# THE PICKING TABLE

JOURNAL OF THE FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY

VOL. 59, NO. 2 – FALL 2018

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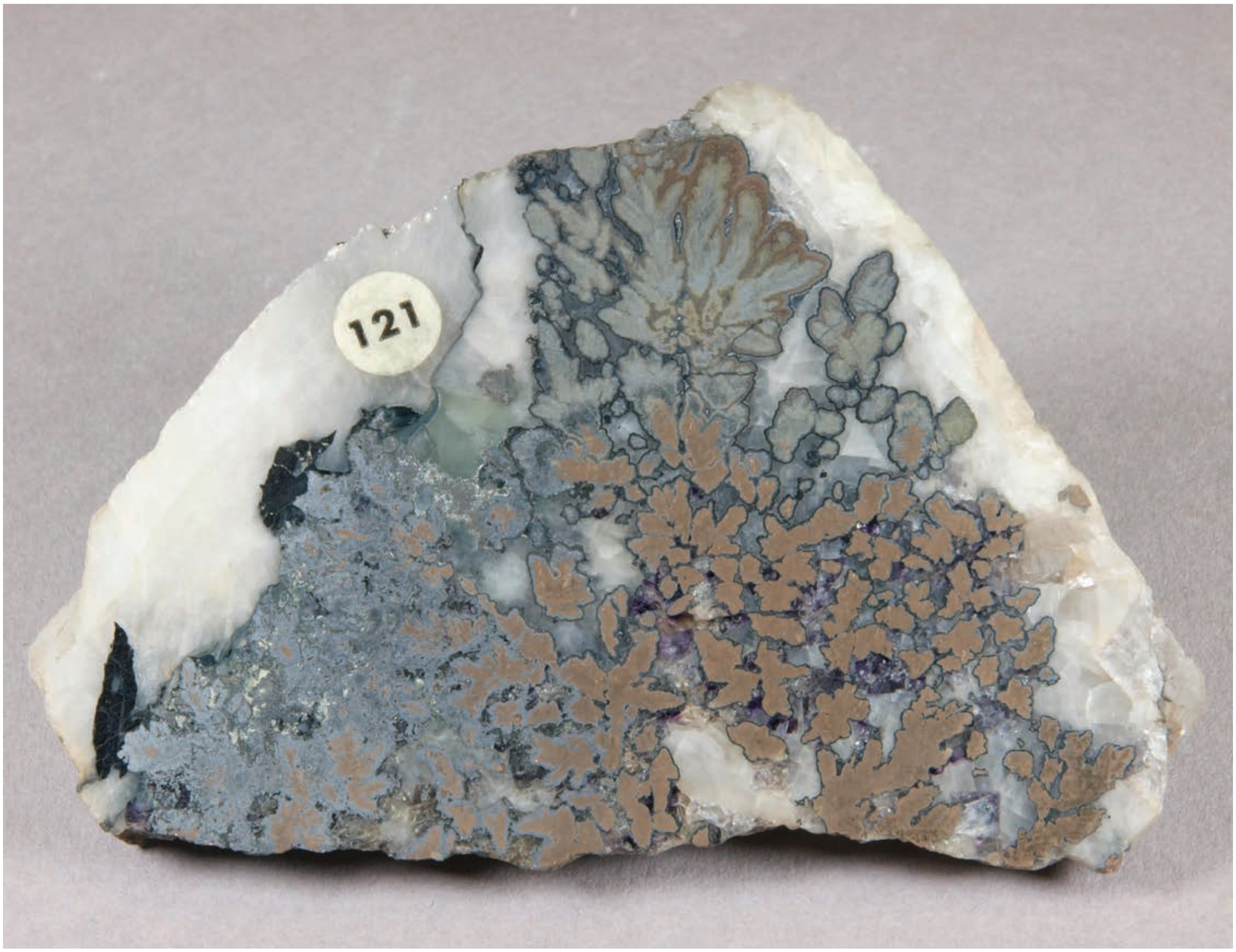


## IN THIS ISSUE



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# THE FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY, INC.

## OFFICERS AND STAFF



Thin plates of molybdenite in a coarse-grained matrix of dark green pyroxene and white calcite (fl. red), with minor pale tan feldspar and (not visible in photo) a small mass of pale honey-brown sphalerite. The slight blue cast to the color of the molybdenite helps to distinguish it from graphite. Fine-grained powellite, inconspicuous except for its yellow fluorescence, forms thin, irregular rims around some of the molybdenite grains. The specimen is from Sterling Hill and is 4.0 × 2.8 × 2.6 inches (10 × 7 × 6.5 cm) in size. *Earl R. Verbeek photo.*

THE
# PICKING TABLE

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### ABOUT THE FRONT COVER

An oblique slice through a dendritic mass of nickel arsenide minerals from the Trotter mine in Franklin. The coppery red mineral is nickeline (NiAs). Succeeding it, in outward growth of the dendrites, are pararammelsbergite ($NiAs_2$, pale gray), rammelsbergite (also $NiAs_2$, darker gray), and gersdorffite (NiAsS, brown, toward top). The black mineral in thin rims around the margins of the dendrites is stilpnomelane. The black mineral at left, in large grains, is magnetite. White calcite and violet fluorite are also present. Franklin Mineral Museum specimen FMM-121, 3.5 × 2.4 × 0.3 inches (9 × 6 × 0.8 cm); *Earl R. Verbeek photo*.


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*The Picking Table* is the official publication of the Franklin-Ogdensburg Mineralogical Society, Inc. (FOMS), a nonprofit organization, and is sent to all members. *The Picking Table* is published twice each year and features articles of interest to the mineralogical community that pertain to the Franklin-Ogdensburg, New Jersey, area.

Members are encouraged to submit articles for publication. Articles should be submitted as Microsoft Word documents to Richard J. Keller, Jr. at: PTMemberFeedback@gmail.com.

The views and opinions expressed in *The Picking Table* do not necessarily reflect those of FOMS or the editors.

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*The Picking Table* is printed on acid-free, chlorine-free paper.

# Fall and Winter 2018 Activity Schedule

**WEBSITE: WWW.FOMSNJ.ORG**

## SATURDAY, SEPTEMBER 15, 2018

**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.**

**NOON – 1:15 PM**
**Future Rockhounds of America**
Franklin Mineral Museum.
Parents are welcome to attend.
For questions, please contact Mark Dahlman at:
fra@fomsnj.org or 301-428-0455.

**1:30 PM – 3:30 PM**
**FOMS Meeting**
Franklin Mineral Museum.
Lecture: *Yesterday, Today and Tomorrow: A Franklin Potpourri*, by Bernard Kozykowski.

## SATURDAY AND SUNDAY SEPTEMBER 29-30, 2018

****62ND ANNUAL FRANKLIN-STERLING GEM & MINERAL SHOW**
Sponsored by the Franklin Mineral Museum.
Littell Community Center (formerly the Franklin Armory),
12 Munsonhurst Rd., 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 Littell Community Center grounds from 9:00 AM – 6:00 PM on Saturday, and from 10:00 AM – 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, OCTOBER 13, 2018

**6:00 PM – 9:30 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 $2.00 for each pound of material taken.
For more information, call 973-209-7212.

## SATURDAY AND SUNDAY OCTOBER 13-14, 2018

****NORTH JERSEY MINERALOGICAL SOCIETY SWAP.**
**9:00 AM – 5:00 PM**
Sterling Hill Mining Museum.

## SATURDAY, OCTOBER 20, 2018

**9:00 AM – NOON**
**FOMS Field Trip**
Collecting at Limecrest-Braen Stone Quarry,
Limecrest Road, Sparta, NJ.
Meet 15 minutes before starting time at the gate.
We will enter as a group and the gates will be closed.
Hard hats, leather shoes, preferably steel tipped, gloves and glasses required.

**NOON – 1:15 PM**
**Future Rockhounds of America**
Franklin Mineral Museum.
Parents are welcome to attend.
For questions, please contact Mark Dahlman at:
fra@fomsnj.org or 301-428-0455.

**1:30 PM – 3:30 PM**
**FOMS Meeting,**
Franklin Mineral Museum.
Lecture: *Mining at Sterling Hill*, by Doug Francisco.

## SATURDAY, OCTOBER 27, 2018

****29TH 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 (children 12 and under are free).
**"If your rocks don't glow, you're at the wrong show."**
Table space available. **For information, call Lee McIlvaine at 215-713-8020 or e-mail uvgeologist@yahoo.com.**

## SATURDAY, NOVEMBER 3, 2018

**6:00 PM – 9:30 PM**
****Night Dig on the Buckwheat Dump,**
for the benefit of the Franklin Mineral Museum.
Doors open at 6:00 PM for check-in and mineral sales.
Dig begins at 6:30 PM
Admission $10.00 adults, $8.00 children 3-12 years of age.
Poundage fee charged. **Call for details: 973-827-3481.**

## SATURDAY, NOVEMBER 17, 2018

**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.

**NOON – 1:15 PM**
**Future Rockhounds of America**
Franklin Mineral Museum
Parents are welcome to attend.
For questions, please contact Mark Dahlman at:
fra@fomsnj.org or 301-428-0455.

**1:30 PM – 3:30 PM**
**FOMS Meeting,**
Franklin Mineral Museum.
Lecture: *Railroading With NJ Zinc*, by John Bazelewich.

## SATURDAY, DECEMBER 1, 2018

**9:00 AM – 4:00 PM**
****FLUORESCENT MINERAL SOCIETY MEETING**
GeoTech Center, Sterling Hill Mining Museum.
Lunch will be served ($10.00 contribution).
**♦BYOB♦**
**!Reservations necessary!** Please contact Howie Green:
royalp53@verizon.net.

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***Events of interest to FOMS members will take place throughout the season at the Franklin Mineral Museum (website: www.franklinmineralmuseum.com and telephone: 973-827-3481) and the Sterling Hill Mining Museum (website: www.sterlinghillminingmuseum.org and telephone: 973-209-7212). Call, or visit their websites for further information.***

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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 membership in other organizations, may be required.

Any information in this schedule, including fees, is subject to change without notice.

*Compiled by Tema Hecht: thecht@att.net*

***Thanks go to Gary Moldovany, Bernard Kozykowski, Richard Keller, Howie Green, Mark Dahlman, Gary Kerstanski, the Franklin Mineral Museum, and the Sterling Hill Mining Museum for this information.***

# President's Message

**GARY MOLDOVANY**
116 LAFAYETTE ST.
HACKETTSTOWN, NJ 07840

First of all, I would like to extend my sincerest thanks to all the members of FOMS who give their time to volunteer for our various endeavors. The editors and staff of *The Picking Table*, our wonderful magazine, give generously of their time to ensure that our publication is top-notch. I also include the members who help park dealers at the swap and collect table fees; those who display their minerals and those who help with show setup and breakdown; and the folks who spent hours at the FOMS table, selling T-shirts, magazines and memberships. Our spring show, where we partner with the New Jersey Earth Science Association and the Sterling Hill Mining Museum, was once again a huge success due to the dedication of our volunteers.

