O
Orthoclase – F

Orthoserpierite – O
Otavite – O

Parabrandtite – O (TL)
Paragonite – O
Pararammelsbergite – F
Pararealgar – O
Parasymplesite – O
Pargasite – F
Pectolite – F
Pennantite – F
Petedunnite – F (TL)
Pharmacolite – O
Pharmacosiderite – O
Phlogopite – O
Picropharmacolite – O
Piemontite – O
Pimelite[10] – F
Powellite – F,O
Prehnite – F
Pumpellyite-(Mg) – F
Pyrite – F,O
Pyroaurite – O
    var. pyroaurite - 2H (pyroaurite)
    var. pyroaurite - 3R (sjögrenite)
Pyrobelonite – F
Pyrochroite – F,O
Pyromorphite[11] – O
Pyrophanite – O
Pyrosmalite-(Mn) – O (TL)
Pyroxferroite – F
Pyroxmangite – F,O
Pyrrhotite – F,O

Quartz – F,O

Rammelsbergite – F
Realgar – O
Retzian-(La) – O (TL)
Retzian-(Nd) – O (TL)
Rhodochrosite – F,O
Rhodonite – F,O
Ribbeite – F
Richterite – F

Roeblingite – F (TL)

Roméite[12] – F

Rosasite – F,O

Rouaite – O (TL)

Roweite – F (TL)

Rutile – F,O

Safflorite – F

Samfowlerite – F (TL)

Sarkinite – F,O

Sauconite – O

Schallerite – F (TL)

Scheelite – F,O

Schorl – O

Sclarite – F (TL)

Scorodite – O

Seligmannite – O

Sepiolite – F

Serpierite - O

Siderite – F,O

Sillimannite – O

Silver – F,O

Skutterudite – F

Smithsonite – F,O

Sonolite – O

Spangolite – O

Spessartine – F,O

Sphalerite – F,O

Spinel – F,O

Starkeyite – O

Sterlinghillite – O v

Stibnite – O

Stilbite – O

Stilpnomelane – F

Strontianite – F

Sulfur (IMA = sulphur) – O

Sussexite – F (TL), O

Synadelphite – O

Synchysite-(Ce) – F

Szaibélyite – O

Talc – F,O

Tennantite – F,O

Tenorite – F

Tephroite – O (TL), F

Tetrahedrite – O

Thomsonite-Ca – F,O

Thorite – F

Thortveitite – O

Thorutite – F

Tilasite – O

Titanite – F,O

Todorokite – F,O

Torreyite – O (TL)

Tremolite – F,O

Turneaureite – F (TL)

Uraninite – F,O

Uranophane – O

Uranospinite – O

Vesuvianite – F,O

   var. cyprine – F

Wallkilldellite – O (TL)

Wawayandaite – F (TL)

Wendwilsonite (TL) – O

Willemite – F,O

Wollastonite – F,O

Woodruffite – O (TL)

Wulfenite – O

Wurtzite – O

Xonotlite- F

Yeatmanite – F (TL), O

Yukonite – O

Zincite – F (TL), O

Zinkenite – O

Zircon – F,O

Znucalite – O

[1] Chemical analyses of a brittle mica from Sterling Hill show that it corresponds to the unnamed chlorine analogue of anandite.

[2] Anorthoclase is no longer recognized as a separate species, but as an alkali feldspar intermediate between low sanidine and high albite. Albite is on the Franklin-Sterling Hill species list; sanidine is not. To which species existing specimens labeled "anorthoclase" belong is uncertain, pending further study. For that reason we do not yet include anorthoclase in the total species count.

[3] Reported in Dunn (1995), with analysis, but the identification has not been corroborated by the cited authority.

[4] Provenance uncertain. Added by Struwe (1957), but analyzed specimen is possibly from Amity, NY, area, and not Franklin.

[5] Possibly fluoro-edenite; further analyses needed to establish F:OH ratios.

[6] Originally described as zinalsite; nomenclature changed by IMA.

[7] Reported from Sterling Hill, but without supporting data. Further study needed.

[8] Nomenclature revision pending with the IMA.

