THE PICKING TABLE

JOURNAL OF THE FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY

VOL. 53, NO. 2 – FALL 2012

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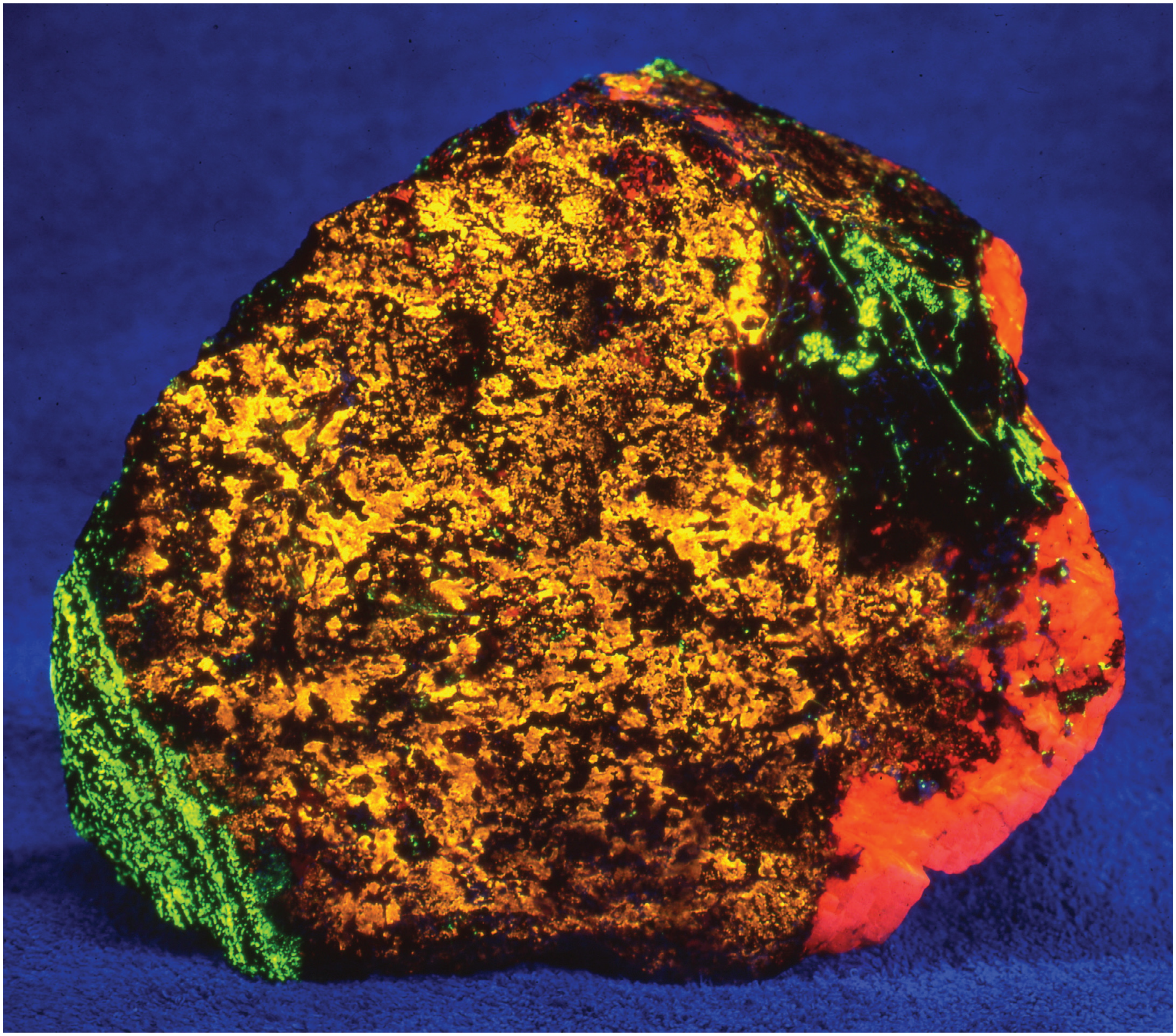

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- **Fluid Flow in Metamorphic Rocks, Part 1**
- **The Strange Morphologies of Graphite From the Trotter Dump**
- **"Christmas Tree Ore" Explained**

www.FOMSNJ.org

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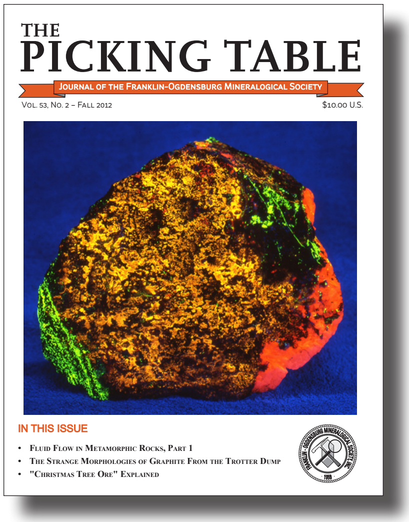
About the Front Cover

A thick crust of bright orange-fluorescent clinohedrite coating a fracture surface in massive hardystonite, bordered on the left by gneissic willemite-franklinite ore and on the right by coarse-grained calcite. The specimen is approximately 10″ (25 cm) across and is from the Mike Massey collection. Currently in the Earl R. Verbeek collection. *Tema J. Hecht 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.

FOMS is a member of the Eastern Federation of Mineralogical and Lapidary Societies, Inc. (EFMLS).

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

FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY, INC.

FALL – WINTER 2012 ACTIVITY SCHEDULE

COMPILED BY TEMA J. HECHT
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NEW YORK, NY 10025
thecht@att.net

SATURDAY, SEPT. 15, 2012

9:00 am – NOON
FOMS Field Trip
Sterling Hill Mining Museum.
Collecting permitted on the Mine Run Dump and
in the Fill Quarry, Passaic Pit, and "saddle" area.
$5.00 admission plus $1.50 for each pound
of material taken.

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: *A Miner's Experiences at Sterling Hill: Mining and Collecting*, by Don Phister.

SATURDAY AND SUNDAY, SEPTEMBER 29-30, 2012

****56TH ANNUAL FRANKLIN-STERLING**
GEM & MINERAL SHOW
Sponsored by the Franklin Mineral Museum.
Franklin Middle School, Washington St., Franklin, New Jersey.

9:00 am – 6:00 pm Saturday (indoors),
10:00 am – 5:00 pm Sunday (indoors).
$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 $18.00.
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
sterlinghillminingmuseum.org

SATURDAY, OCTOBER 20, 2012

9:00 am – NOON
FOMS Field Trip
Collecting at the Taylor Road site.
Meet at the Franklin Mineral Museum.
Park, and walk from there. Fee charged.

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

1:30 pm – 3:30 pm
FOMS Meeting
Franklin Mineral Museum.
Lecture: *Mineral Exploration Adventures in the 1980s in Brazil*, by Juan Proaño.

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

SATURDAY, OCTOBER 27, 2012

** **24TH 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 3, 2012

** **6:30 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.
Admission $10.00 adult, $8.00 children 3-12 years of age.
Poundage fee charged. **Call for details: 973-827-3481.**

SATURDAY, NOVEMBER 17, 2012

9:00 am – NOON
FOMS Field Trip
Collecting at Hamburg Quarry, Eastern Concrete Materials, Inc. Meet at the Scale House to sign releases. Hard hats, leather shoes (preferably steel tipped), gloves, and glasses required.

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

1:30 pm – 3:30 pm
FOMS Meeting
Franklin Mineral Museum.
Lecture: *Under the Microscope:*
The History and Techniques of Micromounting
With Emphasis on Franklin, New Jersey, by John Ferrante.

* * *

**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 Charles Butts, Earl Verbeek, Ralph Thomas, the Franklin Mineral Museum, and the Sterling Hill Mining Museum for this information.

Still Available!

(While Supplies Last)

The first 50 Years of
THE PICKING TABLE,
the “Official Journal of the Franklin-Ogdensburg Mineralogical Society,”
on DVD in Adobe Acrobat PDF format.

Ninety-three issues, 2,256 scans, and hundreds upon hundreds of both B&W and color photos of minerals, events, collectors, as well as articles, event schedules, past officers and editors, mineral descriptions, etc.

All pages have been scanned from ORIGINAL issues of the *PT*. In some cases “imperfections” will be evident, such as yellowing of 50-year-old paper and the occasional marginal note, but all literary inclusions are clearly legible and the photos are true to the originals.

The knowledge you will acquire as you read through these issues will be evident.

Price for the 2-DVD set is $45.00, plus $5.00 shipping.
Personal checks should be made payable to “FOMS”
and mailed to Denise Kroth at:
240 Union Ave., Wood-Ridge, NJ 07075.
Technical support is provided by Richard Keller
(e-mail: PTMemberFeedback@gmail.com).

From the Editor's Desk

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

In the almost two years I've served as managing editor of *The Picking Table*, I feel that our contributors, and our exceptional team of editors, have succeeded in offering a diverse mix of articles to our readers. The present issue continues in that vein.

In the past three issues, we've featured articles on significant collections obtained, "foreign" mineral clubs visiting our area, the history of a Franklin mineral collection assembled 200 years ago, life in "old Franklin," and minerals (including misidentified ones) of particular interest to collectors and scientists alike.

We've also been quite diversified in our choices of *PT* covers. Chronologically speaking, we've shown an outstanding daylight image of a Franklin classic, an old-time photo of a beloved Franklin collecting site, and a portrait of a Franklin icon.

As a dyed-in-the-wool fluorescent-mineral collector, I really wanted to have my first UV cover. Not only have we done this, but we chose to use, odd as it may seem, the first clinohedrite ever represented on a cover of the *PT*!

Our constant goal is to satisfy (pacify?) *all* of our readers. We realize that some members aren't enamored by pretty photos of fluorescent minerals—they want the mineralogy—while others more enjoy the photos, but don't know the science behind them. This particular issue of the *PT* may appeal to the more scientific readers among us. However, even the most scientific and technical of articles include photos intended to maintain, if not spark, the interest of the majority of our members. In each issue we strive to have something for everyone: an eclectic mix of contributions.

Also, we have addressed the issue of allowing our members to stay apprised of our pre-FOMS meeting field trips/digs. In each issue of the *PT*, we publish an activity schedule that gives details of the digs scheduled for the upcoming season. But what if you misplace your *PT*? No problem: The schedule is posted, and duly updated, on Facebook. You merely need to search for "FOMS," click on the page, and then click on "Files." The activity schedule will be updated and listed there. We have Tema Hecht to thank for this.

Finally, below is a photo I came across that I felt would be apropos to send us off into this new *PT*. It makes you wonder if the teacher was a Franklin fluorescent-mineral collector! ⚒

40th Annual New Jersey Earth Science Association Gem & Mineral Show

April 28-29, 2012

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

For 40 years the NJESA Gem & Mineral Show has been a rite of spring for mineral collectors. Friday was clear and dry, a pleasant surprise for the exhibitors and indoor dealers who set up inside the Franklin school. Overnight the temperature dropped to about 32°F; Sussex County has the highest average elevation of the New Jersey counties, and the cooler weather there can surprise the casual visitor from the lowlands. Early on Saturday, with a stiff breeze blowing and the temperature hovering around freezing, normally eager show-goers seemed reluctant to venture outdoors. The thoroughly chilled outdoor vendors, for their part, craved a hot cup of joe and wondered why the crowds were sparser than normal. However, abundant sunshine thawed out swappers and customers alike, and it was a spectacular day for a mineral show.

Inside the school, it was a pleasure to savor the wide variety of exhibits. There were 17 indoor white-light displays organized by John Sanfaçon and 13 ultraviolet displays organized by Richard Bostwick. Special thanks to them and to the exhibitors, who presented a wealth of local and worldwide specimens for all to enjoy.

Just as springtime is full of bold colors, so were the white-light displays. Rudy and Beth Greipel's first case, "A Splash of Color," presented richly hued specimens from all over the world. This rainbow of crystalline beauty included a peacock hematite from Minas Gerais, Brazil, and a fine citrine quartz from San Luis Potosí, Mexico. The Greipels' second case, titled "Metals," showed minerals that are ores of elements from gold to molybdenum. Iron was represented by cubic magnetite crystals from Balmat, New York, and a fantastic goethite specimen from Morocco.

John Sanfaçon presented three cases, the first being "Idiochromatic Minerals," whose colors are characteristic of those minerals and are determined by their chemistry. These included a spectacular astrophyllite that John picked up for three dollars at a Russian flea market. His second case, "Allochromatic Minerals," showed minerals which when pure are colorless, but in nature are colored by impurities. This concept was demonstrated by a palette of multicolored fluorite, tourmaline, corundum, topaz, calcite, garnet, and vesuvianite. John's third case was "Decorative Stones," filled with unusual lapidary material like Australian "Zebra Stone" and brecciated jasper, as well as stunning rainbow obsidian from Guadalajara, Mexico. Two vases made of polychrome serpentine from Taiwan were so colorful it was hard to believe they weren't "doctored," but they take their colors from natural oxides.

The New Jersey Mineralogical Society's case, "Hardness," exhibited minerals covering the full range of mineral hardness from pale green Vermont talc (Mohs 1) to diamond (Mohs 10). Trailside Nature and Science Center presented "Lenape Indians of New Jersey." This display included a wide variety of working tools made from rocks: choppers, hammer-stones, pestles, axes, celts, spears, and arrowheads. A case of "Tilly Foster Mine Minerals" was assembled by the author to show the wide variety of crystallized species that came from this famous iron mine in Brewster, New York. Here were classic chondrodite, clinochlore, brucite, titanite, magnetite, and apatite specimens mined during the latter half of the nineteenth century, before a tragic accident in 1895 killed thirteen miners and led to the closing of the mine.