We still need help with *The Picking Table*. Rich Keller, our managing editor, is searching for technical editors. If you can help, please reach out to him; contact information for all officers is inside the front cover. The FOMS members now on the *PT* staff have been giving generously of their time for many years, and fresh input is needed.

I read somewhere recently that some people believe the hobby of mineral collecting is dying. It's true that we have lost some truly great people in the past few years. Dr. Pete Dunn, whose memorial service was held at Sterling Hill this past May, is one of them. Recently I was saddened to learn of the passing of Ralph Thomas, whose interest in mineral collecting spanned at least five decades; he was thought of as a mentor by many of us. Our eternal thanks go to Dr. Dunn and Ralph for their immense contributions to science and our hobby.

More to the point, I attend quite a few mineral shows in the NY-NJ-CT tri-state area as well as on the West Coast. I have been seeing a renewed interest in fluorescent minerals, particularly those from our own Franklin/Sterling Mining District. The advent of the new UV LED flashlight, a low-cost alternative to the larger, more expensive UV lamps, is bringing many new people into the hobby. I have also been told that there is quite a market on the West Coast for Franklin rarities. All this bodes well for our hobby. Thanks to Mark Dahlman, FOMS is also participating in the AFMS program, Future Rockhounds of America, which is helping to teach mineralogy to young people and get them interested in our hobby.

There are now many sites for mineral collectors on social media; even FOMS has its own website (www.fomsnj.org) and Facebook page. So does the Fluorescent Mineral Society, whose Facebook group (www.facebook.com/groups/fluorescentminerals) has a lot to offer, including experienced collectors giving lots of good advice to beginning collectors. This kind of mentorship is what's needed in our hobby, just as it was generations ago when well-known collectors such as Richard Hauck, Ewald Gerstmann, John L. "Jack" Baum, and Nick Zipco were helping to build interest in and knowledge of Franklin/Sterling Hill minerals and the history of the Franklin Mining District. ⚒

A vein of pale yellow, fine-grained, hydrothermal zincite cutting granular willemite-franklinite-zincite-calcite ore from Sterling Hill. Note the alteration zones in the wall rock adjacent to the vein. Within these zones, the primary (dark red) metamorphic zincite is no longer present, though some remains in the ore farther from the vein. The vein zincite fluoresces pale greenish-yellow under longwave ultraviolet light. The activator is unknown, but it is the same as that responsible for the fluorescence of zincite from the slag piles of the Palmerton, Pa., smelter, as shown by their identical fluorescence emission spectra. This specimen, from Sterling Hill, measures 4.0 × 2.8 × 2.6 inches (10 × 7 × 6.5 cm) and is no. FMM-43 in the collection of the Franklin Mineral Museum. *Earl R. Verbeek photo.*

# From the Editor's Desk

**RICHARD J. KELLER, JR.**
13 GREEN STREET
FRANKLIN, NJ 07416
FranklinNJ@hotmail.com

Welcome, one and all, to the Fall 2018 *Picking Table*.

The first thing you may notice is that this *PT* is shorter than our Spring 2018 issue, which was 45 pages long and is already a collector's item due to its articles honoring the late, great mineralogist, Pete J. Dunn. In fact, you'd have to go back to 1999 and the 88-page, 40th Anniversary issue to find a longer *PT*. However, the sheer number of volunteer hours that went into the "Pete Dunn memorial issue" made me decide to give our editors a break… So this issue is shorter — back to normal, you might say — and as always we're proud of what we do.

It is, however, my sad duty to inform our members that Earl Verbeek has resigned from the editorial board of the *PT*. He's done more than anyone could reasonably expect during the 8 years I've been the *PT*'s managing editor, so if you see Earl, make a point of thanking him for all he's done for us. He will no longer function as a copy editor and proofreader, but I am glad to say he will still be an occasional author, technical reviewer, and specimen photographer.

This *Picking Table* was initially planned to include photos of mineral specimens that were personally collected on-site at Franklin and Sterling Hill. We could not procure enough relevant images, so consider this a "cattle call." If you've found better-than-average minerals on the Buckwheat Dump or the Mill Site Pile, at Braen Stone's Franklin Quarry or at Sterling Hill, let us know. Good specimens found during "unsponsored local digs" are just as welcome as those collected during club field trips and Super Digs. Common minerals with interesting patterns are just as welcome as rare mineral finds. We encourage you to submit descriptions of your finds and the circumstances of those finds, as well as good photos if possible. Our readers who attended the 2018 Franklin-Sterling Gem & Mineral Show may have noticed that three of the seven fluorescent mineral displays at the Littell Center were of specimens that had been personally collected by FOMS members. (Mineral collectors actually do enjoy seeing what their fellow collectors have found!)

There's another excellent reason for sending us descriptions and photos of mineral specimens you've found at Franklin and Sterling Hill: 2019 will bring a 60th Anniversary issue or issues of *The Picking Table*, and we'll need your help and input.

This amazing photo, taken during the Franklin Band's concert at Miners Day 2018, documents Dynomito "Dino" Sorez's premier performance on the Xylobone. He couldn't have done it without the help of Robert Ernst (on left) and Debbie Lockwood, expert percussionists. *Tema Hecht photo.*

By now, FOMS members may have heard through the grapevine, and are herewith seeing in print, that the *PT*'s editorial board is being reorganized. One possible result is a delay in assembling an inventory of technical, peer-reviewed articles. Hence we're reviving the 40th Anniversary *PT*'s tradition of featuring collectors' stories AND good mineral photos. (Aside from the fact that these stories are fun to read, they not only require significantly less technical editing, but also make copy editing and graphic layout easier due to a lack of bibliographies, footnotes, ordinals, etc. Good photos of minerals, as we all have been reminded over and over, are of course worth at least a thousand words apiece, and may take up less space.)

So, about these collectors' stories…everybody has one (at the very least!). Tell us how you came to be interested in collecting Franklin-Ogdensburg (FrOg for short) minerals. Tell us about a favorite mineral you found. Tell us about the person or persons who mentored you in this hobby, and if you have good photos to share, by all means include them. For now, enjoy this issue of *The Picking Table*. ⚒

# Happenings at Sterling Hill

**BILL KROTH**
STERLING HILL MINING MUSEUM
30 PLANT STREET, OGDENSBURG, NJ 07439

The Sterling Hill Mining Museum continues its mission with the help of recent additions to our board of trustees and staff. New projects and new ideas also keep us moving ahead.

Miner and trustee Doug Francisco has undertaken a large-scale project that will give us high-grade mineral specimens, and renewed excitement at our collecting dump for decades to come. An ore silo 25 feet in diameter is located directly under the shaft tracks within the upper headframe of the West Shaft. This container, called a "day bin," received ore that had been run through the primary crusher, resulting in pieces as large as bowling balls. When the mine closed in 1986 this silo was approximately 40 percent full of ore especially rich in zincite, and it has been sitting there without a cost-effective way of being unloaded…until now! Doug has altered the chute on the silo so he can control its opening and closing with a hand winch. He also laid track and modified an ore buggy so that approximately 1000 pounds of ore may be removed in one cycle. We hope to retrieve almost 250,000 pounds of "lost" ore from the last days of New Jersey Zinc production, and place it on our ore dump over the next year so collectors can get some of this great material.

In a few months, our new trustee George Hutnick will be the mayor of Ogdensburg. Presently George serves on the town council and has been a tremendous help in bringing the mine and town together on many projects. George is helping us to install graphics on the existing railroad bridge at the entrance to our driveway, and new local signage to direct traffic to our facility. We have always dreamed of having our logo on the bridge, and with George's assistance that will become a reality. Decades of "mixed relations" between the town and the mine had seemed unlikely to change, but now we are very pleased that George views our facility as a major asset to the town of Ogdensburg. I know that our relationship will become even stronger and more positive.

An even newer trustee, our latest, is Bob Horn. Bob is a longtime mineral collector and is invaluable in assisting us in identifying, labeling, and pricing minerals from worldwide locations. We receive many mineral collections each year; through donations and purchases. Sorting the local material is simple, and we have many here, notably Fred Lubbers, who do an excellent job. But where Bob really shines is in sorting and pricing worldwide minerals. You can always see Bob setting up for our biannual garage sale, and he is here most Saturdays to help. Selling minerals is important, not only for our revenue stream but also for the many collectors who want "foreign" minerals for their collections.

New to the advisory board are Dave and Cathy Astor, residents of Ogdensburg. Dave is the Superintendent of Schools in town and is one of the key folks in our annual Haunted Halloween fundraiser. Dave is incorporating the Sterling Hill Mine in the school's curriculum. We are always honored when Dave calls and asks us to weave the story of Sterling Hill into his various science classes or to have our board member, Gordon Power, judge one of the science fairs. This spring, we even partnered in installing a new weather station for the science class. Now Ogdensburg is part of the Weather Underground network. Cathy Astor is a chemistry teacher at Wallkill Valley Regional High School. This summer, Cathy was a primary contributor and instructor in our GEOSTEM program. We are very happy to have this important connection with our local high school.

While Denise and I bask in the glow of Sterling Hill, its minerals, and its museum, we also recognize that we must prepare the next generation to manage this facility. Winter Rosen is assisting in that task. Since January, Winter has been working with us to manage the museum, and was recently promoted to Assistant Manager. She has a degree in environmental science, really knows her minerals, and has been a tour guide here for three years. Others have similar credentials, but Winter is special in that we know she truly loves Sterling Hill and wants working here to become her career. We have seen Winter "go the extra mile" every day. When our website became unsupportable and needed a very expensive complete upgrade, Winter said, "I know that I can do it. Let me try." One week later we had a much improved, easier to navigate, and professional website package that makes us proud! One bonus is that Winter is able to make changes in a minute rather than our having them done by an expensive consultant. Finally, here as with most museums, attendance is paramount. Every week Winter maximizes our schedules, gathers the required staff, and even gives tours herself, if needed, to assure that we are handling the maximum number of visitors. While we thought that ten classes a day was our upper limit, Winter has on many occasions brought in twelve classes in addition to our regular public tours!

Our 22-ton slab of fluorescent ore is being prepared for display at the American Museum of Natural History, where it will be viewed by over 5 million visitors each year once the museum's halls of gems and minerals have been renovated. We are expecting a substantial increase in visitation as a result, and proud that we have a quality board and staff to handle this future surge! ⚒

# The 46th Annual New Jersey Earth Science Association Gem, Mineral & Jewelry Show & Outdoor Swap

## April 28 and 29, 2018

**STEVEN M. KUITEMS, DMD**
14 FOX HOLLOW TRAIL
BERNARDSVILLE, NJ 07924

The Littell Community Center in Franklin, N.J., was alive again with collectors and displays for two busy days. With ample space and good weather, the outdoor dealers were buzzing with activity as collectors and shoppers looked for bargains, while indoor dealers had higher-end specimens, gems, and jewelry. Amidst this hubbub were the beautiful white-light exhibits and glowing fluorescent exhibits.