[9] Originally described as villyaellenite from Sterling Hill in 1995, but subsequently redefined in 2009 as miguelromeroite.

[10] Material from Franklin appears to be a nickel-dominant smectite clay, and thus properly labeled pimelite rather than willemseite, a nickel-dominant talc mineral. Further study needed.

[11] Possibly phosphohedyphane or a related species; more detailed analysis required.

[12] Roméite is no longer a species name but refers to a series of minerals intermediate between oxyplumboroméite and fluorcalcioroméite. Partial chemical analyses published in Dunn (1995, p. 604) suggest that the member present in the local area is either fluorcalcioroméite or, more likely, the as-yet-unnamed hydroxyl analogue of that species.

Total Mineral Species = 366   **Total Unique Minerals** = 19 **(bold)**

Total Type Locality (TL) **Species** = 71   ⚒

John Kolic:
A Keen Eye and a Good Heart

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On a warm summer day in 1971, Henry Van Lenten and I finished our business at the Franklin Mineral Museum and walked across Evans Street to peer through the fence that protected the Buckwheat Pit from miscreants (and vice versa). We were speculating when mining in the pit had finished and were lost in conversation, when a slim fellow walked over. He wore shoulder-length hair and a headband. "Hello, my name is John. John Kolic." This was the beginning of a long friendship.

John and I had our first collecting trip together at the road cut for I-80, east of Denville. He was pleased with fluorescent feldspar from the gneisses there. At that time, John drove a truck for a scrap aluminum recycler. I had been a miner at Sterling Hill for two years and worked for Gene Clyne, Shift Boss for the Upper Section. At that time, Gene's interest in the local minerals was at its highest pitch, and he was trading mine specimens to Ewald Gerstmann for Franklin classics. It was through Gene that many rare Sterling Hill minerals became known.

John was willing to try his hand at mining, so I approached Gene to see if he could use another man. He set things up so John could start as a New Jersey Zinc Company employee. As I recall, this was in 1973. After John came to work, he was assigned to the Middle Section, but Gene soon had him helping Fred Crump in a crown pillar on 800 level. One day John noticed a cap lamp bobbing around in the back of the pillar when Gene stopped by to check their progress. Then Gene showed up after work with a specimen of very fine pyroaurite crystals. Try as he might, John never did find where Gene got that specimen, but soon he found beautiful alleghanyite crystals in Fred's pillar. So began John's self-proclaimed mission in life, "saving good specimens from the crusher." And he did!

Before long, Gene moved John into a stope of his own, also on 800 level. Fred's pillar was in the West Limb and John's was in the East Branch of the West Limb. John's workplace, 1010 stope, was destined to become part of the lore and legend of the Franklin Mining District. One of John's first tasks was to lengthen 1010 stope to the south, and for this he had to drill and fire several drift rounds. Many years earlier, the Zinc Company had worked out a drill hole pattern and firing sequence for drift rounds in the Franklin Marble, which because of its peculiar nature would choke the blast if the holes were not in the right place and the explosives in them were not detonated in the right order. The key to the NJZ drift round was a modified "burn," a pattern of drill holes in the center of the drift round, designed so the first shot of the blast broke enough rock to make a space for the second shot to break rock into, and so on. In a successfully drilled and blasted drift round, all the rock would be broken up within the perimeters of the drill pattern. In a choked blast, however, some of the shots could not break the rock around them all the way to the ends of the holes; this was called "frozen ground."

On the day of John's first drift round, I finished my work and stopped by 1010 stope to see how John was making out. I arrived as he was finishing loading the explosives, and said, "Hey, John, how's it going?" He answered, "Fine!" I studied the sequence of blasting caps and said, "You know, I've never seen a round loaded like that." John explained patiently, "Mining is an art, and there are several ways to solve any problem." So I made my way up the raise to 700 level, to guard against accidental entry into 1010 stope during the blast. When it did go off, I thought, "Boy, that sounded strange." Next day I went by 1010 to see how the round broke, and was astounded to see the face of the drift round mostly intact, drill holes and all. Then I saw a raggedy hole on the lower left of the face, about the size of a grapefruit. Peering inside, I saw a hollow space about three feet wide. John was so mortified he didn't say anything, so I didn't either and tiptoed off to my workplace. (I must point out that this outcome was not John's habitual result. The standard drift round in Sterling Hill's unruly rock was seven feet long, and in a few years John could regularly drill and break drift rounds thirteen feet deep. I never met another miner who could pull this off.)

