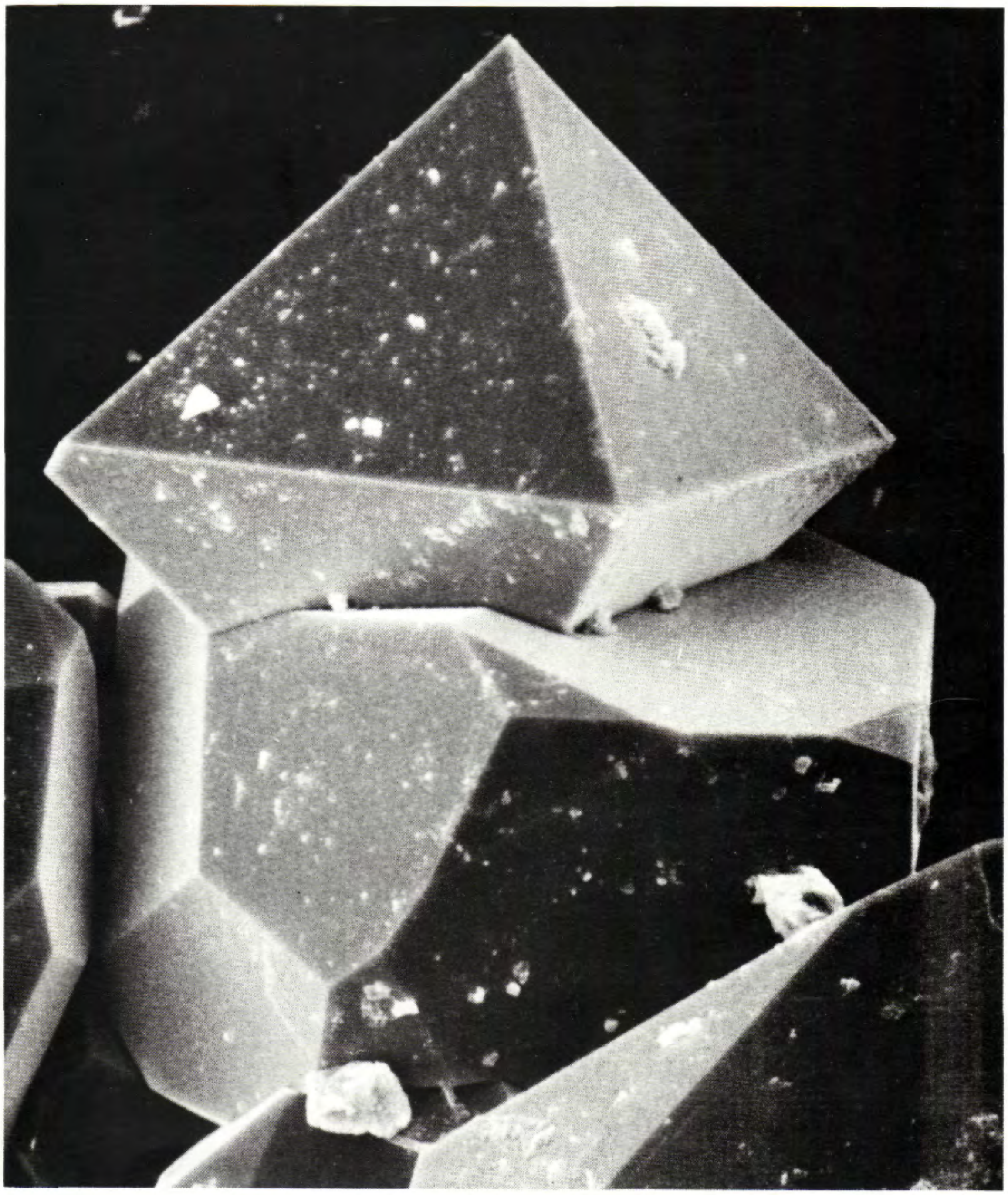
The Picking Table

JOURNAL OF THE FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY, INC.



Volume 34 Number 1 Spring/Summer 1993 $5

The Franklin-Ogdensburg Mineralogical Society, Inc.

Officers and Staff

Membership Information:

Anyone interested in the minerals, mines, or mining history of the Franklin-Ogdensburg, New Jersey area is invited to join the Franklin-Ogdensburg Mineralogical Society, Inc. Membership includes scheduled meetings, lectures and field trips; as well as a subscription to *The Picking Table*. Dues are $10 for individual and $15 for family memberships. Please make check or money order payable to **FOMS**, and send to:

Mr. John Cianciulli, Treasurer FOMS
60 Alpine Road
Sussex, NJ 07461

THE PICKING TABLE

EDITOR
Herb Yeates
P.O. Box 46
White Plains, NY 10605

The Picking Table is published twice each year, in March and September, by the Franklin-Ogdensburg Mineralogical Society, Inc. (FOMS), a non-profit organization.

The Picking Table is the official journal of the FOMS, and publishes articles of interest to the mineralogical community which pertain to the Franklin-Ogdensburg, New Jersey area.

Articles related to the minerals or mines of the district are welcome for publication in *The Picking Table*. Prospective authors should contact the editor at the address listed above for further information.

Subscription to *The Picking Table* is included with membership in the FOMS. For membership, back-issue, and information on available publications see the opposite page and the inside back cover.

The views and opinions expressed in *The Picking Table* do not necessarily reflect those of the FOMS, the editor, or the editorial board.

THE PICKING TABLE

JOURNAL OF THE FRANKLIN - OGDENSBURG MINERALOGICAL SOCIETY, INC.

VOLUME 34 NUMBER 1 SPRING/SUMMER 1993

CONTENTS

ARTICLES

COLUMNS

ABOUT THE COVER PHOTOGRAPH

Hetaerolite, fluorite. Franklin, New Jersey. SEM photomicrograph. A dark red, transparent, pseudo-octahedron of hetaerolite embedded in a colorless, transparent fluorite crystal. See next page for another photo of the same specimen. Field width approximately 0.1 mm.

From the Editor's Desk

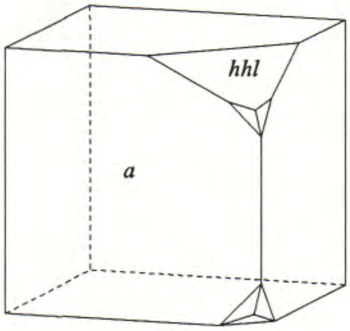
Herb Yeates
P.O. Box 46
White Plains, NY 10605

This issue completes the first year of my term as editor for *The Picking Table*. It has already been quite an interesting experience. Many thanks to those who have so generously given their time by writing articles. Interested readers owe them dearly — you would find **blank pages** otherwise. Bob, Dan, Dick, Steve, Warren and Van: Thanks! To all else: Hey, wake up out there — send manuscripts (please, do *not* send color photos; have them printed as black and white *first*) or look forward to reading air.

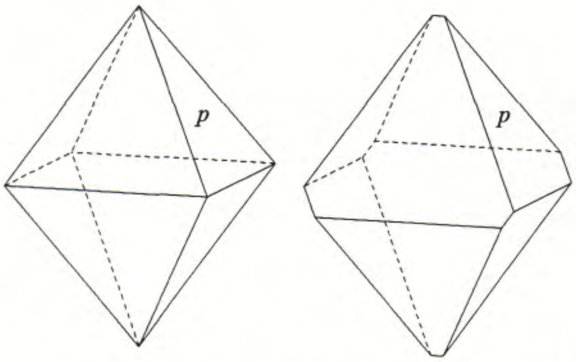
As I indicated to FOMS officers when taking this position, I will serve for a *term* and then pass the editorship on to another willing candidate. This should keep the post "fresh," and allow others to add *their* perspective to our journal. The new FOMS computer system permits much simpler (and more flexible) production than in years past, and should allow for smooth editorial transition. As you read the next few issues, consider giving the job a try yourself. Revenue from the fall show, and new, significant participation from the author pool bode well for *The Picking Table's* continued success.

ERRATUM

The "SW" fluorescent response for hodgkinsonite, as reported in *The Check list for Franklin-Sterling Hill Fluorescent Minerals*, by Richard C. Bostwick (vol. 33, number 2), is that for **long wave** — *not* shortwave ultraviolet radiation.



Fluorite. Idealized crystal drawing showing *a* {100} and *hhl*. Faces of *hhl* are shown modifying only two corners of this crystal. As in the natural crystals in the photomicrograph at right, the form is, in part, unevenly developed.



Hetaerolite. Idealized pseudo-octahedral crystal drawings showing *p* {011}. Drawing on the right depicts uneven form development, such as can be seen in natural crystals in the photomicrograph above right.

Hetaerolite, fluorite, rhodochrosite. Franklin, New Jersey. SEM photomicrograph. Minute dark red hetaerolite pseudo-octahedra (center) on pale pink, slightly curved rhombic crystals of rhodochrosite, and transparent cubic crystals of fluorite (lower right, upper left). Note the uneven development of *hhl* (modifying the corners of the cubes) on the fluorite crystals. Field width is approximately 0.3 mm.

Spring 1993 Activity Schedule

Saturday, March 20th 1993
9AM - Noon — Field Trip — Collecting at the Old Andover Iron Mine, Andover, New Jersey.
1:30 - 3:30 — Lecture — *Fluorescent minerals of Franklin and Sterling Hill*, by Richard C. Bostwick.

Saturday, April 17th 1993
9AM - Noon — Field Trip — Collecting on the Sterling Hill Museum Dump.
1:30 - 3:30 — Lecture — Speaker and subject to be announced by flyer.

Saturday and Sunday, May 1st & 2nd 1993
The 3rd Annual FOMS Swap & Sell, Sterling Hill, Ogdensburg, New Jersey.

Saturday May 15th, 1993
9AM - Noon — Field Trip — Collecting at the Buckwheat Dump, Franklin, New Jersey.
1:30 - 3:30 — Lecture — *Sterling Hill: A geological and mineralogical perspective*, by Steven C. Misiur.

Sunday May 16th 1993
9AM - 3PM — Field Trip — Collecting at the Lime Crest Quarry, Sparta, New Jersey.

Saturday, June 20th 1993
9AM - Noon — Field Trip — Collecting at the Franklin Quarry, Franklin, New Jersey.
1:30 - 3:30 — Lecture — Speaker and subject to be announced by flyer.

Scheduled activites of the Society include meetings/lecture programs and field trips. The regular meetings are held on the third Saturday of March, April, May, June, September, October and November. Business meetings follow the lecture programs listed. Field trips are generally held on the weekend of a meeting/lecture program. Unless specified otherwise, all meetings/lectures are held in Kraissl Hall of the Franklin Mineral Museum, Evans Road, Franklin, New Jersey.

Message from the President

Chester Lemanski, Jr.
309 Massachusetts Road,
Browns Mills, NJ 08015

I would like to take this opportunity to wish the family that is FOMS a very happy New Year, and to express my gratitude for the opportunity to serve as the Society's new President. We are starting a new year of activities; our 34th as a matter of fact. In that 34 years our society has served to perpetuate interest in the mineralogy of the Franklin area. Not all of those were "boom" years either. However, the FOMS persisted and continues to publish one of the finest quality journals of any equivalent society. Recent years have witnessed the reopening of the Sterling mine, a major addition to the Franklin Mineral Museum, the establishment of a museum of mining at Sterling Hill, and the addition of still more species to "the list."

As a society, our mission is far from over. Scientific work on the mineralogy of the area continues on several fronts. There has also been a renewed interest in the geology of the Franklin Marble. Finally, the improvement of both museums is a never-ending project that requires the support of all of us. This year, the fall show may have a change of location — and that circumstance alone will dictate maximum participation by everyone that can contribute time or effort.

I am looking forward to the coming year and the challenges ahead of us. I urge all of our members to participate in our activities schedule, but I also ask each of you to keep in mind that anything worth having requires work to achieve. Our field trip schedule will hopefully help our members enhance their collections with fine specimens and our speaker schedule will undoubtedly provide us with interesting and educational presentations. We owe a great deal of thanks to our committee chairpersons for their efforts to bring about these programs. We also owe a great deal to the editor of *The Picking Table*, Herb Yeates, for his acceptance of the challenge to carry on this difficult task for a term.

I urge all of our members to help us in any way that each can contribute. Articles are needed for *The Picking Table*, we need help at the spring swap and sell, there are always tasks requiring attention at both museums, and the fall show will require significant additional effort to put on this year. Help will be required for the field trips; especially the Lime Crest trip, and we can always use presenters at our meetings. I hope to see all of you at our various functions and thank all of you in advance for any support during my tenure as your President.

Local Notes

News from the Franklin Mineral Museum

John Cianciulli
Assistant to the Curator,
Franklin Mineral Museum, Inc.

NEW SCHEDULE

The Franklin Mineral Museum has a new operating schedule. We are open **seven days a week** from March 1st to December 1st. Our hours are: Monday through Saturday 10:00 A.M. to 4:00 P.M., and Sundays 12:30 P.M. to 4:30 P.M. This year, "Miners' Day" will be held on Sunday May 1. This event celebrates the important role Franklin-Sterling miners have played in the community. For more information about our schedule, or to arrange group tours call us at (201) 827-3481.

THE SHOW

The 36th annual Franklin-Sterling Gem and Mineral Show was held at the Franklin armory on the weekend of October 3rd and 4th. Sponsored by the Franklin Mineral Museum, the show was once again a great success. Attendance was up by slightly more than 10% over that of 1991. Thanks are extended to the show committee and FOMS members who helped setup and break down the show, as well as to those who provided much needed logistical support. In addition to the twenty dealers inside the armory building, the swap-and-sell held in the field behind drew over seventy dealers on Saturday and about fifty on Sunday: a new record!

The show exhibits were outstanding! Peter Chin chose to share a large part of his collection with the public this year. After the show, Mr. Chin loaned the Franklin Mineral Museum the only known wawayandaite specimen in a private collection. It is now on public view in the main exhibit hall for all to enjoy. This year's "wow" award goes to Gary Grenier. Gary hauled all but his house to Franklin from his home in Laurel, Maryland. He filled four exhibit cases with top quality Franklin-Sterling minerals and an informative photography exhibit. This year's "lunker" award goes to Mr. and Mrs. Chester Lemanski. Chet did a terrific job working his huge black willemite crystal out from its matrix. Richard Bostwick once again did a fine job pulling together choice specimens from several collections to produce one of the best exhibits of fluorescent Franklin-Sterling minerals in recent memory. Mr. John Ebner, assisted by Mr. Robert Hawkins, deserves honorable mention for his fine micromineral exhibit. All exhibitors should be commended for their support and contributions to the show.

COLLECTION NEWS

Rocks, rocks, and more rocks! The curator and his assistant have been busy processing recently donated and purchased collections. It seems that when you think you have just about everything, you find something bigger, better or different! We have recently added a number of fine specimens to the Franklin Mineral Museum's collections. From the Al Smith collection we added a very fine torreyite, and two fine "voltzites" (wurtzite mixed with an organo-metallic zinc compound), as well as a number of other excellent specimens. The Fred Howell collection provided a number of additions to both the Franklin and the worldwide mineral collections. Noteworthy Franklin specimens include a very fine pyrite crystal from the Buckwheat mine, and a drill core from the north end of the Franklin ore body which contains esperite and hardystonite. A superb aurichalcite specimen from Arizona, linarite crystals from New Mexico, as well as many other specimens were added to the museum's worldwide holdings. From Dr. Alfred Standfast's most recent mineral donations a beautiful specimen of gemmy, secondary green willemite crystals, and a specimen containing a pocket of pink datolite crystals with an unusual sphere of calcite (4 cm), were added to the collection. Will Shulman's collection, part of which was donated to the Franklin Mineral Museum by his widow Gerry Shulman, provided some representative worldwide specimens. The most noteworthy addition from the Shulman collection is a specimen of eosphorite crystals. Many fine specimens not retained for the museum's collections are available for purchase in the museum gift shop.

A significant donation was received from Dr. Alfred Standfast recently. Dr. Standfast, who is widely recognized for his mineral photography, donated all of his Franklin-Sterling Hill related photographs to the museum archives. This includes his infamous "rogue" collection of photographs. The "rogue" file is a pictorial history of friends of Franklin which goes back fifty years or more.

A room dedicated to the controlled storage of historical documents is being set up at the museum. This archive room will serve as a secure repository for the many records, maps and photographs the museum has in its files. Efforts are being made to clear the new archive room of minerals, so we can get back on track with the task of installing our holdings in this central location. We are very excited about improving the museum's archive, and expect to make major progress with this project during 1993.

Finally, we will be exchanging mineral exhibits with the Rutgers University Geology Museum. The new exhibit will be featured at their annual open house. A Franklin-Sterling geology exhibit is being discussed as a possible addition to the thematic exhibits presently offered at the Franklin Mineral Museum.

NEW COLLECTING MATERIAL FOR THE BUCKWHEAT DUMP

Recently, the Phillips family donated to the Franklin Mineral Museum — and delivered to the Buckwheat dump — an estimated one million pounds of minerals from their property on Buckwheat Road in Franklin. This material is believed to be waste rock derived from the sinking of the Taylor shaft, prior to the development of what is now known as the Buckwheat open pit. Some interesting finds have already been made in this new "mountain of minerals." Fluorescent microcline has been found, as well as large grains of scheelite, allanite crystals, rhodonite, garnet crystals, sphene, and good fluorescent "lean" ore. The museum may get more of this material in the future. Unfortunately there is a "down" side to this story; unidentified (for the moment) collectors have been unlawfully removing carloads of this material directly from the Phillips property. Collecting of this "new" Franklin material will be available to all this spring on the Buckwheat dump when the museum reopens. The Franklin Mineral Museum greatly appreciates the generosity of the Phillips family.

Suggestions for improving museum exhibits and operations are always welcome. Drop in and see us!