There were twelve white-light exhibits, starting with the Franklin Mineral Museum's display, "The N.J. Zinc Co. Display of Franklin-Sterling Hill Minerals." This was a seminal display that inspired many early collectors with its brightly colored specimens of local classics, including rich red rhodonite in blocky crystals, and purple hodgkinsonite with white barite, both from the Franklin Mine. The Morris Museum's display, "Fossil Fish," included many from Wyoming's Green River Formation, but my favorite was a Semionotus fish species from Boonton, N.J.

Dick and Elna Hauck's case, "Foreign Mineral Collections," included many antique boxed collections of miniature mineral specimens and samples. Your reporter's display, "Franklin Classics," featured larger specimens from the Franklin and Sterling Mines that included fine crystals of rhodonite, franklinite, and gahnite. Bernard Kozykowski's two cases of "Mineral Classics" offered a wide range of esthetically pleasing worldwide specimens, especially a stunning rose quartz with three frilly rings of crystals, from Taquaral, Itinga, Minas Gerais, Brazil, and closer to home, a choice example of franklinite and willemite crystals from Sterling Hill.

Brad Plotkin presented "Minerals of England" with a large assortment of species, many with original labels. Standouts in this display were several large calcite crystals from Cumberland, and a choice example of green fluorite crystals from the West Pasture Mine in Weardale. "Veins of Franklin and Sterling Hill" was the theme of the Sterling Hill Mining

Mighty Men of FOMS: Jim Van Fleet (left) and Gavin Hannah (right), take a well-deserved break after the spring show banquet, accompanied by sidekick Alex Kerstanski (middle). *Tema Hecht photo.*

Freddie Lubbers, Sterling Hill's resident equivalent of Groucho Marx, snuggles up to co-conspirator Ally Darvis at the banquet. *Tema Hecht photo.*

Sterling Hill Mining Museum president and show benefactor Bill Kroth is delighted with his auction purchase, a classic green willemite from Franklin, still satisfying after all these years. Sweet! *Tema Hecht photo.*

Chris Luzier and Dr. Jeff Post at the banquet. Chris, one of our leading Fluoresophiles* from Maryland, brought Jeff Post to be with us at the show. Dr. Post is Chair of the Dept. of Mineral Sciences at the National Museum of Natural History (part of the Smithsonian Institution), and Curator-in-Charge of the NMNH's mineral collection. Jeff, we trust you enjoyed your time with us.

*Chris is one of our more advanced collectors of fluorescent minerals, and also brought a remarkable display of Franklin and Sterling Hill sphalerite to the show, which he was happy to accentuate by waving his Convoy S2 ultraviolet lamp in its general direction. Many of us didn't realize sphalerite could be that gorgeous. *Tema Hecht photo.*

Museum's case, which included a remarkable "hot pink" rhodonite vein with a bright orange center of andradite, from Franklin, and a golden yellow vein of secondary zincite from the Sterling Mine.

The Delbarton School's case was titled "Pyrite" and it featured a variety of crystal habits from Navajún, Spain, and iridescent multicolored nodules of pyrite from Illinois. "Members' Recent Acquisitions" was the title of the Morris Museum Mineralogical Society's display, and two outstanding specimens in that case were a most unusual green, glassy, transparent obsidian from the Afar Region of Ethiopia, and a well-carved and polished slab of malachite, with many "eyes," from Shaba Province, Congo (a.k.a. Katanga Province of the Democratic Republic of the Congo).

Highlights of Ken Reynolds' display, "Franklin and Sterling Hill Classics," were a massive specimen of red willemite and gemmy blue fluorapatite, a large plate of fluorapatite crystals in calcite, and five choice rhodonite specimens, all from the Franklin Mine. Bob Horn's case, titled "Franklinite Crystals," exhibited a plethora of large, well-crystallized franklinites from Franklin and Sterling Hill, plus franklinite-rich samples of the New Jersey Zinc Company's prime ores that produced millions of tons of zinc.

Elsewhere in the Littell Center were six brilliant exhibits of fluorescent minerals. The Franklin Mineral Museum's case, "Franklin and Sterling Classics," featured three large specimens that stood out under shortwave ultraviolet light: an outstanding cherry-red-fluorescing axinite-(Mn) from the Franklin Mine, a Sterling Mine two-tone wollastonite with large grains of orange-fluorescing wollastonite that have green-fluorescing centers, and a superb yellow-and-green-fluorescing esperite with willemite from the Franklin Mine. The adjoining case, "Franklin Delights," was the joint effort of Steven and Daniel Kuitems; its three highlights were a Franklin Mine turneaureite, fluorescing orange in a matrix of red-fluorescing calcite; a fibrous wollastonite from Franklin that fluoresced red and orange; and a wide band of blue-fluorescing hydrozincite in willemite-rich ore from the Sterling Mine.

Alex Kerstanski's case, "Franklin Mineral District Wollastonite," had a monomineralic theme with a wide variation in fluorescent color from pale yellow to bright, saturated orange. Two outstanding examples were the orange-fluorescing Second Find wollastonite from the Franklin Mine, and an excellent Sterling Hill "green-eye" wollastonite whose visual pattern reminded me of a green slug crawling up a red calcite wall. "BIG" was Andrew Mackey's title for a case of large "red-and-green" (willemite-calcite) specimens from the Franklin and Sterling Mines. One of them had large grains of willemite whose outlines resembled two puppies facing each other, while another appeared to have a green willemite face with two red calcite eyes and a red calcite grimace.


Lisa Genovese, whose expertise, energy, and culinary talents have done much to improve FOMS banquets and meetings, can be described as a culinary firecracker. Here she shows her affinity for the blasting cap tins she acquired at the auction. What spices will she put in them? *Tema Hecht photo.*


Mark Boyer (foreground) contemplates his historically significant esperite specimen, won at the auction, while Dick Bostwick toasts Mark's superb taste in minerals. *Tema Hecht photo.*


George Belzner, mineral dealer extraordinaire and a gentleman of distinction, displays his wares at the swap. *Tema Hecht photo.*

Lastly we come to two ground-breaking and impressive exhibits of fluorescent minerals from FOMS members in Maryland and Virginia, respectively. Chris Luzier's exhibit, "The Long and Short of It," was powered by both shortwave and longwave UV, and featured many specimens of sphalerite with enough longwave power to make them fluoresce brightly—a specialty of his. (If you were there when Chris came by, he'd enhance the already bright fluorescences of his diverse sphalerites with his Convoy S2 longwave LED flashlight. These are his "babies" and he makes them look extremely appetizing.) In the center of the display was a striking example of red-fluorescing calcite bordered by green-fluorescing willemite, and a superb example of green-fluorescing sphalerite (!), a rarity from the Franklin Mine.

Next came Pat Hintz's display, "Arizona Fluorescents." This was a tribute to Pat's taste in fluorescent minerals, and the appeal of a state that has hundreds of localities where fluorescent minerals may still be collected. Their diversity of fluorescent colors and patterns made it hard to pick favorites, but one specimen of calcite, hyalite, and travertine in red, green, and yellow bands had an appealing wavy effect, while a four-fluorescent-color piece from Miller Canyon of calcite (red), willemite (green), scheelite (white), and hydrozincite (blue) showed a combination of colors unlike those seen in our Franklin Mineral District specimens. Another example was from the Red Cloud Mine (the famous wulfenite locality), where yellow-fluorescing willemite is associated with bands of blue-fluorescing fluorite. Pat rounded out his display with two fine yellow-fluorescing powellites from Miller Canyon, one with green-fluorescing willemite and the other with red-fluorescing calcite. It's obvious that we Franklin "Fluoresophiles" have a lot to learn and collect if we turn our gaze outward.

Thanks to all who took the effort to share these specimens by way of their fine displays. Many thanks also to the volunteers and staff who set up the tables, cases, and electrical components that made these exhibits and the NJESA show possible.


A coming-of-age present: Alex Kerstanski's willemite-green Mustang, glowing in daylight against the background of the Sterling Hill Mining Museum's Mine Run Dump. *Tema Hecht photo.*

# Miners Day, May 6, 2018

*All Photos by Tema J. Hecht*

The giving and receiving of mine stories: from left, Doug Francisco, Paul Rizzo, Chris Auer, Bill Lyons, and Rich Gunderman.

"Superminer" Chris Auer and North Orebody veteran John Anderson share miners' tales and knowing smiles.

Judy Williams and Mark Dahlman, board members of the Franklin Mineral Museum, having a thumbs-up conversation.

The famous Franklin Band being led by its new conductor, Angelina Hamada.

The Three Mine-A-Teers from Sterling Hill (from left, Paul Rizzo, Al Grazevich, and Tom Laner) relaxing after lunch to the music of the Franklin Band.

Left to right: Kristofor Giordano, photojournalist; Richard Bostwick, miner and note-taker; Josef "Little Joe" Mancik, miner; Rich Gunderman, miner; and Mrs. Mancik.

Sterling Hill miners up close: from left, Bill Rude, Bernie Kozykowski, and Harvey Barlow.

91-year-old Ted Hanson shared many stories about his years at Sterling Hill. We hope his son (on right) and grandson (center) write those down.

Steve Sanford: photographer, author, motorcyclist, and Sterling Hill miner; also a lifelong student of earth science and a knowledgeable collector of minerals, fossils, and geology specimens. He has ranged far afield in these pursuits but remains in orbit around the gravitational pull of Franklin and Sterling Hill.

Miners lined up for Kristofor Giordano's group shot. Standing, from left: John Anderson, Al Grazevich, Fred Kirk, Steve Dekmar, John Antal, Bill Rude, Bernie Kozykowski, Harvey Barlow, Edward "Ned" Hamilton, Steve Sanford (in back), Ted Hanson, Doug Francisco, Dick Bostwick, and Chris Auer. Kneeling, from left: Robert Allen, Josef "Little Joe" Mancik, Paul Rizzo, and Tom Laner.

Four "Regulars" and a Roeblingite-in-the-rough. From left: *Picking Table* editor Rich Keller, high-end collectors Paul Shizume and Charlie Butts, first-timer Wendy Singer Hunt from upstate New York, and Franklin Mineral Museum treasurer, Lee Lowell.

Lou D'Alonzo, dean of New Jersey micromounters, accompanied by Franklin Mineral Museum curator Dr. Earl Verbeek (on left), and a companion who drove Mr. D'Alonzo to the Miners Day celebration. Lou's trademarks are his starched shirt, bow tie, and expertise in minerals.

