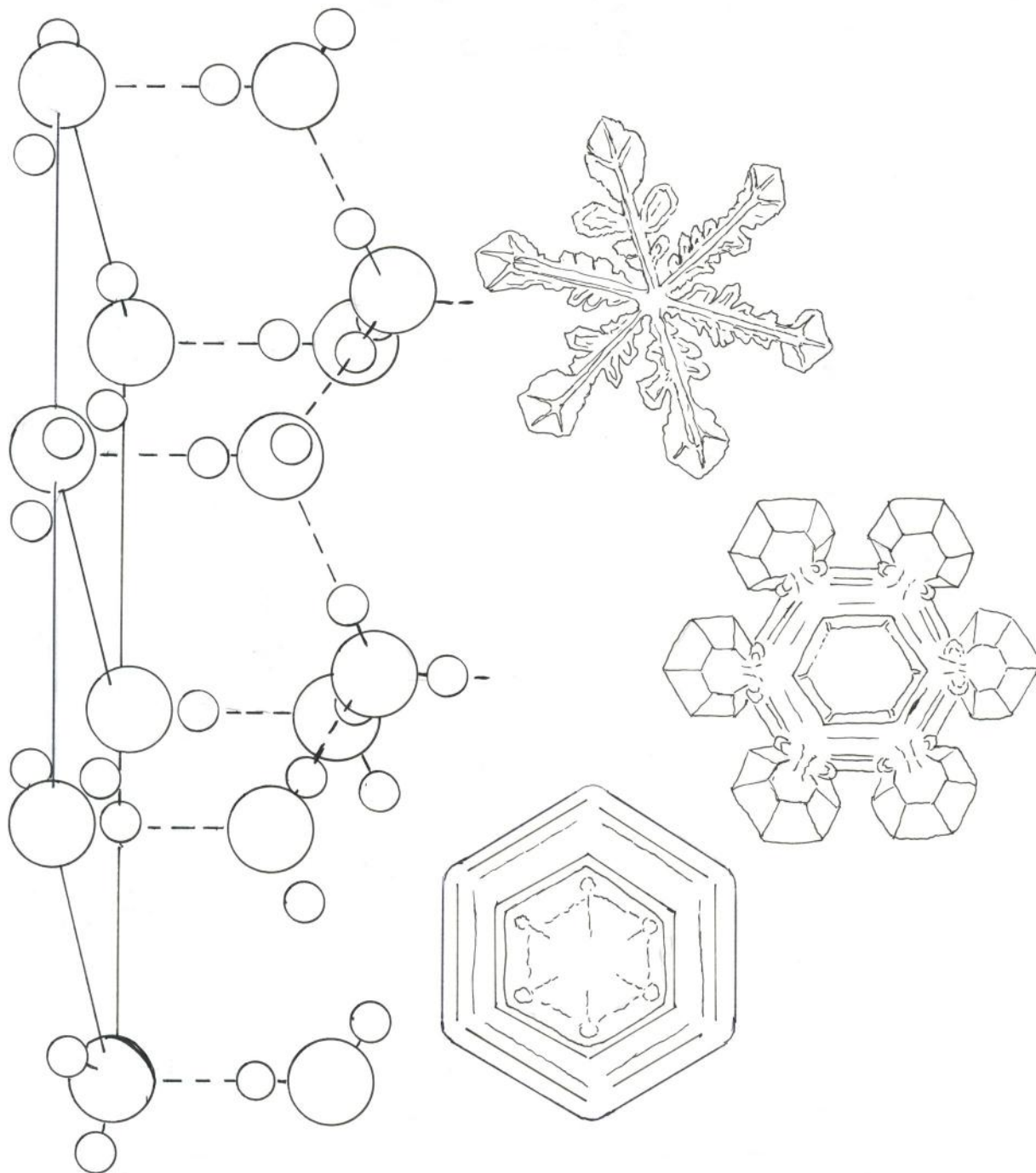


The 46th Rochester Mineralogical Symposium



April 11 - 14, 2019

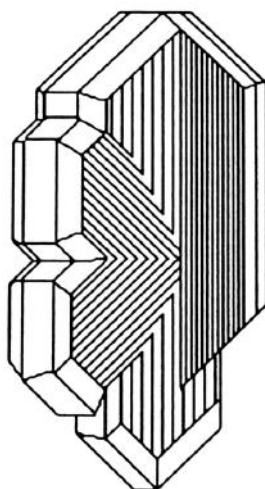


TABLE OF CONTENTS

Welcome!	2
RMS 2019 Program	3
Abstracts of Contributed Papers in Specimen Mineralogy	12
Crystal Growth, A Primer by John Rakovan	31
Distorted Crystals: What Are They and Why Should We Care by R. Peter Richards	32
Criminal Minerals: Investigating Minerals that Break the Law by John Jaszczak	32
The Variety and Appeal of Calcite by Terry E. Huizing	33
Lucius Lee Hubbard: One of the Copper Country's Greatest Mineral Collectors by Christopher J. Stefano	37

Welcome!

Our warmest welcome to the 46th Rochester Mineralogical Symposium!

We continue with our annual program designed to bring you excellent speakers, new information, displays of fine mineral specimens, camaraderie with mineral friends, along with the opportunity to acquire specimens for your collections and great mineral literature as well.

We have a super line-up of speakers this year. We also have a great Technical Session, with many contributions on diverse subjects.

At the core of the Symposium, Saturday morning features a robust program of *What's New in Minerals and Localities*, with exciting new finds from around the world. Many amazing specimens!

For all of you who are returning, we're so grateful for your continuing support. The Symposium is a springtime reunion of mineral friends – we look forward to it each year and it would absolutely not be the same without you.

If you are new to the Symposium, a special welcome! We hope you enjoy your first time with us. We will have a Welcome in the Hospitality Suite (Room 400, on the fourth floor) at 5:00 pm Thursday and we hope you'll drop by and say hi. And in any event, please join in all the fun as if you've been coming all along. Each evening, the Fourth Floor Festivities are a great chance to get to know one another. We look forward to meeting you!

We hope you will have a great time at the 46th RMS!

PROGRAM

Thursday Evening, April 11, 2019

- PM 4:00-6:00 Cocktails and Snacks – Hospitality Suite, Room 400 (4th Floor)
- *5:00 p.m. Welcome New Attendees – Please come by the Hospitality Suite and say hello!
- 6:00-7:45 Dinner – Baxter’s (off the Lobby)
- 8:00 **Welcome and Announcements**
- 8:15-9:15 **Crystal Growth, A Primer** – *Dr. John Rakovan*
- Dr. John Rakovan is a professor of mineralogy at Miami University in Oxford, Ohio. He has broad research interests including crystal growth, structural and morphologic crystallography, mineral-water interface geochemistry, and mineral deposit formation. He is a fellow of the Mineralogical Society of America (MSA) and in 2010 the decavanadate mineral rakovanite was named in his honor. John has been an executive editor of and regular contributor to Rocks & Minerals magazine since 2001.
- Tonight John will tell us about the various factors that influence how crystals grow into the beautiful specimens that are desired by collectors.
- 9:15 until... Fourth Floor Festivities. Dealers’ Rooms are open. Hospitality Suite is open. Camaraderie with mineral friends and great minerals! (All of the dealers are located on the 4th Floor)

Friday Morning, April 12, 2019

AM 9:00

Announcements

9:15-10:15

Distorted Crystals: What Are They and Why Should We Care?

- *Dr. R. Peter Richards*

Pete Richards has a bachelor's degree from Oberlin College in Geology, a MS degree in Mineralogy and a Ph.D. degree in Paleocology from the University of Chicago. His main mineralogical interests involve the morphology of crystals, twinning, and epitaxy. He is the author of the early Macintosh versions of SHAPE. He has published papers on mineralogy in *American Mineralogist*, *Mineralogical Magazine*, *The Mineralogical Record*, *Rocks & Minerals*, *The Canadian Mineralogist*, and *Schweizer Strahler*. He is currently an Affiliate Scholar at Oberlin College and a Consulting Editor for *Rocks & Minerals* magazine.

Pete has been a mineral collector since he was 2 years old (photographic documentation available, maybe). He grew up in the zeolite region of northern New Jersey, wishing he had adult friends who collected minerals and would take him into quarries. Instead, he picked up mineral-bearing bits of gravel in driveways and along railroad tracks, and eagerly accepted hand-me-downs from a neighbor whose uncle collected frequently at the nearby Bound Brook Quarry. Summers in the pegmatite district of Maine were a strong boost to his interest in mineralogy, except that his mother limited his collecting to one Ritz Cracker box full of rocks per trip...

This morning it is our pleasure to have Pete take the podium to discuss distorted crystals, and what we can learn from them.

10:15

Coffee Break

10:30-11:30

Criminal Minerals: Investigating Minerals that Break the Law – *Dr. John Jaszczak*

Dr. John Jaszczak is a professor of physics at Michigan Technological University, adjunct curator at the A. E. Seaman Mineral Museum, and also currently serves as Interim Chair of Michigan Tech's Department of Chemistry.

It was his childhood love of minerals that inspired him to become a scientist- first a chemist and then a physicist; yet his love of mineralogy has always been central to his interests. While studying for his Ph.D. in physics at Ohio State University, “quasicrystals” were discovered and became the focus of his dissertation research. Thinking it would be of great interest to the mineral collector community he presented a brief overview about quasicrystals at his first Rochester Symposium in 1987, thanks to Steve Chamberlain finding a place to squeeze him in the program at the last minute! John met Pete Richards for the first time at this meeting.

After earning his Ph.D. he worked as a postdoctoral associate at Argonne National Laboratory for two years, during which time he became friends with John Rakovan and learned about mineral photomicrography from Dan Behnke. John joined the physics department at Michigan Technological University in 1991, where he has been buried in snow with his family ever since.

John’s mineralogical interests have long focused on unusual crystal shapes, graphite, diamonds, twins, and hemimorphic minerals. While maintaining these interests, he has also become fanatical about the minerals from the famous Merelani gem mines in northern Tanzania. Including the unusual new mineral merelaniite, which he helped to discover, and which was named the 2016 Mineral of the Year by the International Mineralogical Association. In 2017, jaszczakite was named in his honor by Luca Bindi and Werner Paar.

We warmly welcome John back to the RMS speakers podium to tell us about minerals that seem systematically and consistently to break the laws of classical crystallography. This talk will begin to explore the wild world of criminal minerals from mistakes, to twins, to incommensurate crystals (calaverite, franckeite, cylindrite, merelaniite) to the newly discovered natural quasicrystals.