The Franklin Mineral Museum case was titled "Varieties of Willemite," but the real surprise was the variety of colors and textures of this abundant zinc ore from the Franklin and Sterling Hill mines. Colors ranged from "true blue" to red, white, and many shades of green, while textures included radiating crystals, "shot ore," and the blue-green, chert-like veining of "sea-foam willemite." Dick and Elna Hauck's first case, "Mining Art," showed three original pen-and-ink drawings of the workings at Franklin and Ogdensburg, New Jersey, as well as several western USA mining scenes. Dick and Elna Hauck's second case, "Minerals and Mining," presented Tri-State District minerals from Missouri, Kansas, and Oklahoma — sphalerite, calcite, and galena — as well as detailed mining models. "For the Love of Calcite," Brendan and Connie Dunn's case, displayed a fine selection of calcite, with an especially dramatic white calcite on amethyst from Rio Grande do Sul, Brazil. A gemmy specimen of yellow calcite from Sarbai, Kazakhstan, was a fine centerpiece.

John Kolic, local miner extraordinaire, exhibited specimens from Franklin and Ogdensburg. My two favorites, both collected by him underground, were his mcgovernite (a fantastic example with multiple rosettes), and a smallish specimen with large crystals of kolicite. There were also rare uglies like the best akrochordite (a.k.a. "the rock wart") to come out of the Sterling Mine, as well as classic uvite, rhodonite, copper, nelenite in rhodonite, bementite, ganophyllite, magnussonite, zincite, and various lead silicates… Well, you get the picture; this case was truly an inspiration for any collector of Franklin minerals.

"Minerals of Bergen Hill, N.J.," by Brad Plotkin, featured truly historic specimens from some of the great collectors of the past, including Vaux, Bement, Manchester, Lorenz, Jefferis, Reamer, MacDonald, Amend, Foote, Canfield, Kunz, and Hoadley. All these great men had an affinity for this once-prolific spot in New Jersey, which yielded its mineral treasures when roads and tunnels were excavated through its basalt, but is now mostly buried under asphalt and concrete. Don Lapham put in a case of "Lockport, N.Y., Minerals" showing that it's still possible to field-collect fine specimens of calcite, selenite, celestine, and sphalerite there. The Bernard Kozykowski Collection filled two cases with large, colorful, worldwide classics that showed his preference for true cabinet-size specimens. My attention was first grabbed by the brilliant green of dioptase crystals from Katanga, Congo, a huge cube of purple fluorite from the Boltsburn mine, Durham, England, and one of the most three-dimensional Ellenville, N.Y., quartz crystal groupings I have ever seen. A large curving fissure of goethite filled with hemimorphite crystals from Mapimí, Mexico, reminded me of a large row of alligator teeth. European classics rounded out his cases with several fine aragonite, celestine, and sulfur crystals from Agrigento, Sicily.

The fluorescent displays, while best appreciated in the dark, were no less spectacular. The Franklin Mineral Museum presented the grand old theme of "U.S. Flag Colors" in the form of calcite for red, barite for white, and margarosanite and hydrozincite for blue, all from Franklin and Ogdensburg. The label in the Sterling Hill Mining Museum case proclaimed "Three Great Localities" for fluorescent species: the Ilímaussaq complex, Greenland; Puttapa, South Australia; and of course the Franklin and Sterling Hill mines. With tugtupite, calcite, esperite, turneaureite, margarosanite, sodalite, wollastonite, and willemite competing for your attention, you certainly could appreciate why these localities attract collectors. The program title, "Ugly in Daylight but Fun in the Dark," was amply realized, and as spectators were urged to vote for their favorite locality on a pad of paper provided for that purpose, I cast my ballot for the home team.

"Franklin Delights" was your author's title for a case filled with treasures from what I consider the most fascinating locality for fluorescent minerals. This year's selection included a variety of mimetoliths ("picture rocks"), including an ostrich-egg willemite from the Buckwheat Dump and an esperite-outlined "Puff the Magic Dragon." Andrew K. Mackey's "Red and Green" case had a two-mineral theme of willemite and calcite from our local mines, in a variety of patterns and crystal cross-sections that made us imagine how the zinc orebodies must have looked in the mines under a shortwave ultraviolet lamp. Andrew R. Mackey supplemented his father's theme with "The In-Betweens," a case of local wollastonite, barite, willemite, and clinohedrite.

The prize for the most creative case goes to Rich Keller for "Mineralogical Map." Here was Rich's list of localities, so picture in your mind which Franklin/Sterling minerals would correspond to these place-names under UV: Orange, California; Red Rocks, Colorado; Yellowstone National Park; Brown University; Whitestone, New York; Painted Desert, Arizona; Blue, Texas; Pinkerton Park, Tennessee; and Greenville, South Carolina. (Wow, what a list; let me confess that I often use fluorescent-mineral analogies to describe natural scenes, such as a wollastonite-orange sunset, and even foods such as willemite-green Jell-O.)

George Durland made a point with his case of "Some Franklin and Sterling Hill Rocks and Some Also-Rans for Comparison," by matching minerals from different localities. Most memorable was the grouping of a large Challenger Cave, Nuevo Léon, Mexico, calcite cleavage with a piece of brilliant red Franklin calcite and a more subdued red-fluorescing calcite from Långban, Sweden. Brendan and Connie Dunn's case of "Long Wave Classics" included a bright green hyalite opal from Spruce Pine, North Carolina; a red- and orange-fluorescing parvowinchite and tremolite from Talcville, New York; an outstanding violet-blue–fluorescing fluorite from Weardale, England; and many other fine specimens. Warren Miller displayed "World-Wide Willemite" from Arizona to Europe to Australia, with good old New Jersey willemite still dominating the case with its bright green intensity. Howie Green's case of "Swedish Honkers" tried to intimidate us with its large specimens of colorful willemite, johnbaumite, calcite, and wollastonite from Långban, Garpenberg, Jakobsberg, and Harstigen.

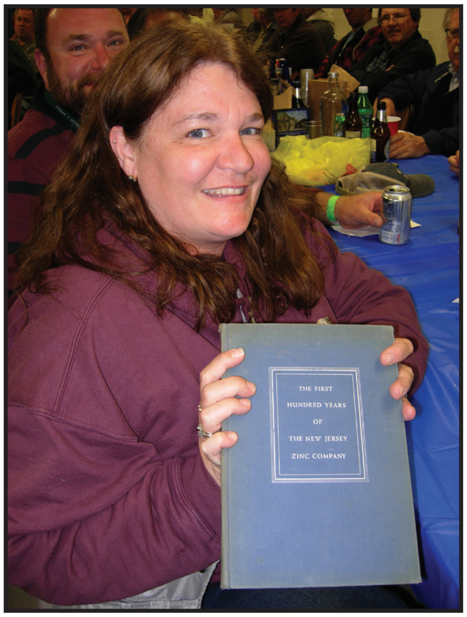
"Dymond's Gems" showed off John Dymond's personal potpourri of willemite, hardystonite, and fluorescing concrete from Franklin, as well as an interesting piece of pottery that had a crystallized willemite glaze. Pete Gillis got the Largest Single Case Award for "Some Old Things Lying Around the House," an eclectic assortment ranging from pale-green–fluorescing genthelvite and dead-zone willemite from Sterling Hill, to Franklin's intensely orange-fluorescing First-Find, Second-Find, and Third-Find wollastonite. A nice surprise was the case put in by Glenn Rhein, titled "Recent Finds From Amity, N.Y." It featured four brightly fluorescing species, from his property at the north end of the Franklin Marble, under shortwave UV: norbergite (yellow), diopside (blue), tremolite (blue), and fluoro-edenite (blue-green). One unusual norbergite looked like a flower under UV, petals and all. Several of Glenn's specimens included dozens of altered tremolite crystals with two or three fluorescent colors each, resulting in a bright parallel-banded effect.

For the exhibitors who lugged their treasures to the show so all could see them, a hearty thank-you! Rounding out this spring adventure was the banquet with its silent and voice auctions, giving us time to reminisce with old and new friends. Those of you who did not brave the cool weather missed a really fine show! It's an opportunity for New Jersey collectors to share their interests with the public, so why not take up the challenge and be a participating exhibitor at next year's event? I know you will have a rewarding experience, and I look forward to seeing you there. ⚒

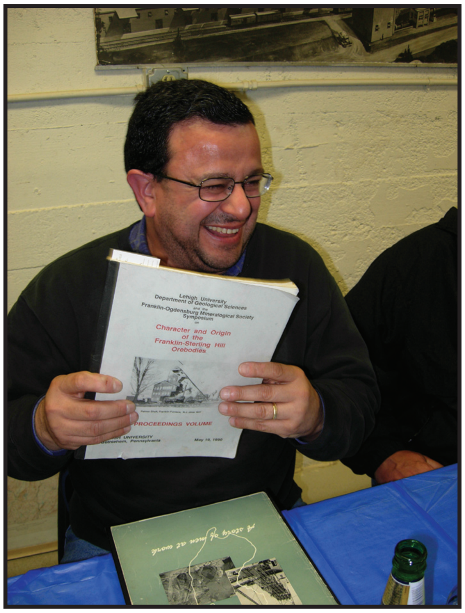
Show volunteers pose for a family portrait: L to R, Chris Gillis, Dick Bostwick, Tema Hecht, Pete Gillis, Earl Verbeek, and John Dymond. *Richard J. Keller, Jr. photo.*

Scenes From the New Jersey Earth Science Association Gem & Mineral Show

Why is this man smiling? The beer? The T-shirt? The photographer? Steve Misiur isn't talking… *Tema J. Hecht photo.*



Heather Moldovany, with newly acquired husband Gary in back and newly acquired bedtime reading in front. *Tema J. Hecht photo.*



Patrón saint? Denis DeAngelis, fueled by high-octane Patrón tequila, generously supports FOMS with his power bidding. *Tema J. Hecht photo.*

Ray Latawiec orchestrates a feeding frenzy of specimens from the Pete J. Dunn collection. *Mark Boyer photo.*

SCENES FROM THE NEW JERSEY EARTH SCIENCE ASSOCIATION GEM & MINERAL SHOW

Brents (Buddy) Travis and Mat Osowski of Way Too Cool. These two guys helped immeasurably during teardown of the show and saved the rest of us from hernias. Way too cool? You bet they are! *Tema J. Hecht photo.*

Chris Luzier with a sign apparently made from crushed margarosanite, hydrozincite, clinohedrite, datolite, and willemite. Awesomeness! *Tema J. Hecht photo.*

Bill and Cathy Bethke with their Way Too Cool "The Triple" (a portable LW/MW/SW lamp) won during the auction. *Tema J. Hecht photo.*

Ron Koppel after his winning bid for several Franklin "limonite pseudomorphs" after mule shoe, railroad spike, and oil lamp. *Tema J. Hecht photo.*

Reincarnation? The legendary Adolph Sutro with muttonchops; the legendary Chet Lemanski without. *Tema J. Hecht photo.*

Miners Day and Volunteer Appreciation Day

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On May 6, 2012, the Franklin Mineral Museum hosted Miners Day and Volunteer Appreciation Day. The weather decided to cooperate, and though it was a bit windy, the sun came out and we were able to have the festivities outdoors. The food selection was wonderful and included pasta, pulled pork, chicken, beef, sausage and peppers, an array of salads, sandwiches, cookies, brownies, shortbread, and a cake donated by Anne Wronka. We shouldn't forget the selection of beverages, some of which put smiles on the guests' faces. A big thank-you goes to the staff of the Franklin Mineral Museum!

The Franklin Band was in attendance, performing "The Star Spangled Banner" for the opening, followed by a tuneful selection of old and new favorites.

After the band's performance, the Master of Ceremonies, Richard (Dick) Bostwick welcomed one and all, asking, "Can you hear me in the back? Can you hear me in the front?" In response, there were cheers, so we assumed that Dick was heard without the microphone. Dick continued, "This is the Franklin Mineral Museum and you are our guests. Like the band, this [Miners Day] is becoming a local tradition."

Dick continued, "We're here, but there are some of us who aren't…Jack Baum passed away on October 6, 2011, and was a great man of Franklin." [Time did not permit a complete recital of John Leach Baum's accomplishments in and for Franklin, but *Picking Table* readers should consult the Fall/Winter 1996 and Spring 2012 issues, as well as page 29 of this issue, for a fuller appreciation of this remarkable man. In summary, Jack graduated from Harvard in 1939 and was promptly hired as a geologist by the New Jersey Zinc Company, which employed him for the next 32 years as an exploration geologist at Franklin, Sterling Hill, and elsewhere. In retirement, from 1965 to 2000, he was curator of the Franklin Mineral Museum; he is among its Hall of Fame honorees, and its entry hall is named for him. So are two minerals: baumite (since discredited) and johnbaumite. In 1981, Jack received FOMS's highest honor, the Lawson Bauer Award. Jack's wife, Augusta, attended Miners Day with him for many years, and joined us again this year.]

Other passings were noted. Sterling Hill miner John Paiva died on March 19, 2012, at the age of 105 (more about him later in this report). Robert Metsger, the last chief geologist of the Sterling Hill mine, died on March 31, aged 91. Two days before Miners Day 2012, Chester "Chet" Lemanski, a long-time Franklin Mineral Museum board member, lost his wife and partner Mary Bridget Lemanski, who was 62. Mineral collectors will remember that for many years the Kraissl-Lemanski collection was a major attraction at the Franklin

Ron Mishkin, former miner at Franklin, enjoying Miners Day.

Mineral Museum, and at the annual FOMS banquet Mary Bridget was the "den mother" of what was affectionately called the Rowdy Table. [Author's note: Sometimes misfortunes gang up on us. A week after Miners Day 2012, on May 16, Robert Svecz died at 59. Bob was the mine geologist at Sterling Hill and worked under Bob Metsger until that mine closed in 1986.]

Dick thanked everyone for being at Miners Day. He went on to say that Franklin, like its neighbor Ogdensburg, is a mining town, has been a mining town for 200 years, and has a great tradition for mining, and producing hundreds of mineral species. Dick went on to state, "We have a total of three museums, two of which are mining museums. There is no comparable area that can say it has three such museums. That makes you guys famous and you have a tremendous store of history. Don't drop it! You are superior people from a superior place. Be very proud of that!"

Mike Ryder, the assistant principal of the Odgensburg Public School and Carolyn Ryder, supervisor of instruction at the Franklin School, presented the Science Awards.