# Memories of Petedunnite

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While proofreading a PDF of the spring 2018 *Picking Table*, I could hardly miss the many tributes to Dr. Pete J. Dunn, in words and color photos. On the front cover is a smiling Pete in his office at the Smithsonian, with his elbow resting on the IBM Selectric typewriter he used to write his many books and articles. On the back cover are photos of two examples of petedunnite, the mineral named for him; one is described in its caption as "the only verified specimen of petedunnite crystals." In Pete's 1995 monograph, *Franklin and Sterling Hill, New Jersey: The World's Most Magnificent Mineral Deposits*, that same petedunnite crystal specimen is pictured in black and white as Figure 17-7, while Figure 17-6 is a polished slab of petedunnite, part of the type specimen. Nowhere is it mentioned that these two specimens are part of the same rock, found on the Buckwheat Dump in 1960 and later broken in two. Half of it was sliced up for analysis and became the type specimen, while the other half, with the crystals, passed through two collections before it came to Pete Dunn. Today the crystal specimen and a slab from the type specimen are on display in the Franklin Mineral Museum. This is their story.

The caption for the petedunnite slab in Dunn's Figure 17-6 reads, "Dark petedunnite segregations within impure petedunnite (abundant gray) with white and gray calcite from Franklin. Specimen is 10 cm in maximum dimension. Privately owned. Photo by the author." ("Privately owned" was Pete's code phrase for a specimen in his personal collection, and although Pete photographed both the crystals and the slab in color, he self-published his monograph in black and white.) The slab is one of several from the specimen used by Pete's friends and colleagues, Eric Essene and Don Peacor, to analyze and describe petedunnite. Pete had tentatively identified the mineral as a zinc-rich clinopyroxene, and when Pete sent this material to Peacor and Essene for further analysis, it's rumored that they took it away from him with the excuse that it was a perfect mineral to name for him. It was rare, it was obscure (then and now the only zinc clinopyroxene), it was from Pete's favorite locality but didn't fluoresce, it was not particularly good-looking, and as Pete says in his monograph, "It is a very boring mineral." Pete himself was anything other than boring, but that was his choice of words for the mineral named for him.

Figure 17-7 is the same petedunnite crystal specimen pictured in color on the back cover of the spring 2018 *Picking Table*, in a photo taken by the Franklin Mineral Museums's curator, Dr. Earl Verbeek. Pete's caption for the black-and-white photo in his monograph is: "Petedunnite crystals (dark gray) in white and gray calcite, associated with indiscernible impure petedunnite, from Franklin. Specimen is 10 cm in maximum dimension. Privately owned. Photo by the author."

On the same page of Pete's monograph as Figures 17-6 and 17-7 is his description of petedunnite's occurrence and paragenesis: "Petedunnite occurs on very atypical specimens found on the Buckwheat Dump in Franklin by Richard Bostwick. The specimen (Figure 17-6) consists of dark-green petedunnite crystals, surrounded by light green pyroxene and associated with willemite, calcite, genthelvite (the first local occurrence of this species), gahnite, albite, quartz, galena, sphalerite, titanite, apatite, allanite, and other species."

In this description and the captions accompanying Figures 17-6 and 17-7, the only clue to the connection between the two specimens is their size, "10 cm in maximum dimension." They were one specimen when they were found on the Buckwheat Dump, at a time when it was possible to drive onto the dump at night and collect with no supervision. I had with me a shortwave UV lamp made by Ultra-Violet Products, Inc. the SL-2537 Mineralight (a.k.a. "black banana"), and a borrowed battery pack. The specimen attracted my attention because the nonfluorescent, fine-grained "light green pyroxene" (as it was later described by Pete), included abundant small grains of willemite that fluoresced bright green under shortwave UV. Van Gogh's "Starry Night" it wasn't, but in the dark it evoked a night sky strewn with green stars. To this beginning collector it was an attractive specimen, an unusual "pattern piece," so I kept it. Red-fluorescent calcite was also present, which certified the piece as a bonafide example of Franklin "red-and-green."

Sometime later, at home, I turned over the specimen and noticed the dark green crystals. They didn't interest me much—fluorescent minerals did—so I broke the specimen in half and set the fluorescent part aside to show friends. As for the other half, I chipped away some of the calcite from the dark green crystals with the steel point of a compass left over from geometry class. As I later learned from Pete, the fine-grained, lighter-green matrix for the willemite "stars" was an impure version of the same pyroxene.

Fast-forward to 1966. I was out of the army, at loose ends, and decided that what I really needed to improve my morale was a motorcycle. I sold the nonfluorescent minerals in my collection to Lee Areson, which gave me just enough money to buy a second-hand Suzuki X6 Hustler. In retrospect I miss some of those specimens (gageite, manganosite, that kind of thing) but the X6 did cheer me up. The dark green pyroxene crystals went to Lee, but as I occasionally visited the Aresons in Middletown to have dinner and see their latest acquisitions, I could always visit my old specimens in their new home.

Forward again, ten or more years, to Pete Dunn's recruitment of his squad of Franklin Friends. Initially he was willing to share prepublication details of new minerals, but he became more cautious when he discovered certain Friends used that information to glom specimens, and in a few cases leaked the new mineral names before he could publish them. However, the Franklin Friends remained useful participants in Pete's efforts to enlarge his knowledge of certain mineral assemblages. He'd ask us to bring specimens to the room in the Hardyston School where we'd have a FOMS meeting later that day. He looked at everything, took notes, and explained to us what he saw and what he was looking for. Sometimes these searches were productive, sometimes not, but as he said, mineralogists often had go down a lot of blind alleys. On one occasion he asked us to bring our specimens of pyroxenes associated with zinc ore minerals, and that's when I brought my "pattern piece" with willemite stars. Pete asked for it, I gave it to him, and the rest is history.

When petedunnite was published, there was an immediate demand for specimens. All I had was a slice of the type specimen that Pete had kindly saved for me, a slice I was happy to show around, but I didn't want to sell it so went back to the Buckwheat…and couldn't find a scrap. About that time I was sent to a convention in Salt Lake City, and while there I visited a local rock shop. Against all odds there was a bin of dusty, weathered "red-and-green" imported from the Buckwheat Dump, priced at $4 per pound. I spent an hour or so rummaging around in that rockpile and was pleasantly surprised to find three pieces of petedunnite.

Meanwhile, back in Franklin, the locals had read the Peacor and Essene paper, seen my slab in white light and under UV, and were finding the new mineral on the Buckwheat Dump. During the brief period when petedunnite was rare and therefore desirable, the Franklin Mineral Museum's curator, John Cianciulli, failed to recognize an example from the Buckwheat and put it out for sale, priced at $5.00. Peter Chin, who at the time was one of the collectors who knew petedunnite when he saw it, bought the five-dollar special and at the FOMS banquet presented it to John with appropriate oracular flourishes. This was the only time I ever saw John Cianciulli blush.

Then Mark Boyer recognized similar material in his backyard, just north of the "Backwards Tunnel" where Cork Hill Road lies atop many tons of road metal imported from the Buckwheat Dump. Between that bonanza and further dump finds in Franklin, there are now hundreds of pounds of petedunnite in local collections and basements, and probably more in local roadbeds. Since almost everyone who wants an example of petedunnite now has one, supply exceeds demand, and the redoubtable Peter Chin now has not only chunks of petedunnite in his collection, but also (drumroll, please) two matching spheres of that mineral!

As for petedunnite crystals, there may be dozens of them among the hundreds of pounds of roughage from the Buckwheat Dump, waiting to be cleaned and worked out of matrix. However, the petedunnite crystal specimen once owned by Pete and now by the Franklin Mineral Museum, the specimen illustrated in his monograph and on the back cover of the spring 2018 *Picking Table*, may still be the only authenticated example of megascopic petedunnite crystals. (Though once thought to be unique to Franklin, petedunnite has since been found at Magnet Cove, Arkansas, the Nain Complex in Labrador, and the Telica Volcano in Nicaragua, but if these localities have produced petedunnite crystals, they are probably microscopic.)

To fill in the history of what is now *the* petedunnite crystal specimen, it was found on the Buckwheat Dump in 1960, and in 1966 went to Lee Areson. Lee died in 1987, the year petedunnite was described. In late 1988, when Lee's collection was sold by Dick Hauck, I visited Dick and Elna's basement in Bloomfield, N.J., and recognized the petedunnite specimen, still labeled as pyroxene crystals. It had never been eye candy, and may be, as Pete said, a "very boring mineral," but I bought the piece from Dick and gave it to Pete Dunn. In 2010 Pete donated his collection to the Franklin Mineral Museum, so the petedunnite crystal specimen is now there for the public to see, with a slice of the type specimen on display nearby. It's been a long, strange path for a dump rock to take, but unlike many Franklin collectors' stories, this has a reasonably happy ending. ⚒

# Hydrothermal Mineral Deposition in a Rock-Dominated Fluid System at Sterling Hill, New Jersey

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## INTRODUCTION

The highly metamorphosed Zn-Mn-Fe ore deposits at Sterling Hill and neighboring Franklin, New Jersey, are world-renowned for their large number of mineral species (372 at last count) and abundance of minerals that are rare or unknown elsewhere. Few of the minerals at these localities, however, occur exclusively as constituents of the primary metamorphic ore; most occur instead in hydrothermal replacement assemblages and in secondary veinlets (mineralized faults) that transect the orebody and its enclosing host rocks. Of the hundreds of mineral species known from these deposits, then, most were found only in small quantities, and some are known from only a single hand specimen. Although the minerals themselves have been extensively studied—witness the 755-page compendium by Dunn (1995)—details of their geologic context are generally few, in part because underground study of volumetrically insignificant constituents of the ore was of little practical importance to mining. Thus, though one might discern from visual inspection that mineral X occurs "on a slip surface in granular ore consisting of reddish-brown willemite and franklinite," commonly it is impossible to know exactly where in the mine it occurred, the nature and origin of the fault along which mineral X was deposited, and the relation of the mineral to other species, rock types, and structures nearby, but not represented on the sample. For many of the local minerals, then, the processes that were operative during their genesis are known only in broad terms.

The acquisition in March 1989 of the Sterling Mine by Richard and Robert Hauck, followed by reopening of the main adit in June 1989, marked the first time in history that this classic ore deposit was open to free and extended scientific inquiry underground. By then the lower half of the mine had been flooded by rising groundwater, but work by several investigators soon commenced on the 1200 level and continues today. Robert Jenkins and Steven Misiur studied numerous mineral occurrences in situ and released their findings in a series of 25 reports on file at the Sterling Hill Mining Museum; some of their findings were also published in such outlets as *The Picking Table* and *The Mineralogical Record*. The authors of the present report, meanwhile, embarked on a study of faults in the mine—their orientations, directions of slip, relative age, mineralization history, etc.—to develop a fault chronology for the area and its relation to the hydrothermal minerals that precipitated within those faults. The work of both teams of investigators resulted in greater understanding of the nature of secondary mineral deposition at Sterling Hill. This paper addresses one facet of that understanding—that many of the postmetamorphic minerals were deposited in a rock-dominated hydrothermal system.