11:30-1:30

Lunch and Shopping Break – 4th Floor Dealers open

Friday Afternoon, April 12, 2019

Contributed Papers in Specimen Mineralogy
Dr. Sarah Hanson – Coordinator and Editor
Dr. Carl Francis - Moderator

- PM 1:30 **Moderator's Welcome** – Dr. Carl Francis
- 1:30 An update on the mineralogy of the Houghton Lake fulgerite. **C. J. Stefano**, S. A. Hackney, and A. R. Kampf
- 1:45 Beryllium minerals of the Mount Rosa Complex area near Colorado Springs, Colorado. **S. L. Hanson** and G. Zito
- 2:00 A new locality for phenakite and cassiterite in Marathon County, Wisconsin. **T. W. Buchholz**, A. U. Falster, and W. B. Simmons
- 2:15 The Emmons pegmatite, Maine's mineral-richest pegmatite. **A. U. Falster**, W. B. Simmons, and K. L. Webber
- 2:30 A new find of uranium and REE mineralization on Noyes Mountain, Greenwood, Oxford Co., Maine. **J. Spiegel**, A. U. Falster, and W. B. Simmons
- 2:45 Gold from the Wild Ammonoosuc River, Grafton County, New Hampshire. **J. S. Genga**, C. B. Handler, and P. E. Tice
- 3:00 Garnet & magnetite from the Wild Ammonoosuc & Baker Rivers, Grafton Co., New Hampshire. **C. B. Handler**, J. S. Genga, and P. E. Tice
- 3:15 Snow crystal photomicrography. **K. Hrechka**
- 3:30 **Coffee Break**
- 3:45 More than meets the eye: fluorapatite from Mont Saint-Hilaire. **J. C. Chappell**, J. F. Rakovan, A. Sommer, B. Phillips, L. Horváth, and E. Horváth
- 4:00 New developments in the study of the Purple Diopside Mound, Pitcairn, St. Lawrence County, New York. **C. Emproto**
- 4:15 Interesting inclusions in green muscovite from the Merelani Hills, Tanzania. **J. Fink**, C. Emproto, J. A. Jaszczak, and J. Rakovan

- 4:30 Stages in pseudomorphism. **R. L. Straw**
- 4:45 On the origin of Japan Law twins. **B. Morgan**
- 5:00 Single-crystal x-ray and neutron diffraction study of the incommensurately modulated structures of low-temperature labradorite. **S. Jin**, H. Xu and X. Wang
- 5:15 Four new mineral localities discovered in St. Lawrence County, NY, while gathering ginseng. **S. C. Chamberlain**, D. M. Carlin, Jr., and D. G. Bailey
- 5:30 End of the Technical Session
- 5:30-6:30 Shopping Break – 4th Floor Dealers Open

Friday Evening, April 12, 2019

PM 6:30-8:00 Dinner – Baxter’s

8:15-9:15 **The Variety and Appeal of Calcite** - *Terry Huizing*

Terry E. Huizing, a consulting editor of *Rocks & Minerals* magazine, is Adjunct Curator of Mineralogy at the Cincinnati Museum Center and focuses his personal collecting activities on calcite, pseudomorphs, and minerals from the American Midwest. The mineral huizingite-(Al) is named for Terry E. and Marie E. Huizing.

Tonight we are delighted to welcome Terry to the RMS speakers’ podium to discuss the mineral calcite, its crystal forms and other factors that make it so popular with collectors.

9:15 until... Fourth Floor Festivities!

Saturday Morning, April 13, 2019

WHAT'S NEW IN MINERALS

- AM 9:00-10:00 **What's New in Minerals and Localities, Part I** – *Jeff Scovil*
- Each year, Jeff Scovil shares his superb photographs of minerals that have appeared on the market since the previous Symposium. Again this year, we welcome Jeff to the speakers' podium!
- 10:00-10:15 **Audience Contributions to What's New in Minerals and Localities**
- 10:15-10:30 Coffee Break
- 10:30 - **What's New in Minerals and Localities, Part II** – *John Betts, with Mark Jacobson, Raymond McDougall and Jim Nizamoff*
- Coordinated by John Betts, this section dovetails with Jeff Scovil's talk, with the goal that by the end of Saturday morning, we will have collectively covered a good portion of what's new in minerals and localities around the world over the past year. This session includes exciting new finds, spectacular finds from known localities, and new information about known finds.
- 12:00-1:30 Lunch and Shopping Break – 4th Floor Dealers Open

Saturday Afternoon, April 13, 2019

- PM 1:30-2:30 **Mineral Collection Matters: A Personal View** - *William A. Severance*
- A Michigan native, Bill holds degrees in Astronomy and Nuclear Engineering from the University of Michigan. Between his degrees, he spent three years in the U.S. Navy, where he sailed around the world in a Destroyer, crossed the equator and survived a collision at night in the Sea of Japan. He is retired from over 33 years as a Nuclear Consultant for the Dupont Company. Bill has assembled a superb collection over many years of collecting, and we have been fortunate that he has shared specimens from his collection year after year by including excellent displays in our cases here at the Symposium.

This afternoon it is our pleasure to welcome Bill to his debut at the RMS speaker's podium, to share some of the stories behind the specimens, and to present excellent photographs of exquisite pieces.

2:30-2:45 Coffee Break

2:45-3:45 **Arizona Sulfates** – *Les Presmyk*

Les Presmyk recently retired as the Principal Mining Engineer for Salt River Project, Arizona's second largest electric utility. He and his wife of over 40 years, Paula, are Arizona natives and are both graduates of the University of Arizona.

Les started collecting at the age of 10 and just attended his 56th straight Tucson Show. Their displays have received AFMS Regional and National Trophies, along with the Prospectors and Pearl Trophies in Denver and the Desautels, Lidstrom and Bideaux Trophies at the Tucson Show. They have been the featured exhibitors at the East Coast Gem & Mineral Show in Springfield, Massachusetts twice.

He is the current vice president of the Tucson Gem & Mineral Society, is a former President of the Mineralogical Society of Arizona, Board member and former Chairman of the Arizona Mineral and Mining Museum Foundation (now the Flagg Mineral Foundation), a founding member of the University of Arizona Mineral Museum Advisory Board and a member of the Tucson Show Committee for 34 years.

Les received the 2002 A. L. Flagg Distinguished Service Award, Is a charter member of the 2014 Mineralogical Society of Arizona Hall of Fame, and the recipient of the 2017 Carnegie Mineralogical Award.

He has explored and collected in a number of localities in Arizona, Missouri and Mexico. Les has written several articles and co-authored the recently published "Collecting Arizona". He has spoken at the Dallas Symposium, the Yale Symposium, and the Northwest Friends of Mineralogy Symposium, along with Numerous Arizona and New Mexico Symposiums, the Tucson, Springfield, and Denver Shows, and many clubs throughout the United States.

Today we warmly welcome Les back to the RMS speaker's podium to talk about the sulfate minerals of Arizona.

Saturday Evening, April 13, 2019

PM 5:15-6:30	SILENT AUCTION
7:00-8:30	Annual Symposium Auction Dinner – Main Ballroom
8:30	ANNUAL SYMPOSIUM AUCTION
Post-Auction until...	Fourth Floor Festivities!

Sunday Morning, April 14, 2019

AM 9:00-10:00	Lucius Lee Hubbard: One of the Copper Country's Greatest Mineral Collectors – <i>Dr. Christopher Stefano</i>
---------------	---

Dr. Chris Stefano was the Associate Curator of the A. E. Seaman Mineral Museum, where he was responsible for designing, installing and maintaining exhibits inside and outside of the museum and caring for the museum's holdings of approximately 40,000 specimens. He conducted historical and scientific research relating to the collection. Chris first became involved with the mineral collection at the University of Michigan assisting an effort to recover specimens stolen during a robbery in 2008. After he graduated, he spent two years performing an inventory and assessment of the mineral collection at the University of Michigan. He is dedicated to mineralogy and geology education and has designed many educational exhibits for mineral shows across the country.

Chris is also interested in mineral specimen photography and has had images appear in magazines such as *Rocks and Minerals* and *The Mineralogical Record*. His latent interest in minerals became serious during his undergraduate studies and by the time he entered graduate school, he was an avid mineral collector and part time mineral dealer. He is also an avid field collector, with significant experience collecting the Findlay Arch of SE Michigan/NW Ohio and the Magnet Cove district of Arkansas, among others.

We warmly welcome Chris back to the RMS speaker's podium to tell us the story of Lucius Lee Hubbard, a renaissance man who assembled a great mineral collection – a collection that, together

with the collections of J.T. Reeder and D.C. Gabriel, forms the core of the collection of the A.E. Seaman Mineral Museum at Michigan Tech.

10:00-11:00

Collecting Arizona Minerals: 150 Years of Mining, 100 Years of Statehood, and My 50-Year Journey – *Les Presmyk*

We are delighted to welcome Les back to the speaker's podium for our grande finale.

11:00

Closing of the 46th Rochester Mineralogical Symposium

See you next year for the 47th RMS:

April 23-26, 2020

A NEW LOCALITY FOR PHENAKITE AND CASSITERITE IN MARATHON COUNTY, WISCONSIN. T. W. Buchholz¹, A. U. Falster², and W. B. Simmons², ¹1140 12th Street North, Wisconsin Rapids, Wisconsin 54494, ²MP² Research Group, Maine Mineral & Gem Museum, PO Box 500, 99 Main Street, Bethel, Maine 04217, USA.

A new site producing phenakite has been discovered in the Wausau Syenite complex, Marathon Co., Wisconsin. The site is located in the Nine Mile pluton, a locality that has previously produced fine phenakite crystals that were found dominantly in the northern part of the pluton where they were associated with altered siderite and late bertrandite. Recently, the Ladick quarry has produced some phenakite associated with cassiterite.

The Ladick Quarry is operated by Ladick Road Materials Incorporated, in the southwest portion of the Proterozoic Nine Mile granite (1505.9 ± 2.7 Ma, Dewane & Van Schmus 2007), Marathon County, WI. Despite very extensive workings, relatively few pegmatites have been exposed. However, a small remnant of a comparatively large pegmatite is exposed in the southern portion of the property.

The roughly horizontal pegmatite as initially exposed was well-zoned, but subsequent operations have somewhat obscured and in part obliterated the zoning. A thin lower wall zone (10-15 cm) consists of moderately coarse microcline, quartz and biotite, followed by a 1-2-meter-thick intermediate zone consisting of coarse microcline and quartz with miaroles in part filled by fluorite, and a coarse quartz-microcline core zone of approximately 1 meter thickness. Zones overlying the formerly exposed portions of the core zone are absent, removed either by quarry operations or erosion. Portions of the intermediate and core zones contain abundant graphic granite.

Recently the outcrop was reshaped to facilitate emplacement of a deer hunting shelter, exposing materials from the lower intermediate zone with sparse mineralization similar to that described below. Additionally, an unusual alteration zone immediately above the lower contact of the dike was exposed. This zone contains numerous voids lined by small crystals of microcline and quartz, and vuggy zones partially filled with microcline, chlorite and clay-rich nodules with outer zones studded with small crystals of phenakite and, locally, dark red-brown cassiterite. The phenakite crystals are a maximum of 0.5 cm to 1 cm in diameter, though generally much smaller. Cassiterite aggregates are up to about 1 cm in diameter.

Although no other Be-minerals have been observed, the second author has noted that some voids in massive microcline in the zone exhibit a roughly hexagonal outline, suggesting the possible former presence of beryl. If so, the Be may have been mobilized in a late hydrothermal alteration event and subsequently deposited as phenakite, while the Al may have been deposited as the ubiquitous clays and chlorite-group minerals. However, it should be noted that beryl is exceedingly rare in pegmatites of the Nine Mile Pluton, presumably due to the overall metaluminous character of the intrusion.

Additional minerals known from past work on the pegmatite include sparse columbite-(Fe), columbite-(Mn), tantalite-(Fe) and tantalite-(Mn). More recently, loose rubble (probably from the lower portion of the intermediate zone and now removed) was found to contain abundant fluorite associated with altered biotite and a series of HFSE-rich minerals, including a grayite-like phase, zircon, possible Th-rich rhabdophane, columbite-(Fe), tantalite-(Fe) or tapiolite-(Fe), an unidentified Zr-Ta-bearing phase, a Th-rich Nb-Ta mineral and a Sc-bearing pyrochlore group mineral. Evaluation of these phases is continuing.

REFERENCE

Dewane, T. J., Van Schmus, W. R. (2007): U-Pb geochronology of the Wolf River batholith, north-central Wisconsin: Evidence for successive magmatism between 1484 Ma and 1468 Ma. *Precambrian Research*, V. 157, pp. 215-234.

FOUR NEW MINERAL LOCALITIES DISCOVERED IN ST. LAWRENCE COUNTY, NY, WHILE GATHERING GINSENG. S. C. Chamberlain¹, D. M. Carlin, Jr.², and D. G. Bailey³. ¹Center for Mineralogy, New York State Museum, 3140 CEC, Albany, NY 12230; ²125 Cemetery Road, Ogdensburg, NY 13669; ³Dept. of Geosciences, Hamilton College, Clinton, NY 13323.

Ginseng collecting causes individuals to scour the wilds of St. Lawrence County each season. When the ginseng collector is also a mineral collector, new exposures of interesting minerals occasionally turn up. The following four new localities were found during the authorized ginseng harvest in 2017.