The son of John Naisby, Jr., who was a Franklin miner, spoke about growing up in Ogdensburg while his father worked in the Franklin mine. He said that education was very important and that the schools were excellent. They helped educate young people in finding trades. He said that when you were in the mines you *worked* and that everyone should be very proud of what they now have here.

Two miners, Al Grazevich and Richard Ramage, spoke about John Paiva. Al worked at Sterling Hill as a timberman, learned his trade from John, and was present on the day John quit after 49 years on the job. The mine superintendent, who was fairly new and given to expressing his opinions, showed up underground and made disparaging remarks about John's work. John became incensed, took his hard hat off, threw it down, said "Summabeech," and walked off the job.

Sterling Hill miners attend Miners Day. Included in this photo are Richard Ramage (left foreground), Steve Dekmar (white checked shirt), Richard Ramage Jr. (red shirt), John Antal (standing), and Doug Francisco (right).

Richard "Dick" Ramage, who went underground at Sterling Hill in the 1930s, worked with John, and said John was the best timberman that NJZ ever had. Any miner could ask John to solve a problem, and he'd do it; in short, you could count on John Paiva. John made it easy for us young kids starting out in the mine, said Richard Ramage. With his voice breaking, Ramage added, "I miss him. At times I walk by the adit and I smell the mine air and get homesick. I still get homesick."

Dick Bostwick ended Miners Day by observing, "We have just gotten a dose of deep-down reality from those [the miners] who lived it." ⚒

FMM employees Bill Harpell, Carol LaBrie, Debbie Caldera, and Trish Clough take a well-deserved break after working hard to make Miners Day the success it was.

The Franklin Band, keeping the cultural heritage of Franklin alive and well. At 142 years and counting, this is New Jersey's oldest town band.

Looking Back at the Show

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Every mineral show in Franklin, spring or fall, evokes many wonderful memories. I attended my first Franklin show in the fall of 1982, when we moved to the area. Back then the show was held at the armory, now the Littell Center. My youngest son, Jed, always came with me. The vendors were patient with him, and so kind. Often they would tell my son stories about the places they had gone to find their minerals. Now and then someone would give him a few polished rocks to keep, just for showing such interest.

Jed looked forward to going to the show every year. He dreamed of purchasing a crystal ball, and he saved his allowance and birthday money all year to pay for it. By the time the show came, he had collected a wad of about forty crumpled dollars. He was excited about going to the show, and we were probably the first people at the armory door that year, but Jed was in for a letdown. Forty dollars hardly paid for the size of crystal ball he had dreamed of. He went from vendor to vendor. Finally, at the end of the day, one kind vendor asked him how much money he had. He laid all of his bills on the table. The vendor took them and handed Jed a baseball-sized crystal ball! Jed was so happy. He still has it.

When Jed was in high school, he was chosen to represent his school in the statewide Science Olympiad. He proudly returned home with a first place trophy in the Rocks & Minerals category, as the champion mineral identifier in New Jersey. How was this possible? How did he know the names of all these minerals? I asked him and he smiled and said, "Every year, when we walked around the Franklin mineral show, what do you think I did? When you stopped to talk to someone I just looked at all those minerals, which were labeled. I tried to learn all of their names." Thank you, Franklin mineral shows, for making my son a champion! Now, over a decade later, he is still attending the shows.

As for me, I have recently retired and moved to Massachusetts, after teaching music for almost a quarter of a century in Franklin. The Home and School Association of the Franklin School has been running the concessions ever since the show moved there. Beginning Friday afternoon and then working well into Sunday night, both parents and staff of the school have worked together. All of the profits go to the school. I thank this organization, as the money earned by this event helped pay for my classroom stereo as well as some of my instruments. I fondly remember wrapping baked donated goods, chopping onions, and creating and hanging up the Rock Pile Café signs, as well as running to ShopRite several times to get more hot dog buns.

Two sisters and a son pose at the spring 2012 Franklin-Sterling Gem & Mineral Show. L to R: Tema Hecht, Jed Gutlerner, Judy Gutlerner. *Richard Bostwick photo.*

The third person in this picture is my sister Tema, from New York City. An amazing fate awaited her. In 1989, someone introduced her to Dick Bostwick, who collected fluorescent minerals from the Franklin area. They married, and soon she became an integral part of the show. She set up exhibitions, created and distributed the show badges, and became co-editor of *The Picking Table* as well as a board member of the Franklin-Ogdensburg Mineralogical Society and the Franklin Mineral Museum. She has photographed many mineral displays as well as the equally colorful collectors at these shows. This time we asked Dick to take this picture of us. It was always exciting for me to have my sister come to my school for the shows, and I've always enjoyed watching how the show comes together. On this occasion, I hadn't seen my sister for 8 months, so the spring 2012 show had a special magic for me.

Looking at this photograph, I can't help but look back to all those special years we've attended the shows. When Tema and I said goodbye at this show, I bought a shark's tooth from one of the outside vendors. "I think my 4-year-old grandson will love this!" I said, and handed him my money. As I started to walk away, he yelled, "Wait! Here! Take these also for your grandson."

He opened up a baggie and filled it with polished stones, inspiring a third generation of my family to love Franklin's mineral shows. ⚒

Fluid Flow in Metamorphic Rocks, Part 1

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INTRODUCTION

Introductory courses in rock identification invariably begin by defining the three major classes of rocks—igneous, metamorphic, and sedimentary—and then listing the visual characteristics of each. One of the first things that students learn is that mineral grains in metamorphic rocks fit tightly together—that is, the grains are everywhere in contact with one another, with no spaces between them. Metamorphic rocks in consequence are said to be *nonporous*, with no voids visible to the naked eye. Indeed, if you place a drop of water on the surface of most of our local rocks, the zinc ores and associated gneisses from the Franklin and Sterling Hill mines, the drop may spread out on the surface, but otherwise it will simply sit there until it evaporates. Such rocks are said to be *impermeable*, or, in common parlance, "watertight."

At both of our local zinc mines, however, there is abundant evidence that the orebodies and associated calcium-silicate gneisses were in places invaded by hydrothermal ("hot water") fluids at some time in the past, and that these fluids both altered the original rocks and gave rise to a wide range of new mineral species. Some of these new minerals, such as pectolite, prehnite, roeblingite, and others of the famed "Parker Shaft suite," are among the most coveted of our local species. But how did these fluids gain entry to the rocks in the first place, if the rocks as crystallized during the peak of metamorphism had essentially zero porosity and thus no or negligible permeability? In this, the first of a planned three-part series, I discuss one of those ways and illustrate it with two local examples, both from Franklin.

MICROCRACKS IN METAMORPHIC ROCKS

As it turns out, when we were taught that metamorphic rocks are nonporous, that's not quite true. As a rough guideline, the total void space in nominally intact (unaltered, undeformed) metamorphic rocks exposed at the Earth's surface ranges from one millionth to one thousandth of the total volume of the rock (Norton and Knapp, 1977). One way to show this is to cut a smooth slab from a specimen of metamorphic rock, cement the slab onto a glass microscope slide with colored (e.g., blue) epoxy, and then grind the slab down until it is so thin that light readily passes through it. The conventional thickness for such a sample, called a *petrographic thin section*, is 30 microns, about half the thickness of a human hair. Examination of such thin sections under high magnification often reveals narrow, irregular "threads" of blue epoxy, each of them filling an original *microcrack* in the rock. By this means the microscopic voids in a metamorphic rock can be made visible, and we see that the porosity is not quite zero after all.

Figure 1. A specimen of massive bustamite in pink grains 0.5 to 1.5 cm across. Note thin, irregular strands of dark brown serpentine along the edges of individual bustamite grains. Dark brown area on right is a post-mining weathering rind. Specimen is about 6 cm in width. *E.R. Verbeek collection and photo.*

Among the most common and pervasively distributed microcracks in metamorphic rocks are *grain-boundary cracks*, tiny openings along the contacts between adjacent mineral grains. To the extent that some of these cracks are interconnected in three dimensions, fluids can enter the rock and migrate through it. The flow paths are tortuous and the openings microscopic, so flow rates generally are low. Nevertheless, geologic time is patient, and given enough time (and enough fluid pressure) an appreciable volume of fluid can pass through even the "tightest" of rock masses. Chemical reactions between the fluid and the rock often result in alteration or replacement of minerals originally present, precipitation of new minerals within the microcracks, or both. In this way a metamorphic rock can become extensively altered by the fluids that pass through it, even though, to the naked eye, no obvious fluid-flow conduits exist within it.

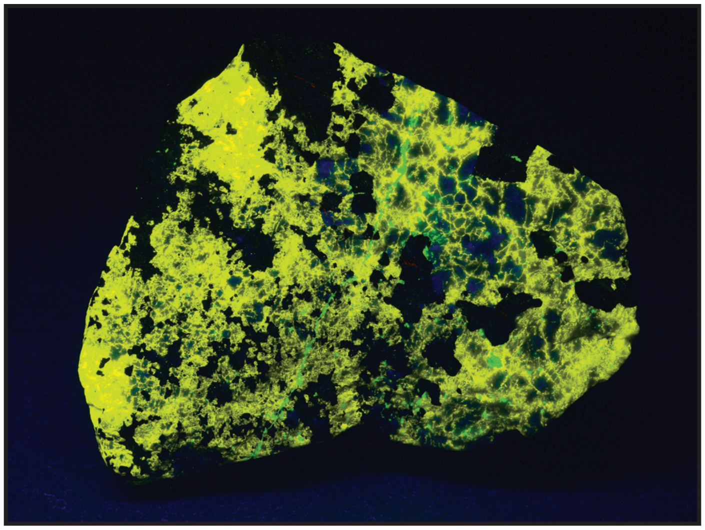

Figure 2. "Spiderweb" esperite (yellow) showing progressive alteration of original hardystonite (blue) by hydrothermal fluids. Specimen is about 11 cm across and is shown here under shortwave ultraviolet light. E.R. Verbeek collection, formerly in the Gary Cardinale collection. *E.R. Verbeek photo.*

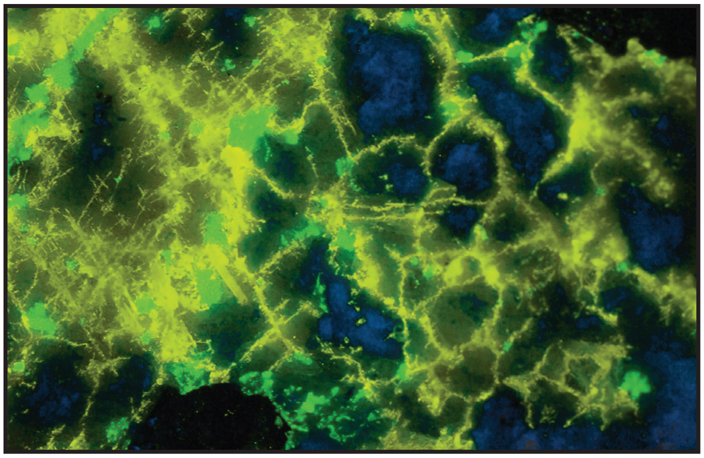

Figure 3. Close-up view, under shortwave ultraviolet light, of a portion of the esperite-hardystonite specimen shown in Figure 2. Alteration of hardystonite (blue) to esperite (yellow) along grain boundaries is particularly obvious in right side of figure. Toward left side the alteration is more advanced, revealing esperite replacing hardystonite along cleavage planes. In places the original hardystonite grains are almost completely replaced. Field of view is 1.2 cm across. *E.R. Verbeek photo.*

SOME LOCAL EXAMPLES

The specimen shown in Figure 1—a small, modest example of granular bustamite—is one that shows visible evidence of grain-boundary flow. Most collectors would deem this specimen unappealing because of its dark brown weathering rind and lack of fluorescence. Note, however, the conspicuous network of thin, discontinuous, threadlike veinlets of dark brown serpentine along the boundaries of individual bustamite grains. These veinlets have a story to tell.

Bustamite is the high-temperature form of manganese silicate (the lower-temperature dimorph is johannsenite) and, in many Mn-rich rocks at Franklin and Sterling Hill, is a component of the peak-metamorphic mineral assemblage. Serpentine, however, requires the presence of a hydrous fluid to form and in the local area is exclusively a late-stage mineral that occurs either in vein assemblages or as replacements of a precursor mineral. Here, then, is a clear example of the alteration of a peak-metamorphic, high-temperature mineral (the bustamite) by hydrothermal fluids migrating through the rock along a network of microscopic grain-boundary cracks. As a geological specimen—one that enables us to understand some of the processes that gave rise to our local minerals—this one claims a status far above its modest collector value.

A second example is shown in Figure 2, a specimen of "spiderweb" esperite. "Spiderweb" esperite is uncommon, though hardly rare, and has become one of the more coveted varieties of the species. But how did it form? The close-up photo of Figure 3 reveals part of the answer. Here we see that the esperite forms an interconnected network of thin films enclosing individual grains of hardystonite. The textural relations show a chemical reaction "caught in the act," as it were, with the original hardystonite in various stages of being replaced along grain boundaries by esperite. In some places (right side of Fig. 3), a core of unaltered hardystonite remains within the "cells" defined by the esperite network, but in others the hardystonite is almost wholly replaced. The fluids responsible for the replacement reaction entered the rock along grain-boundary cracks and there began the process of reacting with the hardystonite grains to form esperite.

The left side of Figure 3 shows a continuation of this process, where hydrothermal fluids migrated not only along grain boundary cracks *between* hardystonite grains (intergranular flow), but also along incipient cleavage planes *within* individual grains (intragranular flow). The result, clearly expressed in the photo, is one or more sets of microscopically thin, parallel esperite veinlets extending into the interior of hardystonite grains. Although such veinlets resemble exsolution lamellae (see Boyer, 2012 for explanation), they formed through an entirely different process: a post-metamorphic replacement reaction rather than synmetamorphic solid-state exsolution. Carried further, the replacement process would have resulted in the completion transformation of hardystonite into a solid mass of esperite. Specimens abound that show the reaction in various stages of completion, providing collectors with a marvelous variety of patterns between the two species.