At any rate, in a short time John had 1010 stope under control, and I was assigned on several instances to work with him. One day I was roofbolting and John was drilling upholes to the south. Soon lunchtime rolled around and John called a halt. We wolfed down our noon meals and headed out to look for specimens. John stayed in the stope and I descended the short ladderway to 800 level to look for alleghanyhite in Fred Crump's abandoned pillar. I had just stepped onto the level when John cried out loudly, "Steve, Steve, come here!" He sounded upset, so I ran back up the ladder, with visions of him hanging by his fingertips in the crib, or perhaps pinned down by loose. Reaching the stope, I saw his cap lamp on the muck pile, unmoving. As I raced up, I saw him crouching under the hanging wall. In his lap was a slab of brown tephroite whose

top surface was pink with hundreds of curved rhombohedral crystals of rhodochrosite.

"John, I thought you were in trouble!"

"No, not right now. Say, would you look at this rock..."

"John! You sounded like…"

"Here, Steve," John said, and handed me a piece about 3½ x 2 inches in size, with rhodochrosite crystals and barite blades that fanned out like fingers. I shut up.

Another time we were drilling upholes for the next cut. I changed drill steels while John ran the Simba, a single-boom jumbo drill. Finally he checked his watch and shut down the drill. I thankfully flipped up my "mouse ears" (hearing protectors) and started out. "Wait a minute," John said, and picked up a scaling bar. He then popped off a nice crystal of red willemite from a place I'd stood under for the last two hours.

During this period, we also field-collected in Franklin, and found good specimens, including esperite and hancockite, near the Sussex Bank. In Shuster Park, by the bandstand, we found more hancockite, and green fluorapatite with willemite the color of red wine.

Besides this serious business, John was not averse to a little monkey business. One day, when work was done, he and another miner were waiting on the shaft station to report to their boss via telephone. As the cage approached their level, the cageman, Steve Yanecko, readied an oil-and-water-soaked rag and launched the missile, hitting John's co-worker in the face. Vowing revenge, the two found a ten-foot section of fill hose and filled it with water from the drinking fountain. One end of the hose was secured with wire to the barrier around the shaft, and the other was fitted with an air coupling and attached to a compressed-air line. When the cage passed by again, the conspirators turned on the air, and 20 gallons of cold water erupted, drenching Mr. Yanecko. He was still dripping when the cage picked them up ten minutes later.

This account could go on indefinitely, as John's mineral rescues were legion, and these tales only skim the surface. Nevertheless they suggest John's acuity, enthusiasm, and generosity.

In the end, all we can do now is say, "Auf wiedersehen, John. Auf wiedersehen." ⚒

Hancockite Reinstated as Species Name

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Hancockite was first described from Franklin, New Jersey, by Samuel Lewis Penfield and Charles H. Warren (1899). Although it has since been found in Sweden and Macedonia, it is and has always been a mineral associated with Franklin. Franklin is the richest source of the mineral, and Franklin material provided the prime research specimens for scientists such as Charles Palache, Wayne A. Dollase, Pete J. Dunn, and others. The original mineral was named after New Jersey resident Elwood P. Hancock (1835-1916), a landscape artist. Hancock started collecting minerals about 1854, and his mineral collection was bequeathed to Harvard University in 1916. Hancockite was the name used by Wayne A. Dollase to identify the structure in 1971 and remains the name in use by many collectors to this day.