Folsom Road Microcline Locality north of Fine, NY (44°15'18"N, 75°08'03"W). Vein of crystals at the top of a cliff. *Microcline*-large white to tan micro-perthite crystals to 22 cm, including Carlsbad and Baveno twins; *Diopside*-lustrous dark green (7.2 wt. % FeO) crystals to 5 cm; *Titanite*-brown shiny crystals to 2 mm; *Allanite-(Ce)*-arborescent black crystallized coatings on microcline to 4 cm; *Muscovite*-mm-sized silvery plates; *Calcite*-massive creamy white cleavages.

Vrooman Ridge Quartz Locality west of Fine, NY (44°14'08"N, 75°07'39"W). Exposures in field north of Vrooman Ridge Road. *Quartz*-veins and small pockets of zoned white and ferruginous 1.4-cm quartz crystals in Potsdam Sandstone. *Barite*-crystal cavities in the sandstone matrix to several cm.

O'Brien Farm Annex, North Russell, NY (44°28'43"N, 75°07'24"W). North end of ridge having previously-known localities for pargasite, diopside, and tremolite. *Tremolite*-large sharp transparent to translucent equant green (2.9 wt. % FeO) crystals to 13.5 cm; *Diopside*-partially altered light green prisms to 1.5 cm, rare; *Talc*-brown to purplish brown (1.6 wt. % FeO) opaque massive material with a melted appearance; *Calcite*-coarsely crystallized white to tan massive material hosting tremolite crystals.

Bullock Prospect, northwest of Russell, NY (44°23'86"N, 75°11'11"W). Adjacent to the previously known localities on the French Property. *Tremolite*-unusual sharp green (2.9 wt. % FeO) tabular crystals flattened along the c-axis to 5.5 cm; *Dravite*-brown lustrous crystals to 1.5 cm; *Calcite*-coarsely crystallized tan massive material hosting tremolite and dravite crystals.



Figure 1. Microcline and allanite-(Ce). Folsom Road Locality, Fine, NY. SCC#40928, 24 cm.



Figure 2. Tremolite and talc. O'Brien farm annex, North Russell, NY. SCC#40966, 13 cm.

MORE THAN MEETS THE EYE: FLUORAPATITE FROM MONT SAINT-HILAIRE.

J. C. Chappell, J. F. Rakovan, A. Sommer, B. Phillips, L. Horváth, and E. Horváth, Department of Geology and Earth Science, Miami University, Oxford, Ohio.

The Poudrette quarry at Mont Saint-Hilaire has long been known as one of the most mineralogically diverse locales on Earth, and contains best of species examples of exceedingly rare minerals. This has led to a long and fruitful collaboration between amateur collectors and professional mineralogists who have described >400 different mineral species and 66 new or type-locality minerals from this small quarry in Quebec. And yet, for all this mineral diversity, no detailed investigation has taken place on a more ubiquitous mineral, apatite, which is found in all rock types in the quarry except one. In this study, we first examined a suite of 12 apatites from the quarry provided by László and Elsa Horváth, and focused on 3 groups identified as fluorapatite with highly elevated thorium contents (Fig. 1). The first group came from an unidentified pegmatite, while group two was collected from the inner zone of the Poudrette pegmatite, and group three was collected from the outer zone of the Poudrette pegmatite. Electron microprobe analyses confirmed the high thorium contents, with group one containing a mean of 0.43 wt% ThO₂, group two 2.29 wt% ThO₂, and group three 0.67 wt% ThO₂. All three values are noticeably higher than any previously observed Th contents for any natural apatite world-wide, and group two contains an order of magnitude higher Th contents than any previous study. Groups two and three also contained ~4 wt% Na₂O, ~5 wt% Y₂O₃, and crystallize in space group *P3*. These observations raise interesting questions about the solid solution between apatite and belovite groups, because the symmetry of these fluorapatites are the same as belovite but Ca and P are still dominant on the cation sites. Fourier transform infrared spectroscopy (FTIR) collected on groups two and three show substantial carbonate substitution in the structure, specifically substituting for the phosphate groups. While elevated carbonate contents in fluorapatite are not unusual, the observation of a signal at ~1200cm⁻¹ in the FTIR spectrum is particularly interesting. This signal corresponds to a carbon-fluorine bond and holds important implications for the substitution of carbonate groups into fluorapatite. The observation of this bond is the first observation of its kind in any mineral, and the molecule which is generated is new to science; a molecule consisting of a single carbon bonded to a single fluorine and three oxygens has never before been described. This is supported by ¹⁹F nuclear magnetic resonance (NMR) spectroscopy data, where a signal is also observed corresponding to a carbon-fluorine bond. What may be most unusual about these fluorapatites is their appearance, in that they look completely ordinary. The crystals are colorless, hexagonal prisms with dimensions of 150 x 50 x 50 μm for group one, 80 x 40 x 40 μm for group two, and 250 x 60 x 60 μm for group three (Fig. 2). No odd crystallographic faces are observed, and the associated minerals include albite, siderite, fluorite, rutile, and calcite. The rather ordinary nature of these fluorapatites is likely why no further investigation was undertaken until now. This study however, is a testament to the continued collaboration between collectors and mineralogists, and suggests that new mineralogical and geochemical insights may be gained from examining what are often seen as “ordinary” mineral examples from extraordinary locales like Mont Saint-Hilaire.

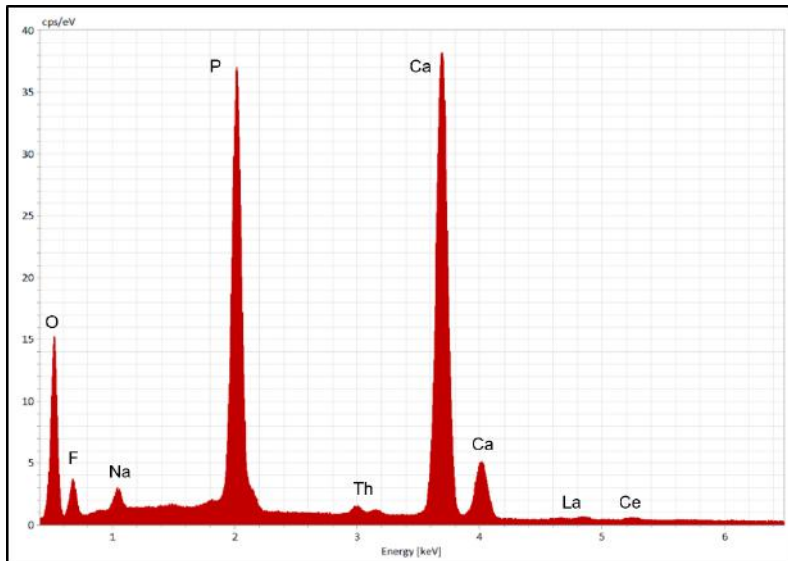


Figure 1. X-ray Energy Dispersive spectrum of group three fluorapatites showing the elevated thorium contents, along with sodium, lanthanum, and cerium.

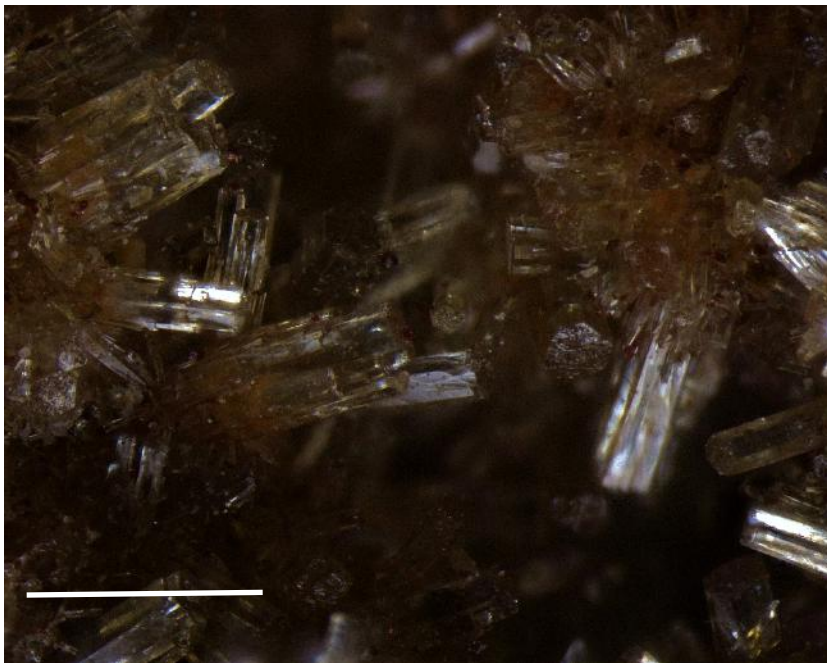


Figure 2. Light microscope image of fluorapatites from group three samples. Scale bar is 300 μ m.

NEW DEVELOPMENTS IN THE STUDY OF THE PURPLE DIOPSIDE MOUND, PITCAIRN, ST. LAWRENCE COUNTY, NEW YORK. C. Emproto, Miami University Department of Geology and Environmental Earth Science, Oxford, Ohio, 45056.

Although the Rose Road locality in St. Lawrence Co, NY has been known to geoscientists since the late 19th century, the site has been the focus of rejuvenated interest to mineral collectors due to the discovery of a new occurrence of exceptionally well-mineralized rock,

dubbed the ‘Purple Diopside Mound’ (PDM), which opened to collectors in 2013. The minerals found at this exposure are distinct from those found a mere 90 m south at the Wollastonite Skarn (WSK), the classic mineral occurrence at Rose Road. The mineralization exhibited at the PDM is heterogeneous with respect to grain size, texture, and mineral distribution. The PDM is more heterogeneous in mineralogy than the WSK, with no apparent order to the distribution of minerals. Some sizeable (meter scale) portions contain >90% diopside, while other nearby rocks contain sparse phlogopite and diopside in calcite matrix. Titanite, fluorapatite, and scapolite occur in variable abundance. The rock is generally coarse, with most grains averaging 2.0-6.0 mm.

The mineral specimens recovered in the years that followed the discovery of the PDM have conveyed a fascinating and complex paragenesis involving numerous different types of pseudomorphs and mineral textures. Through the study of these mineral replacement textures, it is hoped that the geologic history of the site may be unraveled. The focus of this research is on some of the phenomena that remain poorly understood, particularly the abundant pseudomorphs. Samples of scapolite and corundum, two minerals which exhibit complex replacement textures, were analyzed using scanning electron microscopy (SEM) and powder x-ray diffraction. The presence of sphalerite, gahnite, and two unidentified exotic element-bearing minerals at the PDM is confirmed by SEM. Analysis of corundum grains from the PDM shows that they may contain a core of gahnite and a rim of several aluminosilicate phases in variable abundance. Powder x-ray diffraction studies show that nepheline is an important component of the white alteration rinds seen around pink corundum (Fig. 1). Optical microscopy demonstrates the presence of acicular pyrite inclusions elongated parallel to the *c*-axis of the unaltered, meionite-rich interior of the scapolite crystals (Fig. 1). Chemical mapping using x-ray energy dispersive spectroscopy reveals the presence of anhedral pyrite, phlogopite, and marialite in alteration rinds on PDM scapolite. The irregularity of the alteration rind suggests that it is a mineral replacement reaction rather than a metamorphic overgrowth.