GENESIS OF MICROCRACKS

To begin to understand the origin of microcracks in metamorphic rocks, bear in mind that our local ore deposits were once buried to depths of 11-15 km below the surface and experienced temperatures of about 770°C and lithostatic pressures of about 550 MPa during the peak of metamorphism (Peck et al., 2006; Volkert, 2004). Erosion gradually removed the overlying rocks, slowly bringing the ore deposits to progressively shallower depths. They are now exposed at or near the surface, and the rocks are at average temperatures of about 15°C—a radical departure in both temperature and pressure from when these rocks were subjected to peak metamorphism about 1050 million years ago. We now turn to four general mechanisms of microcrack growth, beginning with metamorphism.

Metamorphic devolatilization: One might logically suppose that a rock buried to depths of 11-15 km would have effectively zero porosity because the crushing weight of the overlying rock would squeeze all cracks shut, even microscopic ones, and expel all fluids originally present within them. That is indeed the case, and many metamorphic reactions occur under what geologists would call nominally "dry" conditions. Additional fluid, however, can be generated within the rock as metamorphism proceeds. As one common example, envision the conversion of shale, a clay-rich rock, to slate, mica schist, and finally to gneiss. During this process the original clays, which contain water in the form of lattice-bound hydroxyl (OH^-) ions, are converted first to micas (also containing OH^-) but then into anhydrous minerals such as feldspars, at which point the water is released as a metamorphic fluid. Similarly, amphiboles can release water during metamorphism, and carbonate-bearing minerals can break down to contribute CO_2 to a metamorphic fluid. These and other such processes are referred to collectively as "devolatilization reactions" and are responsible not only for the formation of new fluids in a rock undergoing metamorphism, but also for the tiny openings, the microcracks, within which the fluids reside. Such fluids at the elevated temperatures and pressures of metamorphism are highly chemically reactive and are of great interest as agents of rock alteration and mineralization.

Thermal contraction: As metamorphic rocks cool, and as uplift and erosion bring them to lower-pressure environments closer to the surface of the Earth, microscopic cracks start to form within them. Some of the cracks arise from the differential thermal contraction of different minerals—that is, for a given drop in temperature, some minerals shrink more than others, so tiny cracks form along the boundaries between grains of different mineral species. Even if the rock is composed of only one mineral species, many minerals contract unevenly—more in some directions, less in others—so grain-boundary cracks will still tend to form wherever the grains have different orientations. Nearly all rocks at shallow to moderate depths in the Earth's crust contain arrays of such microcracks, and few are truly impervious to fluid flow.

Erosional decompression: Similar considerations apply to reduction in pressure upon erosion and uplift. Different minerals have different compressibilities, and many minerals are at least slightly more compressible in some directions than others. Grains once under the pressure of 11-15 km of overlying rock will, as the overlying rock is gradually eroded, expand more in some directions than others, again resulting in the production of grain-boundary cracks. Though cooling generally induces thermal contraction, and depressurization induces expansion, the net effect of both is that grains once in strong contact change volume and shape unequally, to the point where myriad tiny cracks form along their boundaries, and also along cleavage planes within individual grains.

Deformation: The number of microcracks within a rock can rise dramatically if the rock is subjected to compressional or extensional stresses during an episode of tectonic deformation. Such deformation, if mild, may leave the rock visibly unchanged, but a microscope will reveal it to be pervaded with tiny cracks that contribute to its porosity. With greater amounts of stress, the microcracks can grow in both number and size, and ultimately coalesce to form through-going fractures, with much larger attendant openings along them. The production of faults and the development of fluid-flow conduits along and near them will be the subject of the next installment in this series.

CONCLUDING REMARKS

Many metamorphic rocks contain great numbers of microcracks that collectively allow some measure of fluid flow within them. Such cracks form in at least four ways: metamorphic devolatilization, thermal contraction upon cooling, mechanical expansion upon decompression, and tectonic deformation. Though such cracks typically result in no more than a few tenths of a percent of porosity in the rock, and of these only some are sufficiently interconnected to allow fluid flow over appreciable distances, geochemical transformations of the original rocks are possible over geologic time.

At both Franklin and Sterling Hill, portions of the orebody and associated rocks have been altered, in some places mildly and in others extensively, by fluids that ranged widely in temperature and composition with time. Among the many postmetamorphic minerals that have formed here, some resulted from the circulation of high-temperature hydrothermal fluids, while others record the effects of lower-temperature fluids, ranging downward in temperature to the groundwater that is still circulating through and altering the rocks today. Production of microcracks within the rocks was the first stage in producing the openings that allowed fluids to penetrate the rocks and thus begin the process of alteration. The evidence is at both Franklin and Sterling Hill, there to be observed by anyone with a hand lens and the impetus to use one.

Parts 2 and 3 of this series will explore the creation of much larger openings in the ore deposits—openings that allowed greater volumes of fluid to move much more freely through the rocks, and that resulted in the formation of some of the minerals most widely sought by collectors of our local species.

ACKNOWLEDGEMENTS

Richard Volkert (New Jersey Geological and Water Survey) provided helpful technical review comments that greatly improved this paper. I am similarly indebted to Mark Boyer for additional remarks and copy edits.

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Spirals, Scales, Cones, and Lamellae:

The Strange World of Graphite Overgrowths From the Trotter Mine Dump, Franklin, New Jersey

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Overgrowths of graphite on tabular graphite crystals and spherical graphite aggregates from the Trotter Mine dump, Franklin, New Jersey, show some rare and interesting morphologies, including hexagonal plates with spirals, layered exfoliated towers, and circular cones. The graphite appears to have formed during several episodes of growth.

INTRODUCTION

Graphite crystals occur plentifully in Franklin Marble occurrences in Pennsylvania, New Jersey, and New York (Crawford and Valley, 1990; Jaszczak, 1997; Volkert et al., 2000; Peck et al., 2006). While the small tabular crystals, typically on the order of a few millimeters across, can be considered rather commonplace, New Jersey has also produced graphite crystals of particular importance and interest to the mineralogical community.

For example, Charles Palache, Professor of Mineralogy and Crystallography at Harvard University and curator of the Harvard Mineralogical Museum, published a study in 1941 of unusually well-formed graphite crystals, some of which had a very rare barrel-shaped habit, from the Sterling Mine in Ogdensburg. He had obtained them from Lawson H. Bauer, chemist at the New Jersey Zinc Company (Palache, 1941; Jaszczak, 1994). Palache's paper has been cited more than 40 times in books and articles in the fields of mineralogy, physics, metallurgy, and materials science (Jaszczak, 2001). The exceptional quality of the crystals was attested to by Austerman et al. (1967), who wrote:

> The natural crystals described by Palache are the highest quality crystals reported in the literature as far as the authors are aware, and his description serves as a point of reference for the graphite crystals grown in the laboratory.

Graphite in fine crystals and unusual aggregates has also been described from the Lime Crest Quarry, Sparta, New Jersey (Jaszczak, 1994).

New Jersey is also host to rare spherical aggregates of graphite. Small aggregates as much as 2 mm in diameter were reported from the Sterling Mine, probably from the Passaic Pit, in Ogdensburg, New Jersey, by Hanna and Jaszczak (1999). More significantly, Franklin and Sterling Hill have produced some of the largest and finest graphite spheres known (Lemanski, 1991). Excellent specimens of graphite spheres with diameters on the order of 1 cm (some more than 2.5 cm) in pink to tan-colored calcite associated with black willemite and franklinite (Hanna and Jaszczak, 1999), are in the collections of the Harvard Mineralogical Museum, A. E. Seaman Mineral Museum, National Museum of Natural History (Smithsonian Institution), and the Franklin Mineral Museum, as well as several private collections.

This paper presents the results of recent studies of interesting graphite from the Trotter Mine dump in Franklin, New Jersey. Although the graphite crystals and aggregates are relatively small (but not too small for micromounters), the surface features and morphologies are both attractive and scientifically significant. The variations in morphology, coupled with the results of Raman spectroscopy that are also presented here, suggest that the graphite was deposited in a series of growth episodes.

GRAPHITE FROM THE TROTTER MINE DUMP

In April 1999, Wayne Cokeley collected graphite crystals in marble from a series of large boulders near the edge of the Trotter Mine dump in Franklin. The marble also contained amber-colored phlogopite crystals. The light tan-colored calcite matrix fluoresces moderately bright orange-red in shortwave ultraviolet light, and thus likely came from in or adjacent to the orebody, within the "manganese halo" that surrounds the ore. Some of the graphite crystals display attractive growth spirals on their basal pinacoid surfaces, as highlighted in Figure 1 (Jaszczak and Rakovan, 2002). Jaszczak and Rakovan also noted the presence of tiny spheroidal aggregates of graphite on some of the phlogopite crystals, but did not describe them in further detail.

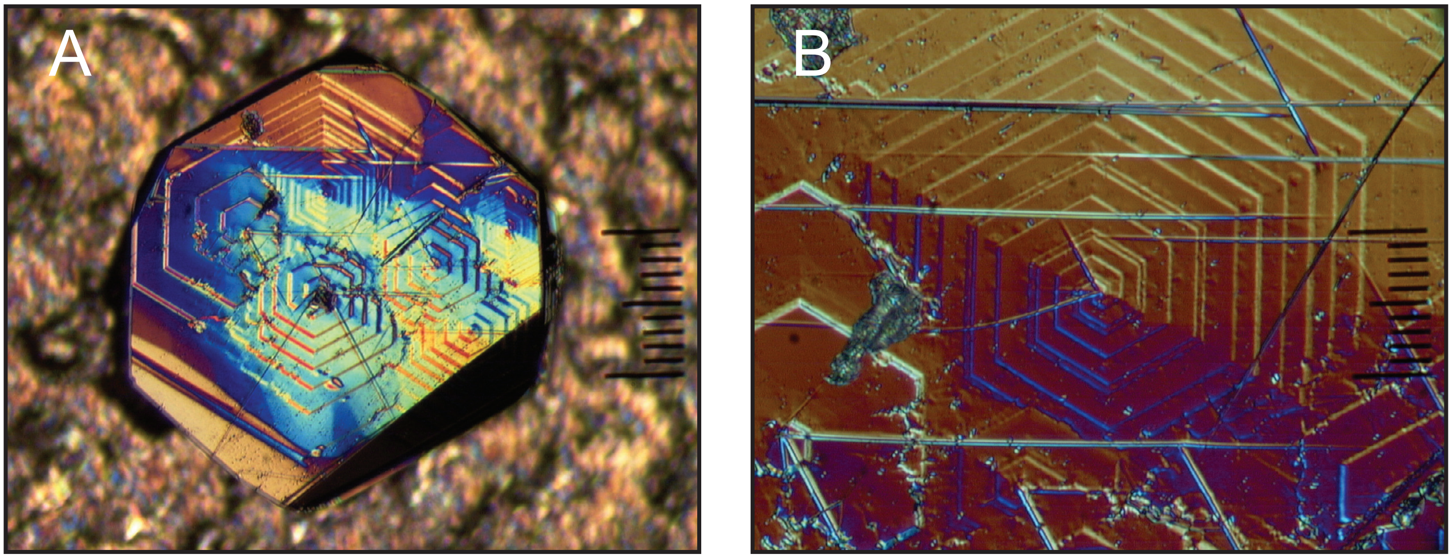


Figure 1. (a) Growth spirals on a tabular hexagonal graphite crystal (0.2-mm scale bar). **(b)** Close-up showing the central part of one of the growth spirals (50-micron scale bar). Optical images taken using Nomarski differential interference contrast microscopy to enhance the surface topography.

Dissolution of marble samples from the 1999 find using dilute hydrochloric acid yielded tabular crystals and spheroidal aggregates of graphite with interesting secondary graphite overgrowths, which were recovered after careful examination of the insoluble residues. The spheroidal aggregates were much less common than the tabular graphite crystals, but were nevertheless fairly easy to find in the insoluble residues using a binocular microscope. Crystals, spheroids, and overgrowths of graphite similar to those described here have been described from Franklin Marble from the Lime Crest Quarry (Jaszczak, 1997), in which they are also commonly associated with phlogopite; however, graphite from the Trotter Mine dump occurrence shows additional textures not observed from Lime Crest.

Figure 2 shows parallel growth of phlogopite crystals associated with a tabular graphite crystal and smaller spheroidal graphite aggregates. Both the tabular and the spheroidal graphite have secondary graphite overgrowths that appear silvery but more dull and velvety than the more mirror-like uncoated graphite crystals. The microstructures of the overgrowths are best observed using scanning electron microscopy (SEM), as illustrated below. Figure 3, for example, shows an aggregate of tabular hexagonal graphite crystals with a later overgrowth of well-faceted (i.e., showing planar crystal faces with sharp edges) graphite crystals. The coarse, single-crystal nature of the earlier-formed hexagonal host crystals is evident at the left of the largest crystal where some of the overgrowth is missing, perhaps having been broken off during processing or handling. Although the crystals composing the overgrowths are tabular and well-faceted on the crystals shown in Figure 3, graphite overgrowths actually can have a wide range of morphologies (Weis, 1980; Jaszczak, 1997; Jaszczak et al., 2003; Jaszczak et al., 2009; Satish-Kumar et al., 2011). Compare, for example, the nicely faceted overgrowths of Figure 3 with those shown in Figures 4 and 5, where tabular host crystals and a spheroidal aggregate of graphite have overgrowths of thin, curved crystals that do not show hexagonal outlines. Likewise, the spheroidal graphite aggregates shown in Figure 6 reveal multiple generations of graphite growth, with thin, wispy crystals partly covered by tabular, sharp hexagonal crystals, and finally, by thicker crystals with rounded outlines.