When Thomas Armbruster et al. (2006) renamed hancockite as epidote-(Pb) in their nomenclature report on the epidote group, it was more than a change of names. It was perceived by many as an uprooting of scientific history and consequent damage to local pride. It caused as much havoc as a renaming of a mineral possibly could, so much so that, two years later, the chairman of the International Mineralogical Association (IMA) at the time, Ernst A. J. Burke, wrote, "The 2006 renaming of hancockite into epidote-(Pb) was greeted with considerable acrimony and was called 'an eternal insult from the IMA' in one editorial [Nikischer, 2007] in a collector publication." In 2014, Olav Revheim and Vandall T. King submitted a proposal to the Commission on New Minerals, Nomenclature, and Classification (CNMNC) of the IMA to reinstate hancockite at the expense of the little used and even less liked name, epidote-(Pb). The proposal was approved, and in their newsletter of September 2015 (Hålenius et al.), the CNMNC published their decision that hancockite is once again a valid mineral name.

Hancockite was first identified as a new mineral from the Parker Shaft in Franklin in 1899, where it was found in brick-red masses associated with andradite, franklinite, and axinite-(Mn). These masses can weigh as much as several kilograms, some of which contain small vugs with tiny hancockite crystals, generally no longer than 0.5 mm nor thicker than 0.15 mm. Material was then abundant and readily available on the Parker Dump. Nonetheless, Penfield and Warren struggled to get a good chemical analysis because "the small size of the crystals and their intimate association with garnet, axinite and willemite [created] considerable difficulty…in finding a specimen from which a sufficient quantity of pure material could be obtained for analysis. A specimen, however, finally
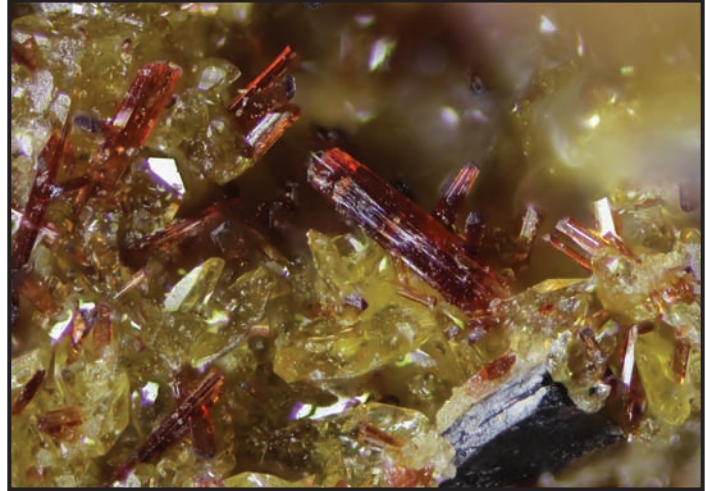
Hancockite (red) with yellow axinite-(Mn), Franklin, N.J. FOV = 3 mm. Detail of a micromount from the Elwood P. Hancock collection, now in the John Ebner collection. *Photo by Van King.*

came to us through Mr. Hancock, consisting of a cellular mass in which the walls and the drusy linings consisted chiefly of hancockite." They found the new mineral to be in every respect similar to epidote, except that it was unusually rich in Pb and Sr, and like piemontite had a red color caused by Mn^{3+}.

Hancockite was a name with 107 years' provenance when Armbruster et al. (2006) renamed it epidote-(Pb). To many it seemed illogical to rename a well-defined, approved mineral after so long a time, yet it was still done. The reasoning behind renaming many epidotes was not as farfetched as it was perceived in the mineral community. EPMA (Electron Probe Micro-Analysis) had become more common in the latter part of the 20th Century, and a large number of high-quality epidote-group chemical analyses were available. It became evident that the epidote group needed reorganization. In particular, allanite showed a wide range of compositions and normalization procedures that often led to incorrect species designations (see Ercit [2002], "The mess that is allanite").

The epidote nomenclature report by Armbruster et al. (2006) addressed these issues and categorized the known epidote minerals into subgroups. The nomenclature report gave clear guidelines for the logical placement of any new mineral in this hierarchy. It also provided clear naming practices for the epidote group minerals, so that each new epidote group mineral within an existing subgroup would be named in accordance with these principles. Following the naming conventions

decided on by Armbruster et al., hancockite, tweddillite, and niigataite did not justify their existing names, and renaming these minerals epidote-(Pb), manganipiemontite-(Sr), and clinozoisite-(Sr), respectively, was a consequent step in the implementation of the new nomenclature. Unfortunately, aversion to the decision to rename these three minerals, particularly hancockite, overshadowed the clarity anticipated by the nomenclature report. The damage to historical literature connections was also apparent. There was also the concern that the IMA had already approved tweddillite and niigataite as new names, and had "grandfathered" hancockite, thereby effectively precluding the renaming of existing species by the IMA's own guidelines.