## ROCK-DOMINATED VERSUS FLUID-DOMINATED HYDROTHERMAL SYSTEMS

In broad terms the notion of a rock-dominated hydrothermal system, and its polar opposite, a fluid-dominated system, is conceptually straightforward. The defining characteristic of a rock-dominated hydrothermal system is that the chemical components of secondary vein minerals were derived wholly or mostly from the enclosing wall rock. This is often described as the rock "stewing in its own juices." The rock body as a whole thus maintains an approximately constant bulk composition, but chemical elements within it are redistributed on a small scale as they are leached from the wall rock and redeposited locally as secondary minerals in veins. Rock-dominated hydrothermal systems are favored by low fluid volumes and sluggish flow rates (often due to poorly interconnected or clogged fracture networks), such that fluids in one part of a rock body are in poor communication with fluids in another. The chemical composition of fluids at any given place, then, is strongly influenced by the mineralogy of the adjacent wall rock. An obvious indicator of possible rock-dominated conditions is that all the elements present in the secondary vein minerals were available from the wall rock.

A fluid-dominated hydrothermal system, in contrast, is one in which hydrothermal fluid compositions were only minimally affected by chemical reaction with the host rock. The fluids may have been derived from distant sources, and the vein minerals deposited from them may bear little or no chemical relation to the rocks in which they are now found. Fluid-dominated systems are favored by abundant fluid and high flow rates, where open and well-interconnected fracture networks and/or bodies of breccia allow large volumes of hydrothermal fluids to migrate with relative ease through the rock. Geochemists would term this an "open system," one in which the bulk composition of the rock mass (rock + fluid + vein minerals) is not constant, but changes over time in response to variations in temperature, pressure, and fluid composition.

Between these two end-member situations lies a complete spectrum of possibilities. Given the lengthy and complicated geologic history of Sterling Hill, and of the New Jersey Highlands region in general, it should come as little surprise that examples spanning a broad range of this spectrum can be found, as mentioned previously by Cummings (1983). Throughout our work in the mine, however, we were often impressed by how closely the mineralogy of the host metamorphic rocks is related to the mineral species that later formed within openings along faults transecting those rocks. This is true not only for hydrothermal minerals, but also, in some cases, for minerals that formed from low-temperature groundwater.

**Figure 1:** High-grade zincite-franklinite ore from the 1250 stope, 1000 level, Sterling Mine. Specimen size: 6.3 × 5.5 × 1.6 inches (16 × 14 × 4 cm). *Earl R. Verbeek specimen and photo.*

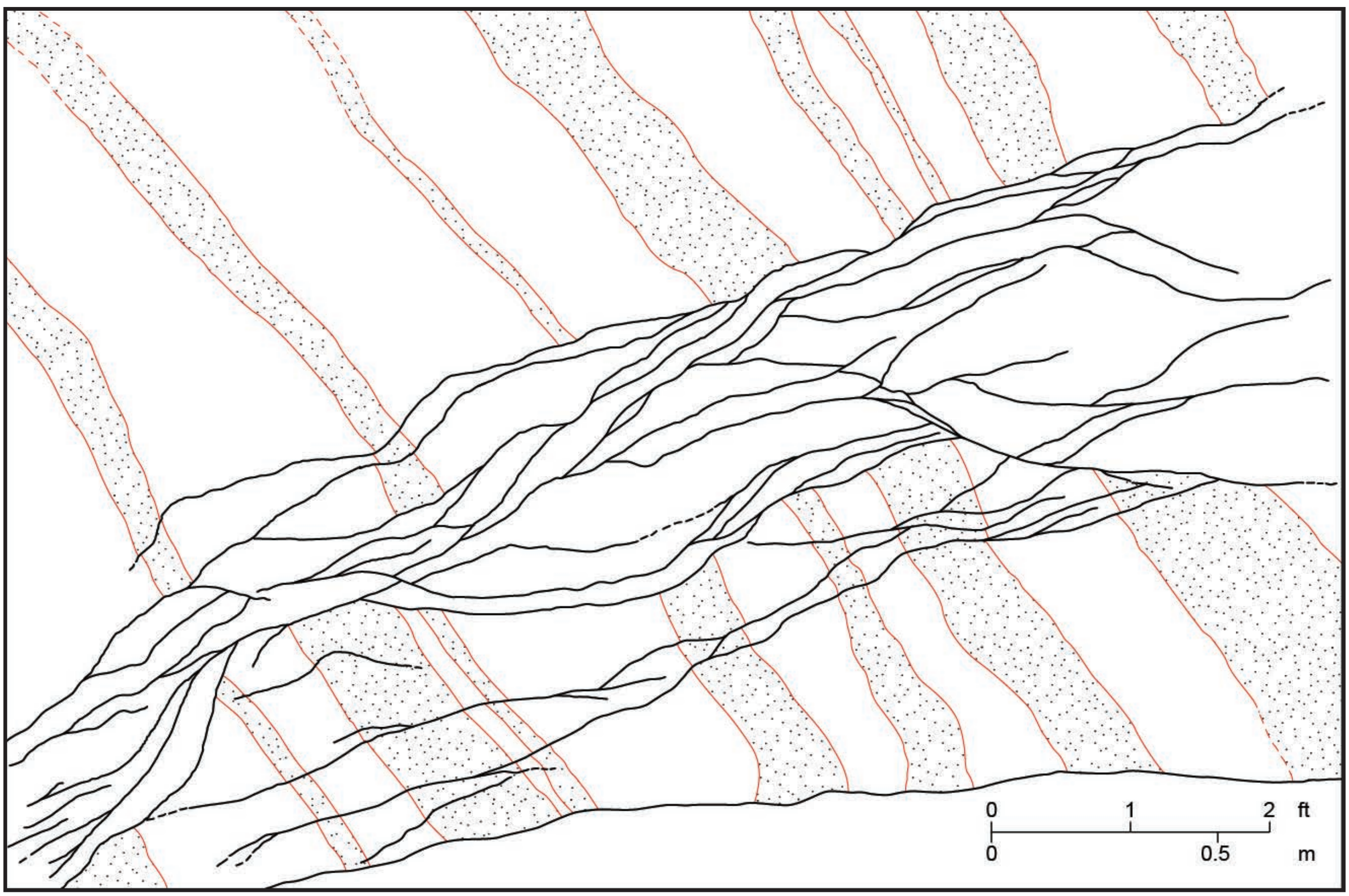


**Figure 2:** Braided fault zone along nearly vertical, southeast wall of the 1250 stope. Illustration was prepared from detailed field measurements, supplemented by tracings from numerous overlapping photographs. Stippled pattern indicates ore layers rich in zincite. These layers gradually lose definition within the fault zone, where most zincite has been dissolved from the ore.

## ROCK-DOMINATED FLUID SYSTEMS AT STERLING HILL

Below we describe several examples where secondary mineral distributions at Sterling Hill are suggestive of deposition in a rock-dominated or strongly rock-influenced system.

**Sphalerite, willemite, and secondary copper minerals**

The 1250 stope on the 1000 level, within the east limb of the orebody, provides an excellent and complex example of wall-rock control on fault mineralization. The high-grade ore in this stope is prominently layered and consists of nearly pure franklinite-zincite layers 3 to 20 cm thick, alternating with layers 5 to 40 cm thick of the same two minerals, but with 20% to 50% of calcite (Figure 1). Willemite, a minor component of the primary ore here, is absent from most of the ore layers.

The hanging-wall contact of ore with coarse-grained Franklin Marble is well exposed along the southeast wall of the stope, where it is complexly offset along a braided fault zone 1 to 1.5 m thick (Figure 2). Individual fault strands are irregularly curved and commonly split and merge to form a network of slip surfaces enclosing lensoidal masses of rock, much of it brecciated. The amount of slip along the fault zone is unknown but probably minor, as the rock above and below is of similar character. Nevertheless, the sequence of ore layers to either side of the fault could not be matched, suggesting that total slip across the zone was several meters at least.

The minerals lining these faults are common species at Sterling Hill. Fine-grained, nearly cryptocrystalline sphalerite (Figure 3A) is a prominent component of the fault veins, and in many places the principal cementing agent of the fault breccia. Most of the breccia masses along individual fault strands range in thickness from 1 to 2 cm, but locally the breccia occupies the entire space between two fault strands and is as much as 8 cm thick, all of it cemented by sphalerite. Much of the sphalerite ranges in color from pale gray to pale honey brown, but some is medium reddish-brown, visually identical to the material occasionally found in some collections mislabeled as friedelite. The longwave orange fluorescence of the sphalerite (Figure 3B) provided a ready means by which the distribution of this mineral within the fault zone could be studied in place.

Though willemite is nearly absent as a primary (original) constituent of the ore, secondary willemite is common in the fault-related veins, particularly within the lenticular cavities that resulted from faulting. Calcite, too, is common in these veins. The two minerals in these cavities are commonly intergrown in banded, ivory-colored masses generally 0.1 to 1 cm thick, but in some places increasing to 2 cm. As with the sphalerite, the fluorescence of the willemite—bright yellowish-green under the shortwave lamp—proved useful in the mine to study the distribution of this mineral within the fault zone.