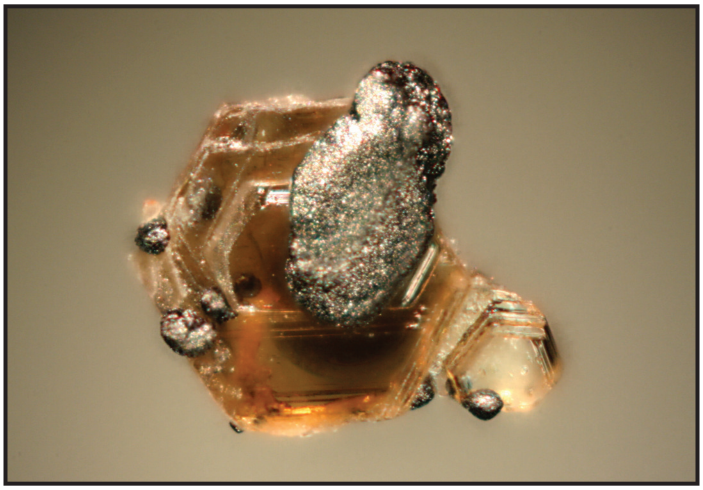


Figure 2. Tabular graphite crystal (1.5 mm) overgrown by later-stage fine-grained graphite, associated with spheroidal graphite aggregates with phlogopite crystals.

The spheroidal aggregates and their overgrowths are some of the most interesting graphite morphologies observed from this occurrence. The spheroid in Figure 7 shows at least three different graphite morphologies, suggesting at least three generations of growth. The first generation of graphite shows curved crystals with rounded outlines (Fig. 7a), similar to those shown in Figures 4 to 6. The next two generations, however, are quite unusual. The second generation is composed of aligned stacks of graphite lamellae that, for some reason, do

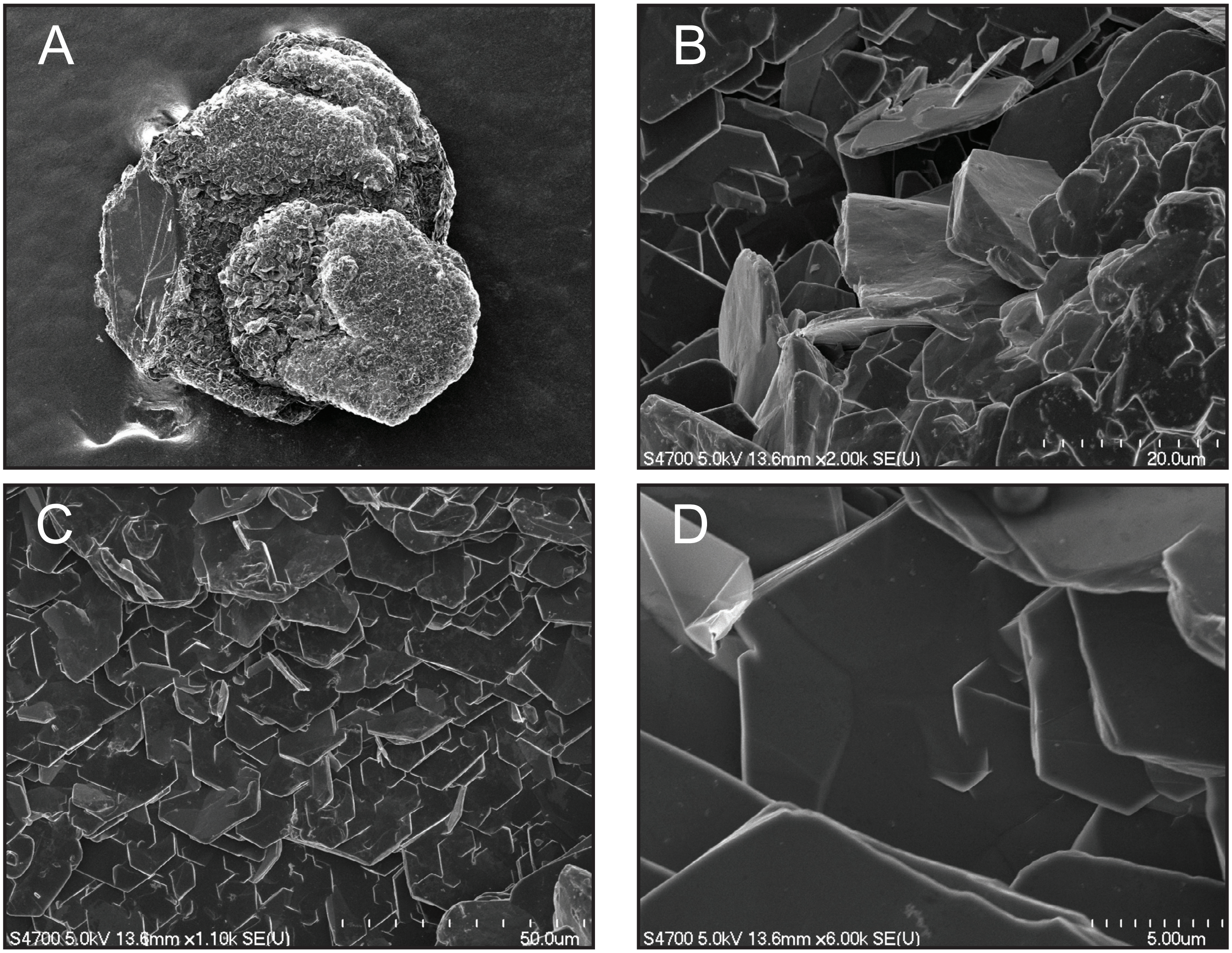


Figure 3. Scanning electron microscope (SEM) images of **(a)** 0.6-mm tabular hexagonal graphite crystals coated by a secondary graphite overgrowth. Part of the first-generation crystals are exposed at the left. High-resolution SEM images **(b-d)** showing the microstructure of the faceted graphite overgrowths. The background in **(a)** is sticky carbon tape used to mount samples for use in the SEM.

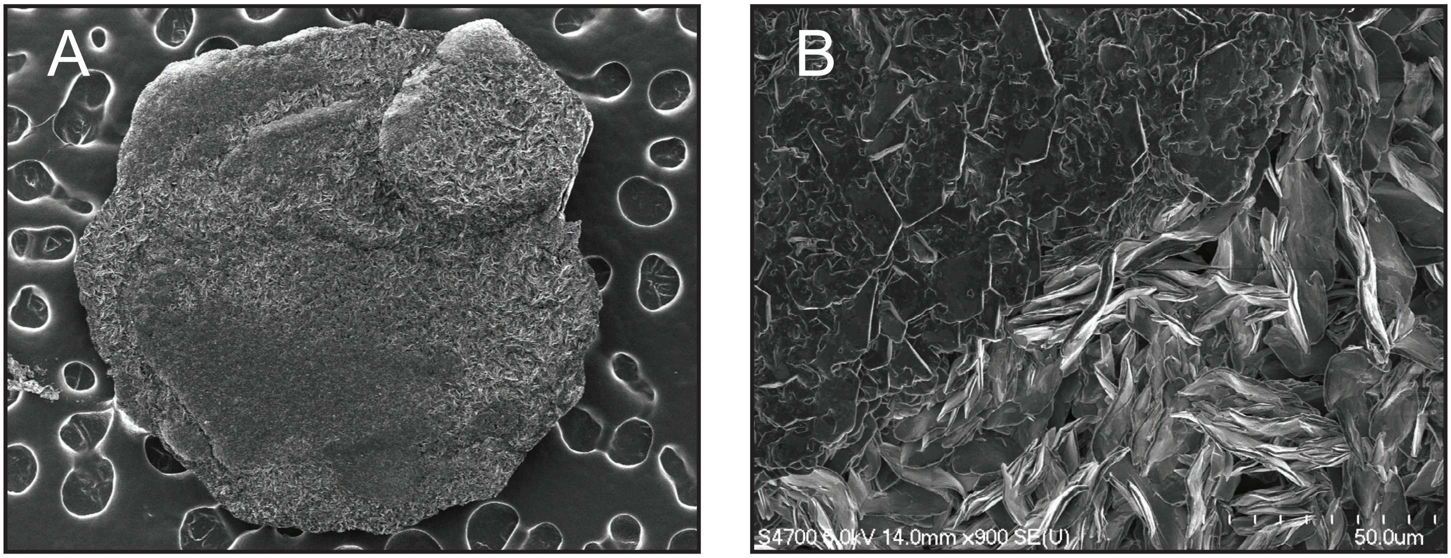


Figure 4. SEM images of **(a)** a 2-mm tabular hexagonal graphite crystal coated by a secondary graphite overgrowth; **(b)** close-up of the overgrowth showing two different morphologies: faceted crystals (upper left) and curly crystals (lower right). The background in **(a)** is sticky carbon tape used to mount samples for use in the SEM.

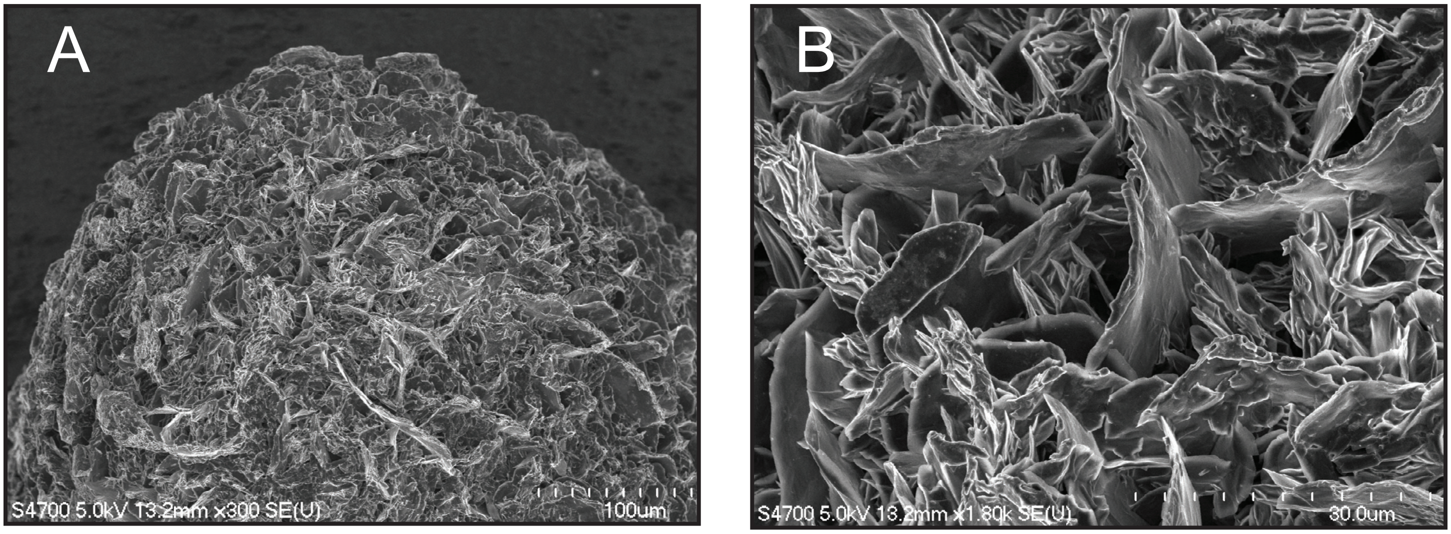
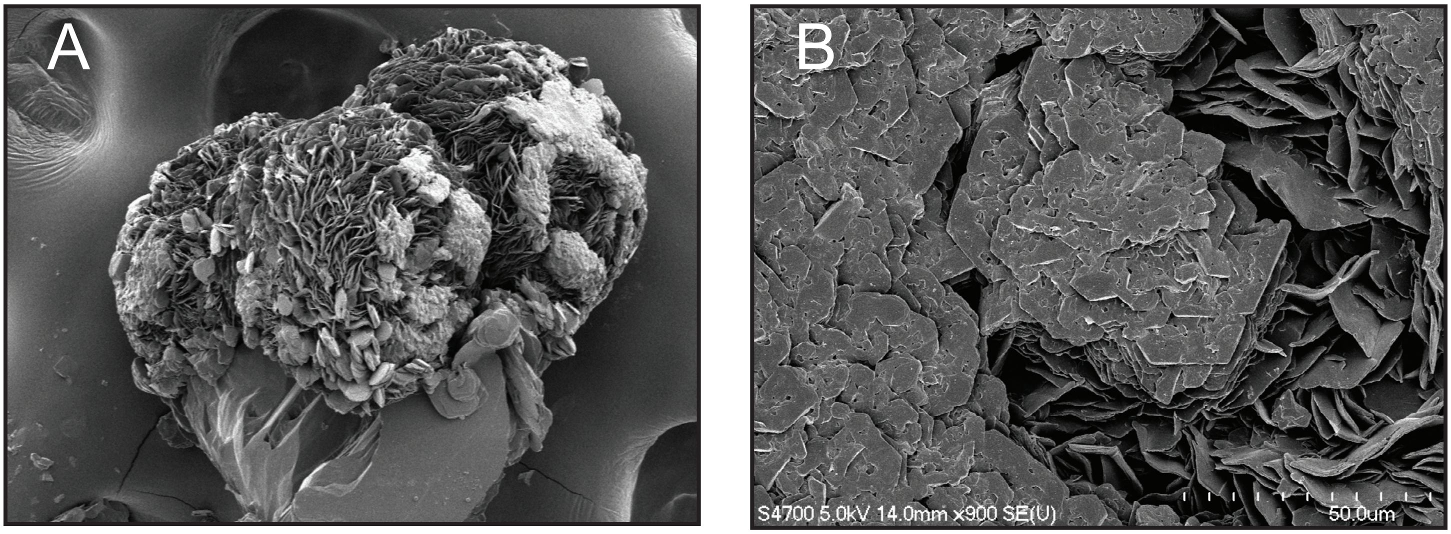


Figure 5. SEM images of a 0.5-mm graphite spheroid whose surface is composed of thin, wispy graphite crystals.