The IMA revised its guidelines for mineral nomenclature in 2013 (Hatert et al.), putting stronger emphasis on historical names. This opened the opportunity for submitting a proposal to reinstate hancockite, niigataite, and tweddillite. The proposal, which was submitted by Revheim and King in late 2014, was approved by the CNMNC and published in their newsletter, September 2015. The full proposal will be published in *Mineralogical Magazine*.

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Letters From the Past

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This installment of "Letters From the Past" presents an important communication in the early history of Franklin as a mining and industrial town. During the early to mid 1800s, many efforts were made to smelt franklinite as an ore of iron, but the intractable ore repeatedly fouled the furnaces. By 1817, much of the Franklin area was owned by Dr. Samuel Fowler, who took a keen interest in understanding the nature of his ores. In 1826, he sent samples of franklinite and zincite to the noted Swedish chemist and mineralogist Jöns Jacob Berzelius, with the following letter requesting his insights on how to work these ores. While there is no record of any reply, Dr. Fowler and others continued to experiment with these perplexing ores. Eventually it was learned that franklinite could be smelted in Franklin's old charcoal-fueled furnace when it was mixed at no more than 1 part per 10 parts magnetite. It wasn't until much later in the 19th Century that the zinc and iron components of franklinite could be processed separately. Here is Dr. Fowler's letter to Dr. Berzelius as transcribed verbatim, including archaic spellings and stylings, from James P. Snell's 1881 *History of Sussex and Warren Counties, New Jersey*:


"FRANKLIN, N.J., June 25, 1826."

"PROFESSOR BERZELIUS, LONDON:

"SIR,—I have taken the liberty of sending a small box of minerals to Mr. Gahn, of New York, who has promised to forward them to you. He has also been good enough to say that he would write to you on the subject. I reside in a section of country rich and interesting in minerals, both as to the numerous varieties of some and the immense quantities of others: I allude particulary to the franklinite and red oxide of zinc. The difficulty we experience in working the former I stated in my catalogue, inclosed in the box I sent you; the latter we have not attempted to work. Berthier, in his examination of the franklinite, did not apprehend the difficulty we experience in reducing the ore. He thought nothing about what the workmen call salamanders or the congelation of the iron in the furnace-hearth, which thereby obstructs the whole process. He examined but one variety of the ore,—which, I do not know. You will observe from the variety of the specimens I send you that it varies much in external appearance.

"There has been as yet but a very imperfect examination of the minerals of this place: I allude particularly to the valley comprising Franklin and Sparta, in New Jersey, and Warwick, in New York, which is a continuation of the same valley. The whole distance is about 25 miles. It is the region of the primitive or white carbonate of lime in which all our minerals occur. Nearly all found here have received names founded on the external character. If agreeable to you, it would afford me pleasure to transmit to you specimens of them all. I request nothing in return but your opinion; and if you can devise a method to work the franklinite and red oxide of zinc, or either, you will confer a lasting favor on New Jersey. The ore occurs here in sufficient quantity to supply all America with iron and zinc, and we look to you with greater confidence for information on the subject than to any other person.