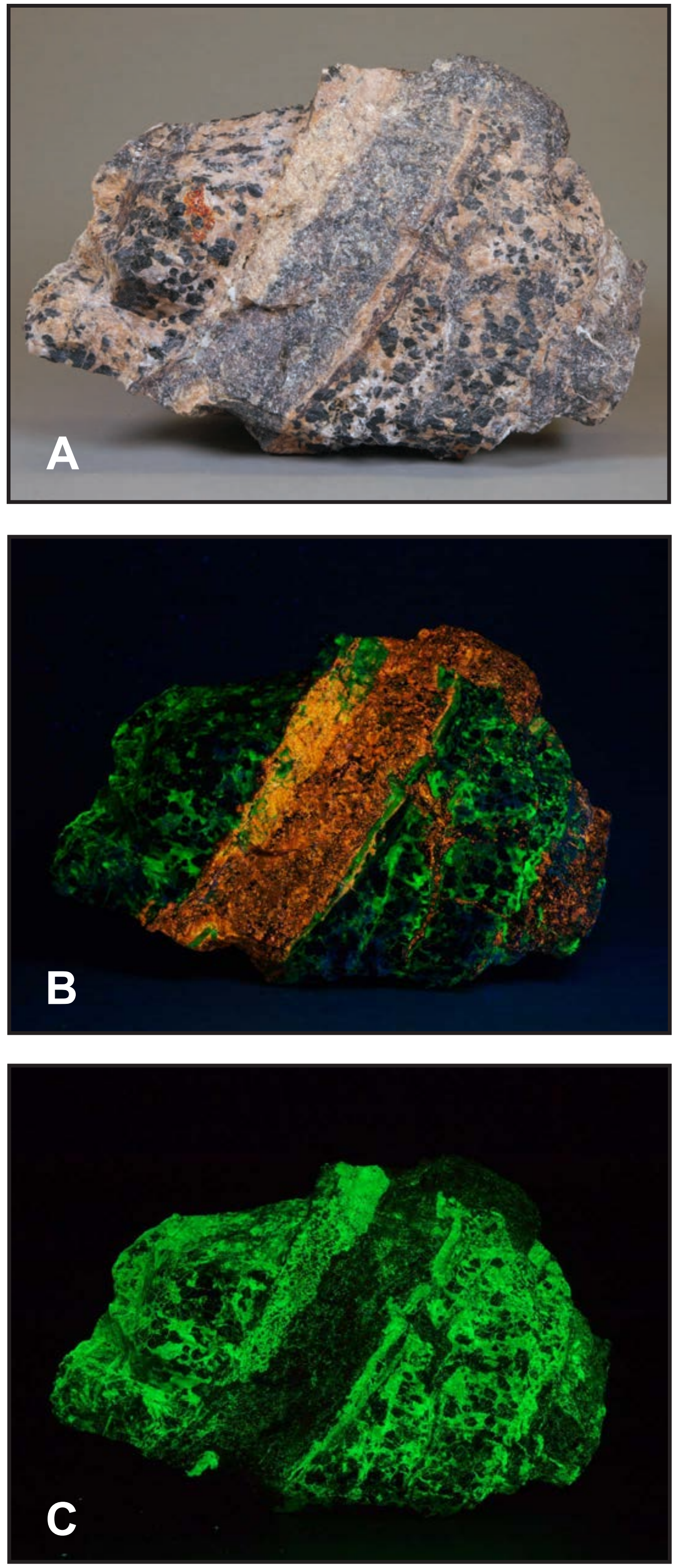


**Figure 3:** Typical specimen of fine-grained sphalerite from the 1250 stope, as viewed under (A), visible light; (B), longwave ultraviolet light; and (C), shortwave ultraviolet light. Specimen size: 5.5 × 3.5 × 1.4 inches (14 × 9 × 3.5 cm). *Earl R. Verbeek specimen and photos.*

**Figure 4:** Specimen of ore depleted of zincite from the braided fault zone shown in Figure 2. Specimen size: 5.9 × 4.0 × 2.0 inches (15 × 10 × 5 cm). *Earl R. Verbeek specimen and photo.*

Both the calcite and the willemite are fine grained, and much of the willemite is inconspicuous by the light of a cap lamp. Additional willemite, as tiny glassy crystals, lines residual cavities within the fault veins. Even more precipitated within the altered wall rock as tiny, powdery white grains whose abundance is readily evident under shortwave ultraviolet light (Figure 3C).

A notable feature of the fault zone is that the masses of ore within it are depleted of zincite, and the original (primary) calcite has been stained pale orange-tan, as opposed to the original white to pale gray color (Figures 3A and 4; compare with Figure 1). No microscopic or geochemical study has yet been made of these rocks, but the near-complete loss of zincite from rocks formerly rich in this mineral suggests that solution-transfer by hydrothermal fluids was an important process operating within the fault zone. The ready solubility of zincite in hydrothermal solutions was noted long ago by Laudise and Kolb (1963). It is tempting to suggest that the zinc placed into solution through loss of primary zincite from the ore was reprecipitated, in large part, only centimeters away as secondary sphalerite and willemite. The solution-transfer effects decrease in intensity outward from the center of the fault zone so that the outermost fault strands cut ore still containing much zincite. Here, along the margins of the fault zone, are the only places that "calcozincite"—a local term for fibrous to splintery masses of intergrown calcite and secondary zincite—was found abundantly within the fault veins. In numerous other places in the mine we have found, too, that secondary, fracture-filling zincite occurs only within rocks containing primary zincite, or in proximity to such rocks; more examples are discussed below.

The mineral content of the fault veins in the 1250 stope changes completely, within distances of several centimeters or less, at the hanging wall contact of ore with the coarse-grained Franklin Marble. Willemite and sphalerite stop abruptly at the contact, and in their place one finds within the marble much chalcopyrite and subordinate bornite lining the fault surfaces. Various alteration products of these minerals—not yet identified but in other parts of the mine including rosasite, aurichalcite, malachite, brochantite, and devilline (Jenkins and Misiur, 1994)—stain much of the calcite various shades of blue and green. No obvious trace of any of these minerals was detected in the ore. The change in mineral content in the fault veins at this locality is total and abrupt, suggestive of a high degree of wall-rock control on mineral precipitation in open voids. In this instance, secondary zinc minerals formed within the ore, and secondary copper minerals (and their alteration products) within the marble, with almost no overlap between them.

**Mcgovernite and zincite**

In late 1990, mcgovernite, a rare and attractive manganese arsenate silicate mineral much prized by collectors, was found within a raise connecting the 740 crosscut on the 800 level to the equivalent crosscut on the 700 level. The raise is entirely in ore of the west limb. Additional mcgovernite on the 800 level occurred immediately north of the entry to the raise. Both occurrences are upward extensions of the main mcgovernite occurrence on the 900 level, where in May 1990 much fine mcgovernite—some in complete rosettes 2 to 4 cm across—was recovered from low-angle faults cutting the 780 pillar. This latter area probably is the site of the original 1927 find referred to by Palache (1935).

Mcgovernite in the raise was found within a small area several meters across, about 8 m below the 700 level, where the raise passes through moderate- to high-grade willemite-franklinite-calcite ore locally containing abundant zincite. Numerous minor faults of N. 30° to 70° E. strike and steep northwest dip cut the ore here and in the drift on the 800 level below. Slickenside striations on most of these faults indicate dominantly dip-slip movement, but whether normal or reverse could not be established with certainty. The fault surfaces are highly undulatory in shape, and it was slip on these surfaces, plus associated brecciation, that provided the void space within which the mcgovernite and other secondary minerals would grow.

Several aspects of fault-zone mineralogy are worthy of note here. Some of the faults are coated along parts of their surfaces with lenticular masses 1 to 4 mm thick of brilliant red-orange secondary zincite interlayered with a white to pale lavender carbonate mineral, presumably calcite. Some of the calcite fluoresces red (shortwave), but most of it shows a bright yellowish-green response due to included willemite. Also common are intimate intergrowths of secondary zincite and calcite to form the mixture known locally as "calcozincite." The link between wall-rock and fault-zone mineralogy here is remarkably close: Stringers of zincite and "calcozincite" occur abundantly as vein components where the ore contains primary zincite, but are wholly absent from all faults where it does not. Faults cutting ore lacking zincite are lined only with calcite. Individual faults that cut several ore layers, some containing primary zincite and some not, show the same effect.

Mcgovernite in these faults was the last phase to form and occurs as brilliant scales 1 to 10 mm across of rich coppery bronze color, either implanted directly on the fault surfaces or on the calcite that coats them. Locally the mcgovernite forms the principal cement between adjacent clasts of brecciated ore; among the specimens recovered from this locality were a few small hand samples showing the brecciated texture to good effect (Figure 5). A curious aspect of the mcgovernite is that it is clearly most prevalent in those parts of the faults that transect ore lacking in zincite. We ascribe its lesser abundance in zincite-rich ore to prior closure of most void space by "calcozincite." Faults cutting zincite-poor ore, in contrast, in many places are only thinly coated with calcite and in some places not at all, leaving ample void space for the later precipitation of mcgovernite. With respect to mcgovernite, then, wall-rock control on its distribution was indirect, but nonetheless effective.

**Serpentine**

Along the main haulage drift on the 900 level, in the footwall of the west limb of ore, a series of minor reverse faults, well exposed on the west rib, cuts the Franklin Marble between 870 and 900 North. The marble displays prominent compositional layering, with some layers rich in orange-brown norbergite and others only in calcite containing scattered scales of graphite. Where the surfaces of these faults are well exposed, they were seen to be encrusted with accretionary calcite (white) and serpentine (green) as much as 1.5 cm thick. This would not be particularly noteworthy were it not for the distribution of these minerals upon the fault surfaces: The serpentine fibers had formed only where the faults transected the norbergite-rich layers (Figure 6), and calcite had formed instead where the marble lacked that mineral. The result: fault surfaces striped in green and white, an elegant testimonial to a rock-dominated system.

It is worth considering the chemical interplay at work here. Here are the chemical formulas for the relevant minerals:

| | |
|---|---|
| Norbergite | $Mg_3[(F,OH)_2SiO_4]$ |
| Serpentine | $Mg_3Si_2O_5(OH)_4$ |
| Calcite | $CaCO_3$ |
| Graphite | C |

From the first two formulas it is apparent that all the chemical components needed to form serpentine were available from the norbergite in the host rock. Conversely, those parts of the fault that transect rock layers lacking norbergite also lack serpentine,

**Figure 5:** Mcgovernite as the cementing mineral of mildly brecciated ore, Sterling Mine. Specimen measures 4.7 × 4.0 × 1.4 inches (12 × 10 × 3.5 cm). *Earl R. Verbeek specimen and photo.*

**Figure 6:** A fault surface coated with serpentine (left) on a matrix of marble rich in norbergite (or chondrodite). This example is from the Lime Crest Quarry in Sparta Township but is identical to examples seen in the Franklin Marble underground at Sterling Hill. Specimen size: 5.1 × 3.1 × 2.0 inches (13 × 8 × 5 cm). *Earl R. Verbeek specimen and photo.*

and contain only calcite, the same mineral that is the dominant component of the wall rock. These relations point to quite small distances of ion migration within the fault zone and conform almost perfectly to a rock-dominated system, with all components of the secondary mineral assemblage in the fault zone having been derived from the immediately adjacent wall rock.

Numerous other faults throughout the mine and in surface exposures show the same effect. For example, on the 340 level, south rib of the 1130 crosscut, serpentine accretionary fibers are present on a fault only where that fault cuts norbergite-rich marble; elsewhere the fault is coated with calcite. The change from serpentine to calcite on the fault surface occurs within a distance of only 1 cm. Similar relations between serpentine on faults and norbergite-bearing host rocks are known from nearby quarries in the Franklin Marble.