News from Sterling Hill

Gary Grenier
Editor, the *Sterling Hill News Letter*

Many significant events have occurred at Sterling Hill since my last report. By the time you read this, the rising water in the mine will have claimed all of the mine's underground working levels. On December 12 1992, Richard and Robert Hauck, Bernie Kozykowski, Rich Luzzi and Steve Misiur descended underground for the last time. With the water level steadily rising in the mine, the Haucks closed the bulkhead doors on the 180' level, removed "last to come up specimens," and prepared to leave the underground working levels. As a message for the future - and a token of the hope to return, a time capsule was placed in the south bulkhead door. Fortunately, Dr. Robert E. Jenkins II and Sterling Hill Museum curator Steve Misiur have mapped and sampled the working areas that previously had never been mapped or sampled and are now submerged. Most notably and recently mapped include the 180' level exposures of the Mud Zone, East Limb, West Limb, and portions of the Crossmember and Keel. Another significant area which was mapped is an inclined tunnel called the "Gravity Tram." This tunnel is situated roughly east-west and crosscuts part of the East Limb and Crossmember, providing a view into the stratigraphy of the upper levels of the mine. Sampling conducted in the Gravity Tram area yielded several discoveries. One involved an assemblage containing uraninite and powellite in a matrix of hedenbergite, quartz, calcite and molybdenite. Rosettes of graphite in a matrix of hedenbergite and pyrrhotite were also found in the Gravity Tram area. Other assemblages not yet been studied have been preserved, and will be described in the future, as will many other research projects which are still in progress.

One such research project conducted by Dr. Jenkins will soon be published in the *Mineralogical Record*. The study is of the 770' area (70' down from the 700' level) nicknamed the "Chalcopyrite Room," in which some 50 species have been identified including two which are new to the deposit. Another project is a study conducted by Dr. Earl Verbeek of the U.S.G.S of the fracture systems in the Sterling mine.

Other work underway includes a study of a wollastonite occurrence by University of Delaware graduate student Anna Moore, and a petrographic study by Dr. Jeff Steiner of City College CUNY and Herb Yeates. Sterling Hill will continue to be the focus of research projects thanks in large part to the tremendous volunteer efforts of those who assisted in the systematic recovery and storage of specimens.

On Saturday October 3rd 1992, President Richard Hauck saluted and thanked the many Directors and Founding members by hosting a reception. Vice President Bernie Kozykowski, acting as master of ceremonies, introduced board member Wasco Hadowanetz who organized the honoring reception. Wasco read proclamations from state and local legislators and turned the floor over to President Hauck, who then unveiled the permanent display plaques carrying all of the Directors, Founding members and volunteer's names. The plaques are now on display in the Sterling Hill Mining Museum.

Yet another event occurred on Monday November 9, 1992 when the American Zinc Association (AZA) held their annual meeting at Sterling Hill. As part of the program, director Frank Talbot of the National Museum of Natural History, Smithsonian Institution was in attendance and presented the floor plan for the new "Hall of Geology, Gems and Minerals," in which some six tons of Sterling Hill ore minerals will be displayed. AZA exhibits used during the Society of Automotive Engineers annual show in Detroit were placed on loan to Sterling Hill. The exhibit included a large audio-visual cabinet that was placed in the old lamp room. The lamp room was cleaned out and turned into a theater. The videotape supplied by the AZA described the many uses of zinc which we often take for granted everyday.

As planned, the first night-collecting on the Sterling Hill dumps occurred in early November. The dump was literally "crawling" with over 50 collectors. Armed with ultraviolet lamps, they caused just about everything to fluoresce, found plenty to bring home, and reminisced about the Franklin Buckwheat Dump and Mill site. Over 1,500 pounds of choice fluorescent mineral specimens were collected, and everyone had a really good time!

The Sterling Hill Foundation continues to acquire and achieve significant written and photographic materials relevant to the lengthy history of Sterling Hill. The Harry Senchuck photo and negative collection is an important recent addition to the Sterling Hill archives. Included in the collection are 4x5 format underground photos, and hundreds of original negatives spanning the period of roughly 1890 to 1960. This collection is of immense value to anyone studying the mining methods and conditions during those periods, and adds substantially to the growing archives at Sterling Hill.

The Foundation is concentrating on improving the museum's displays, with many new items and display arrangements being planned for completion in the off season. If you visited the museum in 1992, there will be something new for you to see in '93!

SPANGOLITE FROM THE STERLING MINE, OGDENSBURG, NEW JERSEY

Robert E. Jenkins II
Chemicals Department
E.I. DuPont de Nemours & Company
Wilmington, Delaware
19898

INTRODUCTION

Spangolite, $Cu_6^{+2}Al(SO_4)(OH)_{12}Cl \cdot 3H_2O$, is a relatively rare mineral, which has been reported in small amounts from the oxidized zones of a number of base-metal deposits, particularly those rich in copper, of the western United States, Cornwall, and elsewhere (*e.g.* Palache *et al.*, 1951). This paper concerns a new occurrence of spangolite from a most unusual location: the Sterling mine at Ogdensburg, New Jersey. It also constitutes the first report of the mineral for this prolific locality.

Spangolite. together with other copper and lead minerals, has been found in a small, partially oxidized sulfide pod in ore near the footwall contact of the East Limb of the zinc orebody, on the south wall of the 740 crosscut, 800 level, at approximate mine coordinates 730N, 960W. About 25 kilograms of material was collected by personnel of the Sterling Hill Mining Museum in 1990, and spangolite was confirmed on two specimens. The collecting site is now flooded.

GEOLOGY

The author was never fortunate enough to visit the spangolite locality, and the following brief geologic description is credited to Mr. Steven C. Misiur. The occurrence lies about 2 m east of the footwall contact of the East Limb of the zinc deposit and about 40 m north of the orebody keel. It is entirely enclosed within medium to coarse grained, granular calcite-franklinite ore containing minor andradite but no willemite. Near the ceiling of the crosscut along the south wall, vugs are present in the ore where calcite has been leached. Porous zones form ellipsoidal, goethite-stained masses, their long axes oriented near vertical, but tilted slightly to the south and reaching a maximum dimension of 60 cm. In one of these zones, brightly colored, oxidized copper and lead minerals, including spangolite, line cavities and coat fractures. Oxidized Cu-Pb species are associated with sparse primary sulfides, replacing calcite in ore. Chalcopyrite and galena are the most abundant primary sulfides. Pyrite is minor and sphalerite rare.

MINERALOGY

General mineralogy of the spangolite locality is shown in the accompanying table. All species were confirmed by X-ray powder photography using a 114 mm Gandolfi camera, or by X-ray bulk diffractogram, both on a modified Philips automated X-ray diffractometer with DEC Vax II hardware control. All species were also studied by SEM-EDS methods, using a JEOL JSM-840 scanning electron microscope (SEM) or a JEOL JXA-35 electron probe microanalyzer, both equipped with Kevex EDS (energy dispersive spectra) detector. Semiquantitative chemical analyses, reported as atomic ratios, for spangolite were performed with the microprobe, using the Tracor "SQ" program and DEC PDP-11/73 hardware. Only five specimens from the assemblage were studied. These are referenced as follows: ST-series, reference collection of the Sterling Hill Mining Museum; J-series, personal collection of the author. Selected species are described below.

GENERAL MINERALOGY OF THE SPANGOLITE LOCALITY

Ore	Primary sulfides	Oxidized assemblage
Andradite	Chalcopyrite	Anglesite
Calcite	Galena	Aurichalcite
Franklinite	Pyrite	Barite
	Sphalerite	Brochantite
		Calcite
		Covellite
		Devilline
		Friedelite
		Goethite
		Gypsum
		Linarite
		Malachite
		Spangolite

Anglesite $PbSO_4$

Anglesite was noted on only one specimen, ST800-740-1. It is present as attractive, doubly terminated prisms, averaging about 20 µm in length, which form continuous white crusts covering several mm² (Figure 1) on linarite or etched galena.

Aurichalcite $(Zn,Cu^{+2})_5(CO_3)_2(OH)_6$

This species is present in relative abundance on specimen ST800-740-3. It occurs as typical, pale blue-green fibers and rosettes, the latter averaging about 1.5 mm in diameter. These were deposited on etched secondary calcite, which coats a fracture surface, and on the surfaces of leach cavities in ore.

Brochantite $Cu_4^{+2}(SO_4)(OH)_6$

Brochantite is common in the assemblage as bright emerald green crusts on devilline and friedelite in leach cavities in ore. The mineral is less abundantly associated with linarite and spangolite. Brochantite crusts form bundles of crystals or less commonly, radiating groups (Figure 2) with individual prisms averaging about 0.2 mm in length. Patches of brochantite cover areas up to 1 cm² and are easily visible to the naked eye.

Covellite CuS

Covellite was observed on specimens ST800-740-1 and J9087 as fans of dark, metallic blue plates with individuals averaging about 2 mm in maximum dimension. Covellite fans were deposited on the surfaces of leach cavities in ore. Malachite partially coats the covellite and may in part replace it.

Devilline $CaCu_4^{+2}(SO_4)_2(OH)_6 \cdot 3H_2O$

Devilline is present on several hand specimens but is most abundant on J9087. It occurs as attractive pale blue coatings on friedelite, commonly with brochantite rosettes perched on top of devilline. SEM magnification resolves devilline coatings into jackstraw to radiating to parallel aggregates of crystal blades, with individuals averaging about 40 µm in length.

Friedelite $Mn_8^{+2}Si_6O_{15}(OH,Cl)_{10}$

Friedelite is the most abundant oxidized mineral in the assemblage and is easily visible to the naked eye. It is present as yellow to yellow-brown to orange crystal crusts on leach cavities in ore and in microfractures. Devilline, brochantite, and spangolite were deposited on the friedelite. SEM magnification resolves friedelite crusts into aggregates of simple hexagonal plates, trigonal prisms, or lacy bunches of indistinct habit. An example of an interesting friedelite aggregate is shown in Figure 3.

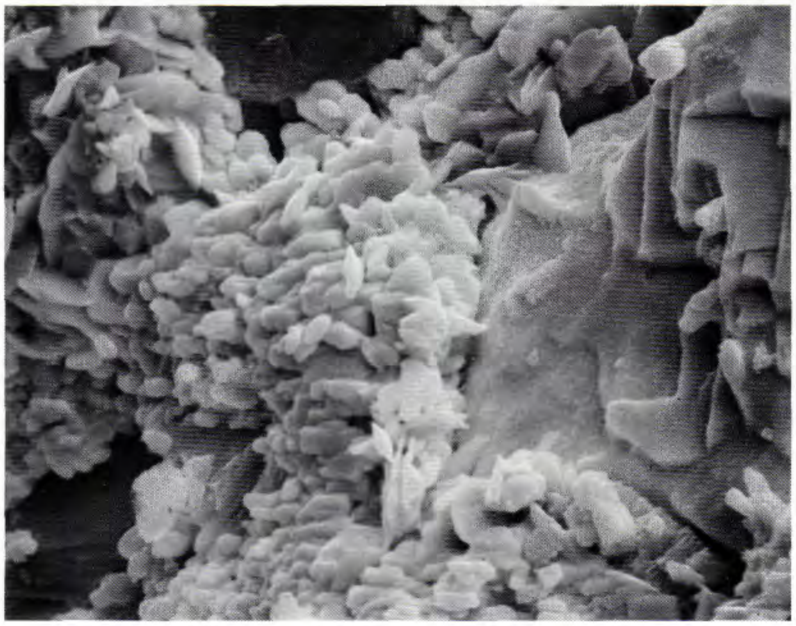


Figure 1. Coating of anglesite prisms on linarite and etched galena, Secondary Electron (SE) photograph, specimen ST800-740-1, field width ~50 microns.

Linarite $PbCu^{+2}(SO_4)(OH)_2$

This copper lead sulfate mineral was noted as typical deep blue, lustrous blades, averaging about 0.2 mm in length on three specimens. It is associated with brochantite or with anglesite and etched galena. Linarite is present in only small amount, and it must be regarded as a rare component of the paragenesis.

Spangolite $Cu_6^{+2}Al(SO_4)(OH)_{12}Cl \cdot 3H_2O$

This species, new to the Franklin-Sterling district, was confirmed on two specimens, ST800-740-4 and J9087. It is present as aggregates of hexagonal plates (Figures 4, 5) or trigonal prisms, with individuals averaging about 30 µm in maximum dimension. The mineral is intimately associated with brochantite. A few of the spangolite aggregates are large enough to be visible to the naked eye, but they are bright green, very similar in color to the brochantite with which they are associated. With spangolite plates attached to matrix by their edges they are megascopically

Figure 2. Radiating group of brochantite prisms with minor fibrous malachite, SE photograph, specimen J9087, field width ~70 microns.

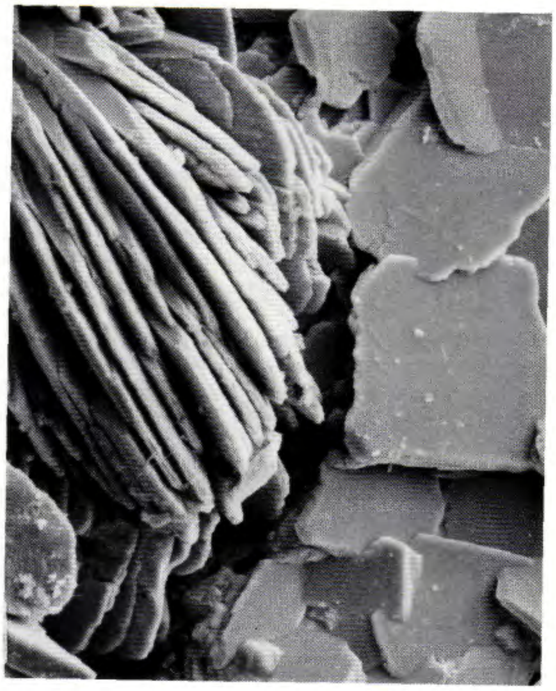


Figure 3. Aggregate of crude hexagonal plates of friedelite with brochantite prisms at left, SE photograph, specimen ST800-740-4, field width ~70 microns.

Figure 4. Brochantite groups and parallel spangolite aggregate (upper right-center) on goethite, SE photograph, specimen J9087, field width ~100 microns.

indistinguishable from prismatic brochantite. X-ray diffraction and SEM-EDS study are the only certain means of distinguishing between the two minerals. Structurally and chemically, spangolite bears close resemblance to the species namuwite, ramsbeckite, and schulenbergite. X-ray data for Sterling spangolite are however, in excellent agreement with those reported for the mineral by Frondel (1949). Furthermore, semiquantitative chemical analysis of Sterling spangolite yields atomic ratios Cu:Al:S:Cl = 5.8:1.2:1.1:0.9, with no Zn detected in 200 second counting time (calculated based on 7 cations, average of 4 analyses). Related species contain essential Zn and no Cl.

DISCUSSION

Although it is considerably less complex, the mineral assemblage at the spangolite locality is similar to that reported by Jenkins and Misiur (in press) from the south opening of the 1250 stope, about 150 m to the north along the hanging wall of the East Limb. Relative simplicity of the assemblage is manifested mostly by the absence of an extensive suite of secondary sulfide minerals, which is present in 1250 stope. This may reflect the absence of supergene alteration effects at the spangolite site; but whether the apparent lack is an artifact of the small number of specimens examined from the spangolite location, or instead is related to local fracture structure or other plumbing system, is unknown.

Another significant difference between the two assemblages is the relative abundance of galena at the spangolite locality. This would appear to explain the presence of minerals like linarite and anglesite among the products of oxidation. Linarite has not been found in the 1250 stope.

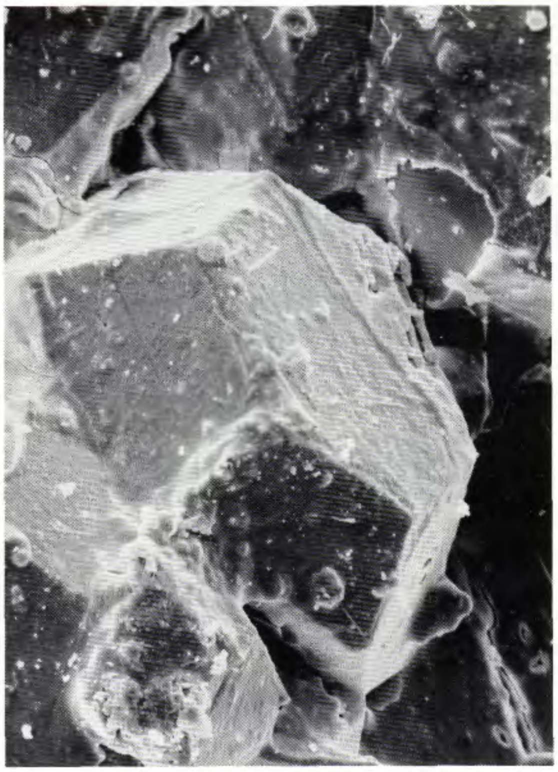


Figure 5. Detail of truncated pyramid of spangolite, SE photograph, specimen J9087, field width ~120 microns.

A brochantite-devilline-linarite association with friedelite and similar garnet-bearing ore matrix was first reported from Sterling Hill by Cook (1972, 1973). The provenance for the single specimen mentioned (Harvard Collection, #109646) was described as adjacent to the Mud Zone on an unspecified level, which would place it at least 120 feet above 800 level. If spangolite is an intrinsic component of this association, it is possible that spangolite specimens from other Sterling Hill locations exist in systematic Franklin-Sterling collections, both public and private.