"I beg you will excuse the liberty I have taken, and believe me, with great regard, your very humble servant,

"SAMUEL FOWLER."
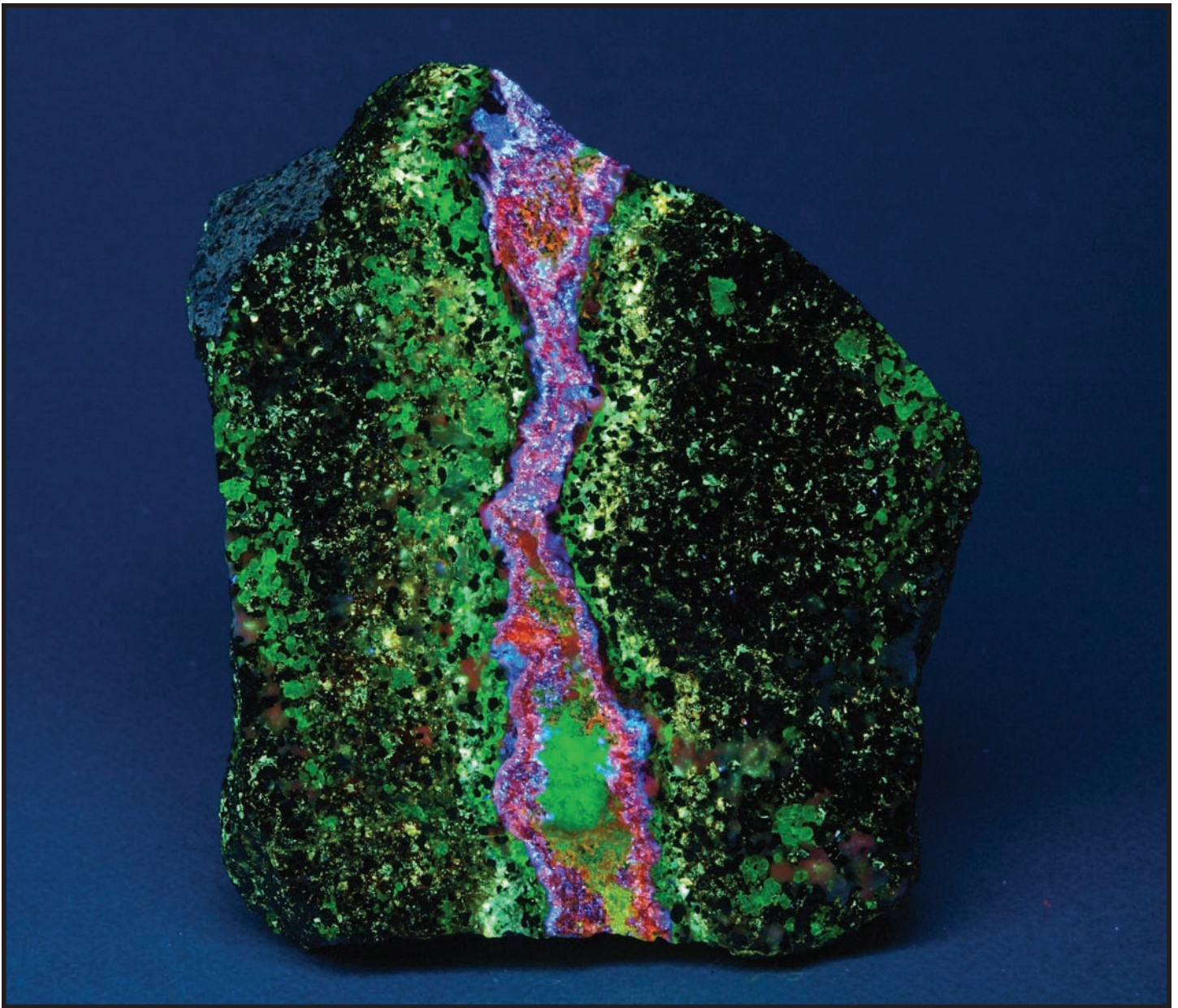
An attractive specimen of secondary sphalerite and zincite from a vein occurrence in 800 stope on 180 level, Sterling mine, Ogdensburg. Shown under longwave ultraviolet light, the sphalerite fluoresces orange through pink to blue, and the zincite, peripheral to the vein, fluoresces pale yellow. Green-fluorescing willemite, fluorescent green, is present both within the vein (toward bottom) and in the matrix of high-grade franklinite-willemite-zincite ore. Earl R. Verbeek specimen and photo, $4.7 \times 3.1 \times 1.6$ inches ($12 \times 8 \times 4$ cm).