### Secondary zincite and "calcozincite"

On the 900 level, in the pillar just south of the 800 crosscut, faults that cut through layered ore are lined with "calcozincite," but only where primary zincite is present in the adjacent ore. The same is true on the 800 level above, along the 740 crosscut in west limb ore, where lenticular voids along faults are filled with a mixture of secondary zincite, "calcozincite," and calcite only where the ore is zincite-bearing. The same faults upon entering franklinite-willemite-calcite ore abruptly lose the secondary zincite and are filled instead with much red-fluorescent secondary calcite and local mcgovernite, the whole locally as much as 8 cm thick. Identical observations were made in west limb ore just below the 700 level, as already discussed under mcgovernite.

The association between zincite-bearing ore and secondary zincite and/or "calcozincite" as fault-lining minerals is a general one throughout the mine and was observed in numerous places. It is observable at the hand specimen scale as well, in our mineral collections: Few specimens of secondary zincite and "calcozincite" (Figure 7) are entirely devoid of zincite in the host rock.

### Hydrozincite

Hydrozincite, $Zn_5(CO_3)_2(OH)_6$, is generally a late-stage product of weathering, formed where zinc-bearing minerals became exposed to oxygenated rainwater percolating downward through the rocks. Accordingly, it is most common at the surface and in the upper levels of the Sterling Mine, but it can also be found at lower levels where faults provide ready conduits for water to penetrate deeply. One notable occurrence was at the entrance to the 1270 subdrift on the 340 level, where vividly fluorescent hydrozincite abundantly coated fault surfaces where these cut lean ore. However, the hydrozincite abruptly disappeared within 0.5 m where these same faults passed into barren marble.

Deposits of postmining flowstone at Sterling Hill provide another possible example of wall-rock control on the distribution of hydrozincite. These flowstone deposits have not yet been much studied, but they are probably composed dominantly of calcite. Splendid examples are visible on the adit level of the Sterling Mine, along the normal tour route accessible to the public. Much of the flowstone in this area, particularly within and near cross-member ore, shows a distinctly blue component to its fluorescence when viewed under shortwave ultraviolet light (Figure 8). The bluish fluorescence is likely due to hydrozincite intergrown with the calcite. Otherwise similar flowstone deposits within the "bat adit," a long passage that extends westward from the west wall of the Passaic Pit, show a substantially weaker blue component to their fluorescence. This adit was driven into barren marble below the footwall of the west limb of ore at Sterling Hill, where a lack of zinc-bearing minerals in the rock is reflected in the lack of hydrozincite in the flowstone. It should be emphasized, however, that this is reasoned conjecture only; the postmining deposits at Sterling Hill are the subject of a future study.

### Miscellaneous examples

Many more examples of wall-rock control of mineralization exist than those discussed above. Here, in brief, are listed a few more.

- Films of fine-grained, red hematite are much more common on faults cutting zinc ore than on faults in marble. The iron in the hematite likely was liberated during hydrothermal alteration of franklinite. In the 1270 subdrift, 340 level, the surfaces of faults in low-grade franklinite ore are hematite-stained, but such stains disappear abruptly as the faults pass into marble.

**Figure 7:** A specimen of "calcozincite" coating a fault surface in zincite-rich ore from Sterling Hill. The specimen measures 4.7 × 3.5 × 2.6 inches (12 × 9 × 6.5 cm). *Earl R. Verbeek specimen and photo.*

- Films and coatings of violet fluorite are common on faults in marble, but distinctly less so in other rock types.
- Serpentine as a fault-coating mineral on faults in marble is generally green, as discussed above, but serpentine on faults in ore is generally brown and translucent, and often interlayered with willemite.
- Epidote is common on fault surfaces in pyroxene-feldspar gneiss (Figure 9), where it formed as a hydrothermal alteration product of feldspar, but is rare to absent in other lithologies. Serpentine takes its place in dolomitic or norbergite-bearing marble, and a dark green to black mineral resembling chlorite takes its place in areas where nonfeldspathic "black rock" is exposed.
- Willemite is exceedingly common as a fault-lining mineral in ore, but only one example was found of willemite in marble, and this example was near the ore contact.
- Many other minerals at Sterling Hill, including arsenates such as magnussonite, köttigite, legrandite, etc., are found only within faults cutting ore.
- Zeolites such as chabazite, heulandite, and stilbite are moderately common within faults cutting pyroxene-feldspar gneiss, but are uncommon to rare elsewhere.

## DISCUSSION

The complexity of the postmetamorphic mineral suite at Sterling Hill can be ascribed to at least two factors: (1) the long and eventful regional geologic history, and (2) the original geochemical complexity of the ores, associated gneisses, and impure marble host rocks, which collectively provided a rich suite of elements to be scavenged by later hydrothermal, vein-forming fluids. The effect of wall-rock chemistry on vein mineralogy added another layer of complexity, wherein the minerals deposited within some of the faults change markedly over distances of a few centimeters as the faults cross from one rock type into another.

The restricted nature of some of the local mineral occurrences has been a repeating theme in the literature on the Sterling Hill and Franklin zinc deposits. Palache (1935), for example, alluded to one-time mineral finds, and Frondel (1972, p. 8) made note of collections that contain "extensive suites of particular material, representing most or the whole of some chance find…." The first explicit mention of rock-dominated vein systems at Sterling Hill was that of Jenkins and Misiur (1994), who studied fault-related vein minerals across the ore-marble contact (hanging wall of east limb) near the south opening of the 1250 stope, below the east end of the 1220 crosscut on the 700 level. In a detailed mineralogical study, Jenkins and Misiur documented more than 40 hydrothermal vein minerals and their alteration products within a volume of rock of only a few cubic meters. Within the ore they noted the presence of secondary willemite and "calcozincite" (secondary zincite intermixed with calcite) and stated that "it is a notable feature of the site that where fractures containing secondary ore minerals pass into marble, those species disappear abruptly, and sulfides appear instead." Prominent among the sulfide minerals are those containing copper (bornite, chalcopyrite, tetrahedrite, covellite, djurleite, and chalcocite), later alteration of which produced such colorful species as brochantite, aurichalcite, malachite, devilline, rosasite, and chrysocolla. The area bears obvious similarities to that studied by us in 1990 in the 1250 stope on the 1000 level, as documented above.

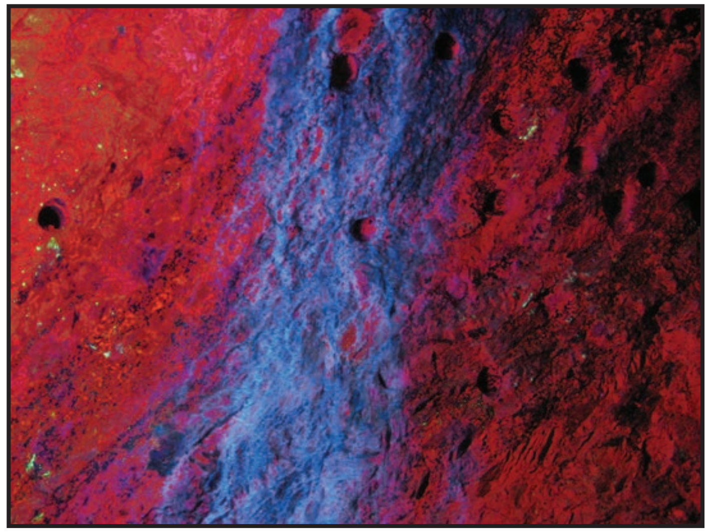

**Figure 8:** Postmining flowstone showing a strong blue component to its fluorescence in a passage through lean cross-member ore, adit level, Sterling Mine. The short drill holes visible in the photo are about 1.5 inches (3.8 cm) in diameter. *Jeff Glover photo.*

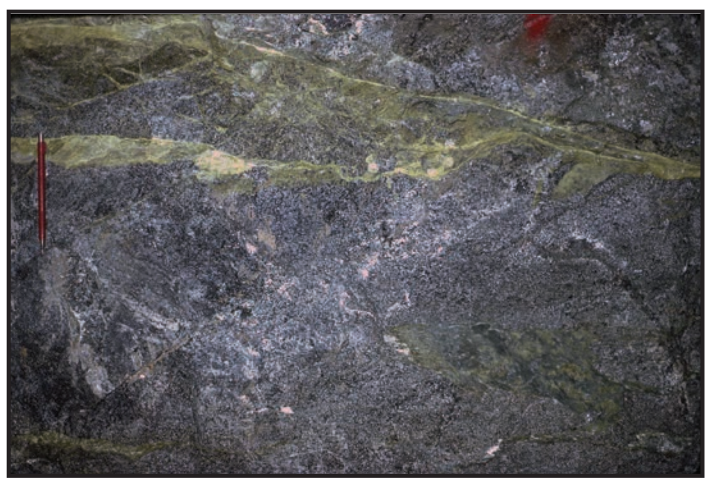

**Figure 9:** Epidote, a hydrothermal alteration product of feldspar, lining faults cutting feldspar-pyroxene gneiss in the Sterling Mine. Although the low-angle faults shown here are of similar geometry to those of Figure 2, and formed during the same period of faulting, the wall rock in the two areas is of wholly different character, as are the hydrothermal minerals lining the fault surfaces. The pencil at left is 5.5 inches (14 cm) long. *Earl R. Verbeek photo.*

Peck et al. (2016), in a study of carbon and oxygen isotopes of secondary carbonate minerals at Franklin and Sterling Hill, outlined the general features of hydrothermal vein activity in those areas. After regional metamorphism about 1.1 billion years ago, while the rocks were still hot and deeply buried, rock-derived fluids dissolved some of the primary minerals and reprecipitated their component elements as high-temperature hydrothermal minerals. Veins formed during this period tend to be mineralogically simple and closed—that is, they lack void space, in keeping with the deep burial of the rocks at the time. Carbon and oxygen isotope values for carbonate minerals in these veins overlap those of calcite in the primary ores and the enclosing Franklin Marble, suggesting local derivation of the precipitating fluids in a rock-dominated system. As time went on, however, and the rocks cooled, successive periods of faulting provided channelways for the introduction of fluids from external sources, leading to varied assemblages of lower-temperature minerals in an increasingly fluid-dominated system. Erosion of the overlying rocks brought the orebodies progressively closer to the surface, eventually allowing surface waters to infiltrate the rocks and form low-temperature minerals, as well as altering many of the minerals deposited earlier. Vuggy vein assemblages and open-space fillings are characteristic of these low-temperature, late-stage minerals. Carbon and oxygen isotopes of carbonate minerals from such assemblages do not overlap those of the Franklin Marble and are consistent both with lower temperatures of formation and with carbon increasingly derived from surface sources. The isotope data are thus consistent with an overall shift, with time, from a rock-dominated system to a fluid-dominated one.

It should be noted, however, that the nature of the wall rock can still markedly influence which secondary minerals form even in an open, fluid-dominated system. For example, consider hydrozincite, $Zn_5(CO_3)_2(OH)_6$, which at Sterling Hill is found in proximity to the zinc orebody, even though it is a product of weathering by descending, oxygenated rainwater. In this case the zinc was derived from the ore, but the hydroxyl component came from an external source. Secondary copper minerals, too, almost always are derived from precursor sulfide minerals nearby. The zinc and copper clearly are locally derived, though the fluids that progressively break down existing minerals to form later alteration products are derived from external sources.