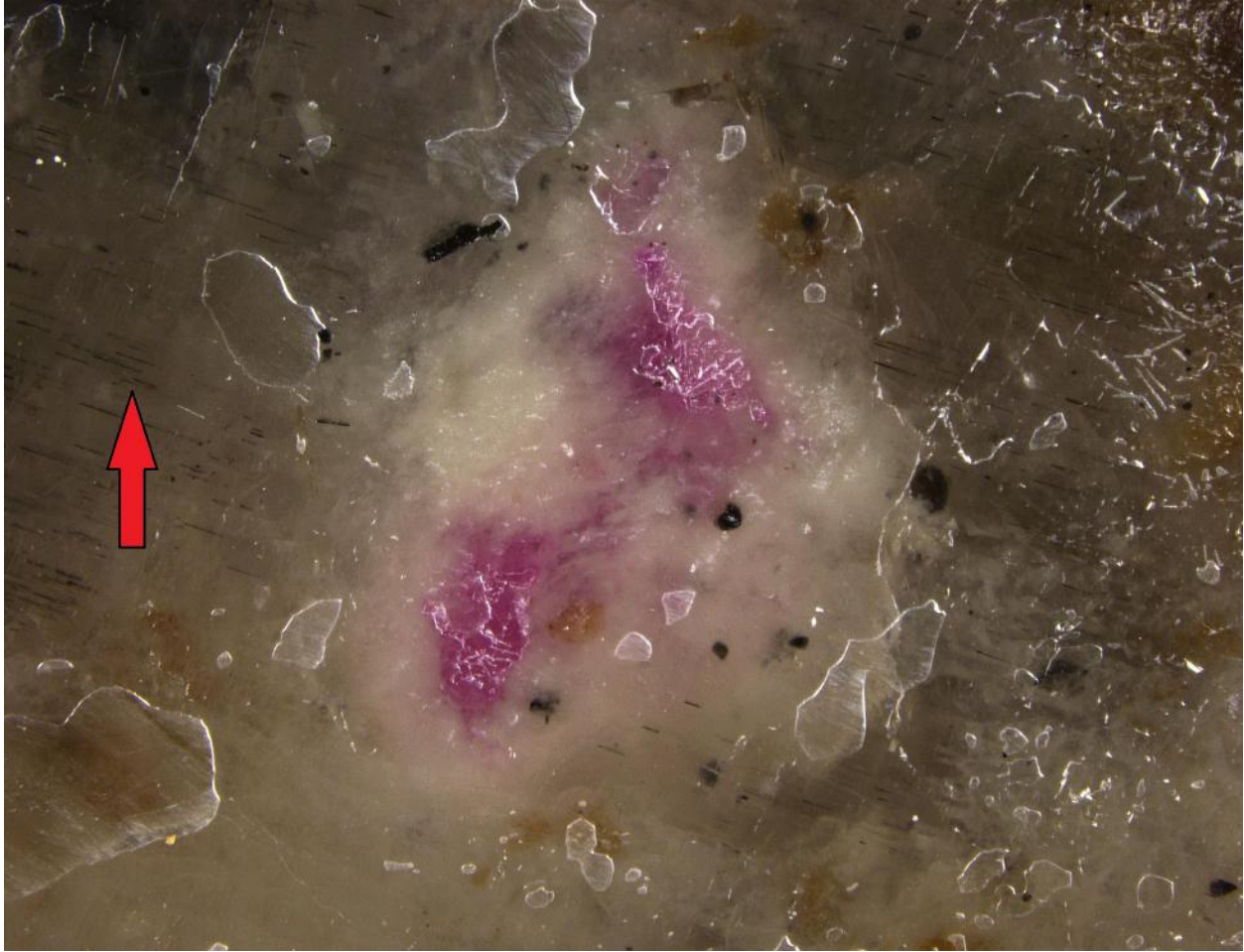


Figure 1. Polished rock chip from the PDM showing pink corundum rimmed by white alteration minerals. The corundum occurs associated with meionite-rich scapolite, which bears crystallographically-controlled acicular pyrite inclusions (indicated by red arrow). Field of view: 6.0 mm.

THE EMMONS PEGMATITE, MAINE’S MINERAL-RICHEST PEGMATITE. A. U. Falster, W. B. Simmons, and K. L. Webber. MP² Research group, Maine Mineral & Gem Museum, 99 Main Street, Bethel, Maine 04217.

The Emmons pegmatite is located on the eastern slope of Uncle Tom Mountain in Greenwood, Oxford County, Maine. At times, the Emmons pegmatite has been referred to as the Uncle Tom Mountain quarry. Recent work has added considerably to the species list of this pegmatite, which numbers now 110. The new mineral species tantalowodginite, associated with tantalite-(Mn) and lithiowodginite has been recovered in additional crystals.

Specific geochemical micro-environments associated with a large lithiophilite mass have produced several interesting finds:

- Within the phosphate pod itself, lath-shaped rhodochrosite blades to several cm long have been found. These crystals clearly are not replacing the lithiophilite but are instead partially replaced near the contact with the lithiophilite by hureaulite and reddingite. Near the top of the lithiophilite, some areas show clearly that rhodochrosite is replacing lithiophilite. This rhodochrosite has a distinctly higher Mn/Fe signature compared to the lithiophilite. Interstitially

associated with this replacement rhodochrosite are several secondary Mn-rich phosphates. They include strunzite, jahnsite group species, pseudolaueite, laueite and stewartite.

- Closely associated montebrazite, fairfieldite, eosphorite-childrenite, kastningite, brazilianite, and goyazite occur.
- At the area of interaction of lithiophilite with an altered beryl, väyrynenite has been found in pink masses. Beryllonite, roscherite, moraesite and hydroxylherderite have also been found in this assemblage.
- Near a small pollucite pod and an altered beryl, a few pieces of raspberry red pezzottaite have been recovered.
- Analcime found in zoned lepidolite veins indicates that in late stages, Cs is depleted and analcime forms instead of pollucite.
- A small amount of Bi species, including native bismuth, bismuthinite, and beyerite have been found included in metasomatic potassium feldspar.
- Sphalerite in mm-sized, red to colorless crystals occurs as inclusions in rhodochrosite associated with lithiophilite. Nearby, where oxidative alteration took place, diadochite has been found.
- A restricted area with elevated Ba content with barian goyazite and perloffite in altered montebrazite and rhodochrosite has been exposed.
- Molybdenite and pyrrhotite were found in small amounts in the core margin potassium feldspars.

It is likely that continued work will produce more species new to the Emmons pegmatite in the future.

INTERESTING INCLUSIONS IN GREEN MUSCOVITE FROM THE MERELANI HILLS, TANZANIA. J. Fink¹, C. Empro¹, J. A. Jaszczak², and J. Rakovan¹, ¹Department of Geology and Environmental Earth Science, Miami University, Oxford, Ohio 45056, U.S.A, ²Department of Chemistry and the A. E. Seaman Mineral Museum, Michigan Technological University, Houghton, Michigan 49931 U.S.A.

Beautiful green mica crystals from the Merelani Hills of northern Tanzania were sent to the authors by Simon Harrison to investigate as a possible vanadium-rich species (e.g. roscoelite). These micas are associated with quartz, graphite, brown phlogopite, and trace amounts of gemmy blue fluorapatite. The mica is extensively fractured in the vicinity of quartz inclusions. These quartz inclusions are subhedral to anhedral with stepped growth features, suggestive of syngenetic growth with the host mica. Energy dispersive spectroscopy (EDS) shows the presence of minor vanadium in the Merelani mica crystals. Roscoelite is the V dominant analog of muscovite, whose green color is the result of constituent V³⁺ in octahedral coordination. However, single crystal X-ray diffraction data, used for structure refinement (R_i = 3.9%), including site occupancy determination, verified that the mica is muscovite with only minor V occupying the M2 octahedral site. The green muscovite has space group C2/m, with cell parameters of $a= 0.71073$, $b= 5.1960$, $c= 9.0161$, $\alpha= 90.000^\circ$ $\beta= 95.752^\circ$, and $\gamma= 90.000^\circ$, and a unit cell volume of 20.0417Å³. Although these samples are simply muscovites with trace amounts of vanadium, interesting inclusions are present within them. These inclusions include graphite, pyrite, and laths of muscovite that extend into flattened void spaces within the larger crystals. The graphites range in shape from circular to hexagonal. The circular graphites are radiating polycrystalline aggregates, whose *c*-axes are predominantly radial, about the center of the circular aggregates, but whose orientation can change in circumferential zones that also show different textures and grain sizes. The hexagonal crystals appear to be single crystals with dominant pinacoids but some also have pronounced prism faces. The circular and many of the

sharp-hexagonal graphites lie parallel to the muscovite sheets. For the single-crystal graphites in this orientation the (001) of graphite is parallel to the (001) of the muscovite. The thicker graphite crystals, with predominant pinacoid and often well-formed prism faces, can be randomly oriented in the muscovite and typically cross-cut the muscovite layers. Raman spectroscopy of the graphite indicates high crystallinity but with increasing disorder-related band intensities as a function of decreasing crystallite size. A strong Raman band is also observed near 1610 cm^{-1} that confirms the high density of graphene-sheet edges exposed on the surfaces the graphite in both the circular aggregates and the single-crystal prism faces. The pyrite crystals occur as flattened cubes that show a preferred orientation, wherein the (100) of the pyrite is parallel to the (001) of the muscovite; however, the pyrites are not uniformly oriented around their [100] axis. Another interesting phenomenon is the presence of fractured pyrite crystals whose separated fragments are offset parallel to the c -axis of the host muscovite, and the degree of offset is the same across multiple proximal crystals. These samples add new examples of flattened inclusions to the observations of White (2018) and inspire additional speculation about models of their paragenesis.

REFERENCE

White, J. S. 2018. Mineral Mysteries: Flattened crystals in muscovite. *Rocks & Minerals* 93:360-365.



Figure 1. Vanadium-bearing muscovite (~ 5 cm wide) with graphite inclusions, from the Merelani Hills, Tanzania. John A. Jaszczak photo.

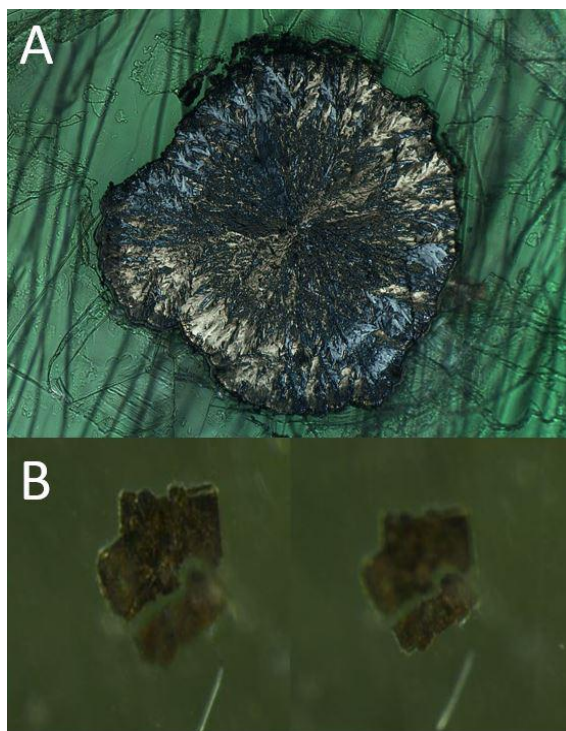


Figure 2. Examples of flattened inclusions in Merelani muscovite. (A) Flat, radial polycrystalline graphite inclusion in muscovite viewed in reflected light with nearly crossed polars, revealing the feathery growth texture and graphite's reflectance dichroism. 1 mm field of view. John A. Jaszczak photo. (B) Fractured pyrite square, where the separated fragment is offset parallel to the *c*-axis of the muscovite. Chris Emproto photo.

GOLD FROM THE WILD AMMONOOSUC RIVER, GRAFTON COUNTY, NEW HAMPSHIRE. J. S. Genga, C. B. Handler, and P. E. Tice, The Oliverian School, Mount Moosilauke Highway, P.O. Box 98, Haverhill, N.H. 03765.