ACKNOWLEDGMENTS

The author wishes to thank both the Sterling Hill Mining Museum and E.I. DuPont de Nemours & Company for permission to publish these results. He particularly acknowledges DuPont personnel, Chip Michel, Ellen Ervin, Ulrich Klabunde, and Richard Harlow for access to instruments and assistance in their use, also Wallace L. Kremer for management support. He is grateful to Pete J. Dunn and Earl Verbeek for their thorough critiques of the manuscript. He also wishes to thank Gary Grenier for the optical photography and Nadir L. Jenkins for preparation of the final typescript.

REFERENCES

Cook, D.K. (1972) Brochantite/devillite[*sic*]/linarite, *in* Franklin mineral notes, *The Picking Table*, **13**, 1, p. 7.

Cook, D.K. (1973) Recent work on the minerals of Franklin and Sterling Hill, New Jersey. *Mineralogical Record*, **4**, 62-66.

Frondel, C., (1949) Crystallography of spangolite. *American Mineralogist*, **34**, 181-187.

Jenkins, R.E. and Misiur, S.C. [in press] A complex basemetal assemblage from the Sterling mine, New Jersey. *Mineralogical Record.*

Palache, C., Berman, H., and Frondel, C. (1951) The System of Mineralogy, vol. 2 (7th ed), 1124 p. John Wiley and Sons, New York.

The Flinkite / Cahnite / Jarosewichite Assemblage from Franklin, New Jersey

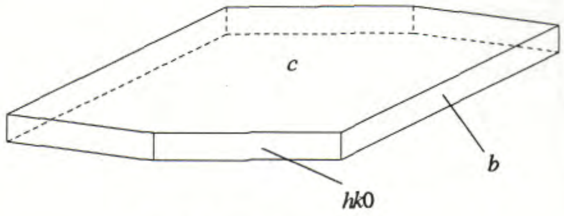
Vandall T. King
P.O. Box 90888,
Rochester, N.Y. 14609

Flinkite has been found at the Franklin mine, Franklin only once. The matrix consists of coarse-grained anhedral franklinite/jacobsite (to 1 cm+) intergrown with generally anhedral, turbid olive-green andradite in which are found small solution cavities in which flinkite occurs associated with cahnite, jarosewichite, allactite, hausmannite, friedelite, calcite, and two unknown minerals. The flinkite was first identified by Dave Cook (1973) and the assemblage was studied by Dunn *et al.* (1982). The turbid, olive-green andradite was observed to show a few crystal faces (to 2 mm) where the etching action which produced the vugs exposed some of the andradite.

Flinkite consists of lustrous, olive-green rosettes and bow-tie aggregates of rectangular plates (generally 1 mm). The large surface of the flinkite plates is pearly in luster and might be described as bronzy because of its olive-green body color. The edges of the rosettes are lustrous and superficially resemble the edges of tiny mica books. Generally the rosettes are closely sprinkled in the vugs, but retain an individual character and do not significantly overlap. When *not* appreciably intergrown in rosette form, flinkite can be found in six-sided plates which are

Flinkite. Rosettes and bow-tie aggregates of crystals.

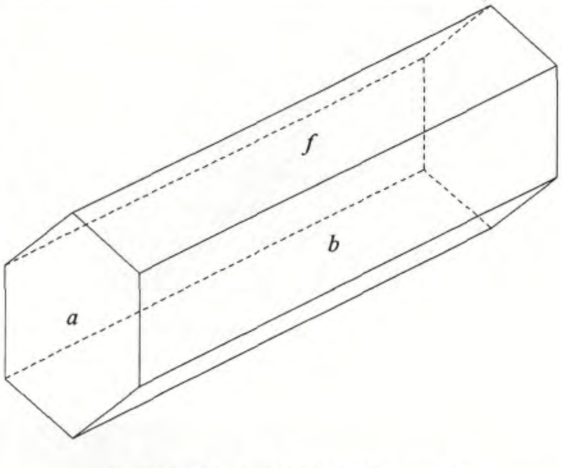
*Crystal forms noted in this paper were determined through visual inspection of specimens, and comparison with published morphological data and computer-generated crystal drawings.



Flinkite. Idealized crystal drawing.

more rectangular than pseudohexagonal. Flinkite appears younger than all associated species except for jarosewichite.

Jarosewichite is among the rarest of the Franklin arsenates. It is known with certainty in only several micro-specimens other than those preserved in museums. Jarosewichite is very dark red with some hint of brown and, at first, can appear to be black. The specimens are very lustrous along the elongated pinacoid and dome faces, *b* {010} and *f* {021},* and are somewhat "warty" to dull or waxy on the *a* {100} pinacoid face. The elongated crystals are very slightly undulatory on *b* and are often grouped in almost parallel bundles which show some curvature. A few dull, radially splayed "botryoids" (to 4 mm) of jarosewichite,



Jarosewichite. Idealized crystal drawing.

with *a* as the major exposed form, occur. Jarosewichite invariably rests on flinkite or cahnite.

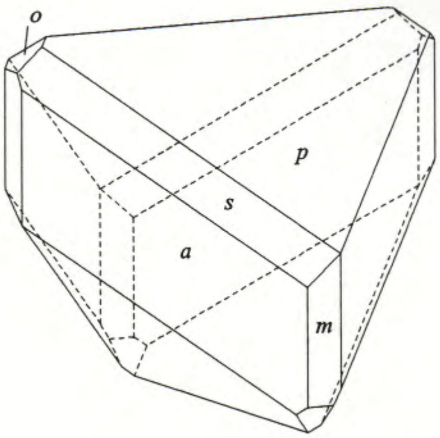
Cahnite is intimately associated with flinkite and appears as its substrate in many cases. In this assemblage it has several appearances. Cahnite, as a substrate directly associated with flinkite or jarosewichite, is frequently cloudy to milky white. Where it is transparent with a bright vitreous luster, the associated andradite of the matrix is bright green and, though microbrecciated, is clear and some small portions (to 1 mm+) of the microbrecciated grains are gemmy. The transparent

Jarosewichite on cahnite. Jarosewichite prisms are aligned upper-left/lower-right in photo; below and left of center.

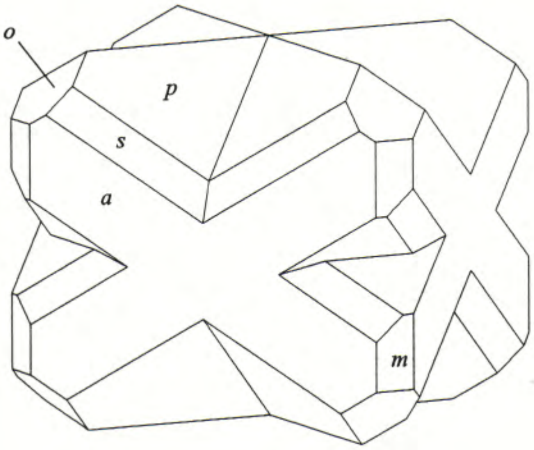
cahnite crystals (to 2 mm) superficially resemble complex and distorted octahedral crystals. Twinning is uncommon in the transparent cahnite. Gemmy cahnite is found on lustrous pseudo-octahedral hausmannite crystals. The flinkite assemblage appears to have been subjected to selective exposure to a solution which etched the cahnite and hausmannite, but did not affect the later flinkite and jarosewichite. In some cases, transparent cahnite twins with slightly etched *p* {111} and *a* {100} and unaffected *s* {311} are found in association with hausmannite crystals which have a bronzy, almost sooty appearance. It is appropriate to note that the cloudy white intracrystalline material between transparent cahnite and bright hausmannite very much resembles a "sand," and it seems that some etching of cahnite has been severe. The more etched cahnite is frequently twinned. Close examination of one specimen revealed that the transparent cahnite crystals were overgrown on etched cloudy cahnite crystals. Additionally, some small dull grains of hausmannite are found in the "sandy" intracrystalline material.

The surface of cahnite appears frosted with a satiny to matte surface. Some crystals show etched furrows which wend into *p* {111}, and form a minuscule "cul-de-sac." Cahnite crystal edges appear very slightly overgrown, or the center of {111} faces seem uniformly etched. A few hopper-shaped growth faces have been observed. A thin light brown clayey film can be found coating some of the cahnite, and the film may be responsible for some of the sootiness of the hausmannite.

A peculiar feature seen only in the cahnite with the clayey film is an offset parallel growth of crystals (to 5 mm), without

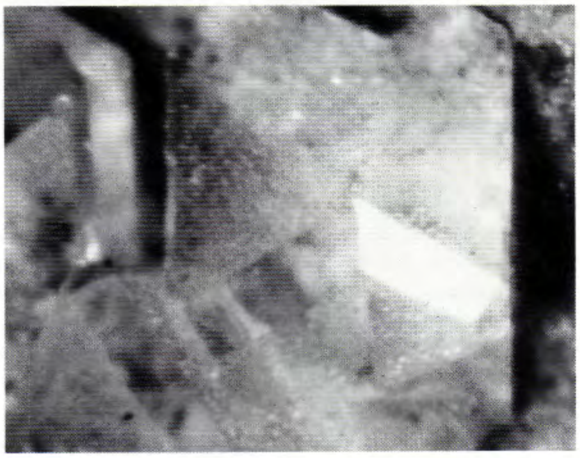


Cahnite. Idealized crystal drawing.

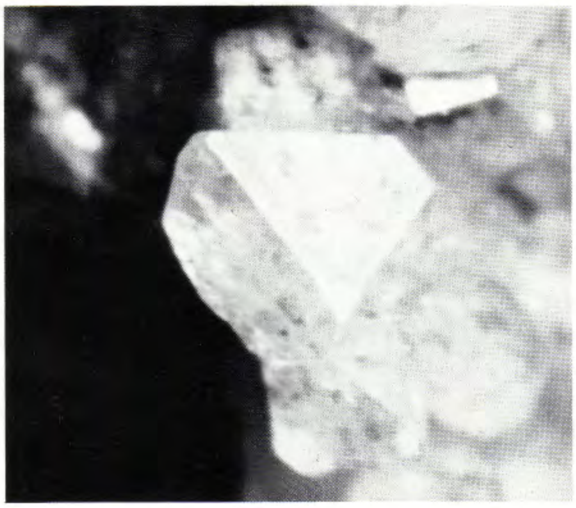


Cahnite twin. Idealized crystal drawing.

Cahnite. Single crystal.



Cahnite. Etched twin crystal.



Cahnite. Single crystal.

Cahnite. Etched twin crystal.

twinning, with "slots" formed where the parallel growth crystals are not in-filled at the intersections of *s* and *p*. Flinkite sometimes appears to be preferentially grown within the slots.

Hausmannite associated with the flinkite assemblage is beautiful for the species. Simple, pseudo-octahedral, lustrous, nearly black, hausmannite crystals (to 2 mm), with red internal reflections, are found with transparent cahnite. Though generally simple in habit the hausmannite can be overgrown by small triangular to polygonal "islands"; slightly skeletal with stepped, hopper growth, or multiply terminated on one terminal apex. Hausmannite associated with slightly etched cahnites can occur in flattened spherical clusters which show small areas of parallel-growth organization among randomly grouped hausmannites. A bronzy tarnish is seen on many specimens and a sooty film (perhaps the same light brown clayey material seen on the cahnites?) is sometimes present. Some of the bronzy hausmannite crystals are flattened and look pseudo-hexagonal. Thin veinlets of hausmannite are occasionally seen extending into the micro-brecciated andradite.

Friedelite usually forms a carpet which lines the cavities. Friedelite varies from tan through brown, and in a few instances appears orange-red in a color zone atop tan friedelite or individually implanted on fine-grained friedelite. Dunn *et al.* (1982) indicated that the material is in the "friedelite group." Much incipient alteration, evidenced by the etching and dissolution phenomena seen on the surfaces of the other minerals of the assemblage, may have affected some of this friedelite as well. The minute friedelite crystals (generally less than 0.25 mm) show a tapering trigonal development with a flat termination on the "wide" end facing the vug interior. Fine-grained masses seem granular rather than waxy.

Some of the bright red-orange, minute crystal clusters (to 0.25 mm) on the tan friedelite appear to be **allactite**. The clusters are so minute that the intersections of tightly intergrown, striated, crystals are the only details seen, and the clusters are irregular to serrated on the edges. Transparent, tan to colorless, irregularly color zoned, steeply scalenohedral **calcite** crystals (to 0.75 mm) were seen on friedelite. The calcite was not discernibly fluorescent.

Two unidentified minerals are found with the flinkite assemblage. One is bright yellow, not unlike cacoxenite, but lacking the peculiar silky luster of cacoxenite. The sprays (to 1 mm) occur as small splintery branch-like microcrystals whose straight-line character is most reminiscent of uranophane as found at the Madawaska mine near Bancroft, Ontario, Canada. The mineral is inconspicuous and rarely is there more than one spray evident in a microscopic field of view. Additionally, a brown to black acicular (about 0.1 - 0.2 mm) mineral is found on the friedelite. The needles may be individually grouped, matted with right-angle fabric, or free-standing with an open right-angle "girder" appearance.

Spray of yellow unidentified mineral.

REFERENCES

Cook, David K. (1973) Recent Work on the Minerals of Franklin and Sterling Hill, New Jersey, *The Mineralogical Record*, **4**, 62-66.

Dunn, Pete J.; Peacor, Donald R.; Leavens, Peter B.; and Simmons, William B. (1982) Jarosewichite and a Related Phase: Basic Manganese Arsenates of the Chlorophoenicite Group from Franklin, New Jersey, *American Mineralogist*, **67**, 1043-1047.

A Mississippi Valley Type Lead-Zinc Vein of Probable Paleozoic Age at the Lime Crest Quarry Sparta, New Jersey

Warren Cummings
1191 Parkside Avenue
Ewing, NJ 08618

Several years ago, on these pages, I wrote on the origin of the Buckwheat dolomite. I presented a case for the Buckwheat dolomite, and the attendant secondary cavity minerals, being a Paleozoic-age feature whose genesis is closely related to both Mississippi Valley-type (MVT) lead-zinc and alpine cleft -type mineral deposits. I noted that examples of MVT, alpine cleft and various hybrid types of mineral assemblages are widespread in northwestern New Jersey and adjacent regions, especially along the northwestern margin of the Reading Prong.

During the FOMS field trip to the Limestone Products quarry in Sparta on May 17th 1992, Ed Wilk and I were invited by Mr. Carroll Laufmann, of Limestone Products, to inspect a sulfide occurrence. The site we visited was on the upper levels of the pit's southeastern side, directly across the pit from the primary crusher. In this area of the quarry, beyond that open to normal collecting, was a large pile of shot rock that contained the best examples of MVT mineral assemblages that I've seen in the Franklin area.

At this site, 25-50 feet beneath the Cork Hill gneiss, the MVT minerals were localized in a fault. Observation of the broken quarry muck and of nearby outcrops indicate that the mineral-bearing structure strikes approximately N60°E and dips approximately 85°E. The fissure has sharp contacts with the country rock, locally exceeds 1 meter in width, and is filled mainly by carbonates. Adjacent to the country rock is a 15 - 20 cm thick layer of grained, gray dolomite (Fig. 1; lB). The gray dolomite looks homogeneous and almost flinty from a distance, but closer inspection reveals a sugary texture and a faint layering parallel to the vein walls. Locally the gray dolomite contains numerous rounded fragments of siliceous rocks unlike the vein's wallrock in the present outcrop. These fragments include skarn, pegmatite and gneiss (Fig. 1; 5) similar to some phases of the Cork Hill gneiss. Many of the fragments had to move, within the fissure, at least 10 meters to arrive at their present location.

The inner side of the gray dolomite band is the most distinctly layered and is coarsely colloform. The colloform spheroids, typically 7-15 cm across, form a continuous succession giving an appearance reminiscent of a stromatolite layer. Following the gray dolomite, and occupying the central zone of the vein, is coarse-grained calcite that where massive mimics the Franklin Marble. This calcite contains local concentrations of coarsely crystalline pyrite, very minor galena, barite and fluorite. Most such concentrations are rich in either pyrite or fluorite but not both. Barite occurs abundantly with both.

Crystals of calcite, fluorite and barite frequently have edges or lengths of 3 to 4 cm while individual pyrite crystals are generally less than 2 cm across. Scattered vugs were found in the central part of the vein but tend to be small, 7 or 8 cm in maximum dimension. Although several free standing fluorite crystals 3 to 4 cm on edge were seen they were closely associated with barite in brittle, fragile groupings. All were in varying degrees of disrepair and none were recovered in an aesthetically pleasing condition.

Pyrite crystals in vugs are mostly overgrown by crude barite blades and minor calcite. Pyrite crystals are dominantly cubic and occur exclusively in distorted, curved groups. That the principal sulfide is pyrite rather than chalcopyrite is typical of MVT environments. Because copper chloride complexes are much less stable than those of lead and zinc in the presence of reduced sulfur, and MVT minerals are typically transported to the deposition site by reduced hydrothermal fluids, chalcopyrite is never more than a minor mineral in MVT assemblages and is often absent.

In the material exposed on May 17th both sphalerite and galena are minor phases found in small, scattered grains. No free standing crystals of either mineral were seen in the vugs. Although galena had never been found in significant amounts in the Lime Crest quarry, sphalerite has been locally abundant in other MVT mineralized structures at this locality.

On October 18th the FOMS again visited the Lime Crest quarry. In the intervening five months the area of the quarry containing the MVT minerals had been blasted again. With the permission of Limestone Products, this area was examined by Ed Wilk, Chet Lemanski and myself. As in the spring, the mineralized segment of the structure was not seen in place, but only in broken material in the muck pile. The distribution of the MVT minerals, both in large boulders and overall in the muck, suggests that the vein or veins widened northward, along strike, to a zone as much as several meters across, where it is truncated by a crosscutting fault. The crosscutting fault is a wide, deeply weathered structure that forms a conspicuous "mud zone" in the east wall of the pit.