In this paper we have attempted to highlight the importance of rock-dominated hydrothermal systems to some of the observed assemblages of secondary minerals at Sterling Hill. We stress, however, that such effects are not specific to the Franklin-Sterling Hill area but are part of the regional, postmetamorphic hydrothermal overprint throughout much of the New Jersey Highlands. The epidote-quartz veins in gneiss from the Oxford Stone Co. Quarry in Oxford Township, N.J., are one example, and a similar assemblage in pegmatite from the Lime Crest Quarry another (Cummings, 1997). Fluid-dominated assemblages abound regionally as well, again with the Lime Crest Quarry providing a notable example, specifically the assemblage of sphalerite, barite, fluorite, galena, pyrite, dolomite, and calcite, numerous specimens of which were produced in 1992 (Cummings, 1993, 1998). An early paper by Cummings (1983) provides a good introduction to the topic of rock-dominated (“alpine cleft type”) and fluid-dominated (“Mississippi Valley type,” or MVT) deposits and makes clear that examples from our part of New Jersey “cover the entire spectrum from typical alpine cleft to typical MVT.”

We hope that readers will now have renewed appreciation for the connection between the various secondary minerals in their own collections and the matrix rock upon or within which those minerals formed. That connection, strong in many specimens but weak or absent in others, is yet another fascinating aspect of Franklin-Sterling Hill mineralogy.

## ACKNOWLEDGEMENTS

We thank Richard and Robert Hauck for free access to the Sterling Mine during the main period of our data collection (1989-1993). Bernard Kozykowski and Steven Misiur provided photographs of the 1250 stope to supplement our own during preparation of the fault map of Figure 2. Warren Cummings provided a most helpful technical review, and both he and Bruce Sloan helped improve the clarity and flow of the text.

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# Remembering Ralph Thomas, the "Glow Father" (1925-2018)


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Ralph Thomas, who died recently at the age of 93, was known to every FOMS member who has attended FOMS meetings during the last three or four decades. He was the perennial center of gravity for the FOMS "Micro Group" that met in Kraissl Hall in the morning, and could usually be seen packing up his microscope and micromounts as the rest of us wandered in for the lecture. Since he came up from Fairless Hills, just north of Phildelphia, his commute wasn't always easy or convenient, but he had a lot of friends.

Ralph rarely missed our spring and fall mineral shows, where he was noted for sitting inconspicuously behind a small table of minerals and mineral-related miscellany, wearing a baseball cap and his shy, contagious smile. Regardless of what you thought of his merchandise, which often drew in younger collectors, you'd leave his table with the conviction that he was the nicest man at the show. Which he was.

A much younger Ralph Thomas, red-headed and full of beans, at his binocular microscope. Some have suggested that the circles under his eyes were caused by his being "glued to that darn microscope," but his contagious and modest smile suggests he is having a fine time, thank you very much. The editors of *The Picking Table* thank Mark Boyer, president of the Franklin Mineral Museum, for the use of this undated image from its archives. *Photo by Alfred Standfast.*

Here in Franklin, the self-proclaimed "Fluorescent Mineral Capital of the World," even a passing interest in mineral fluorescence is normal, but in Philadelphia and environs is not universal. Ralph defied the odds by having two collecting specialties, micromounts and fluorescent minerals. This pairing is not unique; legendary micromounter Neal Yedlin (1908-1977), an unquestioned icon in that field, had a very fine display of fluorescent minerals in his basement in New Haven, which he enjoyed very much but admitted he didn't show it to certain, ahem, mineral snobs. In contrast, Ralph Thomas is an icon of micromounters and glow-freaks alike. Throughout his life he shared his enthusiasm about minerals with fellow humans of all ages and any level of interest. He wrote about minerals and gave them away; he displayed them at mineral shows, libraries, and banks all over Bucks County; he spoke to audiences of all ages from grade schoolers and Boy Scouts to elders; and in 1985 was invited to give (and gave) a series of talks about Franklin to the New Jersey State Museum in Trenton.

Many years ago, he nudged his home club, the Rock and Mineral Club of Lower Bucks County, PA, Inc., toward creating its Micromineral Study Group, then its Micromount Swap-&-Sell, and then in 1976 a Micromount Symposium that still takes place annually under the auspices of the Leidy Microscopical Society. In 1989 Ralph inspired his club to produce the first all-fluorescent-mineral show, Ultraviolation, and since then has richly deserved the honor of being proclaimed "Glow Father," a title bestowed on him by his friends and accomplices. Now in its 30th year, Ultraviolation is still held traditionally close to Halloween, when nights get longer and strange things happen in the dark, but Ultraviolation has alternating periods

Ralph Thomas at the 2012 Franklin-Sterling Gem & Mineral Show. Yes, he's smiling. It's a sunny fall day, he's outside the Franklin School at the FOMS swap, and the fluorescent French Process zinc slag from the New Jersey Zinc Co. smelter in Palmerton has been selling quite well. (The writer of this caption admits buying several pieces of this slag.) *Tema Hecht photo.*

A younger and visibly cheerful Ralph Thomas with his friend Herb Kropnick at the FOMS swap, sometime before 2012. It's April, spring has sprung, and the New Jersey Earth Science Association show is underway in the nearby Franklin School. Sharing the commute has made it easier for Ralph and Herb to be here. *Tema Hecht photo.*

of light and darkness, the dark ones with a pronounced "Wow" factor as the black lights come on, and the rocks change from drab clunkers to luminous fantasies. (As the show's ads remind us, "If your rocks don't glow, you're at the wrong show.")

On the inside front cover of the Spring 2018 issue of *The Picking Table* is a photo of Ralph, aged 92, at his 29th Ultraviolation. His red hair has turned white, his right hand is on the shoulder of a life-size, green-fluorescing skeleton identified as Madame Violette Boné, and his shy smile is still evident. Now he's left us, but Ultraviolation survives. Hail and farewell to the "Glow Father!" ⚒

We're grateful to Eric Brosius for sending us "A Dedication," his memorial to Ralph Thomas, so we could paint a broader picture of Ralph's contributions to the 'mineralculture' of his home turf near Philadelphia. *Rock Chatter* is the newsletter of the Rock and Mineral Club of Lower Bucks County, PA, Inc., and Eric's article headlined its Golden Jubilee 50th Anniversary Special Edition, dedicated to Ralph, known closer to home as The Rock Father.

A rare photo of Ralph Thomas with his Fluorescent Mineral Society colleagues at its December, 2010 meeting in the GeoTech Center at the Sterling Hill Mining Museum. From left: Manuel "Manny" Robbins, author of *The Collector's Book of Fluorescent Minerals* and *Fluorescence: Gems and Minerals Under Ultraviolet Light*; Warren Miller, a PhD chemist who has patiently assembled the finest collection of fluorescent minerals from Franklin and Sterling Hill; Ralph Thomas, whose many achievements are hinted at in this *Picking Table*, relaxed and among friends; Dr. Howard Green, presently Vice President of the Fluorescent Mineral Society and past organizer of the FMS's Northeast Fluoresophiles (NERF) chapter (its annual meeting is now known as the NERF Ball); and Richard Bostwick, who is just happy to be there. Note that the official museum of the FMS, The Thomas S. Warren Museum of Fluorescence, is located in this building, on the other side of the wall on the left. *Tema Hecht photo.*

# The Sterling Hill Mining Museum, Inc.

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**Featuring acres of things to see indoors, outdoors, and underground, including:**

Antique mining equipment displays
Mining memorabilia displays
Historic buildings
Underground guided tours
Museum store stocked with minerals, books, T-shirts, caps, etc.
Food concession and picnic area
And much more!

Every day a collecting site will be open for an additional $5.00 fee.

Contact the mine office for details.

**30 Plant Street, Ogdensburg, NJ 07439**
**Museum phone: 973-209-7212**
**Fax: 973-209-8505**
**Web: sterlinghillminingmuseum.org**
***DON'T MISS THE RAINBOW ROOM!***

**Schedule of operation:**

April 1 through November 30, Museum store is open 7 days a week, 10:00 AM to 3:00 PM. General public tours at 1:00 PM. Group tours may be scheduled by appointment at other times during the day.

December 1 through March 31, **WEEKENDS** - Museum store is open 10:00 AM to 3:30 PM and general public tours are at 1:00 PM (weather permitting). Group tours may be scheduled during weekdays by appointment (weather permitting). Please call if you have any questions.

In April, May, June, September, October, and November, tours at 1:00 PM or by appointment.

The temperature in the mine is 56°F.

# The Franklin Mineral Museum

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**32 Evans Street/P.O. Box 54, Franklin, NJ 07416**
**(Between Main Street and Buckwheat Road)**
**Phone: 973-827-3481**
**www.franklinmineralmuseum.com**

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Exhibited by means of guided tours: Franklin-Sterling Hill mineral specimens, educational exhibits in mining methods and history, including a life-size replica of underground workings, artifacts, gemstones, zinc uses, and a 32-foot-long fluorescent mineral display.

Included in the tours is the Jensen-Welsh Memorial Hall, built especially to contain the Wilfred Welsh collections of fossils, Native American relics, and worldwide minerals and rock specimens assembled for teaching purposes.

Mineral collecting on the Buckwheat Dump. Ample parking. Picnic grounds. Fossil dig and gem panning for kids. Gift shop offering for sale: local and worldwide minerals, fluorescent specimens, agate slabs, onyx carvings, UV lamps, hammers, mineral books, T-shirts, postcards, and much more.

Separate admission fees to the Museum and the Buckwheat Dump. Admission to the Museum includes guided tour.

**OPERATING SCHEDULE:**

*Open to the public*

**March – Weekends Only**

**April 1 – December 1**

**Monday through Friday: 10 AM – 4:00 PM**

**Saturday: 10 AM – 5:00 PM**

**Sunday: 11 AM – 5:00 PM**

Closed Easter, July 4th, and Thanksgiving

*Groups by reservation, please*

**Franklin, New Jersey**
**"The Fluorescent Mineral Capital of the World"**

A large, pale pink, translucent calcite crystal with pitted surfaces, the pits lightly coated with pale blue magnesioriebeckite. The size of this crystal (5.5 inches, or 14 cm long) may be unprecedented at Franklin, and one would be inclined to doubt the locality were it not for Jack Baum's label (inset photo), which reads "Calcite XL, fluo LW, from crocidolite area, Franklin Mine, Fkln, NJ." Embedded in the calcite are several grains of "oil green" sphalerite. Franklin Mineral Museum specimen FMM-7470; *Earl R. Verbeek photos*.