The Wild Ammonoosuc River flows from Woodstock, New Hampshire to its confluence with the Ammonoosuc River, north of Woodsville. Along its 15-mile length, the Wild Ammonoosuc collects sediment from a variety of crystalline rocks, from granites to schists to metaconglomerate. In particular, the gold-bearing Clough Formation sheds sediment into the Wild Ammonoosuc. Heavy mineral separation reveals the presence of garnet group minerals and magnetite, as well as native gold. Gold occurs in these samples as silt- to sand-sized particles, although cm-scale flakes are not uncommonly extracted from the river. The composition is variable, but dominated by Au with subordinate Ag. In particular, EDS analysis of placer gold collected for this study from the Wild Ammonoosuc exhibits notably high purity, averaging 98.85 wt.% Au, 1.15 wt.% Ag. Comparing the composition of gold from the Wild Ammonoosuc with that from other localities reveals a correlation between the relative degree of post-emplacement reworking (*e.g.* transport, redeposition, metamorphism, alteration) and purity, with gold from older, more modified, geologic provinces exhibiting higher purity. Placer gold deposits in localities that are hosted by rock that has experienced less overall reworking, such as the Snake River in Idaho or the San Luis Range in Argentina, averages 10-30 wt.% less Au than gold from the Wild Ammonoosuc. On the other hand, placer gold found in metamorphosed

suites, which may contain gold that has been deposited during more than one sedimentation cycle, such as in the Southern Appalachians or Klerksdorp, South Africa, is typically of higher purity, with numerous compositions even more pure than that of our study area. We posit that energy inputs during metamorphism of the Clough Formation caused a sort of zone-refining effect on protolith gold that remobilized impurities and recrystallized higher purity gold.

GARNET & MAGNETITE FROM THE WILD AMMONOOSUC & BAKER RIVERS, GRAFTON COUNTY, NEW HAMPSHIRE. C. B. Handler, J. S. Genga, and P. E. Tice, The Oliverian School, Mount Moosilauke Highway, P.O. Box 98, Haverhill, N.H. 03765.

The Wild Ammonoosuc & Baker Rivers cut through Silurian and Devonian granitic igneous, gneissic metamorphic, and metaconglomerate formations in the White Mountains of New Hampshire. Heavy-mineral separates were obtained from river-bottom sand, collected at several localities along each stream, to study spatial changes in mineralogy. The separated sand is dominated by garnet and magnetite. The garnet crystals are exclusively rhombic dodecahedra, ranging in color from nearly colorless through pink and lavender; some are nearly perfect in form, indicating virtually no transport or working. EDS analysis indicates compositions dominated by almandine, with minor spessartine, grossular, and pyrope components. Magnetite crystals display the same variability in transport indicators as garnet, and there is a notable decrease in the size of individual crystals and the proportion of magnetite between samples relative to their downstream position. EDS analysis reveals a range of magnetite compositions from relatively pure magnetite to titanomagnetite. Titanium and manganese content are variable and tend to be mutually exclusive. Pines & Tice (2018) proposed that Ti-enrichment in garnet schists in the Baker River Valley was due to metamorphic processing of placer deposits. Our work here suggests that a recursive process of progressive placer enrichment may occur over geologic time, as placer-concentrated rock sheds sediments that are themselves concentrated in stream beds, with the potential for metamorphic reworking in the future.

REFERENCES

Pines, J.E. and Tice, P.E. (2018) REE and Ti/Zr Mineralization in Garnet Schist from the Carrabassett Formation, Rumney, New Hampshire. *Abstracts with Program – 45th Rochester Mineralogical Symposium*.

BERYLLIUM MINERALS OF THE MOUNT ROSA COMPLEX AREA NEAR COLORADO SPRINGS, COLORADO. S. L. Hanson¹ and G. Zito², ¹Adrian College, Geology Department, 110 S. Madison St., Adrian, MI 49221. ²Colorado School of Mines, Metallurgical and Materials Engineering Department, 1500 Illinois St., Golden, CO 80401.

The Mount Rosa Complex, located within the southern part of the Pikes Peak Intrusive Center, is part of the larger 1.08 Ga Pikes Peak Batholith in the Colorado Front Range. There are several mineral collecting localities in this area that have produced collector-quality specimens. These include the Saint Peters Dome, Fairview, Helen Hunt, Mount Buckhorn, Specimen Rock, and Bear Creek localities. Specimens have been collected from miarolitic cavities in pegmatites, within vugs in quartz, and from hydrothermal alteration zones within the Mount Rosa Complex. Crystals of smoky quartz and amazonite are present as well as a number of accessory minerals, including several beryllium mineral species. The suite of Be-minerals from this area is unusual

as beryl is notably absent, with Be instead being represented by a suite of late-stage to secondary minerals.

Hexagonal crystals of blue-green **bazzite** [$\text{Be}_3\text{Sc}_2\text{Si}_6\text{O}_{18}$], the Sc-rich analog of beryl, were collected from the Fairview area where it occurs in small vugs within a quartz vein. These crystals were small (0.5 mm) and etched to partially dissolved and were associated with pyrite, magnetite, and goethite. **Bertrandite** [$\text{Be}_4(\text{Si}_2\text{O}_7)(\text{OH})_2$] crystals are present in many of the miarolitic cavities on Stove Mountain and the metasomatic rocks of Saint Peters Dome (Fig. 1). **Phenakite** [$\text{Be}_2(\text{SiO}_4)$] has only been found in a few miarolitic cavities near Specimen Rock in the northern most section of the Mount Rosa Complex Area. The crystals are clear and show two distinct habits, lenticular and prismatic. Lenticular crystals are the common forms of phenakite in pegmatites in the most northern section of the Mount Rosa area, the Specimen Rock locality. In contrast, prismatic phenakite has been found in only one pocket near Helen Hunt Falls (Fig. 2). Crystals of black, one mm **gadolinite-Ce** [$(\text{Ce}_2\text{Fe}^{+3})\text{Be}_2\text{Si}_2\text{O}_{10}$] were collected from a miarolitic cavity in the Fairview area. It is associated with smoky quartz, microcline, albite, ilmenite, green fluorite, fluocerite and bastnaesite. Dark green **gadolinite-Y** [$(\text{Y}_2\text{Fe}^{+3})\text{Be}_2\text{Si}_2\text{O}_{10}$] crystals were found in a miarolitic cavity associated with smoky quartz, microcline, zircon, and kainosite. Chalky, light tan, 0.5 cm crystals of **hingganite-Y** [$(\text{Y,REE,Ca})_2(\square\text{Fe}^{+2})\text{Be}_2(\text{SiO}_4)_2(\text{OH})_2$] were found in a quartz cavity with crystals of clear quartz, magnetite, pyrite, hematite and bertrandite. Similarly, 0.5 mm chalky-white to light-tan masses of **hingganite-Yb** [$(\text{Yb,Y,REE})_2(\square\text{Be}_2)(\text{SiO}_4)_2(\text{OH})_2$] were recovered from a quartz vug where they were associated with magnetite, pyrite, fluorite, hematite and goethite, kainosite, and bertrandite. Helvine-group minerals recovered from a pegmatite pocket in Cheyenne Canyon included distorted octahedrons of light-rose colored **genthelvite** [$\text{Be}_3\text{Zn}_4(\text{SiO}_4)_3\text{S}$], with some that exhibit rhombic dodecahedron faces. A few of these crystals occur as partial to complete epitaxial overgrowths on tetrahedral **danalite** [$\text{Be}_3\text{Fe}^{2+}_4(\text{SiO}_4)_3\text{S}$] cores. Late-stage beige genthelvite coatings are also present on some on the exposed danalite faces.

The unique accessory mineralogy is attributed to the unusual composition, as well as hydrothermal and metasomatic alteration that occurs in the Mount Rosa Complex. Pegmatite melts and the hydrothermal fluids in the Mount Rosa Riebeckite Granite had high alkalinity and low alumina activity that is typical of Na-amphibole granites. This characteristic influenced the beryllium speciation in these rocks. First, the absence of beryl is attributed to the alkaline nature of the melt, which would lead to the formation of helvine-group minerals rather than beryl. Furthermore, the fluorine enrichment may be, in part, responsible for the occurrence of the unusual Be-minerals. The presence of a F-Be complex could provide a mechanism for the transport, mobility and concentration of beryllium. Subsequent formation of fluorite would then cause the precipitation of beryllium minerals. This model is consistent with the close textural relationship between beryllium minerals and fluorite in the miarolitic cavities.



Figure 1. SEM micrograph of bertrandite (dark color) and genthelvite (lighter color) from the St. Peters Dome area.

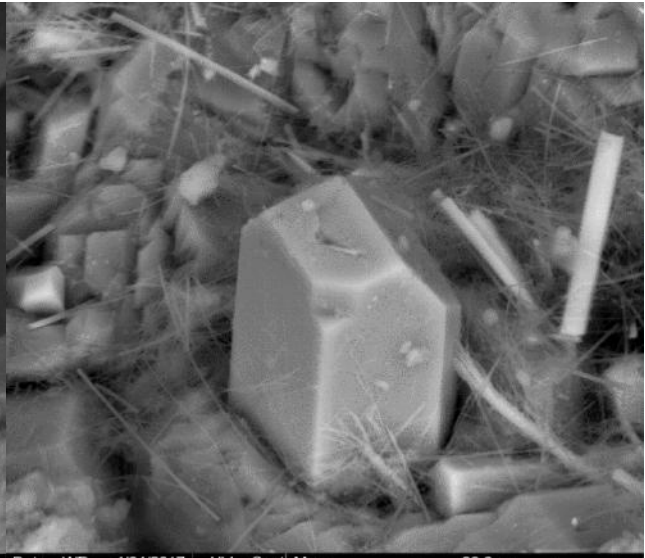


Figure 2. SEM micrograph of prismatic phenakite with tourmaline on amazonite from the Specimen Rock area.

SNOW CRYSTAL PHOTOMICROGRAPHY 101. K. Hrechka, 7201 Ludwood Court, Alexandria, VA 22306, USA.

In the winter of 2015, Kathy Hrechka began photographing snowflakes under her Olympus microscope using a Canon Power Shot digital camera attached to the microscope. She captures the snow crystals within seconds before they melt. She also uses her Samsung cell-phone camera held up to the microscope eye piece. Kathy has discovered each snowfall to have its own signature crystals, based on the temperature and humidity.

The structure of crystalline ice contains water molecules in a hexagonal lattice. There are two hydrogen atoms for each oxygen, so the chemical formula is H_2O . The six-fold symmetry of snow crystals ultimately derives from the six-fold symmetry of the ice crystal lattice. Snow crystals are classified in a variety of forms including stellar dendrites, columns, capped columns, plates, stellar plates, needles, rime, and graupel. This photomicrographic collection of snow crystals illustrates the diversity of ice morphology.

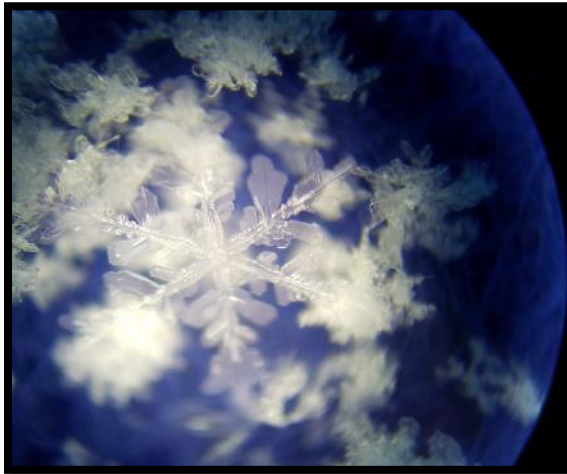


Figure 1. Stellar dendrite, 25X.



Figure 2. Stellar plate, 25X.

REFERENCES

- Libbrecht, K. and Wing, R. 2015. *The Snowflake*. Minneapolis: Voyageur Press.
 Libbrecht, K. 2010. *The Secret Life of a Snowflake: An Up-close Look at the Art and Science of Snowflakes*. Minneapolis: Voyageur Press.

SINGLE-CRYSTAL X-RAY AND NEUTRON DIFFRACTION STUDY OF THE INCOMMENSURATELY MODULATED STRUCTURES OF LOW-TEMPERATURE LABRADORITE. S. Jin, H. Xu and X. Wang, Department of Geoscience, University of Wisconsin-Madison, 1215 W. Dayton St. Madison, WI, 53706.