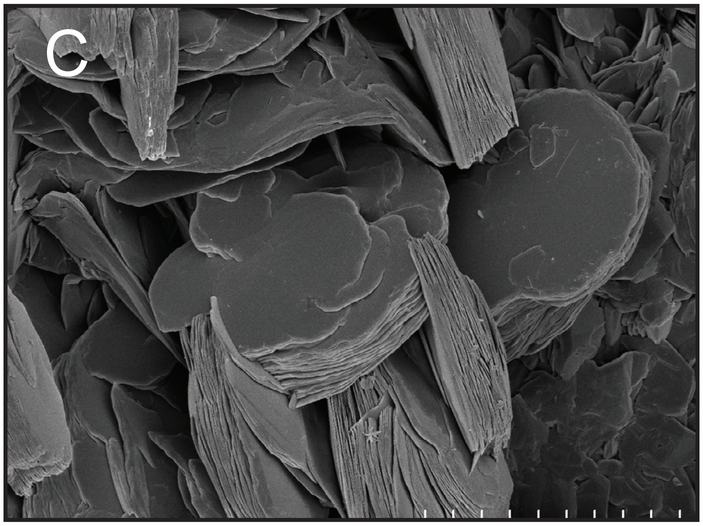


Figure 6. SEM images of **(a)** an aggregate of graphite spheroids to 0.3 mm associated with phlogopite. Higher-resolution images **(b** and **c)** show several generations of graphite growth, with morphologies ranging from curved, to faceted, to somewhat thicker crystals. The background in **(a)** is sticky carbon tape used to mount samples for use in the SEM.

not form a continuous, compact single crystal, but appear to be exfoliated (Figs. 7b-d). A final generation of graphite forms an irregular, rounded "cap" on each layered stack.

Yet another unusual morphology observed as part of the final-generation overgrowth on some of the spheroidal graphite aggregates is shown in Figure 8. Here, the graphite occurs on the surfaces of the aggregate in the form of conical structures up to approximately 10 microns across. Naturally occurring graphite cones were first observed on the surfaces of spheres and triskelial (a shape with three lobes or protrusions) aggregates of graphite in calcite boudins from a road cut south of Gooderham, Ontario, Canada (Jaszczak et al., 2003). Similar cones have since also been recognized on the surfaces of some graphite spheroids from marbles from Naxos, Greece (Satish-Kumar et al., 2011), and in graphite overgrowths from Limberg Quarry, Pargas, Finland (Jaszczak, unpublished). The radial growth of multiple such cones, with a cone-helix type of structure at the atomic scale, has been proposed as a mechanism for the growth of spheroidal aggregates of graphite in cast iron

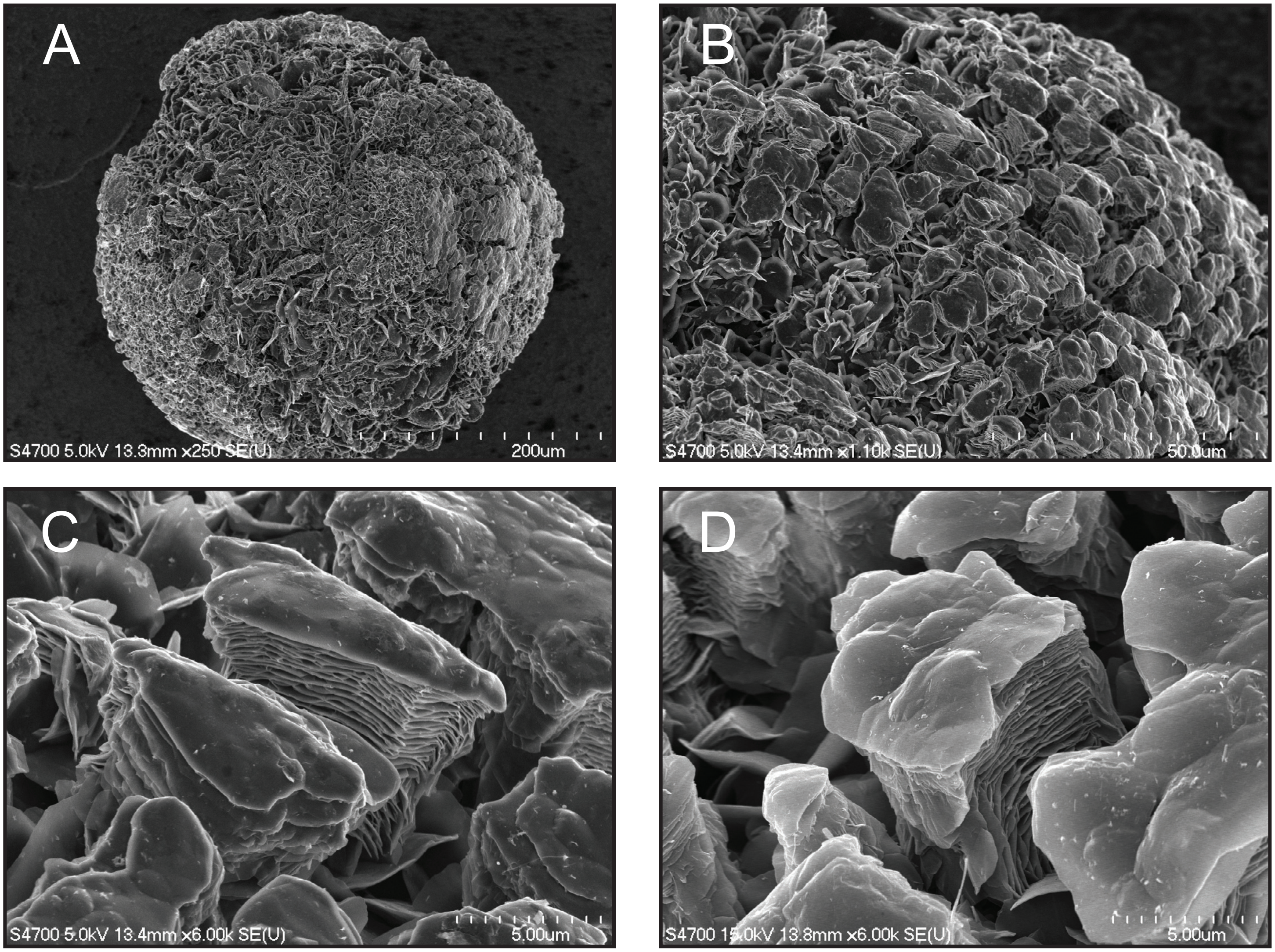


Figure 7. SEM images of a 0.4-mm graphite sphere showing unusual stacked lamellar structures on the surface with a final graphite cap.

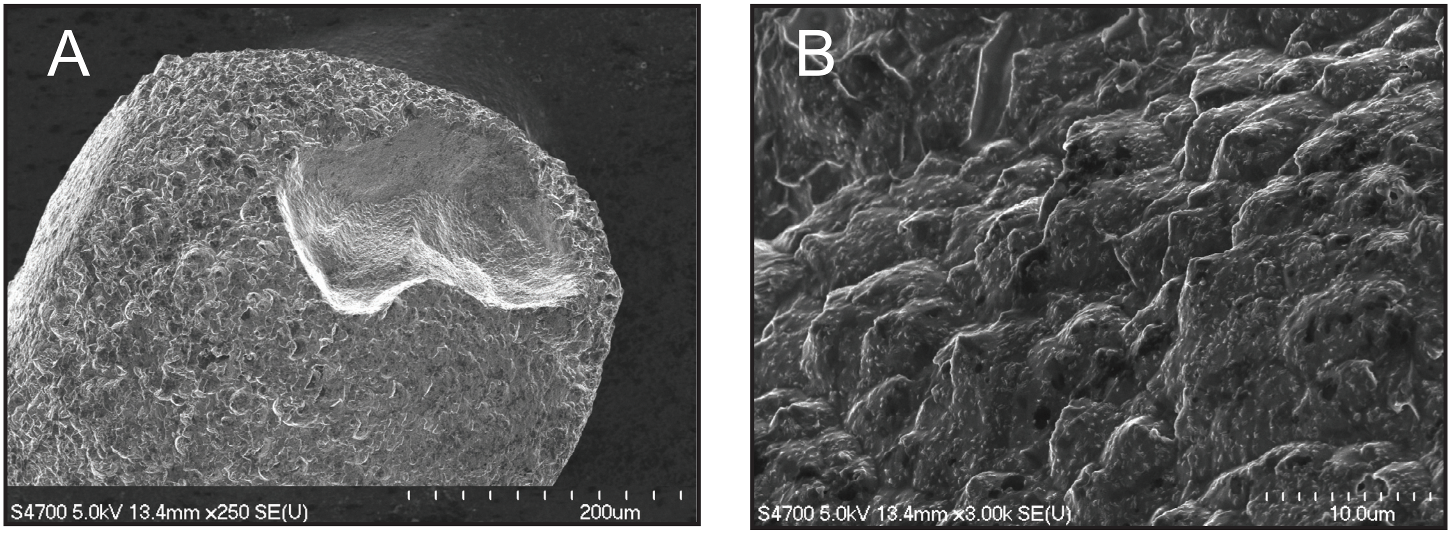


Figure 8. (a) Spheroidal graphite aggregate with **(b)** graphite cones on the surface. The indentation on the upper right of the spheroid in **(a)** is probably due to the graphite having grown in contact with another mineral that is no longer present.

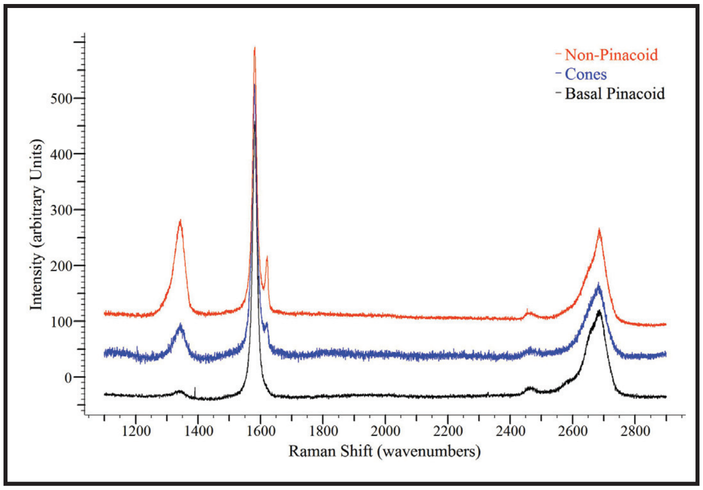


Figure 9. Raman spectra of different overgrowths on spheroidal graphite: a nonpinacoidal crystal face (red/top), a cone (blue/middle), and a basal pinacoid crystal face (black/bottom). Spectra were taken using a Jobin-Yvon LabRAM HR800 Raman spectrometer equipped with a 100× objective lens, and a HeNe excitation laser (633-nm wavelength) focused to a spot size of approximately 1 micron. Spectra were slightly adjusted using a second-order background subtraction, and are shifted relative to each other vertically to facilitate comparison.

(Double and Hellawell, 1974). While the cone-helix structure model is consistent with the cones observed from Gooderham (Jaszczak et al., 2003), it is certainly not the whole story for the spheroidal aggregates as a whole, especially from the Trotter occurrence, since multiple generations of growth are evident in this material.

Raman spectroscopy, which is sensitive to the degree of structural disorder in carbonaceous materials, was utilized to characterize the degree of crystallinity of the graphite overgrowths on the surfaces of several spheroidal graphite aggregates from the Trotter Mine dump. (An introduction to the use of Raman spectroscopy in mineralogy can be found in Jaszczak [2013].) As shown by Satish-Kumar et al. (2011) in a study of marble-hosted graphite in Naxos, Greece, Raman spectroscopy can be a useful tool in guiding and interpreting the results of stable carbon isotope studies for graphite-calcite geothermometry (see discussion below).

Typical spectra from basal pinacoid crystal surfaces, nonpinacoidal surfaces, and cone surfaces in different graphite overgrowths are shown in Figure 9. Spectra for all of the overgrowths show a narrow, intense, first-order peak or band (“G band”) at 1582 cm^{-1} (or wavenumbers*) and a broad but intense second-order band peaking at 2685 cm^{-1}. These features are consistent with highly crystalline graphite. The G band for the cones is slightly broader than for the tabular crystals (18 cm^{-1} versus 16 cm^{-1}), however, which may be due to curvature of the graphite layers in the cones. A broad first-order band at 1343 cm^{-1} is also evident in all three spectra. This band is commonly referred to as the “D band” or “disorder band,” and its intensity relative to the G band is known to correlate with the degree of structural disorder in graphite. This “disorder” can include steps on the surface, which are, in effect, truncations of the long-range order of strongly bonded carbon atoms in a honeycomb arrangement (Jaszczak, 1997; Satish-Kumar, 2011). Note that in the spectrum in Figure 9 the D band is quite weak for the graphite basal pinacoid, but is more prominent for the graphite cones, and is very prominent for the nonpinacoidal graphite surface, indicating relative increasing degrees of structural disorder. A satellite peak appears in the spectra of the graphite cones and nonpinacoidal graphite surfaces at 1621 cm^{-1}. This peak commonly appears when there is a significant density of atomic-scale steps on the graphite surface formed from the carbon layers in the graphite crystal structure (see Jaszczak 1997 for an illustration of the graphite crystal structure), and is routinely observed for nonpinacoidal crystal faces.