At the southern end (the toe) of the muck pile as it existed on October 18th were numerous fragments of pyrite-barite-calcite- rich material similar to that seen in May. Following the muck pile northward the outer part of the vein — the flinty dolomite — continued but the mineral assemblage in the vein center quickly changed. There, the vein width probably exceeded 1 meter. The central portion was at least 1/2 meter thick, and contained brecciated dolomite cemented by masses of fluorite, with subordinate barite and varying amounts of sphalerite, galena and calcite. Because the area of this occurrence was beyond the bounds of normal collecting, Limestone Products generously hauled several truckloads of the muck down to an accessible area. This material abounded in excellent examples of the minerals from this occurrence, and hundreds of pounds were collected.

Unlike the pyrite-barite material seen in May, the October fluorite-sulfide rock was virtually devoid of open pockets. Fluorite ranged in color from purple through bluish- or greenish gray, blue-green to colorless. Although some color banding was seen, especially in the colorless to white variety, there did not appear to be any systematic color trend within the vein. Barite was present sporadically as bladed crystals and fan-like groups of crystals embedded in fluorite. Local masses up to 10 cm across were seen.

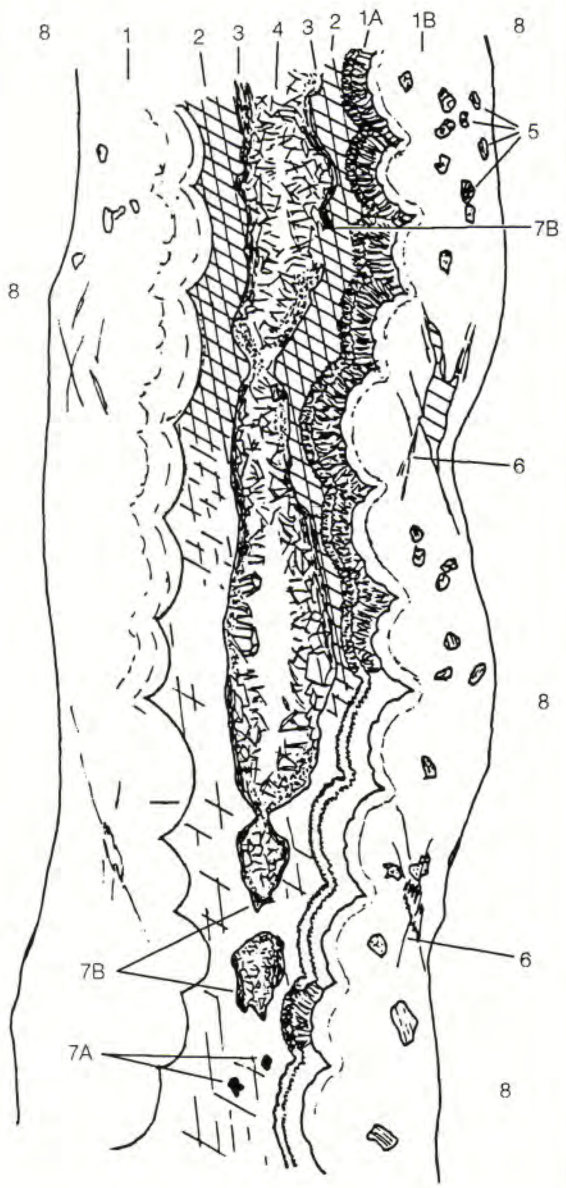


Figure 1. Cross-sectional composite sketch, based on several large, adjacent fragments of pyrite- and barite-rich portion of the vein: (IA), layered, coarsely crystalline dolomite; (IB), gray, flinty dolomite vaguely banded near the inner margin; (2), massive, coarsely crystalline calcite; (3), massive, fine-grained pyrite and/or barite; (4), euhedral pyrite, barite and calcite in vuggy areas; (5), rock fragments dissimilar to vein wall rock; (6), calcite-sphalerite in gash veins; (7A), isolated, coarsely crystalline galena; (7B), fine-grained galena embedded in pyrite; (8), Franklin Marble.

Sphalerite, mostly of slightly brownish yellow color, was very abundant. It occurred both as scattered, anhedral grains in fluorite and barite and as masses, some more than 10 cm across.

Galena was locally abundant and appears to be the last major mineral to have been deposited. Although galena occurs as massive or semi-massive clots within the fluorite-barite-sphalerite matrix, it is most abundant in a network of later fractures that crosscut all the other vein minerals, including the dolomite near the wall rock. Many specimens initially appear very rich in galena, but closer inspection reveals a relatively thin layer of the mineral; breakage having occurred preferentially along the galena-filled veinlets.

Calcite, a common to abundant mineral in the central part of the vein in much of the material seen in May, was minor and inconspicuous in much of the fluorite-rich rock seen in October. Pyrite, locally abundant in May, was also a widespread but minor mineral in October except in the one area previously mentioned.

As the muck pile was followed a few meters farther the massive fluorite-barite-sulfide disappeared and was replaced by highly vuggy vein dolomite and dolomitized breccia. The first of this vuggy material encountered, just a few steps north of the last massive fluorite, contained numerous calcite lined cavities. A few barite blades, mostly overgrown by calcite, and some small, poorly formed fluorite crystals were the only other MVT minerals present. The abrupt increase in calcite and the corresponding decrease in fluorite-barite-sulfide abundance could hardly be more striking. A few more steps northward and the vugs contained virtually all calcite. Although the fluorite-barite-sulfide rock showed no evidence of weathering and secondary oxidation, the effects of weathering became obvious as soon as the vuggy vein dolomite was encountered, and abruptly became pronounced. Within 10 meters north of the last fluorite-barite-sulfide mass the MVT vein material became indistinguishable from that of the "mud zone" fault, which appears to crosscut the MVT structure at nearly a right angle. The intensity of weathering is directly proportional to the amount of open space present in the fissure. Permeable fault planes and vuggy breccias provided access for ground water whose interaction with the marble has resulted in solution of the carbonate and oxidation of the clay-rich residue.

Earl Verbeek (personal communication, 1993) suggested that many of the features described here are consistent with solution collapse breccia; a structure found in many carbonate terrains and a frequent host of MVT ore deposits. Although there is textural evidence of solution, it is unclear whether this was due to karstification immediately prior to the onset of Paleozoic sedimentation, or to the later hydrothermal activity that deposited the MVT minerals. The geometry of the structure, based on float distribution, outcrop observation and its parallel orientation to the regional structural trends, indicates clearly that it originated as a fault. The occurrence of galena in late, crosscutting veinlets indicates that faulting was still active during the late stages of mineral deposition.

Many solution zones in carbonate rocks are partially filled with mud derived from insolubles released from the carbonate as it is dissolved. It seems likely that if a relatively narrow fault zone was effected by solution extensive enough to result in collapse breccias, there should be some evidence of a mud matrix including significant amounts of marble-derived insolubles. Other than the fragments of gneiss and skarn, noted earlier, nothing suggesting the existence of such a matrix was seen. In MVT mineral deposits, mineral deposition is generally limited to open space and is not often associated with intense alteration or replacement of the country rock. If a matrix rich in clays and marble-derived insolubles or Cambrian-age shell debris (as at Sterling Hill) existed prior to the deposition of the MVT minerals, it is likely that recognizable evidence of it would have survived the MVT hydrothermal activity. On the contrary, numerous vugs or large, pure masses of MVT minerals, abundant crustification and cockscomb textures indicate that open space was very abundant and that MVT mineral deposition was not impeded by insoluble debris. Future study of the material collected from this occurrence may lead to a clearer understanding of whether or not near surface solution modified the original fault. At present no clear evidence has been recognized that would suggest that the structure hosting the MVT minerals is a karst breccia rather than a fault breccia.

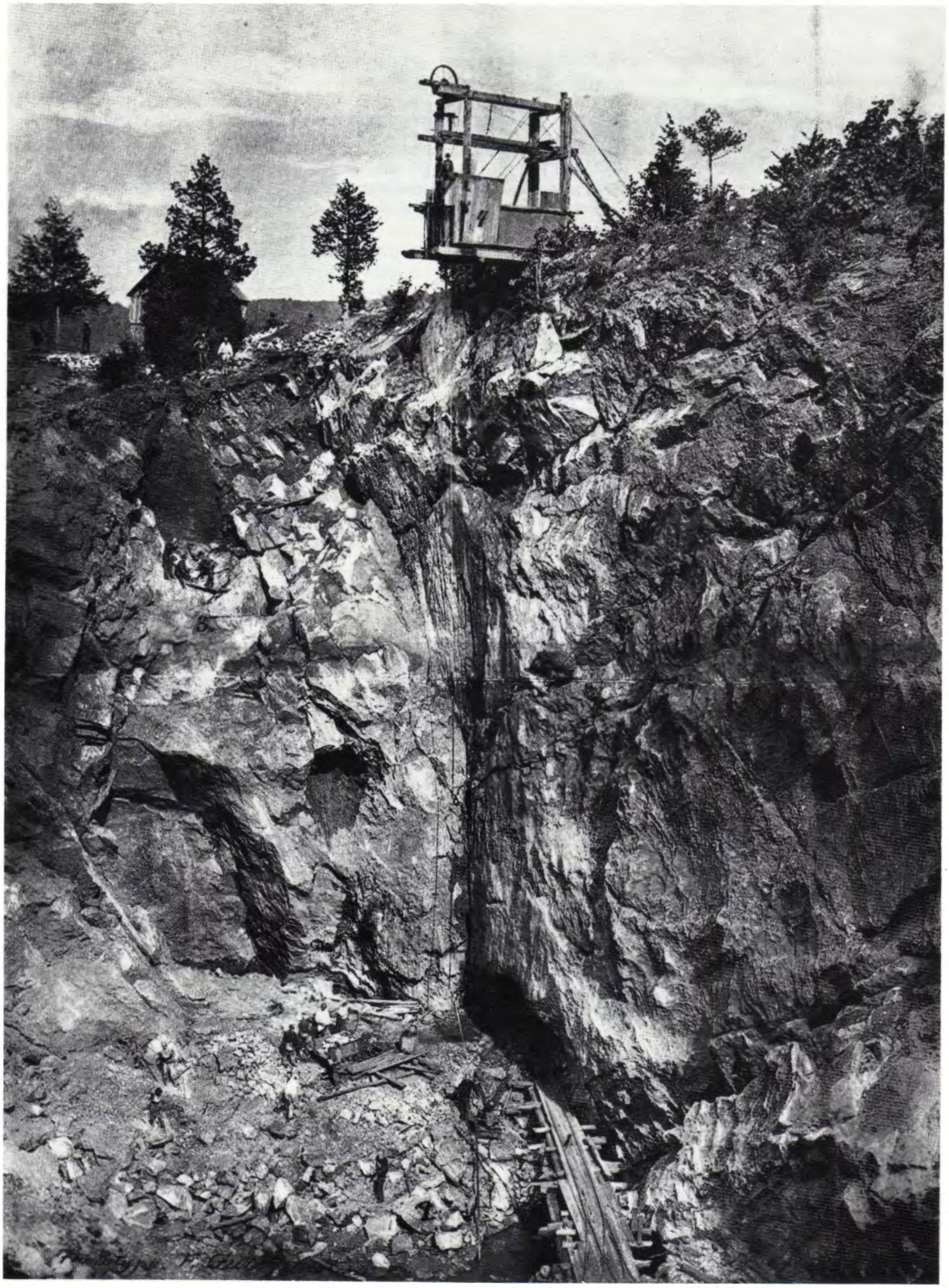
A significant number of the minerals that are so characteristic of the Buckwheat dolomite, including micas, feldspars, rutile, and quartz, have been found previously at Lime Crest in circumstances similar to the present occurrence. However, they appear to be absent from the assemblages observed on May 17th and October 18th. The mineral assemblage and textures indicate that the recently exposed material is a "textbook" example of MVT lead-zinc mineralization. MVT ore deposits typically contain a simple mineral assemblage: the common carbonates and sulfides with varying amounts of fluorite and barite. This occurrence contained the entire typical assemblage; locally in a single hand specimen. The past two field trips have provided an extraordinary opportunity to become acquainted with a type of mineral deposit that accounts for a large share of the world's lead and zinc production.

The MVT mineralized vein described here is one end-member of a spectrum of Paleozoic-age hydrothermal features overprinted on the Precambrian terrain. The precise nature of the mineralization at each locality, whether MVT, alpine cleft or something in between, is related to a number of factors including fluid/rock ratio and temperature. Higher fluid flux and/or lower temperature favored deposition of an MVT assemblage whereas sluggish fluid movement and/or higher temperature favored alpine cleft-type remobilization and open-space recrystallization of mineral components derived from the adjacent country rock.

The Paleozoic overprint is important because it also affected Franklin and Sterling Hill — where it accounts for an unknown number of the late veins that transect the ore deposits. These occurrences also produce fine mineral specimens in their own right.

ACKNOWLEDGMENTS

Many people aided in generating this contribution. I am particularly indebted to Ed Wilk whose enthusiasm, persistence and diplomacy are a key element in making all FOMS field trips possible. It was Ed's curiosity, along with that of Carroll Laufmann, which led to the recognition of this occurrence. Earl Verbeek meticulously reviewed an earlier draft and provided many suggestions that improved the paper's clarity and precision.



The Trotter Tunnel as it appeared circa 1881. The mouth of the tunnel is seen at the bottom of the photo (from Baker, 1881). Photograph courtesy of the Sterling Hill Mining Museum.

The Trotter Tunnel at Sterling Hill: Its Construction and Litigation

Daniel E. Russell
City Historian
City of Glen Cove
Glen Cove, New York

INTRODUCTION

Until Sterling Hill was consolidated under a single corporation in 1897, mining activities on the site were concentrated on three separate parcels, each controlled by different interests. The northernmost parcel was known as Lot 8, and was primarily associated with the operations of the New Jersey Zinc Company, chartered in 1852. Immediately to the south was Lot 9, which contained the mine and mills of the Passaic Zinc Company, one of the most long-lived of the 19th century mining companies involved at Sterling Hill. The southernmost parcel overlying the orebody was Lot 10, also known as the "Noble Mine."

It appears that one of the peak eras of mining activity on Lot 10 began about 1874-1878, with the creation of a tunnel or adit into the orebody by Charles W. Trotter, enabling a more cost-effective exploitation of the ores.

EARLY HISTORY OF LOT 10

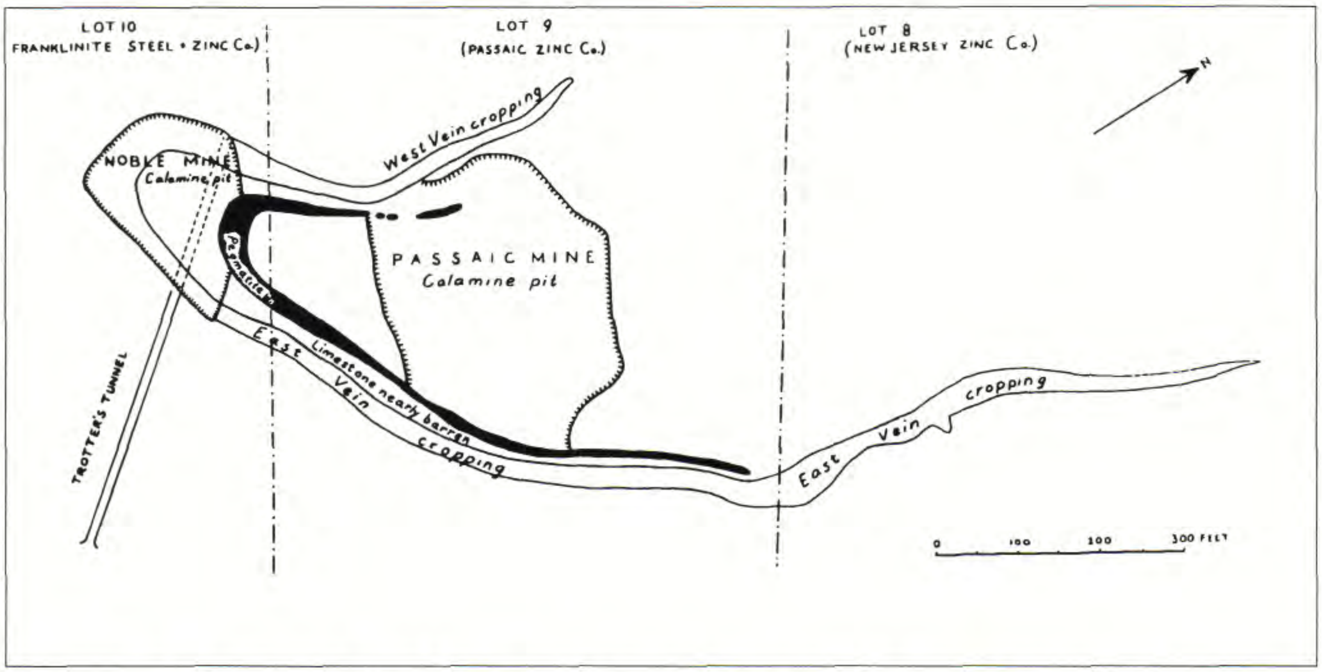
The history of mineral titles to Lot 10 is somewhat more complex than that of the other two parcels comprising Sterling Hill.

The earliest reference to the existence of an economic ore deposit at Sterling Hill dates to a land transfer from 1730, in which the site is referred to as the "Copper tract," either an allusion to surface stains of malachite or azurite that developed upon weathering of sparse, disseminated copper sulfides, or a misidentification of zincite as cuprite. The property was acquired in the 1760's by William Alexander, prominent New Jersey iron founder and self-proclaimed "Lord Stirling," who was to give his "title" to the locality (albeit with a minor change in spelling over time). While Alexander sought to exploit the vast ore deposits at Franklin and Sterling Hill, the inadequate extractive metallurgy of the period and a lack of a genuine understanding of the ores ultimately defeated him.