Plagioclase feldspars, the solid solution between albite ($\text{NaAlSi}_3\text{O}_8$) and anorthite ($\text{CaAl}_2\text{Si}_2\text{O}_8$) are the most abundant group of minerals in the Earth's crust. Labradorite, with a composition between An_{50} and An_{70} , is the most famous species of plagioclase feldspar. It is best known for the iridescent color often observed in large crystals from plutonic anorthosite, which is an interference effect of visible light caused by the nano-scaled exsolution lamellae in the crystal. The labradorite composition is also the most complicated part of the subsolidus phase relations of the solid solution series, with 4 different possible phases reported. The Bøggild intergrowth producing the exsolution lamellae has been proposed to be the phase boundary between the $C\bar{1}$ and $e1$ phase. (Jin and Xu, 2017a)

The single-crystal diffraction data of 8 plutonic labradorite crystals and 1 metamorphic labradorite crystal shows that they all have the incommensurately modulated structures, characterized by the satellite reflections (e -reflections), which cannot be indexed by integer Miller indices. One crystal from a gabbro rock in the Duluth Igneous Complex displays an $e2$ structure with no density modulation, and all the other eight crystals show density modulation ($e1$ structure) with sharp f -reflections (second order satellite reflections). The Al occupancy of the tetrahedral site refined directly from neutron data correlate well with the $\langle\text{T-O}\rangle$ bond distances from the X-ray data refinement. The iridescent labradorite sample from Labrador, Canada shows the highest degree of ordering, which agrees with the slow cooling rate required for the exsolution lamellae. The structure of a anorthosite xenolith in the Duluth Complex is much more ordered compared to the surrounding gabbro rocks, which proves their different origins. The relation between q -vector and composition confirms that the modulation direction and period also depend on the thermal history of the host rock.

Combined with recently published results about the Na-rich plagioclase structures (Jin and Xu, 2017b) and the high temperature $I\bar{1}$ structure of Ca-rich plagioclase (Jin and Xu, 2018), we now have a more complete understanding of the subsolidus phase relations of the plagioclase phase relations. The large variations of the ordering states in plagioclase structures shows potential for developing a way to quantify cooling rates for igneous rocks.

REFERENCES

- Jin, S. and Xu, H. 2017a. Study on structure variations of incommensurately modulated labradorite feldspars with different cooling histories. *American Mineralogist* **102**(6): 1328-1339.
- Jin, S. and Xu, H. 2017b. Investigations of the phase relations among $e1$, $e2$ and $C\bar{1}$ structures of Na-rich plagioclase: a single-crystal X-ray diffraction study. *Acta Crystallographica Section B* **73**(5): 992-1006.
- Jin, S., Wang, X. and Xu, H. 2018. Revisiting the $I\bar{1}$ Structures of High Temperature Ca-rich Plagioclase Feldspar – A single-crystal neutron and X-ray diffraction study. *Acta Crystallographica Section B* **74**(2): 152-164.

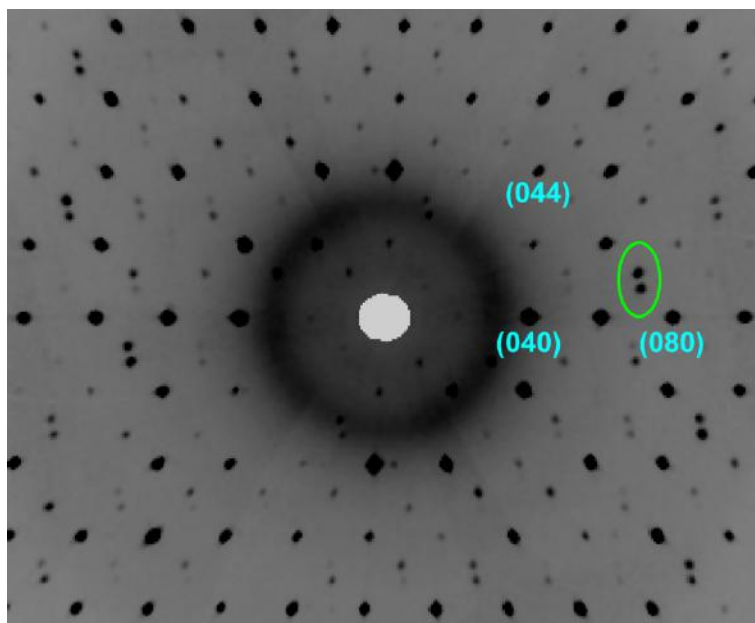


Fig 1. The $0kl$ precession image from single-crystal X-ray diffraction data of labradorite (Volga Blue) from Ukraine. Pairs of satellite reflections can be seen around the absent b -positions ($h+k=\text{odd}$, $l=\text{odd}$). For instance, the strong satellite peaks around the absent (071) position are circled in the figure.

ON THE ORIGIN OF JAPAN LAW TWINS. B. Morgan, 2711 Mechanics Avenue, Savannah, Georgia, 31404.

In *Growth and Morphology of Quartz Crystals: Natural and Synthetic*, Sunagawa, Kawasaki, and Kawasaki (2009) opened the topic of how Japan Law twins originate. They didn't accept the (112) twin plane as a suitable nucleation site, both because of the rarity of that form in quartz and a structural incompatibility of that form for contact twinning. For them, Japan Law twinning was too common and varied to come from such an unlikely source citing relatively large, isolated twins in higher temperature Alpine veins, and lower temperature deposits where twins outnumbered single crystals 4 to 1.

To that variety can be added at least one locality where a layer composed almost entirely of Japan Law twin grains serves as matrix for a later generation of larger twins. Even more complicating is that Japan Law twinning not only develops by early *nucleation*, but also by *oriented attachment*, where smaller crystals form on a larger host crystal in a Japan Law crystallographic relationship.

Sunagawa et al. (2009) sought a structural proclivity that would better explain such a common and varied phenomenon and proposed an *original composition plane* for Japan Law twinning on the most common quartz face, the rhombohedral (101). The (112) twin plane, which they designated the *apparent composition plane* would have resulted from unspecified subsequent growth.

Working from this suggestion, a model of Japan Law twinning has been developed using the (101) rhombohedral face for an *original composition plane*. In order to have the necessary 84.55° Japan Law c-axis angle, the individuals had to be rotated 140.67° from alignment around the [101] axis. Fig. 1 shows this. Prism faces align on both front and back of the twin. Misalignment of surfaces and ridges remain across the twin boundary in the twin notch. Those would be sites where the ridges on one side would foster faster growth on surfaces of the other side until ridges on both sides align at the (112) apparent composition plane. Evidence for this comes from parted Japan Law twins (Fig. 2). The parted surfaces usually have an inner zone with close to (101) orientation of more luster with striations characteristic of intergrown crystals. To both sides are (112) surfaces of less luster characteristic of non-crystallographic contacts.

Japan Law twinning by *oriented attachment* works well with this proposal. Most striations on prism faces are thin (101) surfaces. Any could be a site where a deposition could orient in a 140.67° rotated position.

If the (101) is the *original composition plane*, Japan Law twins would be sharing that plane with another quartz twin law, the Grieserntal Law. A further rotation of 39.33° on the same axis, or an overall 180° rotation defines that law, which is also described as a reflection twin.

Between the two laws Japan Law twins are far more common. Grieserntal Law twins have been found only at a small number of Japan Law localities, and in much smaller numbers. Clearly the Japan Law is most favored. If they do share the same (101) original composition plane there is a structural attraction that is stronger or more likely to be accessed at the 140.67° orientation.

Research suggestions for confirming this proposition include:

- 1) A microscopic study of the early twin boundary for signs of a (101) original twin plane
- 2) Computer modeling of the (101) as a twin plane, checking for stronger bonding patterns at the 140.67° angle of rotation than at 180°

REFERENCES

Sunagawa, I., Iwasaki, H. and Iwasaki, F. 2009. *Growth and Morphology of Quartz Crystals Natural and Synthetic*, Tokyo, Japan, Terrapub.

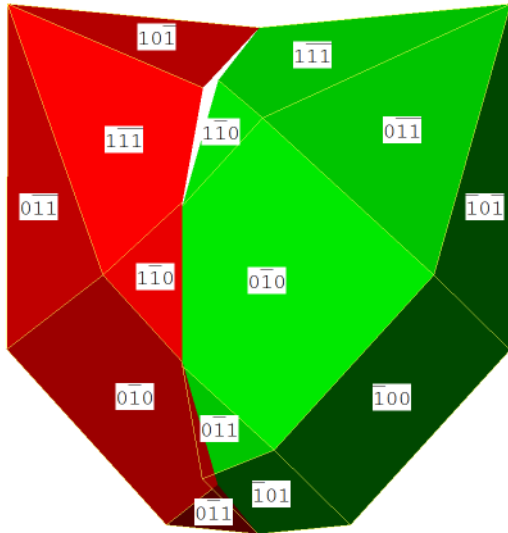


Figure 1. Two crystals joined on their (101) faces at a rotation of 146.67° . The white surface is proposed site of rapid inner notch growth toward a (211) vertical twin boundary. (SHAPE drawing).

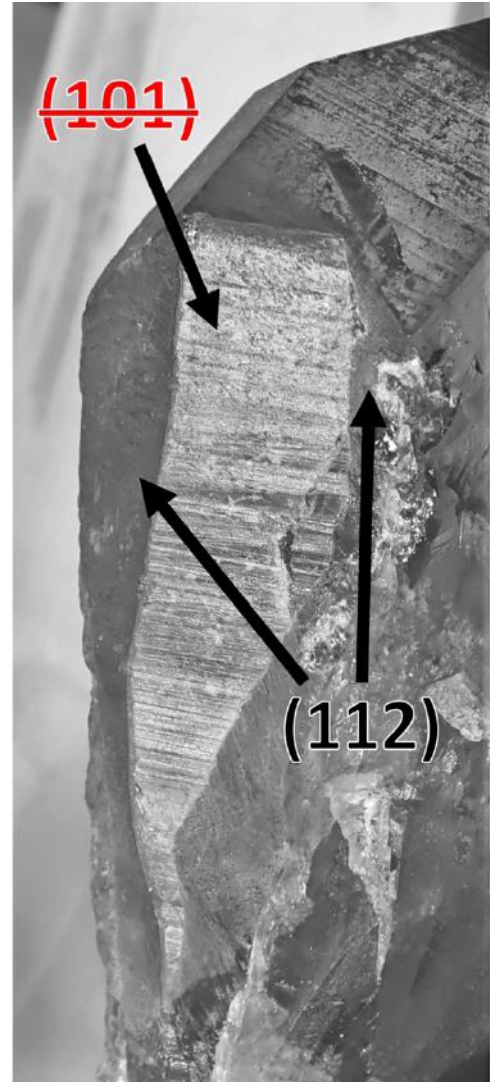


Figure 2. Parting surfaces inside Japan Law twin. Mount Mambosa, Zomba, Malawi. 8.5 cm high. Author's specimen and photo.

A NEW FIND OF URANIUM AND REE MINERALIZATION ON NOYES MOUNTAIN, GREENWOOD, OXFORD CO., MAINE. J. Spiegel¹, A. U. Falster², and W. B. Simmons²,

¹Maine Dynamining & Minerals, 90 Federal Street, Belchertown MA 01007, ²MP² Research Group, Maine Mineral & Gem Museum, 99 Main Street, Bethel, ME.

During access road construction between the Hayes and Outback pegmatites on Noyes Mountain, Greenwood, Oxford Co., Maine, an unusual mineral assemblage of uranium-rich mineralization was discovered in a 3-6 cm thick garnet layer in pegmatite. Uraninite is the major component and forms black masses up to 1.5 cm across. Associated are black fibrous masses of coffinite up to 5 mm with patches and coatings of pale-yellow uranium silicate (possibly soddyite) and less common autunite/meta-autunite with intense yellow-green fluorescence. This fluorescent coating is wide-spread within and around the mineralized garnet-rich zone. Accessory zircon, monazite and xenotime group species up to 2 mm in maximum dimension are intimately associated with the uranium assemblage. Inclusions in uraninite of U- and/or Pb-rich fluorcalciopyrochlore species (formerly known as uranpyrochlore and plumbopyrochlore), a light rare earth element enriched suite of minerals consisting of allanite group species, small amounts of a bastnäsite group species and a heavy-rare-earth-element enriched group of mineral species consisting of Yb-rich fergusonite-(Y) or euxenite-(Y) have also been identified. These species occur generally in sizes below 1 mm in maximum dimension. This REE signature is more typical for anorogenic pegmatites formed in an extensional tectonic regime than those in a compressional regime like the pegmatites of the Oxford field. Uranium content of this pegmatite is consistent with either orogenic or anorogenic pegmatites but the HREE and LREE content is elevated, which is generally typical for anorogenic pegmatites. The presence of elevated U is consistent with either orogenic or anorogenic pegmatites but elevated REE content is atypical for pegmatites in the Oxford pegmatite field. This pegmatite may represent a hybrid source or some unusual concentrations of both REE and U.