DISCUSSION

Morphological studies of graphite are of interest in metamorphic geology. Calcite-graphite associations are commonly used as geothermometers for metamorphic rocks by studying the differences in stable carbon isotope ratios $^{13}C/^{12}C$ in the calcite and graphite. Peck et al. (2006) have studied the stable carbon isotope composition of two graphite crystals with lustrous surfaces [that is, lacking overgrowths], along with associated calcite from the 1999 Trotter Mine dump occurrence, and determined temperatures of 789° and 818°C. These temperatures are consistent with, but toward the higher end of, the temperatures for granulite facies conditions in the New Jersey Highlands (Peck et al., 2006). However, isotopic studies of graphite overgrowths on earlier-formed tabular graphite crystals typically lead to anomalous temperatures that probably reflect isotopic disequilibrium due to graphite growth in open-system conditions (Peck et al., 2006; Satish-Kumar, 2011). Graphite with secondary overgrowths is thus to be avoided or carefully considered in such studies. As noted above, graphite in marbles from Naxos, Greece, shows morphologies (including cones) similar to those described here from the Trotter Mine dump. For Naxos graphites, Satish-Kumar et al. (2011) demonstrated a good correlation between the degree of structural disorder, as measured by Raman spectroscopy, with the degree of isotopic disequilibrium. This result is consistent with graphite growth taking place in multiple episodes. Since the overgrowths were deposited after the formation of the tabular host crystals, have a higher degree of structural disorder, and show greater morphological diversity,

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*A “wavenumber” is another name for the unit of “inverse centimeter” (cm^{-1}).

it is likely that the overgrowths formed at lower temperatures than the host crystals. It is further likely that the spheroidal aggregates also grew later, and under cooler temperatures, than the coarser-grained tabular crystals, as evidenced by the similar morphologies of graphite crystals in the spheroidal aggregates and those within overgrowths on tabular crystals in the same rocks. In localities where spherical graphite and tabular graphite crystals occur within the same rocks, we have noted that the tabular crystals have secondary graphite overgrowths. Such localities include the Lime Crest Quarry, Sparta, New Jersey (Jaszczak, 1997); the Gouverneur Talc Company No. 4 Quarry, Harrisville, New York (Jaszczak et al., 1999); Route 28N, Minerva, New York (Jaszczak et al., 2009); the Treadway Quarry, Moriah, New York (Jaszczak et al., 2009); an excavation near Cantley, Quebec, Canada; Highway 507 road cut south of Gooderham, Ontario, Canada (Jaszczak et al., 2003); and the Limberg Quarry, Pargas, Finland.

CONCLUSION

Graphite forms a surprising variety of morphologies, including tabular and barrel-shaped hexagonal crystals, wispy curved crystals, cones, tubes, and lamellar columns. This morphological richness ultimately traces to carbon's unique bonding versatility and the effects of diverse environmental conditions on graphite's growth. The overgrowths shown here clearly document that graphite deposition took place over time and under changing conditions. Just what the conditions were for each of the different generations of growth remains an open question.

ACKNOWLEDGMENTS

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A Tip of the Hat

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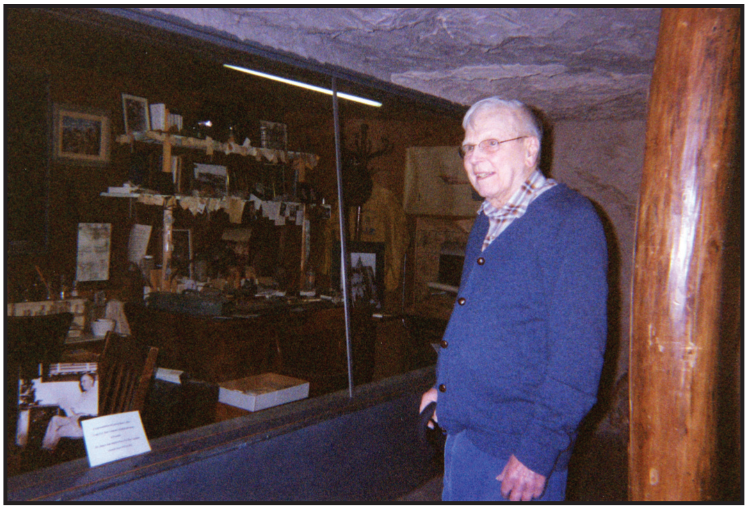
Allow me to comment about Mark Boyer's fine essays on Franklin lore and mineralogy. I cite two examples from *The Picking Table*, volume 53, number 1 (Spring 2012).

Mark's "An Evening With Jack Baum" was especially enlightening. In 1953 when I was aged 13 years, my mother drove me to the offices of the New Jersey Zinc Company in Franklin. Here, I met youthful Jack, who soon pressed some specimens in my hands. Would you believe it? That one event sparked my fascination for Franklin minerals, which eventually became my lifelong passion for science in general. (It also probably kept me out of jail!) By the way, this esteemed gentleman remained a good friend, close to the time of his passing.



Jack Baum at the Franklin Mineral Museum admiring the replica of his office. *Mark Boyer photo.*

Soon, I could be found on the remains of the Parker Dump, which then still existed. Imagine my excitement of finding hardystonite, hancockite, manganaxinite, roeblingite eyes, etc. I give credit to Jack for all this. And Palache's monograph, of course. And, lest I forget, a youthful (at that time) Dick Hauck.

But Mark's second note on willemite exsolution from tephroite is an example of true scientific observation and explanation. It is also a study in mineral *paragenesis*. This term, often misunderstood, has its origin from the Greek: *para*, which means *beside*; and *genesis*, which means *origin*. That is to say, "beside the origin" or "next to the origin." I like to think of paragenesis as *association in time and space*. Through detailed examination of hand specimens with a loupe, the paragenesis can often be determined. Even *exsolution* (as Mark correctly describes it) can be distinguished from *replacement* in many cases. His explanation of the origin of the phenomenon is also on the mark. Pay especial heed to the exsolution lamellae (plural Latin: *layer*) of willemite (green) in tephroite (black) in Earl's fine photograph. Lamellar phenomena are often observed in mineral samples. A notable case is exsolution among the feldspars, and sarcopside exsolved from triphylite or graftonite in granitic pegmatites. With investigation by a heating stage and diffractometer, even minimum temperature of crystallization for the host mineral can be ascertained. Even more detailed study can enable an investigator to determine, quite precisely, the mutual crystallographic orientation of host and lamellae.

The rule of thumb is that, with increasing temperature, the mixing of different, often incompatible, cations increases. Much of this is the result of increasing *thermal vibration* of ions, a phenomenon often studied by a thermal stage attached to an X-ray diffractometer, and subsequent structure refinement, all easily done by contemporary instruments.

These phenomena are accessible through scientific inquiry. The amateur can often detect and observe such phenomena with simple equipment: acids for etching and dissolving, a loupe or microscope for close examination, UV source, etc.

But the most important item to remember is *paragenesis*; association in time and space. Mark my words: The greatest satisfaction is to uncover how things are *related* to each other. This is the greatest joy. It is one step along the way to see how things are connected to other things. ⚒

Christmas Trees and Polka Dots

Third in a Series on Franklin Collectors' Jargon

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One of the most frequently heard expressions among Franklin mineral collectors is **Christmas Tree Ore** (a.k.a. "Christmas Tree Rock" and "Polka-Dot Ore"). Unfortunately, all too often the term is misunderstood and misapplied to describe virtually any pattern of red and green fluorescence. This broad interpretation of the term, while widespread, is a far cry from its original definition. So for this third installment of my series on Franklin jargon, I've done a bit of investigating to straighten out a rather convoluted story.

The corruption of this term's original meaning is long-standing, possibly dating to even before the Franklin mine closed in 1954. Much confusion about the term can be traced to its first widely published appearance in print. In his 1964 book, *Nature's Hidden Rainbows*, Robert Jones Jr. asserted (as it turns out, erroneously) that "'Christmas Tree Ore'... is the red and green fluorescent calcite-willemite and the yellow fluorescent calcium larsenite [the former name of esperite] scattered throughout giving a spotted appearance to all the colors. The red and green calcite-willemite is sometimes called by the same name but the true 'Christmas Tree Ore' must have calcium larsenite and perhaps some other fluorescent material with it." The first problem with Jones's definition is that it contradicts the local, original collectors' understanding of the term. The second problem is its vagueness—it could describe a lot of things. In particular, Jones' definition doesn't mention whether or not the matrix is nonfluorescent, which would set off the spots.

A few years ago, Richard Bostwick asked Bob Jones about his use of the term *Christmas Tree Ore* and what he had actually seen. Bob recalled that sometime in 1952 or 1953, he had visited the home of a miner on the west end of Taylor Road in Franklin and was shown a specimen with spots of fluorescent red, green, and yellow. The miner's son boasted that this piece was "the real, *genuine* Christmas Tree Ore" because it had calcium larsenite in addition to calcite and willemite. The specimen was not for sale at the time, and Bob never did acquire any such piece. Ten years later, he recalled that visit when he wrote *Nature's Hidden Rainbows*. Unfortunately, Bob had taken the miner's son to be an authority, not realizing that oftentimes Franklin mineral collectors can be mighty cocksure as well as not just a little deluded!

This issue was raised when Allen Silverstein, a California mineral dealer, offered for sale a specimen he claimed was the "true Christmas Tree Ore" mentioned in Bob Jones's book. He sent it to Dick Bostwick, who was skeptical: The specimen is largely franklinite and zincite, with "splatterings" of esperite and willemite and patches of calcite. Allen then showed it to Bob Jones, who told him that while he couldn't remember exactly what he *had* seen many years ago at the miner's home, he was quite sure this wasn't it. Thus it seems that Jones's 1964 description of Christmas Tree Ore is somewhat dubious if not utterly mythological, but we may never know unless the miner's original specimen comes to light.

What then is the true, proper, original meaning of "Christmas Tree Ore"? According to no less an authority than former N.J. Zinc Company geologist John L. Baum (Bostwick, 2007), the term was used by pre–World War II–era collectors such as Elwood Shuster to refer expressly to the polka-dot pattern of red-and-green–fluorescing calcite and willemite in a nonfluorescent, dark brown matrix known at the time as *zinc-schefferite*. (Technically, this matrix is a manganoan pyroxene now considered to be augite, but more on this later.) According to Jack Baum, the isolated yet abundant round spots of fluorescent red and green on a dark background resembled glass-ball Christmas tree ornaments to the miners who first saw this material underground.

Another name for Christmas Tree Ore is **Polka-Dot Ore**. This term, accompanied by a color photo of a fluorescent red- and green-spotted specimen, appears in Sterling Gleason's 1960 book, *Ultraviolet Guide to Minerals*. Bob Jones reproduced the photo in *Nature's Hidden Rainbows* and captioned it "Polka-dot formation of calcite and willemite in a matrix of zinc-schefferite." Obviously, owing to being misinformed on the topic, Jones did not use the terms *Christmas Tree Ore* and *Polka-Dot Ore* synonymously. It should be noted in passing that the word *ore* is hardly appropriate for any of this material, as the willemite is so sparse in the pyroxene matrix that it was considered waste rock.

The proper geological term for this polka-dot pattern is *poikiloblastic*, which describes a texture of metamorphosed rock wherein small grains of one mineral are riddled throughout larger grains of another mineral. This effect is also called "sieve texture." Poikiloblastic inclusions are characteristically rounded or spherical. During metamorphism, the minor minerals within an assemblage crystallized in a nearly spherical shape—due to the tendency of material in a plastic state to assume the maximum volume for the least surface area—hence the creation of "polka dots" (Spry, 1969, p 170; Vernon, 1975, pp 140-142).

As old specimen labels attest, the pyroxene matrix of Christmas Tree/Polka-Dot Ore was once called *zinc-schefferite*, which was considered a valid species in Charles Palache's day. Palache (1935) described zinc-schefferite as a pyroxene that ranged in color from white to light brown to a rich, dark brown. Bob Jones, relying on Palache's broad definition, perpetuated the use of the term *zinc-schefferite* for the Polka-Dot Ore matrix. Later, Clifford Frondel and Jun Ito (1966) made distinctions among the Franklin pyroxenes. Basically, they found that the lighter-toned zinc-schefferite, ranging from pale buff to medium-dark brown, is actually a zincian variety of diopside. The darker material, the semisweet-chocolate brown to brownish or greenish black mineral that Palache and others had generally regarded as jeffersonite, Frondel and Ito classified as falling within a solid-solution series grading from aegerine-augite to augite. A few years later, Frondel (1972) made a further clarification, stating that the mineral matrix for specimens "speckled with large inclusions of calcite and willemite" can be regarded simply as augite. Associated minerals in this assemblage can include barian feldspar (formerly known as hyalophane), andradite, and apatite. A few specimens also feature large masses of "semigemmy" willemite.

In contrast, the zinc-schefferite of a lighter tone (i.e., zincian diopside, as it has been more strictly redefined by Frondel and Ito), can be associated with hardystonite and can have films of clinohedrite on its parting planes. Since this variety of diopside is so visually distinctive and recognizable, the name *zinc-schefferite* lives on among Franklin collectors as a useful term to distinguish it from other forms of diopside. Zincian diopside, like augite, also can host poikiloblastic spots of calcite and willemite, and occasionally hardystonite as well. What Bob Jones saw many years ago in the miner's collection very well could have been a piece of light-brown zinc-schefferite with polka-dot spots of esperite altered from a preexisting hardystonite. Such a specimen is theoretically possible, although none has ever been verified to exist. Another possibility is that Jones saw spots of esperite, calcite, and willemite in an andradite matrix, a known but rare combination.

It is uncertain how extensive the poikiloblastic diopside and augite material was at Franklin, but it is likely that it was collected at different times and locations in the mine. Palache mentions that zinc-schefferite was abundant in massive ore in workings accessed through the Parker Shaft. This is evidenced by the many large pieces of Christmas Tree Ore that were found in the waste rock dumped at the Franklin Mill Site. The label of one mine-collected Christmas Tree Ore specimen from the collection of Franklin miner Joe Venuto states that it was collected in 1950 from the 760 North Pillar, four cuts below the 850 level. Joe Venuto told Earl Verbeek (2008) that he recalled the extent of this particular occurrence to be about the size of a doorway. Surely this material must have been encountered periodically from the days of the sinking of the Parker Shaft until the closing of the Franklin Mine in 1954.

Good specimens of Christmas Tree/Polka-Dot Ore were once plentiful on the collector's market. Today choice pieces are hard to come by, although a few good pieces were recovered from the Franklin Mill Site in the mid-2000s. Nonetheless, the fluorescent pattern of red and green spots in nonfluorescent augite is instantly recognized as a Franklin classic, even impressing some very renowned and respected mineralogists. Drs. Clifford Frondel and Jun Ito noted in their 1966 paper that such specimens containing "numerous rounded inclusions of calcite and of willemite ... have been sold in trade under the incorrect name zinc-schefferite. They have a spectacular appearance in ultraviolet radiation...." Indeed they do! By any name, this material has been a longtime favorite among fluorescent-mineral collectors. You can see why when you feast your eyes on the accompanying photos of a piece of classic Franklin fluorescent "eye candy."