After Alexander died in Albany, N.Y. during the final months of the American Revolution, a portion of his vast estates scattered across northern New Jersey was acquired by Robert Ogden and his sons, who similarly possessed large interests in iron mining, smelting and forging in New Jersey. By 1800, Sterling Hill was owned by Elias Ogden, son of Robert. Elias died intestate; a commission was appointed in 1805 to divide his estates in the Wallkill Valley, including Sterling Hill, among his heirs. The orebody at Sterling Hill lay beneath "Lots 8, 9, and 10 of the Ogden Division." Lot 10 remained in the possession of various members of the Ogden family until 1837, when it was purchased by Dr. Samuel Fowler, son-in-law of Robert Ogden.

Fowler, an amateur mineralogist as well as a physician, had previously acquired Lots 8 and 9 at Sterling Hill between 1818 and 1824, and also possessed rather considerable holdings at Mine Hill in Franklin, all secured either through purchase or inheritance from his in-laws. He corresponded with many of the leading mineralogists of the era, both in the United States and abroad, on the unique minerals of the deposit. More importantly, Fowler aspired to see the deposits at Sterling Hill and Franklin exploited on a commercial basis, and devoted considerable effort throughout his life to this end.

After the death of Dr. Samuel Fowler in 1844, Lot 10 was inherited by his daughter, Mary Estelle Fowler, and, in 1847, was acquired by her brother, Samuel Fowler Jr. (most commonly



Map showing location of Lots 8, 9 and 10, as well as Trotter's Tunnel, in relation to the outcrop of ore at Sterling Hill.

referred to in local histories as "Colonel" Sam Fowler, although this military rank was not bestowed upon him until only a short time before his death during the Civil War). That same year he sold the property to the New Jersey Zinc and Copper Mining and Manufacturing Co., who remained in possession of the parcel until 1853, when Fowler repurchased the lot.

Samuel Fowler Jr. severed the title to the zinc ore from the so-called "iron ore" (franklinite) title. At that time, only zincite was used as a significant ore of zinc at Sterling Hill, although in later years both hemimorphite and willemite would be recognized as valuable sources of zinc. The franklinite, when properly treated, yielded an iron-manganese alloy called "spiegeleisen" (literally, "mirror iron"). Added to iron, the manganese removed most of the impurities from the molten metal, a critical step towards making high-grade steel.

Fowler's decision would result in decades of court battles between more than a dozen corporations and would, more than any other factor, impede the development of mining at both Franklin and Sterling Hill for nearly half a century.

Fowler sold the title to the zinc ores on Lot 10 to the National Paint Company. This company appears to have sold part of the mining rights on the parcel to the Consolidated Franklinite Company of New York on 29 June 1859. Attempts by the National Paint Co. to commercially exploit the deposit failed, and the company went into bankruptcy prior to 1861.

During the lengthy resolution of the bankruptcy proceedings, the zinc ore titles become extraordinarily confused and intertwined. The rights to the zinc ores owned by the Consolidated Franklinite Company of New York were sold to the Consolidated Exploring and Mining Company on 23 June 1863, who resold the title to Lot 10 to the Franklinite Steel Co. on 5 December 1863. While the deed was executed by Ashbel Green and Daniel H. Curtis as trustees of the Consolidated Franklinite Co., it was also countersigned by James L. Curtis (brother of Daniel H. Curtis) as President and Director of the Consolidated Exploring and Mining Company.

James Langdon Curtis was active in many (if not most) of the mining ventures at Sterling Hill and Franklin in the mid 19th century, serving as President of the New Jersey Zinc Co., New Jersey Exploring and Mining Co., Consolidated Exploring and Mining Co., Franklinite Steel Co., Franklinite Steel and Zinc Co., and serving on the Board of Directors of nearly half a dozen other companies, including the Franklinite Mining Co., directly involved in attempts at mining at Franklin and Sterling Hill. Curtis was described by an associate as a "careful, intelligent and conservative gentleman."

To further complicate the title history, the zinc title to Lot 10 was also sold by both Peter S. Decker, Sheriff of Sussex County, at an 1864 court-ordered public auction to repay some of the National Paint Co.'s debts; and by George W. Savage, Receiver of the State of New Jersey, at the time of the final liquidation of the assets of the National Paint Company by the court in 1878. Title to the same ore, then, had been sold multiple times to different parties.

The history of the iron title to the parcel is less convoluted. Samuel Fowler Jr. transferred the iron title to Samuel Brooks and Silas M. Stilwell in 1852 for the consideration of $100,000. Brooks and Stilwell conveyed the property to the Sussex Iron Co. in 1853 for a consideration of $350,000. On 1 January 1855, the Sussex Iron Company sold their rights to the franklinite in Lot 10 to Samuel Fowler Jr. and James Langdon Curtis. On 7 Dec. 1855, Fowler and Curtis sold all the rights to the franklinite on Lot 10 to the Franklinite Steel Company. The stated consideration for the property was $10. The Franklinite Steel Co., which already owned part of the zinc title to Lot 10 purchased from the Consolidated Mining and Exploring Co., had been formed in 1854 under an Act of the New Jersey State Legislature. The President of the Franklinite Steel Co. was James Langdon Curtis.

On 29 April 1871, the Franklinite Steel and Zinc Co. — which had been created under Act of Legislature of State of New Jersey on 6 April 1871 — purchased for the nominal sum of $1 both the zinc and franklinite rights to Lot 10 from the Franklinite Steel Company. The Vice President of the Franklinite Steel and Zinc Co. was James Langdon Curtis, who would after a few years rise to the Presidency of the corporation. According to period accounts, he owned four-fifths of the capital stock of the Franklinite Steel and Zinc Co.

NEGOTIATIONS TO MINE LOT 10

In early 1874, the Franklinite Steel and Zinc Co. entered into negotiations with Charles W. Trotter, of Brooklyn, N.Y., who desired to secure a license to mine zinc ores on Lot 10.

Charles W. Trotter was the son of Jonathan Trotter, third mayor of the City of Brooklyn and one of the founding officers of the New Jersey Zinc Company. The younger Trotter had been engaged at Elizabethport, N.J. in the manufacture and sale of white oxide of zinc. The license to mine his own zinc ore on Lot 10 would allow him to increase his own margin of profit on zinc white, permitting him to better compete with the New Jersey Zinc Co. and the Passaic Zinc Co., each of which was supplied by its own mines at Sterling Hill on Lots 8 and 9, respectively.

On 28 April 1874, The Franklinite Steel and Zinc Co. issued a seven year license to Trotter to mine and remove 10,000 tons of zinc ore, in the form of "carbonate of zinc, silicate of zinc and red oxide of zinc" from a 165-foot wide strip of land along the northernmost border of Lot 10. Each year Trotter was to remove one-seventh of the total 10,000 tons, or roughly 1400 tons.

The term "red oxide of zinc" was commonly used throughout much of the 19th century to refer to the mineral zincite, which then constituted the primary zinc ore mineral at Sterling Hill; likewise, "carbonate of zinc" equates to the modern mineral species smithsonite, which was actually quite rare at Sterling Hill (but still routinely found a place in most descriptions of the zinc ores appearing in legal documents). The term "silicate of zinc" however, was used interchangeably to refer to both hemimorphite (a hydrous zinc silicate) and willemite (an anhydrous zinc silicate). Regretfully, none of the period accounts of the licensing, construction, or litigation of the Trotter Tunnel state which mineral was meant.

The Franklinite Steel and Zinc Co. stipulated that Trotter was to "properly open and work said mine...at his own cost and expense," and that Trotter was to pay the company the sum of $10 for each ton of zinc ore (set at 2,240 lbs.) removed, but he was allowed to deduct the cost of opening and working the mine from this per ton fee paid to the company. The costs incurred in mining the ore were not to include any of the expenses Trotter realized after the ore was brought to the mouth of the mine, such as costs for transportation, merchandising, beneficiation, and processing.

In effect, these provisions established that the initial risk of the mining venture was to be wholly Trotter's, not the Franklinite Steel and Zinc Co.'s, but provided a mechanism by which Trotter would ultimately be reimbursed for the mine development work from the Franklinite Steel and Zinc Co.'s share of the proceeds of the ore sales.

The Franklinite Steel and Zinc Co. also required that all mining was to be performed under the supervision of a mining engineer to be selected by the company. The company also reserved the right to mine the ore for Trotter, in which case no deduction would be allowed him for the cost of mining. The company stipulated that they reserved the right to work the mine whenever such activity would not interfere with Trotter. Further, all "tools, implements and property used in opening and working" the mine were to become property of Franklinite Steel and Zinc Co. upon expiration of Trotter's license.

Trotter also was required to advance $5,000 on the predicted revenues from the ore; of this, $3,000 were to be paid immediately to the Franklinite Steel and Zinc Co. and the remaining $2,000 were to be immediately expended in the opening and working of the mine. Any residual amount from this $2,000 not required to initiate operations at the mine was to be remitted to the Franklinite Steel and Zinc Co.

CONSTRUCTION OF THE TROTTER TUNNEL

License in hand, Trotter began to lay plans for mining on Lot 10. The Franklinite Steel and Zinc Co. engaged Daniel T. Mapes, a New York City civil engineer, aged 48, to serve as their on-site engineer to supervise Trotter's work.

Trotter later recalled that no agreement had been made during the negotiations with the company on precisely how the ore would be mined. A small open-pit mine already existed on the site; Trotter wrote that the "expectation then rather was to mine from above through the pit which already existed, and hoist the ore out therefrom. On full examination of the ground, and on consultation with the company's engineer, however, [I] abandoned that project and determined upon entering the hill with a tunnel..." The tunnel was the suggestion of Mapes, who had proposed to Trotter the possibility of "constructing a tunnel, and horizontally striking the vein of zinc ore." After consultation with various officers of the Franklinite Steel and Zinc Co. who claimed an intimate knowledge of the orebody on Lot 10, Trotter was assured that he would strike the orebody about 150 feet from the point at which the mouth of the tunnel was proposed.

The concept of a tunnel agreed upon, Trotter began hiring men to begin the work. He engaged as superintendent for the driving of the tunnel, and subsequent mining operations, William I.J. Kemble, a resident of Franklin. Kemble, about 52 years old at the time, had been a miner since 1846, working the zinc deposits of Franklin, and even doing a stint as a miner in California.

The mouth of the tunnel was placed roughly 50 feet west of the edge of the main thoroughfare through the district, the highway that connected Franklin to Sparta. (This road — long since supplanted by a new highway on the opposite side of the valley through which the Wallkill River courses — corresponds roughly to the modern-day Plant Street.) The tunnel itself was to be laid out along a southeast to northwest axis.

On 6 July 1874, Trotter's crew began to drive the tunnel — by hand.

Mapes wrote, "It was determined not to use machinery in driving the tunnel, because, I supposed and all thought, that the deposit of zinc ore would be found at a point not further than one hundred and fifty feet within the hill from the tunnel's mouth..."

Trotter acknowledged his reliance on the opinions of the Franklinite Steel and Zinc Co. executives in framing his approach to the construction of the tunnel, however incorrect their understanding of the orebody was to prove to be. He later stated "...relying upon such representations, and desirous to save expense, I refrained from obtaining a steam engine or other such expensive machinery often used in more difficult and extensive jobs." However, he added, "the rocks were found to be very hard, in places highly crystalline and difficult to blast out."

Trotter placed as many men on the project as he thought practical. Too many men would merely get in one another's way, so he employed two shifts, one tunneling by day, the other by night. Not counting the engineer, superintendent, blacksmith, carpenters, and teams of horses with their drivers to haul waste rock away from the work site, this amounted to a mere 8 men per shift.

When the tunnel reached a length of 150 feet, the vein of zinc ore had not been struck. "When we penetrated to that distance," Mapes stated, "we supposed daily that we should find the zinc, and so proceeded on..." The tunnel progressed deeper and deeper into Sterling Hill, without result. Trotter continued the work, convinced that any day zinc ore would be struck.

It was not until 1 Feb. 1876, more than 18 months after the tunnel was begun, that the first sign of the orebody was reached. Trotter's crew had tunneled through more than 360 feet of rock and 20 feet of earth — more than twice the distance that the "company experts" had claimed. This costly mistake can be attributed to an inaccurate 19th century understanding of the shape and dip of the orebody, in part due to inadequate and frequently contradictory geological field work, but certainly perpetuated by representatives of the various corporations which owned a stake in Sterling Hill who wished investors to believe that the orebody continued far to the south, perhaps even farther than Sparta. (In fact, based on this assumption, three additional lots of the Ogden division, each well south of the actual bounds of the Sterling Hill orebody, were acquired in the mid-19th century by mining companies, and one of these lots was owned by the Franklinite Steel and Zinc Company.)

The first ore struck by Trotter's workmen consisted of a 14-foot-thick mass of "silicate of zinc," located on the southern wall of the tunnel. According to Mapes, they found the ore "largely mixed with dirt...of so poor quality that the average would not pay to manufacture, and it was necessary to select merchantable ore from the mass."

In July, 1876, Trotter's men struck franklinite. "The object of all parties was to reach the red oxide..." Mapes wrote. "Therefore we tunneled further through seventy feet of franklinite, and then found only the silicate at last...[The Franklinite Steel and Zinc Co.] did not wish [Trotter] to mine the silicate, but to proceed and reach the red oxide, which the officers...assured him would certainly be found after getting through the Franklinite..." (Mapes' comment that the Franklinite Steel and Zinc Co. "did not wish" Trotter to mine the silicate at first hand may appear confusing, since their license specifically permitted him the use of this mineral. It appears that Mapes was trying to express the fervent desire of the corporate officers that Trotter not stop his tunnel at that point, but to continue and attempt to reach the primary ore, zincite.)

In hopes of imminently striking zincite, Trotter continued to drive the tunnel deeper into Sterling Hill. On the other side of the franklinite vein was an additional 25 feet of dirt, after which they struck a second mass of "silicate of zinc" 6 feet wide.

Trotter continued through the mass, and continued tunneling a short distance into barren rock, before he ceased excavating. At no time did Trotter strike the promised zincite vein.

Kemble described the body of "silicate of zinc" as "not hard — that is, it is not necessary to blast; the work was done with picks." The franklinite, however, was "very hard, requiring severe blasting" to penetrate. The barren limestone (Franklin Marble), "though not as hard as the franklinite, was worse to tunnel, its nature being such that, when blasted, it is apt to create irregular and uneven walls."

Trotter's tunnel was completed about October 1876; at that time, his crew began mining operations for the recovery of the "silicate of zinc." Ultimately, Trotter had driven the tunnel more than 505 feet — more than three times the length that the Franklinite Steel and Zinc Co. had estimated would be necessary — at a cost of $15,000.

Trotter described his creation — no doubt with a modicum of pride — thusly:

> "The tunnel itself is well made, sufficiently so for all purposes of its construction; where it passes through rock it is from seven to nine feet high, and from six feet to seven feet wide; whenever not in rock it is timbered, and is then about six feet wide at the bottom, four feet and a half at the top, and six feet and a half high."

Trotter installed in the tunnel a 20"-wide narrow gauge railway, for the purpose of "facilitating the driving of the tunnel, and also of carrying ore when raised to the ore dock." The ore cars used in the tunnel were "three feet wide, four feet high, and four feet long," Kemble wrote, although "one of the cars is a little larger and wider." He added that "the tunnel is lighted by candles or lamps stationed at different points."

Although the work on the tunnel had progressed slowly, Trotter had not stood still.

On the east side of the Sparta - Franklin highway, Trotter constructed a dock for the storage of ore. The dock was about 300 feet long and varied between 16 and 23 feet wide, made of solid stone, and located on the same level as the floor of the tunnel. One observer described the ore dock as being "constructed of earth and mining debris with a facing of rock (unmarketable) got from the tunnel and there is no wood work or planking about it except boards laid down for a space of twenty or thirty feet whereon to lay fine ore..."

On a level eight feet below the ore dock, Trotter constructed a rail spur of the same gauge as the adjacent New Jersey Midland Railway Co., and ran about 500 feet of rail to connect to the Midland's line. Part of the land was leased from the New Jersey Zinc Co., the remainder being leased for $60 a year from Rebecca F. Ross, one of Samuel Fowler Sr.'s daughters, who still retained partial surface rights at Sterling Hill. Trotter also acquired a plot of land 25 by 30 feet for a blacksmith shop from the New Jersey Zinc Company.

The total cost of the ore dock and rail spur was $1,000.

NEW NEGOTIATIONS

In addition to the improvements being made to Lot 10 in anticipation of mining, Trotter began new negotiations with the Franklinite Steel and Zinc Company.

On 4 November 1875, while the excavation of the tunnel was still in progress and months before the first glimpse of ore was seen, Trotter obtained a second license from the Franklinite Steel and Zinc Co. which provided him the right to mine an additional 10,000 tons of zinc ore on Lot 10. Subject to the same stipulations as his previous license, the new agreement extended his authorization to mine for 4 years, with a quarter of the ore (2500 tons) to be removed each year after the original seven years of the first license expired.

The new document was, in addition to Curtis, signed by Silas Stilwell as Assistant Secretary of the Franklinite Steel and Zinc Company. Stilwell was a prominent New York City attorney and financial analyst who in 1831 authored the first legislation to abolish imprisonment for debt, and subsequently revised the New York State banking laws. His father had made considerable investments in the iron foundries of the Hudson River Valley in New York, and it appears that Silas continued the family interest in the metals industries.