AN UPDATE ON THE MINERALOGY OF THE HOUGHTON LAKE FULGURITE. C. J. Stefano¹, S. A. Hackney², and A. R. Kampf³, ¹A.E. Seaman Mineral Museum, Michigan Technological University, Houghton, MI, ²Materials Science and Engineering, Michigan Technological University, Houghton, MI, ³Mineral Sciences, Natural History Museum, Los Angeles, Co. Los Angeles, CA.

Fulgurites are natural glasses which result from melting of soil or rocks during lightning strikes. The Houghton Lake Fulgurite (HLF), discovered in 2014 near the town of Houghton Lake, MI, is an unusually large example with a diameter of up to 14 cm. Large fulgurites often contain new-formed minerals which result from the extreme temperatures achieved during the lightning strike. We have previously reported that spherical grains of iron silicides are present in the HLF. Continued study has identified most of the common species as well as located a number of minor species which are still not adequately identified. Primary species present in the HLF include naquite (FeSi), linzhiite (FeSi₂), xifengite (FeSi₃), and schreibersite (Fe₃P). This represents the first time that iron silicides in fulgurites have been identified using X-ray and electron diffraction techniques, allowing for separating chemically similar but structurally different species. This work has provided insight into cooling rates of natural fulgurites and leads to a prediction of differences in the mineralogy of iron silicides in artificial “fulgurites” resulting from downed power lines, which we hope to test in the future.

STAGES IN PSEUDOMORPHISM. R. L. Straw, 1913 Hackberry Rd., Bloomington, IL 61704.

Pseudomorphs present a number of challenges including positive determination of the original mineral species and stages in the transformation. The new mineral can be positively identified by techniques including but not limited to x-ray diffraction (XRD). The original mineral can also be positively identified by these same techniques if some of it remains.

Stages from original mineral to pseudomorphs will be examined and evidence of proof considered. The following will be reviewed as time permits:

Malachite after barite, Democratic Republic of Congo – malachite on barite subject to dissolution

Tennantite after azurite, Tsumeb – some residual azurite present

Pyrite and marcasite after pyrrhotite, Santa Eulalia – measure transition by magnetism

Quartz after calcite, Idar-Oberstein – chalcedony on calcite with amethyst filling

Quartz after fluorite, Wheal Mary Ann – chalcedony on fluorite and quartz backfill

Quartz after danburite, Charcas San Luis Potassi – partial dissolution of danburite

Malachite after azurite, Chessy-les-Mines – malachite starting at the surface

Copper after cuprite, Rubtsovskiy Mine – gradual replacement on cuprite surface

Pyrite after chalcopyrite, Bulgaria – gradual replacement on chalcopyrite surface

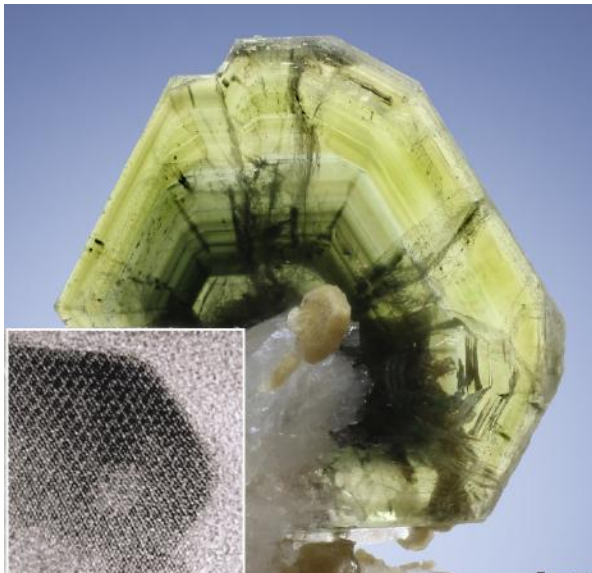
Quartz and epidote after andradite, – andradite, andradite mold, and both pseudomorphs

A collaborative effort in the future would be helpful to fill in stages missing from the above, suggestions for other examples, and a place on the web where the pictures can be viewed by pseudomorph type.

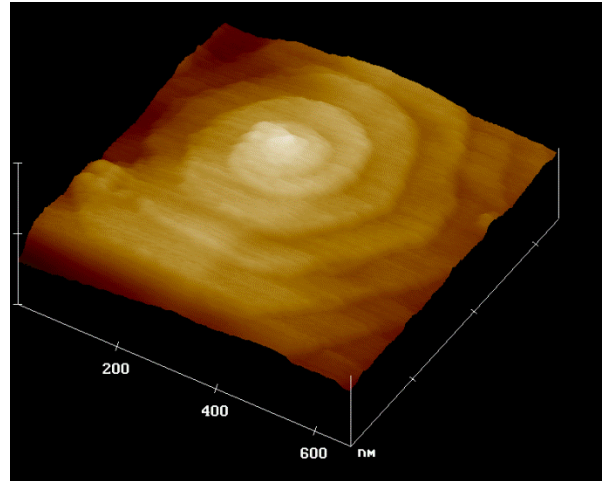
Crystal Growth: A Primer

John Rakovan, Department of Geology and Environmental Earth Science,
Miami University, Oxford, Ohio. rakovajf@miamioh.edu

One of the most appealing aspects of minerals is the regular geometric morphology of their crystals and the flat, often polished looking, faces that bound them. Symmetry of the atomic structure ultimately determines the geometric relationships among crystal faces (e.g. the angles between them) but the presence of flat crystal faces is dependent on the growth mechanism. The perfection of a crystal face depends on growth rate and its ability to grow unimpeded, e.g. into an unrestricted or open space. The specific faces that will form, for example the cube or octahedral faces on a fluorite



Concentrically zoned fluorapatite crystal from Panasqueira, Portugal. Inset: TEM photomicrograph of a fluorapatite showing the crystal lattice. From [2]



Atomic force microscopy image of a growth spiral on the (001) surface of a graphite crystal from Namibia. From [1].

depend on their relative energetics which in turn can be influenced by the chemistry and physical characteristics of both the crystal and the growth medium. Morphology is also influenced by kinetics including the relative growth rates of different faces. This talk will explore the various factors that influence how crystals grow into the beautiful specimens that are desired by collectors.

References: [1] Rakovan, J., and Jaszczak, J.A. (2002) *American Mineralogist*, 87, 17-24.
[2] Krekeler, M.P.S., Guggenheim, S., and Rakovan, J. (2004) *Clays and Clay Minerals*, 52, 263-274.

Distorted Crystals: What Are They and Why Might We Care?

R. Peter Richards, Department of Geology, Oberlin College, Oberlin, Ohio

Distorted crystals are crystals that don't conform to our expectations about their appearance, based on our general and specific knowledge of mineralogy. In one sense or another, they include bent crystals, crystals with inappropriate morphology, crystals with deceptive morphology, twins, faden crystals, gwindels, hoppers, whiskers, and dendrites. They are often quite beautiful and striking, especially to those who understand that they are unusual.

As unusual crystals, they help to bound and sharpen our sense of what is usual. In seeking to understand their unusual shapes, we can learn a lot about crystal growth and the natural environments in which it occurs. Unusual habits can serve as clues to unusual environments or to aspects of their crystal structures that are otherwise hidden. Many examples of distorted crystals have no obvious explanation, which can be frustrating. Or it can heighten our interest and curiosity about the wonderful and diverse realm of mineral crystals.

"You mean they just GREW that way?" "Yep, Ray, they just grew that way. Isn't that amazing?"

Criminal Minerals: Investigating Minerals that Break the Law!

John A. Jaszczak, Professor and Interim Chair, Department of Chemistry, Michigan Technological University, Houghton, Michigan

As naturally occurring crystalline materials, most minerals are assumed to obey the classical laws of crystallography. Nobody, and no mineral, is perfect, however, and minerals routinely "break the law" by hosting imperfections and impurities due to entropy and growth conditions. Many minerals get into frequent trouble with the law but yield wonderful outcomes with phenomena like twinning. It is increasingly recognized, however, that many minerals are just incorrigible! They seem systematically and consistently to break the laws of classical crystallography. This talk will begin to explore the wild world of criminal minerals from mistakes, to twins, to incommensurate crystals (calaverite, franckeite, cylindrite, merelaniite) to the newly discovered natural quasicrystals.

The Variety and Appeal of Calcite

Terry E. Huizing, Cincinnati Museum Center, Cincinnati, Ohio. tehuizing@fuse.net

The Four Cs

The four Cs (color, clarity, cut, and carat weight) traditionally describe the appearance of faceted diamonds and promote the appreciation of this particular gem to a wide audience.

In a similar fashion, a different set of four Cs can be used to describe calcite and explain why calcite is such a popular collector's mineral. The four Cs of calcite are **common, clarity, colorful, and crystal structure**.

Common - Calcium, carbon and oxygen are abundant elements in the earth's crust that frequently combine to form calcium carbonate. Calcite is the stable form of CaCO_3 at the surface of the earth. Thus calcite is a widely occurring mineral that is common and abundant in all classes of rocks - igneous, metamorphic and sedimentary. Sedimentary deposits of limestone and chalk are almost entirely composed of calcite; marble is metamorphosed calcite. Calcite occurs in silicate rocks, pegmatites and hydrothermal veins; it precipitates in hot springs and caves and is even found in biologic settings. Rocks, such as granites, that are poor in calcium have little calcite.

Because calcite occurs abundantly, many mineral collectors have access (either through the mineral marketplace or by collecting) to locations that produce large, beautiful crystals. Availability and abundance often are the key to "low" price, a factor in assembling a specialized calcite collection. Thus, I submit that *common* is a key factor that explains collector interest in calcite.

Clarity - Clear and transparent crystals of calcite are uncommon, and when these occur they command premium prices in the mineral market. Such desirable specimens add strength to any collection.

Colorful - Calcite is colorless and transparent or white when pure; other colors are uncommon and highly desirable. When colored crystals are found, they are generally yellow to honey-colored. The cause for the yellow color is unknown but is thought to be associated with impurities of iron or perhaps to defect color centers.

Some of the most colorful calcite crystals result from the replacement of calcium by manganese, iron, zinc, cobalt, lead, strontium, magnesium, or barium. Although this substitution is typically on the order of only a few percent, it produces such notable calcite varieties as pink *manganoan* calcite, beige *plumbian* calcite, rose-red *cobaltian* calcite and tan *ferroan* calcite. Colorful calcite is also produced by admixtures of other minerals.

Clear and transparent crystals of calcite when included by such strongly colored minerals as boulangerite, celadonite, copper, hematite and others can often produce striking specimens. The inclusions may occur either on an early calcite growth surface that has been overgrown by a later generation of clear calcite (a *phantom*), or it may be uniformly disseminated throughout the calcite crystal. Calcite may even incorporate up to 70% sand within its structure.

Whatever the cause for colorful calcite, all well-crystallized specimens are highly prized and generally priced accordingly. A calcite collection with a wide variety of colored calcites is a major step above a collection of “common” calcites.

Crystal Structure - Calcite's structure consists of alternating layers of calcium atoms and carbonate groups stacked along the *c*-axis. Calcium has octahedral coordination with six oxygens from six different CO₃ groups. The crystal structure and composition determine the properties and appearance that makes calcite so interesting to collectors.