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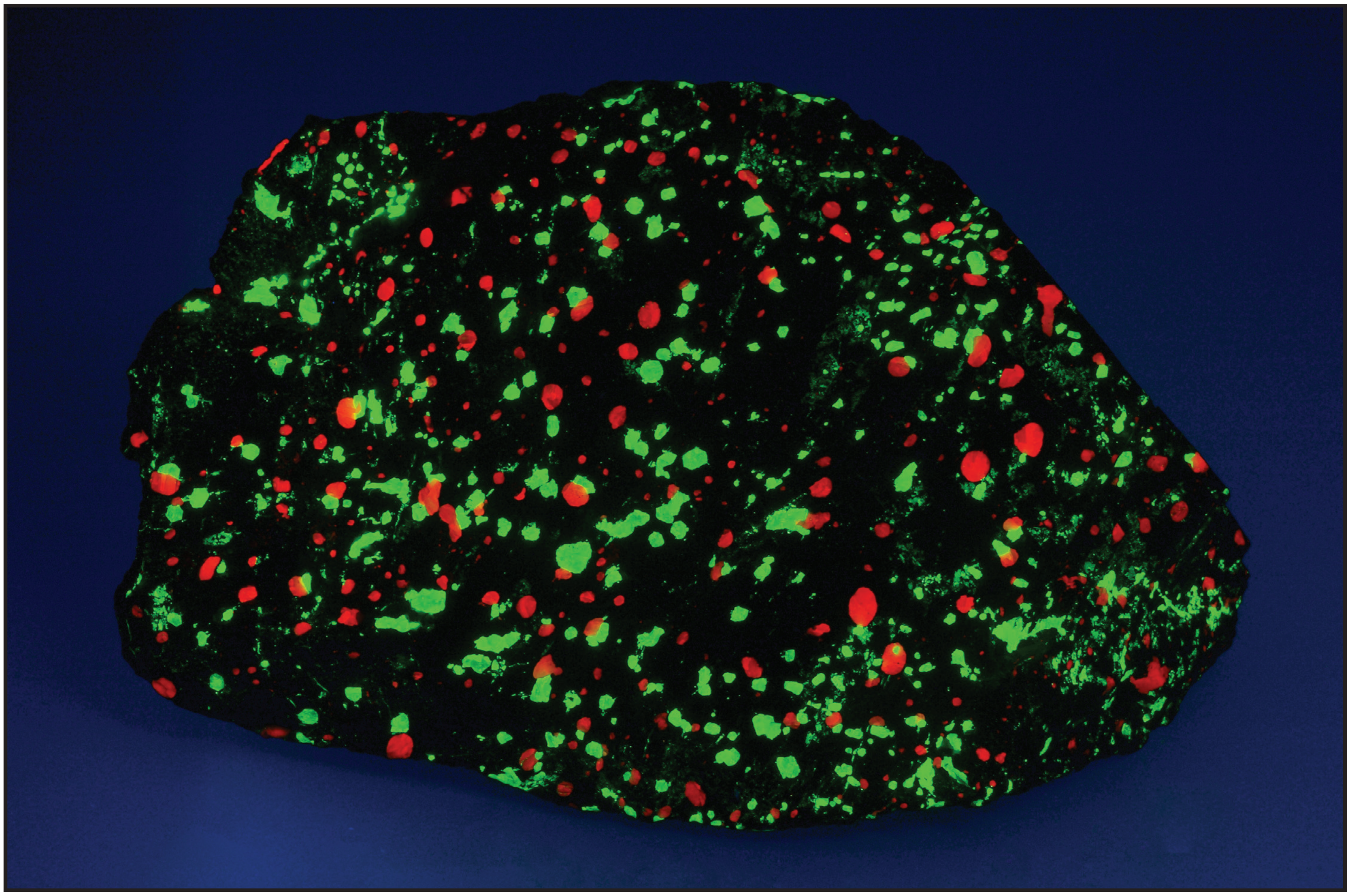

One of the best-known specimens of Christmas Tree Ore, a.k.a. Polka-Dot Ore. This one is owned by Richard Bostwick and is currently on public display in Zobel Hall at the Sterling Hill Mining Museum. Specimen measures 6.5 × 4.2 × 1.9 inches (16.5 × 11.5 × 4.5 cm). *E.R. Verbeek photo.*

The same specimen in white light, showing the semisweet chocolate–colored augite matrix in which lie rounded grains of calcite and willemite. Ironically, this nonfluorescent mineral matrix is essential to the definition of two fluorescent mineral terms. *E. R. Verbeek photo.*

The Franklin Mineral Museum

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Jack was a man of several legends, but the one he was most known for by all those who were interested in the local minerals and mining history was his dedicated volunteer service to the Franklin Mineral Museum. Shortly after the museum was organized by the Franklin Kiwanis in 1964, Jack was selected curator of the museum. As the retired resident geologist for the New Jersey Zinc Company at Franklin, he was well suited for this position. This was essentially a second life's work for Jack, for he served as curator for 35 years—from 1965 to 2000—and over this period he was one of the staunchest supporters of the museum.

In addition to his curatorial duties, Jack was appointed chairman of the museum's building committee, and in this role he oversaw the plans and construction arrangements for the addition to the N.J. Zinc Co. engine house, built in 1888, which housed the museum displays and the mine replica during 1964. This addition, with new display cabinets installed, provided room to expand the museum's collections beyond the initial display of 30 rocks and minerals the Kiwanis acquired.

Through Jack's efforts and those of Richard Hauck, who was appointed by the museum board as chairman of the mineral procurement committee, the museum received several collections on loan. One of these was a collection from the Mine Hill Mineral Shoppe at 59 Main Street in Franklin, owned by Chet Lemanski and Donald Quick. This collection was eventually purchased by Alice Kraissl, the assistant curator, and donated to the museum in 1969. Local folks who knew Jack from his years of work for the N.J. Zinc Co. often offered their minerals for loan to the museum.

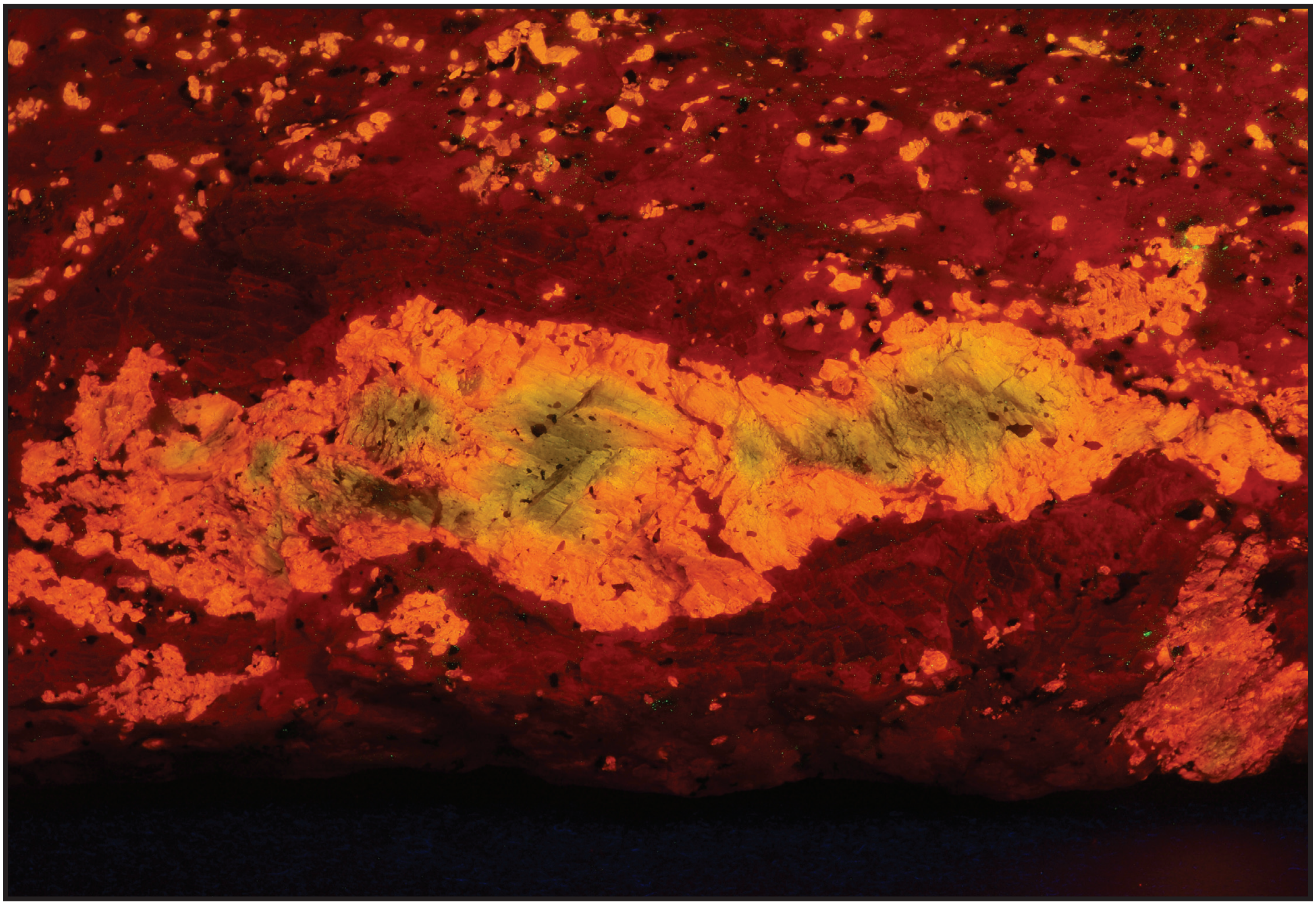
In addition to enlarging and managing the collections, Jack studied questionable and unknown minerals from Franklin, Sterling Hill, and local quarries. With the assistance of mineralogists from several institutions, particularly Harvard, his alma mater, and the Smithsonian, identifications were verified. He examined many mineral collections acquired by the museum and cataloged those specimens he felt were appropriate to add to the museum's collections, and those worthy of sale, he labeled and priced.

Jack hosted many scientists and students, as well as gave tours and lectures to groups, which significantly increased the museum's visibility throughout the country and overseas. He authored many geological articles for scientific publications and contributed many mining and historical articles to the FOMS journal, *The Picking Table*. He worked closely with major benefactors, such as the Kraissls, Mitteldorfs, Welshes, David Jensen, and Mildred Harden, for donations of funds and collections. Kraissl Hall, the Jensen addition, and Welsh Hall resulted primarily through Jack's efforts.

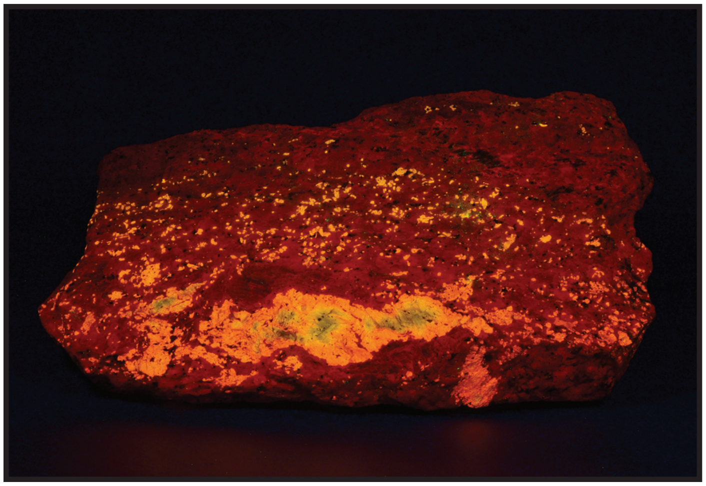
Besides curatorial and outreach efforts, Jack also made financial donations to the museum over the years. One of the most significant ones was for the enlargement of the lobby and entrance addition in 1995. Jack was frugal but very generous to the museum. In 1966, when the board suggested that admission be $1.00 for adults and 50 cents for children, Jack suggested that these rates be cut in half and the board agreed. During my tenure as the museum treasurer, I made it a point to submit to him copies of the monthly expenses although I was not required to do this. He would invariably question some of the expenditures, and I noticed years later as I was sorting through his museum files that he made little notes on the expense sheets questioning the need for some expenditures. However, Jack didn't make any arguments at the board meetings about spending practices, but when the board approved some transactions, I noticed Jack's disagreement in his facial expressions. I also sided with him on many occasions and spoke my piece at the board meetings. Yes, he was too much a gentleman to challenge board decisions.

Jack's contributions provided a strong foundation upon which the museum gained its prominence as a repository of the labors and efforts of the hundreds of workers for the N.J. Zinc Co. at Franklin and Ogdensburg, and of the mineralogists and geologists who published numerous articles on the mines and minerals, and of the many, many collectors. All of these efforts during Jack's long museum tenure yielded the great museum as we see it today and as the many visitors from all over the world have seen it.

Zinc is critical for good health, and Jack's association with this mineral for 32 years with the N.J. Zinc Co. and 35 years with the museum likely contributed to his longevity! ⚒



A large specimen of "green-eyed" wollastonite from Sterling Hill. The color-zoned fluorescence results from variations in the content of manganese substituting for calcium in the wollastonite ($CaSiO_3$) structure. Manganese substitutes for calcium in two crystallographic sites in wollastonite, and in each of these it fluoresces under shortwave ultraviolet light. However, because the crystallographic sites have different geometries, the color of light emitted by the manganese also differs: deep orange for one site, green for the other. At low levels of manganese, the green emission dominates, as seen in the center of the "eyes." At higher concentrations the green emission weakens and the orange emission strengthens, so a single grain can have a green-fluorescent core grading outward into zones of yellow fluorescence and thence into orange-fluorescent rims. This specimen, measuring 12" × 6" × 2.5" (31 × 15 × 6.5 cm), is a fine example; it was collected by Robert Hauck from the 340 level at Sterling Hill and was obtained by the Franklin Mineral Museum upon dispersal of his collection in 2011. It is now in the museum's large fluorescent display and has been cataloged into the collection as no. 7312. *E.R. Verbeek photos.*



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