On 1 September 1876, Trotter renegotiated his licenses with the Executive Board of the Franklinite Steel and Zinc Company. Acknowledging that the intent of the original licenses "having been duly carried out by...[Trotter] as far as practicable," Trotter would for one year be permitted to "mine out silicate of zinc ores from the tunnel and mine on Lot No. ten aforesaid, at his own expense and charge, and sell and manufacture the same," and, after deducting his expenses for the actual mining costs, divide the profits from the sale equally with the Franklinite Steel and Zinc Company. The whole of the profits due to the company were to be credited towards the "account of the expenditures on said mine." In other words, all the profits otherwise due to the Franklinite Steel and Zinc Co. were to placed towards Trotter's expenditures (inclusive of the cost of the additional length of the tunnel) in developing and operating the tunnel and mine, in a manner which would greatly accelerate his reimbursement. All other stipulations in the original contract were to remain in force.

This modification was in part derived from the failure of Trotter to find zincite in the tunnel, as the Franklinite Steel and Zinc Co. had promised he would, and stood as a form of compensation for the rather significant error the Franklinite Steel and Zinc Co. experts had made in estimating how far Trotter would have to tunnel before he struck ore.

On 14 September 1876, Trotter obtained a third license from the Franklinite Steel and Zinc Co., this time to mine 40,000 tons of the franklinite ore his tunnel had penetrated. Trotter claimed that the franklinite license was "urged by officers of the company" who thought that it would not only assist in negating the debt of the tunnel but could also infuse new capital into the Franklinite Steel and Zinc Co.

As was the case with his earlier licenses, Trotter was "to do all the work in mining and taking out said ore, and marketing and disposing of the same, and is to furnish all the labor, teams and tools, and money necessary to mine, take out and market said ore." During the ensuing year, the license called for Trotter to pay $1,950 to the Franklinite Steel and Zinc Co. against anticipated revenues from the sale of the franklinite, but that all proceeds beyond that amount were to be "applied to the liquidation of the cost of making said tunnel." Once the cost of mine development had been satisfied, Trotter and the Franklinite Steel and Zinc Co. were to share equally in the profits. Oddly, the license is open-ended; while it clearly establishes the quantity of ore Trotter was to have, it states nothing about the time frame in which he was to take it. By May, 1877 he had paid $1,350 against this figure, indicating he was able to meet his financial obligations to the company.

In October, 1876, Trotter published a "circular letter" to a number of iron manufacturers on the availability of "Franklinite ore" for iron production. However, observers claimed that as late as 22 March 1877, Trotter had done nothing to begin mining franklinite under the license, except for the ore removed in excavating the tunnel. While Trotter's business was admittedly manufacturing zinc products, and the zinc ores were therefore his primary concern, his lack of activity in mining the franklinite seems to indicate the absence of a ready market for the ore.

A COMPETITOR FOR LOT 10

About the time that the Trotter tunnel was completed, the Franklinite Steel and Zinc Company entered into negotiations with John Silsby, also of Brooklyn, N.Y., for a lease of the franklinite rights (exclusive of any interest in the zinc ores) for the whole of Lot 10.

Apparently, Silsby had been introduced to the officers of the Franklinite Steel and Zinc Company by Henry C. Gardiner, a New York attorney. Gardiner later wrote that he had for a long time been interested in the franklinite deposit on Lot 10, "...but from the fact that the owners of the mines not possessing the capital to work the mines" and since the Franklinite Steel and Zinc Co. was not on intimate terms with the iron industry, "the ore has not been brought into general use as it ought to have been." The franklinite ore was, as an ore of iron and manganese, valued at between $5 and $20 per ton.

One of Gardiner's acquaintances was Henry Martin, then age 45. Martin had been involved with mining since boyhood, especially in the mining and smelting of iron and copper ores. He had served for 14 years (five of which he was copartner in the firm) with the Sable Iron Co., which had holdings in Clinton and Essex Counties in New York State. He had been President of the Baltimore Copper Co. for 5 or 6 years, and considered himself "thoroughly informed practically as a miner."

Martin possessed, according to Gardiner, "an intimate and extensive acquaintance with the manufacturers of iron in Pennsylvania and elsewhere, and ...a great ability and skill for the sale and introduction of ores." Gardiner was also acquainted with Silsby, whom he called "a man of large means amply sufficient to furnish all the necessary capital for working and developing the mines contained in Lot No. 10." Gardiner believed "that if the knowledge and skill of Martin could be joined with the capital of Silsby, a market could and would be created for franklinite ore to such an extent that the mines contained in Lot 10 would be able to supply only a very small part required."

On 15 March, 1877, a draft memorandum of agreement was signed by James Langdon Curtis and John Silsby. It is interesting to note that Curtis makes no mention therein of executing the document as an officer or representative of the Franklinite Steel and Zinc Company. The agreement outlines that Curtis would personally "cause the Franklinite Steel and Zinc Co. to make, execute and delivery to [Silsby] a good and sufficient lease of all the veins, lodes or beds of Franklinite" contained on Lot 10, in return for payment of $1 from Silsby. It outlines that Silsby could mine franklinite on Lot 10 over a period of 21 years. The document describes Lot 10 as "that tract of land beneath the surface of which Charles W. Trotter has constructed a tunnel across a vein of Franklinite about seventy feet in width."

The memorandum of agreement also states that Silsby would be responsible for any payments "he may or shall have paid (Trotter) for the use of the said tunnel..." which certainly intimates that Silsby would be permitted access to Trotter's tunnel, but in a manner economically equitable to Trotter. Most importantly, the document provides that Silsby would accept the lease "subject to the license and privilege granted to Charles W. Trotter to mine and remove forty thousand tons of Franklinite and ten thousand tons of Zinc ores..."(emphasis the author's).

On 22 March, 1877, the Franklinite Steel and Zinc Company executed to Silsby a lease, for a term of 21 years, for "all the veins, lodes, and beds of Franklinite...contained in, upon and beneath the surface..." of Lot 10, receiving in return the nominal payment of $1.

The lease contained a number of covenants and restrictions. First, the Franklinite Steel and Zinc Co. was to receive half of the net profits from mining and selling the franklinite ore. They also reserved the same rights as they had reserved from Trotter in his licenses, specifically, that Silsby was to "properly open and work said mine...at his own cost and expense." He was to pay the Franklinite Steel and Zinc Co. the sum of $10 for each ton of ore removed, but he was allowed to deduct the cost of opening and working the mine from the cost per ton. All "tools, implements and property used in opening and working" the mine were to become property of Franklinite Steel and Zinc Co. upon expiration of the lease.

He would mine, remove and sell 5,000 tons of franklinite ore the first year, and, each year thereafter, promised to mine at least 15,000 tons of franklinite "provided there be a market for the same at fair and reasonable prices." During the first year of the lease, Silsby was to "diligently seek and endeavor to find and create a market and demand for the purchase and use" of the franklinite ore, and for the remaining 20 years he would "mine, remove and sell the said ores to the fullest extent of the productive capacity" of the mine, "provided there shall be a demand and market therefor, at prices paying a fair and reasonable profit."

Silsby also agreed that if the Franklinite Steel and Zinc Co. caused a corporation to be created for the purpose of mining the franklinite, Silsby would surrender his lease in return for half of the full-paid capital stock of the corporation. Both parties would receive their profits thereafter in the form of stock dividends, as opposed to a direct profit split from ore sales.

The company also reserved the profits from their agreement with Trotter to themselves.

Yet in their lease to Silsby, no mention is made that the lease is "subject to the license and privilege granted to Charles W. Trotter." The original wording of the memorandum of agreement between Silsby and Curtis is, instead, replaced by a rather nebulous provision that the Franklinite Steel and Zinc Co. "reserves to itself" the same "rights and privileges...subject to the same conditions and limitations" as appear in Trotter's licenses. Nothing in this provision establishes that Silsby was required to recognize the Franklinite Steel and Zinc Co. license to Trotter; it merely states that Silsby and Trotter were to respect in identical fashion the rights of the Franklinite Steel and Zinc Co. in their exploitation of Lot 10.

How the wording and intent of the memorandum of agreement became so grossly altered in the matter of a few days is not apparent. This is not the first case of one legal document being transmogrified into a new title transfer which expresses entirely different legal rights; in the early 1850's, title to the "franklinite and iron ores" at Mine Hill, Franklin, suddenly metamorphosed into title to "the iron ore known as franklinite," laying the groundwork for decades of litigation over the very meaning of the two terms, and what difference in mining rights they conveyed (especially after a process was discovered to make it technically feasible to recover zinc from franklinite). It is certainly ironic that James Langdon Curtis was also a principal corporate officer, and dominant shareholder, of the company that was responsible for this earlier "change."

Thirty days prior to the actual execution of the lease, Silsby had already begun to make a market for the ore: The Cambria Iron and Steel Company had agreed to take 20,000 tons a year, and a Mr. Henderson had agreed to take 12,000 tons a year for his iron works.

In preparation of mining Lot 10, Silsby appointed Martin as his "agent," to manage all activities on Lot 10 as well as act as ore salesman and promoter.

Silsby would later claim that from the outset he had "desired to get along in the easiest manner" with Trotter, despite the fact that he was of the opinion that his lease superseded Trotter's license of Lot 10.

Henry Martin paid a visit to Trotter on Saturday, 17 March 1877, just two days after the draft memorandum of agreement, to inform him that Silsby had leased Lot 10 for mining of franklinite and to express that he "desired to have a pleasant understanding, and that they should not interfere with each other in selling the ores, and that each could throw custom into the other's hands." It also appears that Martin inferred to Trotter that Silsby was intent upon using Trotter's tunnel for the mining of the ore.

By that time, Trotter had taken on as partner in his venture William Dixson, and requested time to confer with his partner on the matter.

When Martin met again with Trotter and Dixson, three days later, Trotter said "You thought we could work together without any interference with each other. I think differently. How would you propose to obviate difficulties?"

Martin replied that Silsby proposed to put his own mining crew into the tunnel, alongside Trotter's men and under the direction of Trotter's superintendent (Kemble), and to share equally half the salary of the superintendent.

Trotter responded that he "would do nothing of the kind" and added that "there is no more franklinite ore in Lot Number 10 than what belongs to me...forty thousand tons." Trotter later recollected that he told Martin that he saw no way in which Silsby could exercise his right to mine the franklinite ores in the tunnel without interference with Trotter's efforts.

Trotter would later claim that Martin stated "Well, then, I suppose we shall have to sink a shaft" to which Trotter said "Very well."

Silsby subsequently wrote a note to Trotter, sent via Henry Martin, that "the allegation you have made, that there are not exceeding forty thousand tons of Franklinite on lot No. 1, is a gross error, there being in said lot No. 10, as I think you know, from 500,000 to a million of tons."

Gardiner hurriedly arranged a meeting between himself, Trotter, and Silas M. Stilwell (although it is not known whether Stilwell was acting in his official capacity as Assistant Secretary of the Franklinite Steel and Zinc Co., or merely on his own accord), in New York City to ask Trotter to drop all his objections to Silsby's use of the tunnel, "to the end that the franklinite ore could be at once brought into the market."

Gardiner offered to try to secure for Trotter the payment of 25 or 50 cents a ton for every ton Silsby mined, until Trotter's expenses for the tunnel had been reimbursed and for Silsby to mine and sell the franklinite for Trotter, at a cost to Trotter not to exceed $1.30 a ton.

Trotter responded that he knew that "Silsby had no market for the (franklinite), and could not obtain one," adding that because of the low zinc content of the franklinite it was worthless for making zinc, and "that the iron manufacturers would not use it." Trotter claimed he "had done everything in his power to sell the ore, and could not sell a pound." He added "that he had sent circulars to all the iron manufacturers and that he had not received a single answer from any of them," and thus from his own experience he knew that the ore could not be sold.

Trotter stated that if he accepted their offer, "Silsby would mine only a few hundred tons and would then stop altogether, because he could get no market." Trotter firmly believed he "could not mine the ore for less than two dollars per ton, and that he knew a great deal more about the business than Silsby."

Gardiner informed him that Silsby had already found "a market for all the ore they could get out of the mine, and that the iron manufacturers were urging Silsby to send forward the ore."

At that point, Trotter grew angry, and stated that if Silsby wanted the tunnel, he was willing to sell him all his interest in the tunnel and his zinc factory at Elizabethport. Gardiner asked him what he would want for the tunnel alone, sans the zinc works, to which Trotter declined to respond.

Stilwell told Trotter "you know that I am your friend; that if you will state what you think you ought to have, I will do all I can to secure to you from the company everything that is your due, and more; but I hope that you will throw no obstacle in the way of Silsby in developing our property. Silsby is the man we have been looking for for twenty five years, and have never found him until now. I consider it of the greatest importance to the company that he shall be allowed to proceed at once and open our mines and sell our ores. You, Charles, have tried to sell these ores, and have not succeeded; now we have the opportunity, and I do hope you will not prevent it."

Trotter agreed to another meeting between Stilwell, Curtis (now President of the Franklinite Steel and Zinc Co.) and himself at Stilwell's 20 Nassau Street office in New York City. Stilwell later told Gardiner that "Trotter declined to say what he wanted and nothing whatever could be done with him."

One can imagine that Trotter felt himself ill-used by both the officers of the Franklinite Steel and Zinc Co. and Silsby. After spending 20 months driving a tunnel into the side of Sterling Hill, more than three times the length that the "experts" supplied by the Franklinite Steel and Zinc Co. had claimed necessary, after finally striking zinc ore — not rich zincite, but lesser quality "silicate of zinc" — and being unable to market the rich franklinite he had struck, the Franklinite Steel and Zinc Co. wanted him to step aside so that Silsby could take possession of the works. To add insult to injury, Silsby had succeeded where Trotter had failed in marketing the rich franklinite, and apparently done so without much effort — creating a market even before he officially took possession of the mine.

When Silsby learned second-hand of the meetings, he interpreted the action as an attempt by Trotter to extract from him a "bonus" ...an extortion payment to allow Silsby's crew to "go into the premises and mine quietly without ...opposition..."

"Finding all attempts to get along with...Trotter peaceably to fail," on 14 April 1877 Silsby served written notice on Trotter and Dixson to immediately surrender possession of Lot 10.

It would appear that Silsby felt that his lease constituted a valid activation of the clause, repeated in all of Trotter's licenses, which gave the Franklinite Steel and Zinc Co. the right to mine both the zinc and franklinite ores for Trotter (and nothing in the clause prohibited the Franklinite Steel and Zinc Co. from engaging a third party to perform the mining). Also, Silsby may have believed that since the Franklinite Steel and Zinc Co.'s lease made no provision requiring him to recognize the validity of Trotter's mining licenses, (and noting that Curtis' memorandum of agreement — which did recognize Trotter's rights — was not legally binding in the face of the Franklinite Steel and Zinc Co.'s lease) and that, most critically, his lease from the company gave him access to all of the franklinite on Lot 10, Silsby concluded that his lease legally constituted a revocation of the franklinite license granted Trotter. Or, at least, it duly constituted a convenient pretext to eliminate the impediment which Trotter had become to Silsby's operations.

When Trotter was served with the notice at his New York City office, he asked Martin, who was acting as courier for Silsby, "Well, what is it you want?" Martin responded "I want a reply from you as to what you are going to do." Reviewing the contents of the notice, Trotter refused to comply, saying "I shall do nothing of the kind."

On 2 May 1877, Silsby sent Trotter four more notices, the first demanding possession of the tunnel, the second demanding access to the tunnel to mine, the third demanding possession of all of Lot 10 external to the tunnel, and the fourth revoking all of the licenses granted Trotter by the Franklinite Steel and Zinc Company.

Upon receipt of the notices, Trotter responded "I decline to do as Mr. Silsby requests." To Silsby's revocation of the

Franklinite Steel and Zinc Co.'s licenses, Trotter stated "That's of no consequence. Mr. Silsby has no power of that kind. I decline to comply with any of his demands."

However, Trotter took the opportunity to attempt to clarify an earlier comment he made to Silsby. "I don't claim that there are only 40,000 tons of franklinite. I meant that all the ores above the level, or bottom or floor of the tunnel will not amount to above forty thousand tons."

LITIGATION

Silsby, at this juncture, called in his attorney, Robert Gilchrist of the firm of Gilchrist and Gilmore, who filed a petition with the Chancery Court of the State of New Jersey seeking an injunction against Trotter and Dixson.

On 3 May 1877, Theodore Runyon, Chancellor at Chancery of the State of New Jersey, issued an injunction against Trotter and Dixson, enjoining them to not interfere with Silsby or his men in their access to the tunnel on Lot 10, or in Silsby's mining in the tunnel or in Lot 10. Further, Silsby was to have access to all of the tunnel railways, railroad tracks, and cars from Trotter's operation.

In granting Silsby's petition, the court noted "it is intended by this order to give protection to said Silsby in the right to use said tunnel contemporaneously with the use thereof by said Trotter...but always so as to not interfere with (Trotter's) mining operations there..."

Runyon also ordered Silsby to post a $10,000 bond to Trotter.

On the morning of Saturday, 12 May 1877, Trotter's crew was at work in the tunnel under the direction of Kemble, breaking down ore, loading it into cars and placing it on the ore dock. In the afternoon, Kemble put the crew to work on the construction of a railroad switch on the spur line they had constructed to the New Jersey Midland Railway's line. Kemble noticed that Martin had arrived at Lot 10, "without any apparent business errand."

Between 3 and 4 o'clock that afternoon, Martin was joined by Owen Connelly, a Silsby employee, and a Mr. Shriver, Deputy Sheriff of Sussex County. The small group approached Kemble.

Martin said "Mr. Kemble, I make you acquainted with Mr. Shriver, the Sheriff; he has some papers for you."

Deputy Sheriff Shriver handed Kemble the injunction and a subpoena to appear in court to answer the charges wrought by Silsby.

"We take possession of the tunnel" Martin announced.

Martin and Shriver went to the tunnel. Kemble followed after them a few minutes later.

"...When I got there the door of the tunnel was locked," Kemble recalled. "There was a new padlock on it, which was not there before they went to the tunnel, of which I had no key." He had "been accustomed before that, when leaving the tunnel at night to lock it or cause it to be locked."