Durability

If calcite has any negatives, they most certainly would be associated with durability. Calcite *hardness* (Mohs scale = 3) and *cleavage* (readily induced) require careful handling of crystals throughout the acquisition, curation and display processes. In addition to the obvious need to avoid contact with harder objects, calcite should never be subjected to freezing conditions, as crystals may be included with small amounts of water. Internal fractures and external damage decrease the desirability of specimens.

Forms of Calcite

Calcite has been described as the mineral with the most forms; in fact more than 600 have been documented. A single crystal of calcite may be bounded by more than one form. It is not uncommon for three, four or even five or more forms to be combined on a single crystal; thus, the documented form combinations seen on calcite number into the thousands. Although this variety of combinations is greater than that of any other mineral, all of the forms of calcite fall into five groups. They are:

Pinacoid – An open form made up of two parallel faces that are each perpendicular to the *c*-axis. This form terminates a crystal.

Prism – An open form composed of six or twelve faces, all of which are parallel to the *c*-axis. Short or long prismatic crystals are frequently terminated by either the pinacoid or a rhombohedron.

Rhombohedron – A closed form composed of six faces; three at the top of the crystal alternate with three at the bottom. The two sets of faces are offset by 60 degrees. Rhombohedral crystals range from shallow to steep, and often occur in combination with other forms.

Scalenohedron – A closed form with twelve faces grouped in symmetrical pairs, three pairs above and three below in alternating positions. In perfectly developed crystals, each face is a scalene triangle; the faces meet in a zigzag line around the girdle of the crystal. Scalenohehedral crystals, often with prism faces and rhombohedral terminations, are the most common habit observed on calcite. More than 200 different scalenohedra have been described, although simple crystals are uncommon.

Dipyramid – A closed form having twelve faces, six on the top of the crystal and six immediately below them on the bottom; each face is an isosceles triangle. This form is considered uncommon.

Twinning

When two crystals grow in fixed rather than random relationship to one another, they are described as *twins*. These relationships are related to the structure of a mineral, and for calcite there are four recognized twin laws. Typically, twins are uncommon and are highly prized by collectors.

The most common twin law for calcite occurs when the *c*-axes of the twin is at 180° to one another and lies in the same plane. These are easily recognized by the reentrant notches along the contact at the basal plane.

The other three calcite twin laws are inclined at an angle to one another. Identifying the correct inclined-axis twin law can be difficult at times because the habits of twinned crystals are quite different from the habits of untwinned crystals. Rapid growth occurs on faces where the two parts of the twin meet, resulting in modifications of the crystal shape.

The second-most common twin law for calcite occurs when the *c*-axes of the twin are inclined at an angle of 127°29.5' with respect to one another. Here the twin plane is parallel to a face of a shallow negative rhombohedron. These are often described as “butterfly” twins.

When the *c*-axes of the twin are inclined at an angle of 90°46' with respect to one another, the twin plane is parallel to a face of the positive rhombohedron, which is defined by the cleavage of calcite. Occurrences of this calcite twin law are quite rare and include the “heart” twin, or if the reentrant notch is completely filled-in, as “axe-head” twins.

If the *c*-axes of the twin are inclined at an angle of 53°46' with respect to one another, the twin plane is parallel to a face of a steep rhombohedron. This is moderately- rare twin law for calcite. These have been described as “fish-tail” and “bishop-hat” twins.

Aggregates

Habits of calcite crystal aggregates can be described as fibrous, nodular, stalactitic or botryoidal. These can be an interesting addition to a collection of crystals.

Collectible

To put the four Cs described above into perspective, a calcite collection that contains specimens that are damage-free, has a wide representation of crystal forms, and includes examples of the four twin laws is another major step above a collection of common calcites.

Calcite is a desirable and collectible mineral. Because calcite seemingly occurs everywhere, it has been possible to acquire and preserve excellent calcite crystals from mining ventures that have been operated primarily for metals. As older mines became uneconomic and are closed, new mines in new places become the source for metals. Thus, availability of calcite cycles from boom-to-bust at every location.

Consequently, it is challenging to include older classics in a calcite collection without compromising one's budget or quality standards. Specimens from the late 1800's and early 1900's mining operations in Germany, England and Michigan are highly desirable and command high prices for even mediocre specimens.

In the late 1900s, mines in Mexico and Peru, at Tsumeb and at many of the MVT deposits in the midwestern United States were producing seemingly inexhaustible quantities of minerals, including choice calcite. But where are these specimens now?

Today, mines in the former Soviet Union, India and China and on the African continent are the source for much of the fine calcite available in the marketplace. I suggest you not let this opportunity pass by. Of course, there will eventually be other new localities, but will they meet the standard of older and modern classic localities?

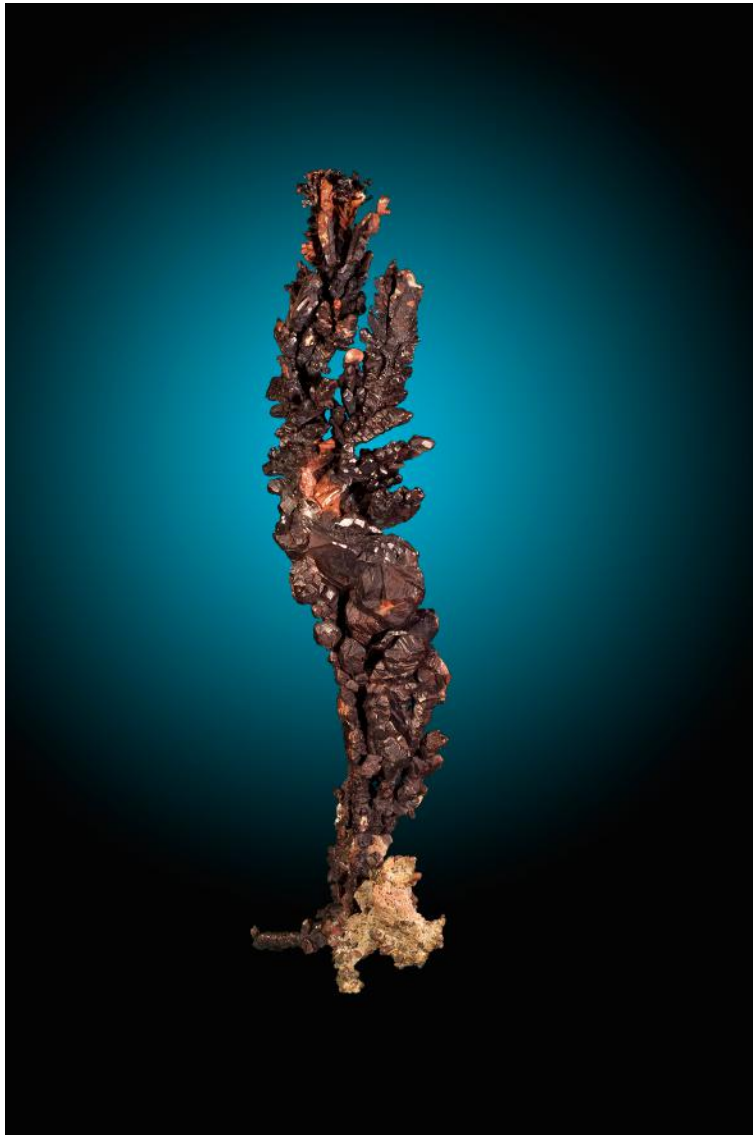
Summary

A well-documented calcite collection is, obviously, only as good as the specimens it contains. When careful attention is given to acquiring specimens without damage and those with a wide variety of crystal habits, including the four twin laws of calcite, the collection has a strong foundation. The addition of calcites colored either by substitution or from inclusions, and specimens from classic localities, both historical and modern, further enhance the collection. Ultimately, it is the collector's taste in aesthetics that completes the collection to his/her satisfaction.

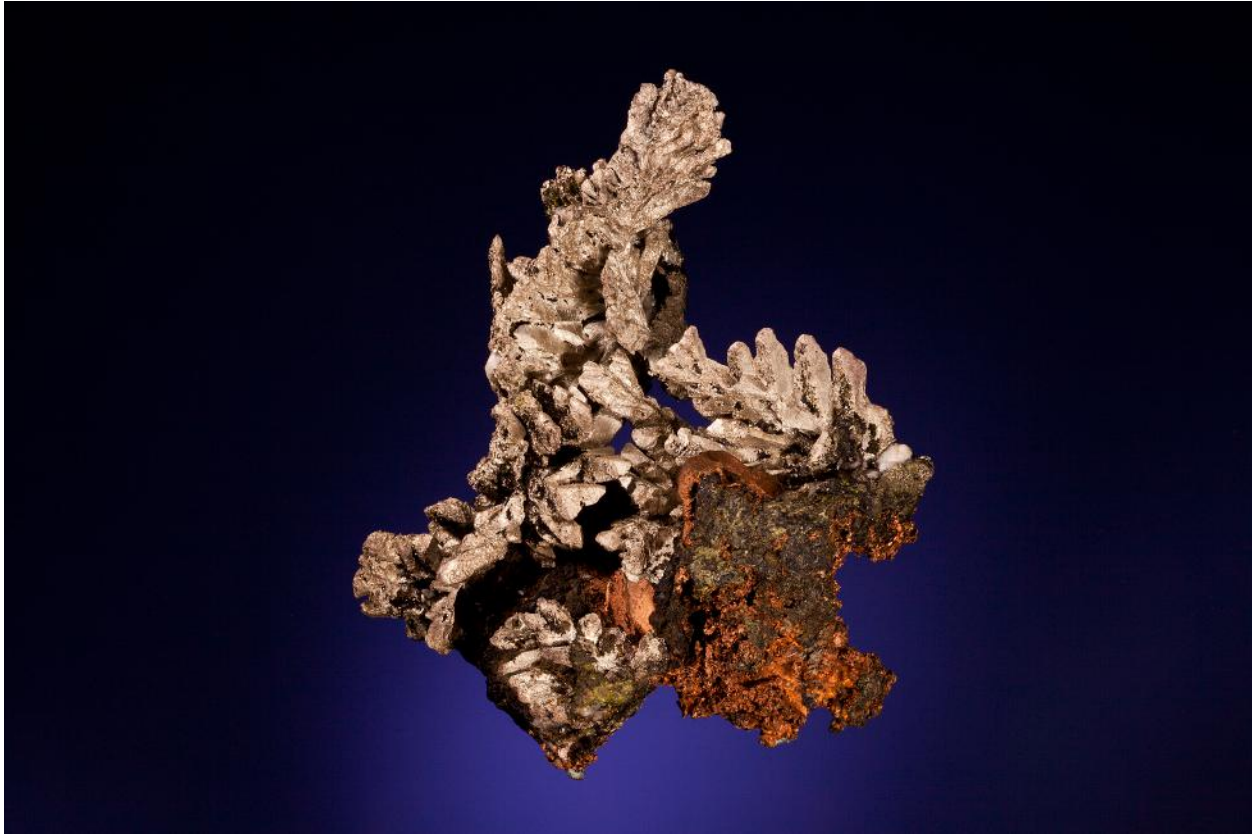
Lucius Lee Hubbard: One of the Copper Country's Greatest Mineral Collectors

Christopher J. Stefano, Houghton, Michigan

Lucius Lee Hubbard (1849-1933) was a renaissance man who built one of the most important mineral collections ever assembled from Michigan's Keweenaw Peninsula. An accomplished outdoorsman and an extraordinary geologist, he discovered the last major native copper deposit found in the Keweenaw. And above all, he was a collector who assembled a remarkable collection and made significant gifts of his specimens to the University of Michigan and to Michigan Tech's A.E. Seaman Mineral Museum.



Copper, Keweenaw Peninsula, 23 cm. Michigan Mineral Alliance specimen (UM 1674).
Christopher Stefano photo.



Silver, Cliff Mine, Keweenaw Co., Michigan - 10 cm

A.E. Seaman Mineral Museum specimen (LLH 508)

John Jaszczak and Christopher Stefano photo.

Cover Art by Susan Robinson