Martin later recorded that the reason he caused the tunnel to be locked on the day the injunction was served was "because the usual time for locking it had arrived, which on Saturday is about half past three to four o'clock" and added that Trotter's crew had already quit for the day.

One of Trotter's ore cars was trapped outside when the tunnel was sealed. Kemble asked if they would open the tunnel and put it inside, "as the boys might do mischief with it." The next day being Sunday, he feared the local boys would run the ore car up and down the track. According to Kemble, Martin refused; Martin would later claim they agreed that it would be just as easy to take the car off the track, which his men did.

According to Martin, Kemble's final words to him that day were: "If I had known that the injunction was out, I would have fixed the tunnel so you would not have worked there for any six months."

On Monday morning, about 7:30 a.m., Kemble returned to the site with a 4-man crew to continue the mining. They found the tunnel occupied by 12 of Silsby's miners at work removing zinc ore, a second crew of Silsby's men removing franklinite, and both crews using Trotter's cars to run ore out to the dock. "The tunnel was so occupied that it was impossible for me to do any work therein without interfering with the work they were doing, and so, in obedience to the Chancellor's order...I forbore to endeavor to work there."

The Silsby mining activities were under the direction of Owen Connelly, who had been installed as superintendent under Martin. (As a minor historical footnote, Connelly would serve, about 1906, as Harvard mineralogist Charles Palache's guide during his investigations at the Noble Mine.)

Kemble briefly discussed the situation with Martin. He pointed out that the court order only forbade interference, not mining. Martin said "Suppose when you send a car in you should meet one of ours coming out?" Kemble agreed that this could be construed by the court as interference, and so desisted from his attempts to mine.

Trotter had previously mined and stored on the ore dock approximately 400 tons of franklinite, as well as roughly 560 tons of zinc ore. The zinc ore, however, was "mixed with dirt, and of poor quality." Unable to obtain the Franklinite Steel and Zinc Co.'s recommended price of $10 per ton, Trotter had been selling it at $4 a ton. Silsby's men "heaped up the ore belonging to Messrs. Trotter and Dixson...lying upon the ore dock, so as to give more room upon the dock" for their own ore.

Describing the physical workings of the mine soon after Silsby's men took possession of Trotter's tunnel, Martin noted that the tunnel was properly 350 feet long.

> "At that point the mine itself commences and on the left side of the line of the tunnel a space of about 30 feet toward the left and twenty feet forward has been mined for zinc; and from this point up to the surface there is a hole... From the surface of the hill to the bottom of the tunnel (measured through said hole or pit) is a distance of about seventy five feet. Said pit or hole is used for light and air, and most of it was made several years ago in mining franklinite, but has long since been abandoned. It is of the area of about 20x30 feet, varying in diameter."

The "pit or hole" appears to have been a relic of an earlier 19th century attempt to exploit the franklinite deposit on Lot 10, and was not necessarily part of either Trotter's or Silsby's work. Martin continued:

"Beyond the said space of 30x20 feet so mined as aforesaid, are two other spaces which have been mined by [Silsby]; one is 10x12 feet and the other about 12x12 feet, so that there is a space of over 800 superficial square feet, at a distance beyond 350 feet from the mouth of the tunnel which has been mined, and the general height of the said two smaller spaces is about 10 to 12 feet..."

The litigation that ensued consisted of recriminations and counter-recriminations between Trotter and Silsby.

The attorney for Trotter and Dixson stated "their business in relation to the said mine was entirely broken up and destroyed by losing possession" of the tunnel.

Silsby wrote to the court:

"It is of the greatest necessity for your orator to be able to mine Franklinite immediately, to supply the market he has already created in good faith... If said Trotter and Dixson are allowed to keep your orator out of said tunnel, and from exercising his mining rights there, they will cause your orator irreparable injury, deprive him of the market he has created, and will be taking away ore by their mining which your orator is equally entitled to..."

Silsby requested that the Court appoint an independent mine manager to oversee operations both in the tunnel and in Lot 10 in general; the manager was to work under the direction of the Court. He requested that, if Trotter and Dixson were not restrained from actual mining in the tunnel or in Lot 10, that the Court would at least issue an injunction against them from interfering in the mining activities of his own crews. He asked the court to enjoin Trotter from any mining activities at all on Lot 10, including the tunnel.

Silsby's attorney charged that Trotter, from date of his lease until the date of Silsby's lease, had done nothing to mine the 20,000 tons of zinc ore or the 40,000 tons of franklinite ore. Although the terms of Trotter's first license dictated that he should have already removed 2800 tons of ore, Silsby's attorney was more likely trying to make the point that Trotter's mining activities were nonexistent rather than claiming breach-of-contract.

Silsby informed the court that Trotter had admitted to him that "he had not been able to find any purchasers for any franklinite, that he had issued many circulars, had had but one or two answers, and they led to no results."

Trotter stated that Silsby, since his seizure of the site, had been marketing ore at half the price fixed by Trotter. Trotter's price had to include cost of mining, into which they had to factor the cost of the tunnel; Silsby, "having possession of the tunnel without expense," was able to fix lower prices.

Martin retorted that Trotter's license had stipulated he was to be reimbursed for the cost of the tunnel from the portion of profits due to the Franklinite Steel and Zinc Company. He added "it is not the cost of the tunnel that makes the difference in the price, but it is the asking of more than the market price, and the wasteful and expensive manner in which the mine has been worked." By "care and attention," he claimed Silsby was able to mine at a cost $2 per ton cheaper than Trotter.

"As an illustration," Martin told the court, "two men under (Silsby) will load five cars in a day, while four men under Trotter would load but three." Martin stated that from Trotter's sale of zinc ore, he should already have been reimbursed the cost of the tunnel, notwithstanding the Franklinite Steel and Zinc Company's contractual pledge to reimburse him. Trotter's superintendent had admitted to him that they had been unable to sell any of the franklinite, "though having it on hand over a year."

Martin wryly added "...if he charges more than the trade will pay, it is not the fault of [Silsby]."

Finally, he pointed out to the court his opinion that, with the mine under Silsby's direction, Trotter and Dixson would be able to recoup their investment more quickly than if Trotter and Dixson worked alone.

Martin testified that since 14 May, 1877, when his own crew had begun mining via the tunnel, they had exposed in a space of 110 feet in the tunnel an estimated 60,000 to 70,000 tons of franklinite.

Silsby described Trotter's tunnel to the court as an "irregular and ill built tunnel, but useful." He estimated that the tunnel, with other improvements made to the site by Trotter, was worth between $5,000 and $8,000...well below Trotter's actual cost of $15,000.

Silsby complained that the construction of the tunnel "ought to have been accomplished with an adequate number of men, and proper machinery, in four months from date of license." Mapes, however, who was painfully aware that the decision to excavate the tunnel had been based on an estimated distance of 150 feet, not 380 feet, to strike ore, dissented. "In my judgment, the method determined on and executed was the best, the cheapest, and as expeditious as was desirable or desired... The work was driven with all practicable speed..."

Silsby claimed in court that the tunnel represented the only manner in which the ores of Lot 10 could be worked, "except at an expense which will be very great and extraordinary," and further, that there was no other place on Lot 10 through which another tunnel could be constructed.

Silsby stated the tunnel was sufficiently large as to permit from 20 to 25 men to mine ore in it, while Trotter had never used more than 5 or 6 men in it. He further estimated that he could enlarge the tunnel so that, within 30 days, 50 men could mine in it without disturbing one another. Trotter countered by reminding the court "there is but one track in the tunnel, nor is another possible. There is no place in it where a siding could be made in which to switch cars off the main track." Henry Martin, in a brilliant flash of logic, proposed "a very simple contrivance of a bell on each car, to be rung so as to signal that a car was coming in or going out, would dispense with all necessity for two tracks in the tunnel."

A tunnel, Trotter declared to the court, was not the only manner in which Lot 10 could be worked. "It is true that the tunnel is a cheap and better method of mining the ores, and was for that reason adopted," he said, "but it is likewise true that on a certain point in the hill, penetrated by the tunnel, there is a pit sunk long ago some fifty feet in depth and which could be sunk still further, and through which franklinite outside the line of the tunnel could be reached and raised."

While the courtroom battle for the tunnel raged back and forth, Silsby's men continued to exploit the orebody on Lot 10.

Martin had discovered that Trotter's cars were "very poor and unfit to use," and he had three new cars made.

From 14 May 1877 until late December of that year, he had between 20 and 23 men at work in the tunnel, and an additional 7 to 10 men working outside. Martin felt confident that the operations on Lot 10 could be enlarged to hold "double and more than double" that number.

Kemble, who had remained "at or near" Lot 10, in the employ of Trotter and Dixson, "for the purpose of protecting their interests as far as possible" had observed the work of Silsby's crews. He noted that "scarcely anything has been brought out of the mine except the ore itself, showing to a practical miner that no care is taken in the process of mining in the removal of earth from it, or in other dead work, so that there must remain within the tunnel considerable quantity of earth and rubbish which hereafter must be removed at very great expense..."

He stated he had overheard Connelly give orders "to work all the men you can on the silicate, and leave all the dirt standing that will stand."

"We will work out all of their damned silicate," Connelly added.

Kemble observed that, by 4 December, 1877 — less than 7 months after taking possession of the tunnel — Martin had removed 1,042 tons of the best zinc ore from the tunnel, 770 tons of poorer quality zinc ore, and about 1,685 tons of franklinite ore. Kemble estimated that the best zinc ore was worth $12 to $15 per ton, and the poorer quality $6 to $8 per ton; the franklinite was worth between $5 and $7 a ton. However, Martin had told him that the franklinite was being marketed for $3.50 a ton.

Trotter estimated the value of the franklinite to be at or above $6,000 and added that the 1810 tons of zinc ore had been sold by Silsby to the Lehigh Zinc Co. in Pennsylvania for in excess of $18,000.

Kemble observed Silsby's men using Trotter's railroad spur connecting to the New Jersey Midland Railroad on one occasion; he noted that about 50 tons of ore had been piled into cars of the Sussex Railroad, marked for delivery to Aitkins Brothers, Pottsville, PA.

Finally, on 15 January 1878, Theodore Runyon, Chancellor for the State of New Jersey, rendered his opinion on the contested tunnel and mining rights.

His decision determined that both Trotter and Silsby were entitled to the use of the tunnel, but that Silsby's right was subordinate to Trotter's; that until such time as Silsby was ready to furnish the zinc ore to which Trotter was entitled (pursuant to his license from the Franklinite Steel and Zinc Company), and until Silsby notified Trotter of his election to do so, Trotter was to have exclusive use of tunnel as long as his operations rendered it necessary that he have exclusive use.

When Silsby was ultimately able to mine the ores for Trotter, and when Silsby notified Trotter of his intent to do so, Silsby would then be entitled to exclusive use of the tunnel for the purpose of furnishing those ores, AND FOR THAT PURPOSE ONLY, for such time during the year as required to furnish Trotter with ore; during the rest of year, Trotter was to have exclusive use of the tunnel, provided Trotter's operations rendered exclusive use necessary.

Whenever Trotter's mining operations did not require exclusive use of the tunnel, Silsby was to have use of the tunnel "to such extent as will not interfere" with Trotter's use. Further, whenever Trotter suspended work temporarily, or whenever his mining operations did not render the use of the tunnel necessary to his crew, Silsby was to have the entire use of tunnel.

Finally, Runyon ruled that "if it becomes necessary for the protection of the parties in the enjoyment of their respective rights as thus defined," the court reserved the right to appoint a manager of the tunnel.

While the decision of the Chancery Court handed down a temporary triumph to Trotter, the ultimate victory would be Silsby's.

On 9 April 1878, only months after the court rendered its verdict, the Franklinite Steel and Zinc Co. sold their interest in Lot 10 — consisting of title to both zinc and iron ores — to an intermediary party, who transferred the title on 28 April to the Manganese Iron Ore Co., a corporation in which John Silsby held the position of President. To consolidate his claims to the zinc title, Silsby also purchased at auction the title to Lot 10 possessed by the National Paint Co. upon the final liquidation of that company's assets by the Chancery Court of New Jersey in the same year. James Langdon Curtis held prominent position on the Board of Trustees. The Manganese Iron Ore Company was not legally bound to comply with any of the licenses given to Trotter by the Franklinite Steel and Zinc Co., either with respect to providing him access to the tunnel for mining, or to recompense any outstanding expenses from the development of the mine. Effectively, Trotter was cut off and locked out from the ores of Lot 10.

Trotter turned his attentions to Franklin, where he acquired rights for a thirty-year period to a section of the orebody there from James L. Curtis, surviving trustee of the Franklinite Mining Co., in 1877. The mine he developed on the site still preserves his name. By 1881 he was in court again, embroiled once more in the protracted litigations over mineral rights at Franklin and Sterling Hill. This time he was ironically named as co-defendant with James Langdon Curtis in a suit brought by the Franklinite Steel and Zinc Company against them, which claimed that Curtis had sold Trotter some of the Mine Hill mineral rights without authorization of the corporation. In 1883, both Trotter and Curtis were sued by the New Jersey Zinc and Iron Co., successors to the New Jersey Zinc Co., who claimed that they in fact already owned the mineral rights to a parcel of land that Curtis had sold to Trotter.

In 1881, Charles Augustus Heckscher, Treasurer of the Lehigh Zinc and Iron Company, acquired part of Trotter's Mine Hill holdings as part of the settlement of a series of lawsuits between the two men. By 1887, Trotter had sold out all of his Franklin holdings to Heckscher, who would launch the final phase of litigation that would end in 1897 with the consolidation of all the mining rights at both Franklin and Sterling Hill under the umbrella of a single new corporate entity: The [second] New Jersey Zinc Company.

Silsby's victory at Lot 10 was, however, short lived. While the Manganese Iron Ore Company had published a lavish prospectus in 1881, it failed to generate sufficient interest among investors, who were undoubtedly in part put off by the complex array of lawsuits over conflicting mineral rights and titles throughout the district. By 1882 the Manganese Iron Ore Company was bankrupt; its assets were sold in 1887 to Edward Cooper and Abram Hewitt, two of the most powerful men in the U.S. iron industry. It does not appear that Cooper and Hewitt undertook any extensive activities on the site, and in 1896 they transferred the parcel to the Passaic Zinc Co. who, on 1 February 1897, fused their holdings into the newly formed New Jersey Zinc Company.

Today, most of the Trotter tunnel remains preserved at Sterling Hill, although roughly 200 feet of the structure which penetrated through ore was mined away in subsequent operations. Its eastern entrance, facing modern-day Plant Street, is sealed with a massive iron door.

REFERENCES

Manuscript Resources:
New Jersey Chancery Court
John Silsby vs. Charles W. Trotter and William Dixson, 1877.

New Jersey Zinc Company Records
Alexander Library, Rutgers University

Sussex County Clerk's Office
Record of Deeds
(various volumes)

Published Sources:
Baker, G.W. (1881) Geological Report on the Mineral Belt of Sussex County, N.J., Sterling Hill-Mine Hill. Manganese Iron Ore Company.

Palache, Charles (1935) The Mineral of Franklin and Sterling Hill, Sussex County, New Jersey. USGS Prof. Paper 180.

The Third Annual FOMS Outdoor Spring Swap & Sell

May 1st & 2nd 1993

at The Sterling Mine, Ogdensburg, New Jersey

Table Fee schedule:
Per 10 foot wide parking space; $20 for one day/ $35 for both days. Participants must supply their own tables.

Hours:
Saturday: 7:30 a.m. to 6:00 p.m.
Sunday: 9:00 a.m. to 5:00 p.m.

Bus parking is available

Area Museums:
Franklin Mineral Museum
(regular fee)

Sterling Mining Museum & Mine Tours
(regular fee)

For further Information:
Chester Lemanski, Jr.
President, FOMS
309 Massachusetts Road,
Browns Mills, NJ 08015
(609) 893-7366

Close by the Swap & Sell:
FOMS Publications and Information table
Snack Bar
Gift Shop
Rest Rooms
Fluorescent mineral specimens
Fossils/Gems/Jewelry
Mining Antiquities
Earth Science Publications
Lots of Camaraderie

Collecting opportunities:
Buckwheat dump, Evans Road, Franklin
(regular fee)

Sterling Hill dump (on site)
(regular fee)

Important Notice:
In the event of severe weather, the event will be canceled for the adverse weather day ONLY.

SEE YOU THERE !!!

New-to-the-Science:
FRANKLINPHILITE

FRANKLINPHILITE, THE MANGANESE ANALOG OF STILPNOMELANE, FROM FRANKLIN, NEW JERSEY

Pete J. Dunn
Department of Mineral Sciences
Smithsonian Institution
Washington, DC 20560

Donald R. Peacor
Department of Geological Sciences
University of Michigan
Ann Arbor, Michigan 48109

Shu-Chun Su
Hercules Inc., Research Center
Wilmington, Delaware 19894

ABSTRACT

Franklinphilite, the manganese analog of stilpnomelane, ideally $K_4Mn_{48}(Si,Al)_{72}(O,OH)_{216} \cdot nH_2O$ (with n≅6), is triclinic, space group *P*1 or $P\bar{1}$; the pseudo-orthohexagonal unit cell has parameters $a = 5.521(4)$, $b = 9.560(6)$, and $c = 36.57(5)$, with $V = 1930.2(5)$ Å^3 and $Z = 3/8$. Holotype material, with 54 mol % of the endmember, is dark brown, occurs in radial aggregates of platy crystals, has a density of 2.66 g/cm^3, and is biaxial, negative, with $\alpha = 1.545(5)$, $\beta = 1.583(3)$, and $\gamma = 1.583(3)$; pleochroism is distinct with X = pale yellow and $Y = Z$ = deep brown. In the holotype specimen, franklinphilite occurs in a centimeter-wide vein intimately associated with friedelite, and crosscutting a breccia of aegirine, calcite, chamosite and interlayered 7-Å and 14-Å phyllosilicates. It also occurs with nelenite, rhodonite and tirodite in another assemblage. Both occurrences are from Franklin, Sussex County, New Jersey.

INTRODUCTION

During the course of an extensive investigation of layer silicates from Franklin and Sterling Hill, Sussex County, New Jersey, we noted a specimen of stilpnomelane from Franklin with an anomalously high Mn content. Manganoan stilpnomelane has been identified before, and reported previously on a sample from Franklin which was Mn-dominant (Dunn *et al.*, 1984). However, that material contained only 35 mol % of the theoretical manganese end-member, being Mn-dominant by a plurality; accordingly, we deferred naming it then. Newly discovered manganese-dominant material has now been characterized; it contains 54 mol % of the end-member and its description follows.

We have named this mineral *franklinphilite* using the locality-name root *Franklin* and the Greek word φιλός (*philos*) for "friend." The name is in allusion to its chemical composition; it contains the elements which contribute to the uniqueness of the chemical relations of Franklin and Sterling Hill. The name also honors the many geologists, mineralogists and collectors who have been *friends of Franklin* and who have contributed to our understanding of the deposit. The new species and the name have been approved by the IMA Commission on New Minerals and Mineral Names. The holotype specimen is deposited in the Smithsonian Institution under catalogue # NMNH 167390.

Parsettensite has informally been considered a possible Mn-analog of stilpnomelane and the status of this mineral has long been ambiguous. Recently, Guggenheim (1986), Ozawa *et al.* (1986), and Guggenheim and Eggleton (1987, 1988) have investigated parsettensite and found it to have a unique modulated structure, distinct from that of stilpnomelane.

OCCURRENCE

Franklinphilite is known from two distinct assemblages at Franklin, Sussex County, New Jersey. Given the large number of secondary manganese silicates at this locality, it is probable that other franklinphilite assemblages exist.

Franklinphilite was found on the Buckwheat dump; nothing is known of its original mine location or of its geological setting. Although the specimen is of anomalous appearance, it is assuredly from the Franklin mine. The original massive specimen was from a low-temperature assemblage which probably occurred as a cavity filling or vein filling; it was about 30 cm in size. Hand-specimens derived from this original specimen vary substantially in appearance and in the relative proportions of the principal minerals.

One hand-specimen obtained from the larger original specimen is the type specimen for baumite (Frondel and Ito, 1975). Baumite was discredited by Guggenheim and Bailey (1989, 1990), who reported it to be a coherent intergrowth of 7Å and 14Å phases related to greenalite-caryopilite and chlorite, respectively. They also provided information on the phases associated with baumite and the difficulty of characterizing them.

Another hand-specimen from the original specimen is the holotype specimen for franklinphilite. This is a breccia consisting of abundant calcite, franklinite fragments, fine-grained friedelite, chamosite (the "brunsvigite" of Frondel and Ito, 1975), aegirine, the dense fine-grained mixture formerly known as baumite, and 1 x 3-cm broken fragments of crude willemite crystals. This breccia is crosscut by a 3-cm wide vein composed of fine-grained, medium brown, impure friedelite, which contains a central 1-cm zone of impure, fine-grained, dark brown franklinphilite (Fig. 1). This zone is composed of small radiating clusters of platy crystals; euhedral crystals were not observed,

This article is a partial reprint from the Mineralogical Record, *volume 23, November-December 1992, pp. 464-468. See the original article for Figure 2 and X-ray data.*

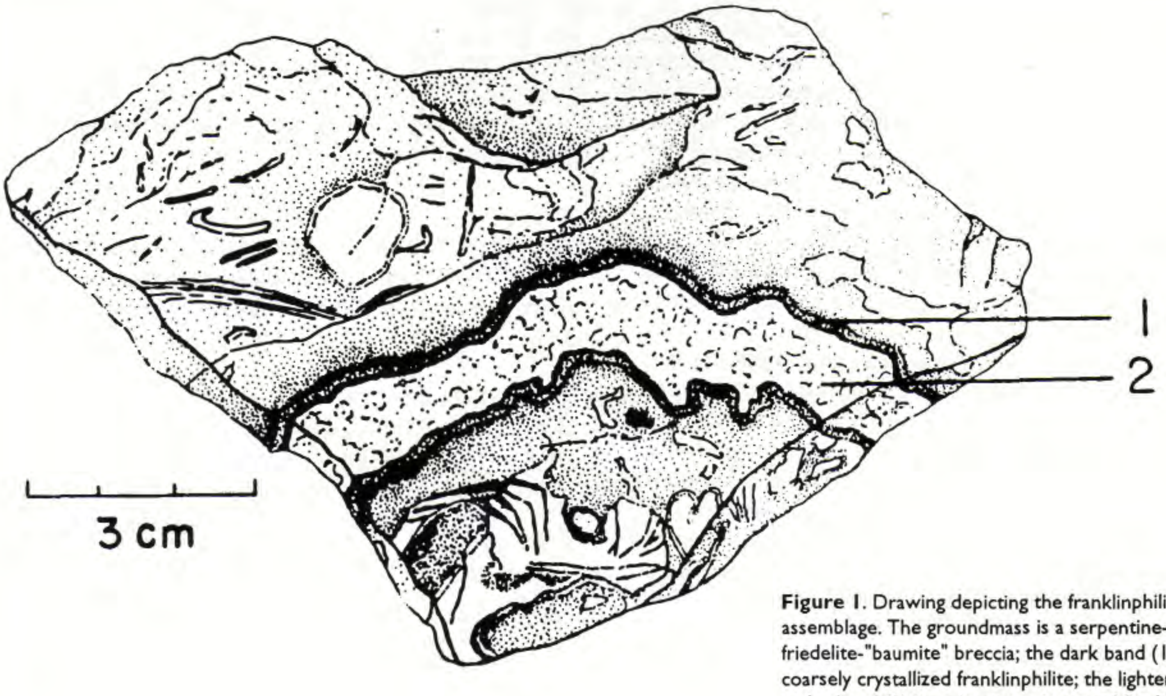


Figure 1. Drawing depicting the franklinphilite assemblage. The groundmass is a serpentine-calcite-friedelite-"baumite" breccia; the dark band (1) is coarsely crystallized franklinphilite; the lighter-colored, wider band (2) is an impure mixture of franklinphilite and friedelite. Drawing by Mary A. Parrish.

but franklinphilite is more coarsely crystallized, and darker brown at the vein margins where it is in contact with impure friedelite.

Franklinphilite is also known from a second assemblage from Franklin, described by Dunn *et al.* (1984). In this assemblage, franklinphilite is black, nearly opaque, and associated with nelenite, rhodonite and tirodite. Descriptive data are given by Dunn *et al.* (1984) as an adjunct to the description of lennilenapeite and are therefore not repeated here; the specimens are in the Harvard Mineralogical Museum collection (specimens #89999, #89365 and #92791-b).

PHYSICAL AND OPTICAL PROPERTIES

The holotype franklinphilite is very dark brown with a light brown streak and a vitreous to slightly resinous luster. The hardness is approximately 4 (Mohs); cleavage on {001} is imperfect; fracture was not observed; franklinphilite is brittle. The density of fragments varies, due both to impurities and incipient cleavages; the range of observed values is 2.6 to 2.8 g/cm^3 compared with the calculated value of 2.66 g/cm^3.

Optically, franklinphilite is transparent to translucent, and biaxial with $2V$(meas) = 10(3)°, $2V$(calc) = 0°. The indices of refraction, measured in white light, are α = 1.545(5), β = 1.583(3), and γ = 1.583(3). Because of the poor quality of the material, orientation of the indicatrix was incompletely determined; only the angle between X and (001), approximately 6°, could be measured. Pleochroism is distinct with X = pale yellow, $Y = Z$ = deep brown; dispersion was not detected. Franklinphilite is not discernibly fluorescent in ultraviolet radiation.

CRYSTALLOGRAPHIC DATA

Several cleavage fragments were mounted for single-crystal X-ray diffraction studies, but all specimens gave precession photographs with diffuse and broad reflections. This occurred in part because of curvature that inevitably was created during cleavage, but also was apparently caused by original defects. The unit cell and space group could therefore not be unambiguously determined using only such photographs. However, the photographs were directly compared with corresponding photographs of lennilenapeite and other stilpnomelanes; these were found to be nearly identical, insofar as could be judged given the imperfect nature of the franklinphilite photographs. implying that franklinphilite is isostructural with stilpnomelane.

In order to obtain higher quality diffraction patterns, electron diffraction patterns were obtained by spreading crushed fragments on holey carbon films, and using a Phillips CM-12 scanning transmission electron microscope (STEM) fitted with a Kevex solid state detector. Sharp, well-defined *hk*0 single-crystal patterns were preferentially obtained as grains were oriented with the {001} cleavage (indexed relative to the orthohexagonal cell; see below) normal to the electron beam. Such patterns were of two types, duplicating the examples of *hk*0 patterns of stilpnomelane and friedelite, respectively, as illustrated by Guggenheim and Eggleton (1988). Grains for which [001] was parallel to the electron beam displayed diffraction patterns typical of those obtained by Crawford *et al.* (1977) for stilpnomelane, with alternate rows of reflections parallel to the *c*-axis displaying sharp and diffuse reflections, respectively, with the diffuse streaking parallel to c^*. Qualitative energy-dispersive X-ray analyses were obtained for grains exhibiting diffraction patterns; those grains showing the typical stilpnomelane-like diffraction patterns gave data consistent with compositions identical within error to that obtained by electron microprobe analysis; those having the friedelite-like pattern contained only Mn, Si, O and Cl in amounts corresponding to friedelite.

Powder X-ray diffraction data were obtained using a 114.6 mm diameter Gandolfi camera, polycrystalline specimen, $FeK\alpha$ radiation, and Si as an internal standard. Because franklinphilite is, by analogy, isostructural with stilpnomelane and thus triclinic, but pseudo-hexagonal, observed d-values for non $00l$ reflections may be indexed with more than one choice of pseudo symmetrically related indices. Powder diffraction data therefore cannot be used to refine the cell parameters for the triclinic cell. However, Eggleton and Chappell (1978) recommended using an orthohexagonal cell. The cell parameters were therefore refined by least-squares using such a cell, utilizing indices as given for corresponding reflections by Guggenheim and Eggleton (1988) for lennilenapeite and stilpnomelane. The resultant lattice parameters are $a = 5.521(4)$, $b = 9.560(6)$, $c = 36.57$ Å, and $V = 1930.2(5)$ Å^3. Z = 3/8 for this cell; the non-integral value derives from the fact that the pseudo-orthohexagonal cell is a subcell of the true triclinic cell, for which Z = 1. Table 1 [see original publication for this data] contains a list of the powder X-ray diffraction data, with reflections indexed on the orthohexagonal cell. The lattice parameters for the pseudotrigonal cell are $a = 22.08(1)$ and $c = 12.19(2)$ Å. These compare with values of 22.05 and 12.19 Å, as reported by Guggenheim and Eggleton (1988) for lennilenapeite, and 22.11 and 12.14 Å for manganoan stilpnomelane.

CHEMICAL COMPOSITION

Because of the presence of numerous fine inclusions, franklinphilite could not be analyzed by wet-chemical methods; electron microprobe wavelength-dispersive analysis was employed. The analytical data were obtained utilizing an ARL-SEMQ electron microprobe using an operating voltage of 15 kV and a sample current of 0.025 μA, measured on brass. Standards used were hornblende (Si,Al,Fe,Mg,K,Na), ZnO (Zn), and manganite (Mn); the data were corrected using standard Bence-Albee correction factors. Due to impurities, the concentration of water could not be measured directly and it was calculated by difference; the value so obtained (8.1 weight % H_2O) compares very favorably with that (8.4 weight % H_2O) for other franklinphilite samples from Franklin (previously described as manganese-dominant stilpnomelane) for which water was directly determined (Dunn *et al.*, 1984). Franklinphilite is homogeneous. The resultant analysis yielded: SiO_2 44.0, Al_2O_3 3.6, Fe_2O_3 7.8, MgO 6.4, K_2O 1.5, Na_2O 0.4, ZnO 5.9, MnO 22.3, H_2O [8.1], total = 100%. Total iron is assumed to be ferric iron, in part based on the associated aegirine.

The empirical formula, calculated on the basis of 120 total tetrahedral plus octahedral cations, as is the convention for stilpnomelane, is $(K_{2.64}Na_{1.07})_{\Sigma 2.71}(Mn_{26.08}Mg_{13.18}Zn_{6.02}Fe^{+3}_{2.72})_{\Sigma 48}(Si_{60.77}Al_{5.86}Fe^{+3}_{5.38})_{\Sigma 72}(O_{163.23}(OH)_{52.77})_{\Sigma 216} \cdot nH_2O$, with Mn >> Mg > Zn in holotype franklinphilite. There is extensive solid solution with lennilenapeite, the Mg-analog of stilpnomelane, as shown by the data of Dunn *et al.* (1984).

ACKNOWLEDGMENTS

The authors are indebted to Mr. John L. Baum, curator of the Franklin Mineral Museum, for his donation of the type specimen, to Mr. John Cianciulli for assistance with museum specimen research, to Ms. Mary Parrish for the specimen drawing, and to Mr. Herb Yeates who suggested the Greek suffix in the mineral name.

REFERENCES

CRAWFORD, E. S., JEFFERSON, D. A., and THOMAS, J. M. (1977) Electron-microscope and diffraction studies of polytypism in stilpnomelane. *Acta Crystallographica*, **A33**, 548-553.

DUNN, P. J., PEACOR, D. R., and SIMMONS, W. B. (1984) Lennilenapeite, The Mg-analogue of stilpnomelane, and chemical data on other stilpnomelane species from Franklin, New Jersey. *Canadian Mineralogist*, **22**, 259-263.

EGGLETON, R. A., and CHAPPELL, B. W. (1978) The crystal structure of stilpnomelane. Part III, Chemistry and physical properties. *Mineralogical Magazine*, **42**, 361-368.

FRONDEL, C., and ITO, J. (1975) Zinc-rich chlorites from Franklin, New Jersey, with a note on chlorite-nomenclature. *Neues Jahrbuch für Mineralogie Abhandlungen*, **123**, 111-115.

GUGGENHEIM, S. (1986) Modulated 2:1 layer silicates. *Abstracts with Program, 14th General Meeting of the International Mineralogical Association*, Stanford, California, 116-117.

GUGGENHEIM, S., and EGGLETON, R. A. (1987) Modulated 2:1 layer silicates: Review, systematics, and predictions. *American Mineralogist*, **72**, 724-738.

GUGGENHEIM, S., and EGGLETON, R. A. (1988) Crystal chemistry, classification, and identification of modulated layer silicates. *Mineralogical Society of America Reviews in Mineralogy*, 19, Hydrous Phyllosilicates (exclusive of micas), Chapter 17, 675-725.

GUGGENHEIM, S., and BAILEY, S. W. (1989) An occurrence of a modulated serpentine related to the greenalite-caryopilite series. *American Mineralogist*, **74**, 637-641.

GUGGENHEIM, S., and BAILEY, S. W. (1990) Baumite discredited. *American Mineralogist*, **75**, 705.

OZAWA. T., TAKAHATA. T.. AND BUSECK, P. R. (1986) A hydrous manganese phyllosilicate with 12 Å basal spacing. *Abstracts with Program, 14th General Meeting of the International Mineralogical Association, Stanford, California*, 194.

PUBLICATIONS AVAILABLE

FROM THE FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY, INC.

THE PICKING TABLE

Complete Set of *The Picking Table*
(Volume **1**, #1 through the current issue)
the set..$85.00 (+$6.00 UPS fee)

Individual back-issues of *The Picking Table*
Volume **1**, #1 through volume **23**, #2: each issue..$2.50
Volume **24**, #1 through volume **29**, #2: each issue..$3.50
Volume **30**, #1 through volume **33**, #2: each issue..$5.00

(Add $0.75 for issues through vol. **23**, #2; and $1.00 for issues beginning with vol. **24**, #1 for postage)

Note: All issues of *The Picking Table* prior to volume **23** are available only as *photocopies*.

Books and other publications

Palache, Charles (1935) The Minerals of Franklin and Sterling Hill, New Jersey.
U.S. Geological Survey Professional paper 180, 135pp. Soft-cover, FOMS reprint 1974.
$10. *(+$2.50 postage)*

Frondel, Clifford and Baum, John L. (1974) Structure and Mineralogy of the Franklin Zinc-Iron Manganese Deposit, New Jersey. Economic Geology, **69**, 2, pp. 157-180. Photocopies only are available.
$2.50 *(+$1.25 postage)*

Horuzy, Paul (editor) (1990) The Odyssey of Ogdensburg and the Sterling Zinc Mine.
Privately printed, Sterling Hill Mining Company.
$6.50 *(+$1.75 postage)*

Shuster, Elwood D. (1927) Historical Notes of the Iron and Zinc Mining Industry in Sussex County, New Jersey. Privately printed. Franklin Mineral Museum reprint.
$3.00 *(+$0.75 postage)*

Proceedings Volume, Lehigh-FOMS Symposium (1990):Character and Origin of the Franklin-Sterling Hill Orebodies, 118pp.
$12.50 *(+$2.50 postage)*

The Henkel Glossary of Fluorescent Minerals.
Journal of the Fluorescent Mineral Society, Special Issue, volume **15** (1988-89).
$12.50 *(+$1.75 postage)*

Most publications are made available at Society meetings. However, if ordering by mail, make check or money order payable to **FOMS,** and address your order to:

Mr. Steven C. Misiur, Asst. Treasurer FOMS
309 Fernwood Terrace,
Linden, NJ 07036